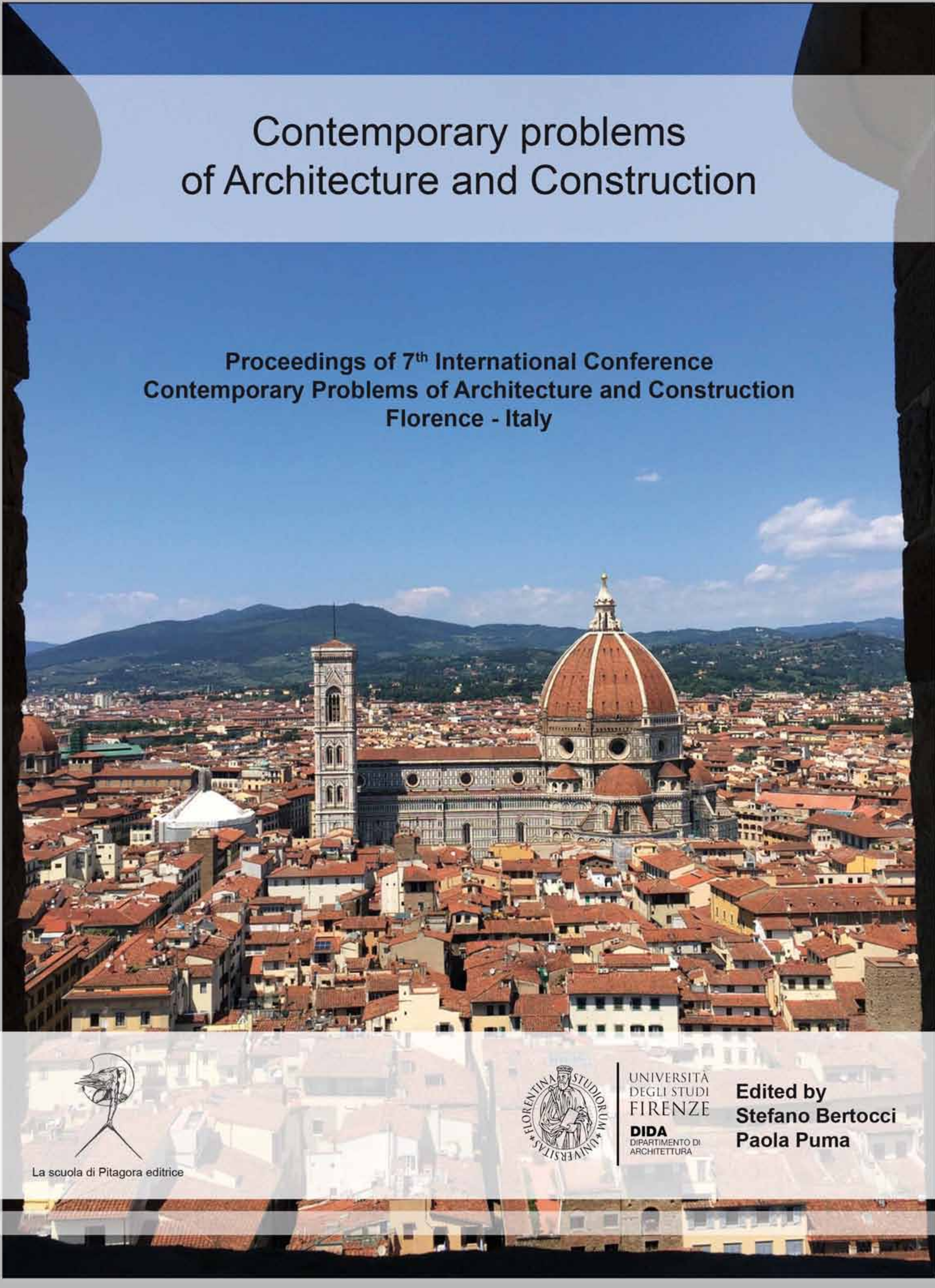
Contemporary problems of Architecture and Construction



Proceedings of 7th International Conference
Contemporary Problems of Architecture and Construction
Florence - Italy

La scuola di Pitagora editrice

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Edited by
Stefano Bertocci
Paola Puma

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Contemporary problems of Architecture and Construction

Selected, blind peer reviewed papers from
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November 19th-21st, 2015, Florence - Italy

Edited by
Stefano Bertocci
Paola Puma

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GREETINGS BY THE UNIVERSITY OF FLORENCE
DEPARTMENT OF ARCHITECTURE/DiDA

Saverio Mecca
Director of the Department of Architecture
University of Florence, Italy

I am honoured to present in Florence this book that collects contributions for multiple experiences of international research on the topic of Contemporary problems of Architecture and Construction, particularly complex and articulated.
The management of the contemporary aspects and problems of historical heritage, the preservation of cultural memory, are necessary activities that concern and cut across a variety of different disciplines, whose complexities are evident as long as they require a specific definition of the identity of the architecture.

7th International Conference
Contemporary Problems of Architecture and Construction
Florence, 2015

The Department of Architecture DIDA is a structure of the University of Florence dedicated to scientific research, educational and formative activities, transfer of knowledge, innovations of the activities addressed to architecture, industrial design, territorial and landscape planning.
The Department of Architecture promotes the internationalization of the research activities, of the valorisation and transfer activities, of the scientific and technological advice, even in cooperation with other academic and research structures, both public and private, as it is underlined in the book that we are presenting.
The DIDA, looking forward to these aims, organized an internal system of laboratories by instituting the DIDALABS. The mission of the DIDALABS is to support, both scientifically and technically, the education, the research and the higher formation, the transfer of knowledge of the DIDA and of the Athenaeum in the areas of architecture, industrial design and landscape and territorial planning area.
Above all, the Survey of the Architecture Laboratory LRA is our structure predisposed to the formation and research above the Architectural and Archaeological Heritage. It produces surveys of the architectural, the urban and landscape complex integrating the competences that are now being employed in the sectors of documentation and preservation of the Heritage.
These activities may also support the public and private institutions operating in the sector of Cultural Heritage.
The knowledge transfer represents the fundamental element, which can valorize or potentiate the formative offer through the conducted scientific experiences.
In addition, these experiences permit to tune the operative methodologies for the digital survey, giving essential instruments in order to understand and evaluate the preservation and restoration interventions.
The activities developed by the laboratory include several examples of case studies relating to UNESCO sites, investigated with the architectural survey and the Science of Representation, explicating in these pages the technological development that has focused on the representation of architecture during the recent years outlining paths of inquiry through which to define methodologies and operational protocols for the understanding of the historical and monumental complex.

The research presented often involve students, graduate students or PhD students, increasing the value of the experience with that of advanced training and education in a sector in which knowledge can be developed only staying in contact with the architectural and engineering contemporary problems.
I believe that the occasion of this International Conference, which presents a full program of roundtables and meetings, represents an important opportunity for dialogue and scientific exchange on the subject, being able to offer excellent points of reflection for teachers, professionals and students under an international point of view to the historical heritage.
Know in depth a building, especially when its historical and cultural value is strongly established, as in some cases that will be presented here in this volume, is the basis for the preparation of a conservation project that will necessarily be caught and not just aimed at the preservation but aiming too its transformation so that it can be revived and returned to the community.
I believe that all phases of the survey and analysis of a monumental property without hesitation could be define purely an “architectural project”.
Finally, our warm thank you to the organizers and members of the research groups that have helped to enrich their experiences and reflections with the issues of the Conference.

Stefano Bertocci, Paola Puma
The scientific referees for University of Florence, Department of Architecture-DiDA

A short history of the International Conference on Contemporary Problems of Architecture and Construction

To present the 2015 edition, we should like to premise a short history of the conference: in 2008 and 2010 Yerevan State University of Architecture and Construction has organized the first and the second International Conference entitled “Architecture and Construction - Actual Problems”.
The conference was held in Jermuk, Armenia. The third year was organized in collaboration with the Beijing University of Civil Engineering and Construction from October 20th to 24th, 2011, and was entitled “International Conference on Contemporary Problems in Architecture and Construction” and this title is used up to the present day.
The fourth conference was held in Czestochowa (Poland) from September 24th to 27th, 2012, as a joint effort of the Yerevan State University of Architecture, the Beijing University of Civil Engineering and Construction and the Czestochowa University of Technology.
The fifth conference was organized by the Saint Petersburg University of Architecture and Construction from June 25th to 28th, 2013, as a joint effort of the Yerevan State University of Architecture, the Beijing University of Civil Engineering and Construction, the Czestochowa University of Technology and Saint Petersburg University of Architecture and Construction.
The sixth conference edition was organized by the VŠB - Technical University of Ostrava (Czech Republic) from June 24th to 27th, 2014, jointly with the Yerevan State University of Architecture, the Beijing University of Civil Engineering and Construction, the Czestochowa University of Technology and Saint Petersburg University of Architecture and Construction.

The 7th International Conference on Contemporary Problems of Architecture and Construction

The “7th International Conference on Contemporary Problems of Architecture and Construction” we are proud to guest in Florence, is held in 2015 at University of Florence, organized by the Department of Architecture-DiDA on 19th -21th November, 2015, with the collaboration of the others universities and entities involved in the partnership.
The 7th Conference is promoted by six different universities, all represented by some of their members in the Scientific Committee:
- University of Florence, Italy
- National University of Architecture and Construction of Armenia, Armenia
- Beijing University of Civil Engineering and Architecture, China
- University of Technology Czestochowa, Poland
- St. Petersburg State University of Architecture and Civil Engineering, Russia
- VSB - Technical University of Ostrava, Czech Republic.

The Fondazione Romualdo Del Bianco with its International Institute Life Beyond Tourism, who has been essential in facilitating at early stage the contact between University Florence and the other Promoters, has had an essential role in to the dissemination of the conference throughout its international network of universities and the organizing managing.

This edition of the conference is an interdisciplinary symposium dedicated to the architectural and urban works -from the 2nd half of 20th century- and to urbanism with a special focusing on topics of “cultural heritage’s culture”.
The intention of the organizers is, in fact, continuing the discussion on the relationship between the society and the technical and cultural meanings of architecture and urbanism. Also representatives of other fields than architecture have had the opportunity to submit contributions and open the space for the discussion of other problems.
The purpose of the conference is to find and evaluate in the open discussion the current state of knowledge of architecture (see at topic 1. Civil Engineering, reconstruction, sustainable construction, materials and technologies and topic 2. Architecture and Design, urban planning, urbanism) not only from the perspective of different scientific fields but from the experience from various countries with their different developments and approaches (see at topic 3. Environmental engineering, energy, green buildings).
Besides the technical and infrastructural dimensions of the construction (see at topic 4. Geotechnics, seismicity hazard analysis and prevention and topic 5. Construction, structural mechanics, transport problems), we focused on one of the largest fields of specialization of the Italian competence: the culture of heritage (see at topic 6.Technologies and operational methodologies for conservation and topic 7. The fruition of the heritage: cultural value-based travel, routes and landscape. New uses and enhancement of monuments).
The issue is addressed from many points of view: from the methodologies of documentation and survey to the protection theory and practice.
Finally, the highlights of the Florentine edition: the most recent new lines of research regarding the fruition of heritage and its enhancement in its many different meanings.

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GREETINGS BY THE FONDAZIONE ROMUALDO DEL BIANCO-LIFE BEYOND TOURISM

Paolo Del Bianco
President of the Fondazione Romualdo Del Bianco-Life Beyond Tourism
Florence, Italy

Dear Participants in the 7th International Conference on Contemporary Problems of Architecture and Construction,

the Foundation, myself and our collaborators are happy to have been able to work in conjunction with the universities represented in the International Scientific Committee for the organization of the 7th International Conference on Contemporary Problems of Architecture and Construction, the first edition in Florence. So – on behalf of the Foundation – I would like to welcome to Florence and to our headquarters conference rooms all those from 49 universities and institutes from 19 countries who have contributed with their papers and presence to the success of the initiative.

Please allow me a special thanks to the National University of Architecture and Construction of Armenia in the person of the Rector Prof. Gagik Galstyan and Pro Rector Vardgues Yedoyan, who proposed us last year to collaborate for a Florentine edition of the conference. Also thanks to the staff of the Florence University that supported the initiative since the beginning with their expertise and availability.

The Fondazione Romualdo Del Bianco-Life Beyond Tourism was initiated after the fall of the Berlin Wall as a result of an idea that came to me, at that time I was a hotelier and businessman, to favor in Florence mutual familiarity and knowledge among young university students from the countries of central and eastern Europe and Western ones. The goal was to unite them by means of architecture, art and culture and Florence was a place where they could have the opportunity to meet, sharing knowledge and experiences, improve their human and cognitive skills. Therefore, since 1996 the Foundation has always based its activities on such crucial factors as: Travel, Youth, Interculturalism, Cultural Heritage, Dialogue, Knowledge and Respect for Diversity. Firmly believing in the importance of all this, the Fondazione has sought over the past few years to make a systematic contribution to this form of rapprochement, and so its network has grown year by year, moving ever further eastwards, thanks to these youngsters: over 200,000 study days in Florence to foster encounters devoted to study and research among young people from all over the world, over 500 institutions and universities from 80 countries of the five continents have bonded together to form the Foundation’s international network.

Cultural and architectural heritage provides a strong motivation for bringing young people together, thus in the Fondazione it is not seen as an end in itself but as a tool for the achievement of our mission. This may seem like an odd way of interpreting art and architectural heritage, but our aim is to foster opportunities for interpersonal acquaintance among different cultures, thus forging relationships which, while maybe not always based on mutual understanding, lead at least to an appreciation of diversity, thus to esteem and possibly even to friendship.

Over the years the Fondazione’s activities thus gave a new meaning to the word hospitality, which in my capacity as a hotelier I had never associated with the feelings that these young people experienced, almost to the point of tears, before their departure from Florence. From that moment on, I set out on a new path linking the concept of hospitality to feelings, and feelings to personal commitment, in order to foster opportunities for intercultural dialogue, thus making my contribution to Peace. I perceived a new mission for the art of hotel hospitality and began to experience a certain revulsion for the word “tourism” inasmuch as it is universally associated with consumer-related services, creature comforts and so on, but not with hospitality, not with hospitality from the heart. If we truly understand travel to be an exercise in meeting, knowing, communicating, appreciating and respecting cultural diversity, then we have to forgot using the word “tourism”. The Fondazione, too, has increasingly focused its attention on heritage as a fantastically strategic factor in its mission.

While not ourselves scholars yet still playing a role in the service industry for the huge masses of people who travel to admire our cultural and architectural heritage, we began to ask ourselves questions to which we sought answers, especially in connection with how the use and enjoyment of cultural and architectural heritage could help in building lasting peace among peoples. Around tangible and intangible cultural and architectural heritage people meet, they ask questions, they dialogue, they get to know each other, they gain an appreciation for cultural diversity, they get their bearings and they get used to showing respect for that diversity, even if they cannot get a real insight into its deeper aspects and scope.
If we are able in translating the work of architecture or art into a work produced by mankind and setting it in its broader (especially socio-historical) context, comparing it with coeval works in other countries; if we educate the broad masses to appreciate the overall context in which a work of architecture or art was conceived, commissioned, funded and ultimately made to a given design and with given materials for a given function, and then compare that context with the context of other countries and other religions, then it becomes a far easier task to bring those masses closer to cultural and architectural heritage and to get them involved with it. In fact it could even become a “consumer product” effective in fostering intercultural dialogue. This, because mass tourism is not stupid by definition, it becomes stupid if it is treated stupidly.

That is the belief that inspired the Fondazione to develop a philosophy which it has christened Life Beyond Tourism, an operational practice designed to offer a virtual platform to intercultural knowledge through heritage.

All of this may be traced back the fact that the event, the work of architecture or art, the context, in fact everything comes together to foster the conditions for an emotion which is crucial, when combined with knowledge, for understanding the deeper significance of a work of art and for penetrating the spirituality (in the sense of man’s unending search for the meaning of life and the universe) of the culture that produced it. Thus architecture, art and culture are seen also as a crucial opportunity for dialogue because it can prompt us to see in every human being the selfsame questioning astonishment that we all share.

At a second stage, the Foundation, with the participation of all the members, has arrived to further translate the philosophy in the Life Beyond Tourism Model, with the Manual for its practical application on the territories and its Certification to measure the results into the terms of Intercultural Dialogue.
A Memorandum of Understanding was signed with ICOMOS 2013, March the 4th, and consequently the Model was applied in Florence during the 18th ICOMOS General Assembly (November 2104); with <vivafirenze.it>, the Model was able to give its own economic support to the General Assembly itself.. Finally, the resolution n° 42/2014 of the 18th ICOMOS General Assembly the ICOMOS institutional recognition and support for a worldwide dissemination was recognized.

To understand the level of interest that Life Beyond Tourism found - right now- in the faculties of Tourism, we add with pleasure that the first week of this September 2015, in Japan in Tokyo, at the Josai International University (JIU), intensive academic courses on the philosophy Life Beyond Tourism and its Model have started for its practical application with Quality Certification.
The intensive course was one-week duration and it will be any semester weekly intensive course. The Docent was Visiting Professor Arch. Corinna Del Bianco. The connection between the Foundation and the Josai International University was established thanks to Prof. Masanori Aoyaghi from Tokyo University, currently Commissioner of the Agency of Cultural Affairs in Japan.
The next seminar will take place in Tokyo at the Toyo University next October 2015. Any educational or training institution interested in including in its teaching programs the subject of a new sustainable development strategy for the territories and their cultural (architectural) heritage, for developing tourist economy are invited to apply the Foundation.

In pursuing our mission, we have always placed man's activity at the very heart of our work, viewing it as an admirable construction within the created world, capable of being proactive, of seizing opportunities such as those that now, for all their intrinsic difficulties, offer themselves to us in this newly globalised world. Based precisely on all of these young people from different countries, our driving aim has been to use practice to forge the experience of getting to know one another, working together to express shared concepts, to bring them to fruition in the harmony of an environment extraneous to all those taking part yet, at the same time, common to all of them inasmuch as it is part and parcel of our common world heritage.

This is the program by which Romualdo Del Bianco Foundation intends to gather the enthusiasm, the adhesion, the participation of those who see architecture, art and culture not only as an universal expression of beauty, elegance and refinement, but also as a powerful mean to contribute to the development of the intercultural dialogue. You, your colleagues and students are welcome in joining us.

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SESSION 1

CIVIL ENGINEERING, RECONSTRUCTION, SUSTAINABLE CONSTRUCTION, MATERIALS AND TECHNOLOGIES

APPLICATION OF THE HYDRODYNAMIC LEVELING METHOD IN ERECTION WORK

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Keywords

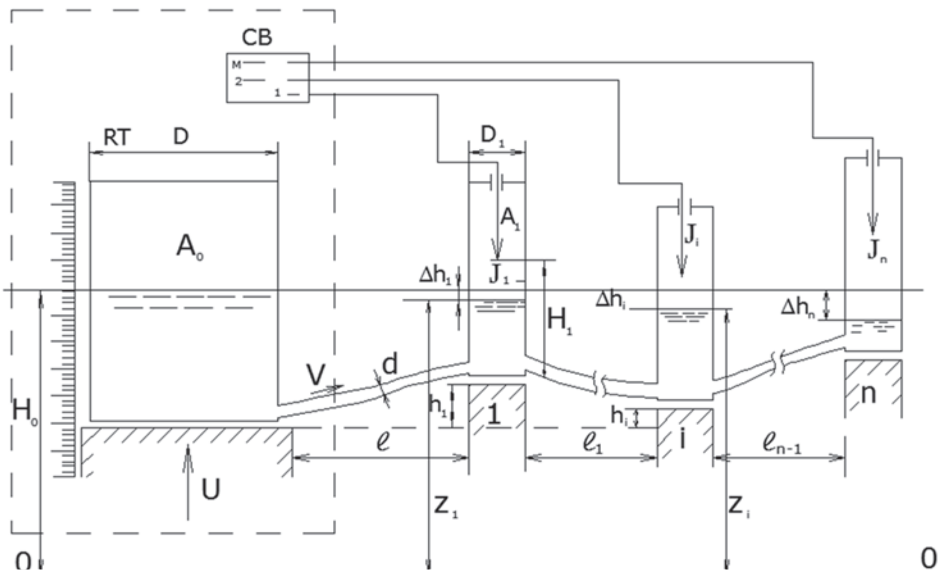
hydrodynamic leveling, observation, providing

ABSTRACT

The advancement of technical progress pose problems before engineers and researchers to automate some production processes. Design and creation of new systems of automatic control bring research problems of time-varying processes in the forefront.
Hydroleveling is used in building of unique structures and erecting large-size processing equipment.
It applies equally to construction of high-rise structures, linear and annular accelerators, radioactive instrumentation and radar telescopes, automatic production lines, assembly belt lines, high-head dams, special overhead covers etc. Experience of operation of various structures has shown that necessity of carrying out precise leveling often arises during their operation.
This study aimed at carrying out observations of objects under operation enables determining of structures sinking values and obtaining regularities of their increase so that at a later date predict expected sinking and take in time measures for preventing emergency state of structures. This paper presents possibility of application of hydrodynamic leveling technique in erection work. Such researches are grounded usage of the method and providing precise measurement while erecting special equipment.

1. INTRODUCTION

In mounting of special structures or heavy-duty equipment it is necessary to carry out geodetic support with the purpose of their installation in designed position to an accuracy of 0.1mm. Until now to these ends a method of hydrostatic leveling have been applied (Vasiutinski. I.Yu. 1976).
Now let us consider the possibility of usage of the hydrodynamic leveling (Movsesyan R.A., Barkhudaryan A.M. 1976) technique for determining the difference, while performing erecting work, between heights of two points where transducers are attached. Fig.1 shows the diagram of the hydrodynamic leveling system.
In mounting of a special equipment often necessary to install two or more slabs in one horizon. toward this end it is possible to employ open-loop (fig.2) system or close-loop (fig.3) system of hydrodynamic leveling.



1) Principal diagram of the hydrodynamic leveling

2. THE MAIN CONCEPT

Let us assume that the slab I is in level position and it is necessary to bring the slab II in the same horizontal plane. Control-measuring vessels (transducers) 1 and 5 are installed on the I slab, control-measuring vessels 2,3, and 4 – on the II slab.

For each specific system installation time t_0 of steady motion of the fluid in the system is determined theoretically or experimentally.

Parameters of the system is selected in such a way that in measuring the high position contact of the liquid and any point of the signaling device occurred after steady motion is set up.

As opposed to the current system of hydrodynamic leveling, on a hoister a two-sectional regulating tank is installed (fig.4). The regulating tank in its interior by a vertical partition is divided in two independent sections of A_0' and A_0'' areas, respectively, as shown in fig. 4. Fluid of one section is communicated with the main system through a manifold equipped with a valve.

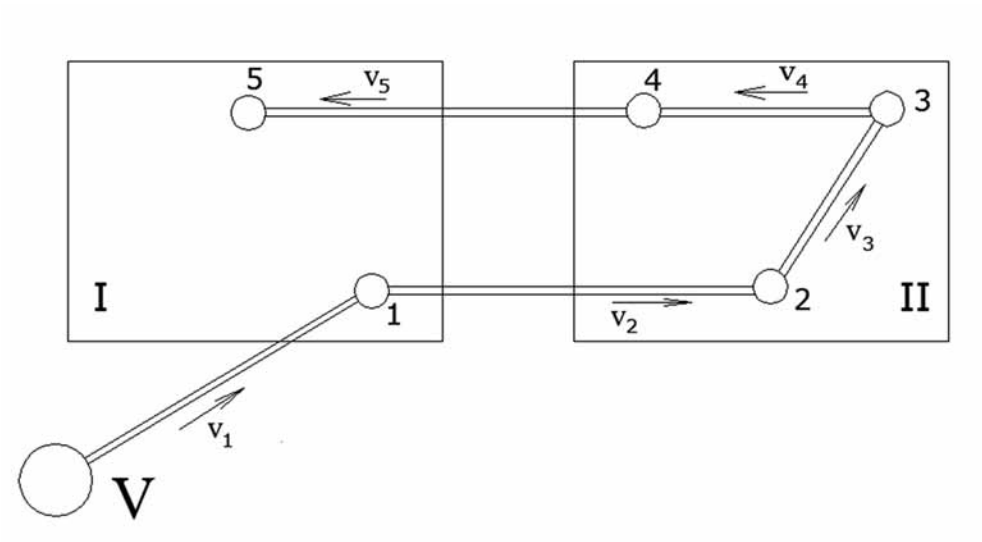
Measurements are carried out in two phases. In the first one the regulating tank is lifted with open K valve, in that the fluid's level change in measuring heads occurs due to volume change of fluid in both the first and the second sections of the regulating tank.

Fluid travel in measuring heads till its contact with the signaling devices is regulated by functioning of meters in corresponding canals.

When reading is coming to an end readings of corresponding meters $N_1', N_2', N_3', N_4', N_5'$ are taken.

The regulating tank is brought to its initial position. After equilibrium state of fluid is setup the valve K is closed and the second phase of measurements is proceeded. Similarly in the second phase readings of meters $N_1'', N_2'', N_3'', N_4'', N_5''$ are taken.

Having known readings of meters of two phases of measurements, by corresponding formulas differences of levels of points 2,3, and 4 relative to 1 and 5 control points are determined.



2) Open-loop system

3. OPEN-LOOP SYSTEM OF HYDRODYNAMIC LEVELING

1. Suppose the hydrodynamic leveling system is in open-loop state (fig.2). In the first state, when the regulating tank with the valve open and after steady motion is established, the rate of rising of the fluid level in the system is determined by the formula

$$u_{cm}' = \frac{\left(A_0' + A_0''\right)u}{A_0' + A_0'' + 5A} = c_1 u \,, \tag{1}$$

where u is the velocity of lifting the regulating tank; A is the area of the free surface of the fluid in the measuring head vessel.

Average velocities of fluid's travel over separate sections are

$$
\begin{aligned}
&\mathrm{v}_1' = 5c_1 u \frac{A}{\omega};\\
&\ldots\\
&\mathrm{v}_\mathrm{i}' = (6-i)c_1 u \frac{A}{\omega}; \qquad (i = 2;3;4)\\
&\ldots\\
&\mathrm{v}_5' = c_1 u \frac{A}{\omega}.
\end{aligned} \tag{2}
$$

2. In the second phase, when the regulating tank with the valve closed, velocities of moving liquid are determined by the following formulas

$$
u''_{cm} = \frac{A_0'}{A_0' + 5A} u = c_2 u, \tag{3}
$$

$$
\begin{aligned}
&\mathrm{v}_1'' = 5c_2 u \frac{A}{\omega};\\
&\ldots\\
&\mathrm{v}_\mathrm{i}'' = (6-i)c_2 u \frac{A}{\omega};\\
&\ldots\\
&\mathrm{v}_5'' = c_2 u \frac{A}{\omega}.
\end{aligned} \tag{4}
$$

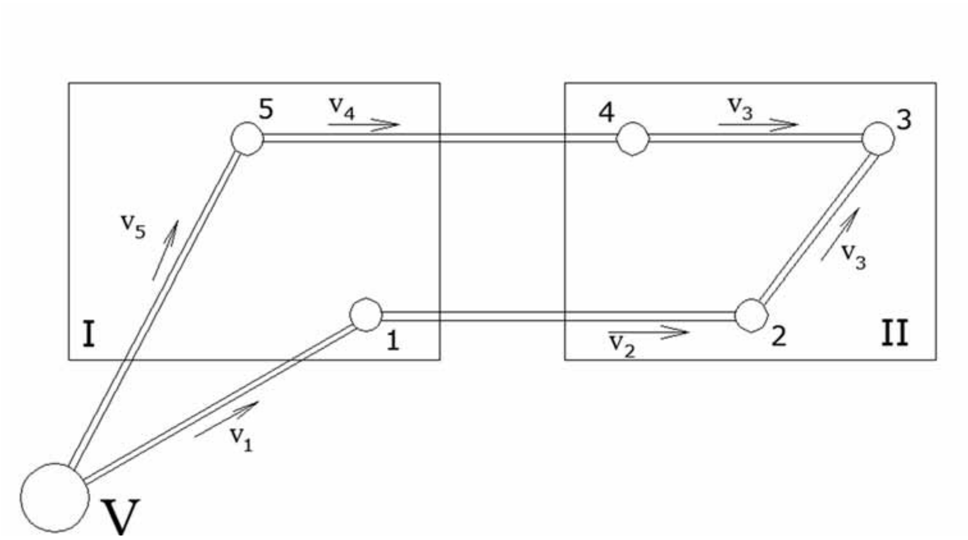
Let the moment the liquid comes in contact with the point of the signaling device, hydraulic grade line be $a - a_1$ and with the point of the signaling device in the i -th head be $b - b_1$ (fig.5).

From fig.5, we have

$$
\begin{aligned}
H'_{i-1} &= \Delta h_{i-1} + \sum h'_{i-1};\\
H''_{i-1} &= \Delta h_{i-1} + \sum h''_{i-1};
\end{aligned} \tag{5}
$$

where Δh_{i-1} is the difference between points of signaling devices in the i-th and the first measuring heads; $\sum h'_{i-1}$ $\sum h''_{i-1}$ are total energy losses in sections between the first and i -th measuring heads.

Taking into account that $\sum h_{i-1} = \sum_{j=2}^{i} K_j \mathrm{v}_j$, expressions for total energy losses can be written as



3) Close-loop system

Movsesyan R.A., Barkhudaryan A.M. 1975).

$$\sum h'_{i-1} = c_1 u \frac{A}{\omega} \sum_{j=2}^{i} (6-j) K_j ;$$

$$\sum h''_{i-1} = c_2 u \frac{A}{\omega} \sum_{j=2}^{i} (6-j) K_j .$$

Introducing $c_1/c_2 = m$, we get

$$\sum h'_{i-1} = m \sum h''_{i-1}$$

then instead of (5), we have

$$\Delta h_{i-1} = H'_{i-1} - m \sum h''_{i-1};$$
$$\Delta h_{i-1} = H''_{i-1} - \sum h''_{i-1}; \quad (6)$$

from which a formula for determining distances between levels has been derived

$$\Delta h_{i-1} = \frac{m H''_{i-1} - H'_{i-1}}{m-1} \quad (7)$$

or

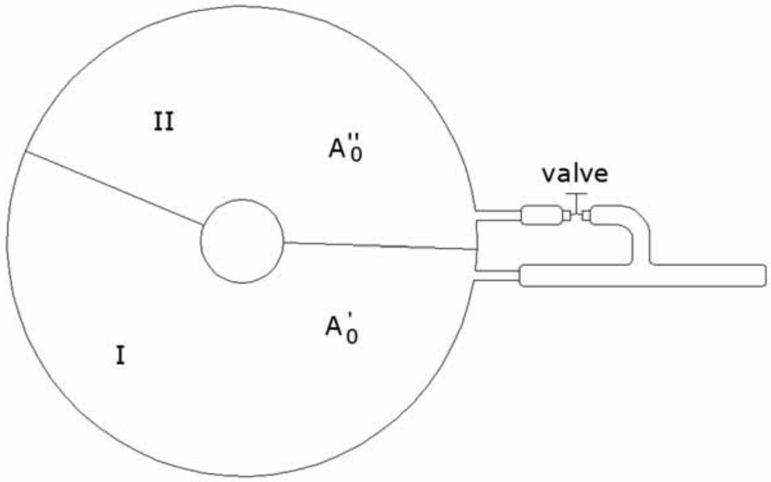
$$\Delta h_{i-1} = \frac{c_1 u}{N_0 (m-1)} \left(N''_i - N'_i - N''_1 + N'_1 \right)$$

where N_0 is the number of impulses, coming into the control unit per unit time:

$$c_1 = \frac{A'_0 + A''_0}{A'_0 + A''_0 + 5A} \quad .$$

4. CLOSE-LOOP SYSTEM OF HYDRODYNAMIC LEVELING

Suppose that the hydrodynamic leveling system a is close-loop one (fig.3). It is evident that at equal lengths of



4) Two-sectional back

connection hoses and diameters of measuring heads (vessels) the third transducer will be boundary, that is the liquid enters there in from both sides.

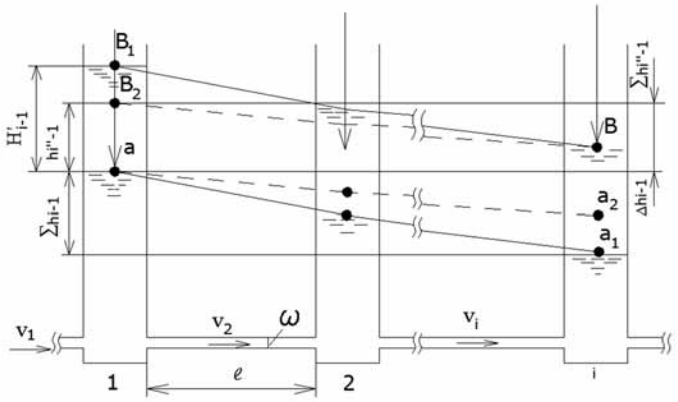
Then velocities of the liquid motion over separate sections are defined as

$$\begin{aligned} v_1 &= v_5 = 2{,}5cu\frac{A}{\omega}; \\ v_2 &= v_4 = 1{,}5cu\frac{A}{\omega}; \\ v_3 &= 0{,}5cu\frac{A}{\omega}. \end{aligned} \tag{8}$$

The close-loop system by the boundary transducer is conventionally divided into two open-loop ones, in that the boundary (third) transducer receives a part of discharge from one side and the rest – from the other.

The difference of the mark of the signaling device's point of the third transducer relative to the first one is determined by the formula (7).

It is not difficult to see that at $i > 3$, the difference of the mark of the third signaling device relative to i-th is determined by the following formula



5) Piezometric lines

$$\Delta h_{3-i} = \frac{c_1 u}{N_0 (m-1)} \left(N_3'' - N_3' - N_i'' + N_i' \right); \tag{9}$$

Then, when $i > 3$ we have

$$\Delta h_{i-1} = \Delta h_{3-1} - \Delta h_{3-i} = \frac{c_1 u}{N_0 (m-1)} \left(N_i'' - N_i' - N_1'' + N_1' \right)$$

Thus, it has been find out that in both open-loop and close-loop hydrodynamic leveling systems the distances between levels of points are determined by the same (7) formula.

5. CONCLUSIONS

- in determining distances between levels of points there is no need to carry out measurements the level of the liquid in the regulating tank;
- in the section under consideration the value of energy loss does not take part in the formula of distances between levels of points;
- temperature impact on measurement accuracy is excepted, because measurements are made one after another, practically, temperature during that time can be regarded as constant;
- application of the hydrodynamic leveling method assures high accuracy of measurement in erecting work.

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THE USE OF FUZZY INFERENCE SYSTEMS TO PROVIDE MORE INTELLIGENT HOSPITAL MANAGEMENT SYSTEM

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Keywords

building management system (BMS), fuzzy inference system, hospital heating and ventilation system

ABSTRACT

Nowadays minimizing energy consumption becomes one of the most important concerns of human. One of the best solutions for this, is the Building Management System (BMS) which can reduce energy consumption of the buildings up to a significant degree A BMS is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems. Since hospitals' electrical and mechanical systems have a direct effect on quality of health services provided by clinicians. In this regard, this paper shows the implementation of fuzzy inference engines to make the building management system more intelligent. Heating and ventilation systems of Laleh hospital, in capital city of Iran are now under control of such system.

1. INTRODUCTION

Building Management Systems are mostly applied in buildings which are equipped with different types of mechanical, electrical, and plumbing systems. Systems linked to a BMS typically consume 40% of a building's energy usage; if lighting is included, this number approaches 70%. BMS systems are quite important component for energy management. Now over ten thousand square meters, half of the buildings in the United States use building management systems and more than ten percent of the energy are being saved. Controlling, monitoring, optimizing and reporting are four basic applications of BMSs. One of the widely used examples of these applications is the control of heating and ventilation and air-conditioning. For example, in order to run the ventilation system in summer, automatic shutters can be closed when it gets warmer than specific degree or the blinds and curtains are open when it rains.

In order to higher the intelligence and also performance of a BMS, it is possible to use a fuzzy inference engine. Since Fuzzy Inference (FI) can take non-numeric input variable, which is called linguistic variable, such as "cold", "warm", "high", "near", etc. as well as numeric variables as its inputs. Such phrases, i.e. linguistic variables, are frequently used by experts and this capability of FI let us to translate experts' knowledge into rules and conditions without any extra effort and mathematical interpretation. For example, one of the rules that control the output temperature of the hot deck heating is used is:

If the air is warm, the controller valve should be closing slowly"

"Warm" and "slowly" are not a mathematically precise concepts. Such words, for control heating and ventilation of buildings are used by experts as human will understand them. However, with help of fuzzy inference system it is possible to make the machines, software and hardware understood what "warm" and "slowly" means.

The control and maintenance of heating and ventilation systems of Laleh Hospital in Tehran, Iran, has been equipped with such inference system to make the BMS less manual and more intelligent. BMSs have a significant impact on the healthcare services since they can provide hospitals and their mechanical and electrical systems with higher performance and reliability. In this regard, we have focused on implementation of fuzzy inference system in Hospital Management System to have more intelligent management systems and automatically delivery of better and efficient healthcare services. This paper is structured as follows; the second section outlines the principles and fundamental concepts in building management systems. Section three is focused on the principles of fuzzy inference engine are in brief. In the fourth section the implementation and practical results are explained and finally conclusion and future work are given.

2. BUILDING MANAGEMENT SYSTEM (BMS)

Building Management System (BMS) is one of the most practical approaches to optimize buildings energy consumption. It controls different parts of the building using predefined conditions and rules. A BMS help mechanical and electrical components to provide better services, minimize their energy consumption, and make them more efficient and productive.

The main advantages of using building management systems is to create a favorable environment in the building, significantly reduce of costs related to maintenance, optimization and energy saving, monitoring and control of all areas using only one PC or even mobile device.

System control is one of the most important applications of BMS. This paper focuses on the implementation of fuzzy inference systems in heating, ventilation and air conditioning system of a specialized hospital in Tehran, Iran, so this section dedicates to this.

One of the most important applications of electrical systems, which can be controlled by building management systems, is heating, ventilation and air conditioning (HVAC). Using a HVAC can help to optimize the energy consumption (Energy Saving), reduce maintenance costs; create comfort for users, increase security and flexible. Each benefits from building management systems Control heating and ventilation will be described in more detail. Smart heating and ventilation can have different applications. For example, at presence or absence of people in a patient room, system changes its action status (from on to off). A thermostat controls the temperature of the indoor temperature to keep it constant. Efficient pumps, chiller, cooling tower, torch and all mechanical devices can be controlled by such system. The system can also be controlled remotely in a more comfortable manner. It can be controlled by a network-based software (Web-based). In this case one can predefine some scenarios for the computer to do some repetitive tasks. For example, with a temperature control system in different parts of the house, it can get the status of all electrical equipment every 15 minutes and use the remote control if needed.

What this paper tries to show is the use of fuzzy inference engine for intelligent hospital management system to control the heating and ventilation system. So, the next part the basics of fuzzy inference systems are discussed.

3. FUZZY INFERENCE SYSTEM

A fuzzy inference system (FIS) is a system that uses fuzzy set theory to map inputs (features in the case of fuzzy classification) to outputs (classes in the case of fuzzy classification). A fuzzy inference engine uses fuzzy logic principles for the composition rules, which are usually in the form of if - then statements stored in the database (Sugeno, 1985). To compute the output of a FIS one must go through six steps:

- determining a set of fuzzy rules
- fuzzifying the inputs using the input membership functions,
- combining the fuzzified inputs according to the fuzzy rules to establish a rule strength,
- finding the consequence of the rule by combining the rule strength and the output membership function,
- combining the consequences to get an output distribution, and
- defuzzifying the output distribution (this step is only if a crisp output (class) is needed).

Fuzzy rules are a collection of linguistic statements that describe how the FIS should make a decision regarding classifying an input or controlling an output. Fuzzy rules are always written in the following form:

If (input1 is membership function1) and/or (input2 is membership function2) and/or , then (output is output membership function).

For example, one could make up a rule that says:

If temperature is high and humidity is high then room is hot.

There would have to be membership functions that define what we mean by high temperature (input1), high humidity (input2) and a hot room (output1). The purpose of fuzzification is to map the inputs from a set of sensors, such as thermometers, to values from 0 to 1 using a set of input membership functions. These input membership functions, can represent fuzzy concepts such as “high” or “low”, “hot” or “cold”, etc. When choosing the input membership functions, the definition of what we mean by “high” and “low” may be different for each input.

In the next section, these six steps are explained with applications to hospital ventilation and air conditioning management systems.

4. IMPLEMENTATION

In order to make an intelligent building management system, inference and intelligent decision-making ability must be added to the system. This paper seeks to obtain the inference engine for intelligent control of building heating and ventilation system. As described in the previous section, for implementation of fuzzy inference engine, first fuzzy input variables must be defined. Then the inference rules need to be added to the knowledge. As is shown in Figure 1, a fuzzy inference engine is used to control heating and ventilation system of a specialized hospital in Tehran, Iran. The input of the heating coil has four parameters; temperature of cooling coil, temperature of heating coil and the outside air temperature and humidity (respectively with following names:DamayeKhoroojiAzKoyle-Garmayesh, DamayeKhoroojiAzKoyleSard, DamayehavayeBiroon, RotoobateFaza)

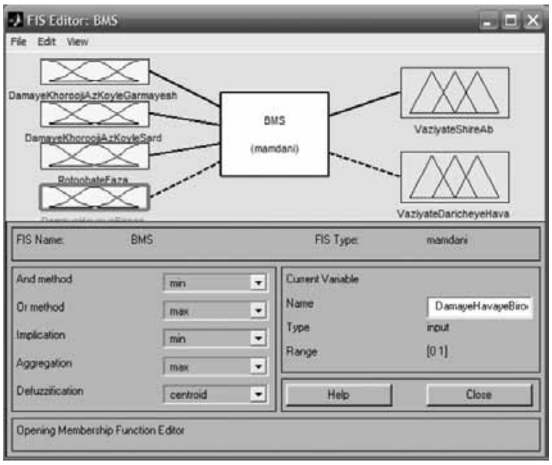

Fig. 1. Components of the fuzzy inference engine to control the heating and ventilation system of the Laleh Hospital

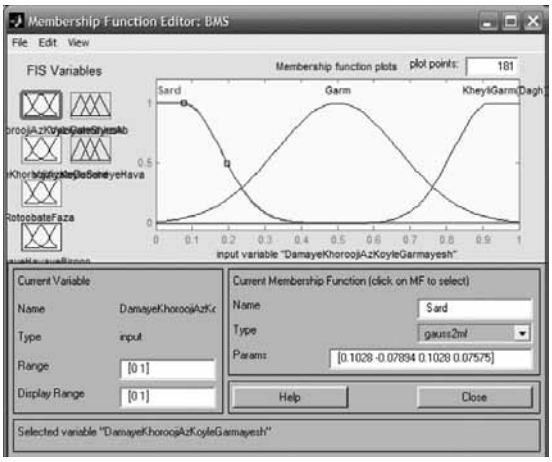

Fig. 2. Temperature output variable membership function of the heating coil

There are two outputs for the status of the vent and the status of the valve (VaziyateDaricheyehava, VaziyateShireAb). Next step is to assign the inputs variables' membership functions. Figure 2 shows the membership function of the first input. As shown in this figure2, the values of these variables are categorized into three classes, cold, warm and hot. These three classes with names Sard, Garm and KheyliGarm (Dagh) are marked. The input membership functions similar to a Gauss curve have been selected and this selection has been made based on experts' comments and experiences.

After introducing all inputs' membership functions, the inference rules should be defined. The purpose of these rules is making the system able to infer. For example, assume that the four parameters are in their normal condition and temperature has been set 22 ° C, which is recommended in most cases. In this case, the weather is almost perfect for the user; the air valve should remain unchanged. In Figure 3, all rules in the knowledge base are shown. The first row corresponds to a state in which it was described in this example.

This rule has to be defined as:

If (DamayeKhoroojiAzKoyleGarmayesh is Garm) and (DamayeKhoroojiAzKoyleSard is Sard) and (Rotoobate-Faza is Monaseb) and (DamayehavayeBiroon is Monaseb) then (VaziyateShireAb is Monaseb) and (Vaziyatedari-cheyeHava is BedooneTaghirEdameDahad)

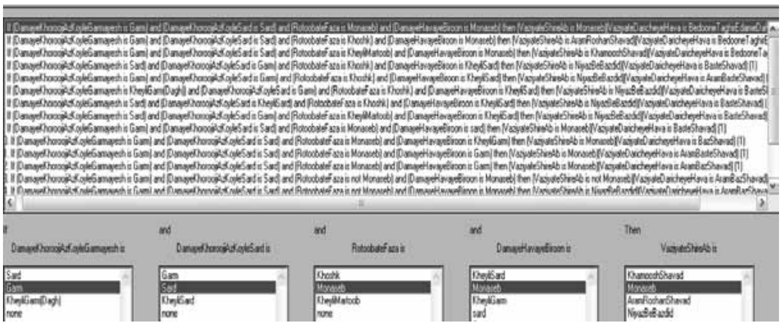

Fig. 3. Rules of knowledge base

Now the building management system can use multiple sensors to measure temperature, humidity, etc. Then according to the rules defined and stored in the knowledge base, the statuses of the two output parameters are determined and the corresponding action is performed. For example, the vent becomes open. Such system has been implemented to the control mechanism of the heating and ventilation system located in Laleh specialized hospital, Tehran, Iran. The results of the work of reducing the 5% and 25% energy and maintenance cost respectively (for one year test interval). In addition less time spent on manual work and less need for human expert are other advantages of using smart management system based on fuzzy inference system.

5. CONCLUSIONS

Building Management System (BMS) is one of the most practical approaches to optimize buildings energy consumption. It controls different parts of the building using predefined conditions and rules. System control is one of the most important applications of BMS. This paper focuses on the implementation of fuzzy inference systems in heating, ventilation and air conditioning system of a specialized hospital in Tehran, Iran. The results of the work of reducing the 5% and 25% energy and maintenance cost respectively (for one year test interval). In addition less time spent on manual work and less need for human expert are other advantages of using smart management system based on fuzzy inference system.

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NUMERICAL STUDIES FOR RETOFFITTING OF CONCRETE COUPLING BEAMS WITH STIFFENED LATERALLY RESTRAINED STEEL PLATE

POSTER

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Keywords

deep coupling beams, seismic retrofitting, adhesive,bolt connection

ABSTRACT

Existing deep reinforced concrete (RC) coupling beams with low shear span ratios and conventionally reinforced shear stirrups tend to fail in a brittle manner with limited ductility and deformability under reversed cyclic loading. Previous studies have developed a new retrofitting method with stiffened laterally restrained steel plate (SLRSP) for existing deep RC coupling beams. Experimental studies have revealed that the types of bolt connection and bolt slipping have great influence on the performance of retrofitted coupling beams. Dynamic set bolt connection with adhesive injection can help the specimens achieve much better shear capacity and deformability. In this study, numerical studies were conducted to investigate the effects of the properties of the adhesive, with or without the adhesive on the behavior of retrofitted coupling beams.

1. INTRODUCTION

Many old reinforced concrete (RC) buildings in developed countries need to be strengthened due to the aging of construction materials, changes in functional use or new design loading requirements. Coupled beams in coupled shear walls are very important structural components that provide the necessary lateral strength, stiffness and deformability for the whole building to resist extreme environmental loads, including wind and earthquake. To ensure the desired behaviour of coupled shear wall systems, coupling beams should be sufficiently strong for resisting wind load, and have good energy dissipation ability and low strength degradation rate for seismic resistant applications. While existing deep coupling beams inevitably failed from diagonal tension when the shear reinforcement was insufficient (Paulay, 1971). In past decades, the design of many concrete buildings (including coupling beams) in China and Hong Kong did not take into account earthquake actions. According to the new design codes, many existing coupling beams are found to be deficient in shear. Sudden failure of these coupling beams will threaten the safety of the building.

Compared with the research about strengthening of RC floor beams, only a few studies are applicable to strengthening existing RC coupling beams. Harries et al. (1996) studied a shear strengthening method for existing coupling beams with a span-to-depth ratio of 3.0. In their study, the retrofitting measures involved a number of different attachment methods to fix the steel plate to one side of the coupling beams. They found that the composite method of bolting with epoxy bonding to attach the steel plates both in the span and at the ends performed the best. Minor plate buckling was found in his tests. Most of the previous studies focused on coupling beams with span-to-depth ratios larger than 2.0. Since the widths of the door and window openings usually range from 1.0 to 1.5m, most coupling beams are quite short and deep. Cheng and Su (2011a&b) experimentally studied the use of a laterally restrained steel plate (LRSP) without stiffeners to retrofit deep concrete coupling beams with a span-to-depth ratio of 1.1. In their test, thin mild steel plates were utilized. The steel plate started to develop a diagonal tension field after the onset of global buckling at the early stages of loading and exhibited nonlinear behavior at relatively small inter-story drift ratios. Due to the post-buckling loading capacity and tension field action in the steel plate, LRSP retrofitted coupling beams failed in a ductile manner. However, shear buckling of steel plate in the early stages usually results in reduced strength, stiffness and energy dissipation capacity accompanied by significant pinching. Adding steel stiffeners to the steel plate is a good way to defer the shear buckling and large-scale experiments of LRSPs with stiffeners have been carried out (Cheng and Su, 2015reviewing).

In this study, a nonlinear finite element model using the finite element program ABAQUS was developed to investigate the whole behaviour of the retrofitted deep coupling beams with stiffened laterally restrained steel plate (SLRSP) such as the load-rotation curves and failure characteristics. The effects of the properties of the adhesive and with or without the adhesive in the gap between the concrete and bolt on the behavior of retrofitted coupling beams were discussed.

2. EXPERIMENTAL STUDIES

Three specimens with the same dimensions and reinforcement specifications (see Fig.1), but different retrofitting schemes, were fabricated and tested. The details of reinforcement details of the specimens and test setup, loading procedure can be found in Cheng&Su (2011a). The first specimen DCB8 with a plain RC arrangement was used for control purposes. The LRSP method and stiffeners were all applied to Specimens DCB9 to DCB10. Stiffeners are structural elements connected to the steel sheet by continuous fillet welds. Rigid stiffeners are used to ensure that the plate can reach its full plastic strength and avoid overall buckling. Two types of bolt connection are adopted in the specimens. One is the general bolt connection(adopted in DCB9) which screws the bolts by tightening torque to about 0.3 kNm (according to China Standard Q/STB 12.521.5-2000). The other is the dynamic set bolt connection(adopted in DCB10) which minimizes any possible slippage between various components at the connections by injecting adhesive to fill the gaps between the bolt shank and surrounding concrete (see Fig.1). The experimental study revealed that the use of laterally restrained steel plate with stiffeners for the seismic retrofitting of concrete deep coupling beams has demonstrated effectiveness in increasing deformability and energy dissipation while reducing strength and stiffness degradation. Also, the retrofitted beams failed in a ductile manner. The type of bolt connections used is found to have significant effects on the performances of the retrofitted coupling beams. Dynamic set bolt connections with adhesive to fill in the gap between the concrete and bolt can alleviate bolt slippage and make the retrofitted coupling beams achieve a desirable seismic response.

3. NUMERAL STUDIES

The finite element software ABAQUS 6.14-2 (DSSC, 2014) was utilized to investigate the whole behaviour of the retrofitted deep coupling beams with stiffened laterally restrained steel plate (SLRSP). All the nodes along the edge of the vertical wall on the right were fixed, while the nodes along the vertical edge on the left were constrained to undergo equal horizontal displacements. This would maintain parallelism of the two wall panels in the loading process and thus simulate the conditions of equal beam-end rotations in real structures.

In the finite element model, six parts were created including concrete, reinforcements cage, stiffening rib, steel plate, bolts and the loading rigid bodies. The reinforcement cage consists of the longitudinal bars and stirrups. The concrete, stiffeners, steel plate, bolts and the rigid bodies were modeled using solid C3D8R elements. The reinforcement cage was modeled using T3D2 truss elements. The elements size was about 30mm for the whole model. The reinforcement cage was embedded into the concrete part. The stiffeners were tied to the steel plate. For DCB9 without adhesive in the gap between the concrete and bolt, a general contact element was selected. In its normal direction, the contract "hard" is made and in its tangential direction, the friction factor of 0.15 is selected to simulate the bolts slipping. For DCB10 with adhesive filled in the gap between the concrete and bolt, an adhesive contact element was selected. The geometry of the model and the finite element mesh are shown in Fig.2. The deformation mode and stress distribution of DCB10 are shown in Fig.3.

4. VERIFICATIONS OF NUMERICAL MODELS USING EXPERIMENTAL RESULTS

To verify the proposed model, the numerical results such as the load-rotation curves, crack pattern, bolt slipping and shear stress in the steel plate were compared with the experimental results.

• *4.1 Load-rotation curves*

Fig.4 shows the agreement of load-rotation curves obtained from the NLFEA and the experimental studies. For DCB9 without adhesive filled in the gap between the concrete and bolt, due to the significant bolt slips, the steel plate did not deform in the early rotation level (< 0.04 rad). The post-peak behavior of DCB9 is very brittle. Compared with DCB9 and DCB10, it can be found that the post peak behavior of DCB10 with adhesive filled in the gap between the concrete and bolt connection became ductile. These results show that the NLFEM model can predict the behaviors of retrofitted coupling beams accurately.

• *4.2 Crack Patterns and Failure Behaviors*

Fig.5 compared the distribution of SDEG (scalar stiffness degradation) of the two specimens. When the concrete cracking occurred, the stiffness of the cracking region will be degenerated. The value of 0 means no damage. The value of 1 means completely damage. The value between 0 and 1 means the occurring of cracking. Through the distribution of SDEG value, cracking pattern in the specimens can be predicted. From comparison of DCB9 with DCB10 at the same rotation of 0.01, it can be obviously found that the SDEG value of DCB9 is larger than that in DCB10.This means at the same rotation, more cracking happened in DCB9 which resulted in rapid stiffness degradation. This can also explain why DCB9 behaved in a brittle manner.

• *V4.3 Longitudinal Rotation of Bolts Connections*

Fig.6 shows the comparison of the longitudinal rotation of bolt connections from the experimental and numerical results. It can be seen that numerical results matched well with the experimental results. For DCB10 with dynamic set bolt connection, the longitudinal rotation is much less than that of DCB9 with general bolt connections. This can confirm that dynamic set bolt connection can provide enough stiffness.
4.4 Shear Stress Distributions in Steel Plates
Fig.7 shows the comparison of the experimental and numerical results of the shear stress in steel plate of DCB9 and DCB10. Fig.7(b) and 7(d) give the numerical results of shear stress in steel plate at the same rotation 0.02 rad. The values of shear stress got from the numerical study are generally higher than that of experimental results. It can be found that the value of shear stress of DCB10 is much higher than that in DCB9. This is due to the reason that for DCB10 with adhesive injected in the bolt connections, steel plate and concrete beam can work together to resist part of the shear force. While for DCB9 with general bolt connections, steel plate didn't deform due to the large slipping of bolt connection at the early loading stage. Therefore the steel plate didn't help to resist much shear force at the early loading stage.

• *4.5 Effect of Adhesive in Bolt Connections*

Turon(2007) advised that the stiffness of the cohesive elements should be 1-50 times to the connected material's stiffness. To study the effects of stiffness of adhesive on the performances of retrofitted beams, 2Gpa, 200Gpa and 20000Gpa were selected for the stiffness of adhesive. It can be seen from Fig.8 that the loading capacity of the retrofitted beam increased with the incensement of stiffness of adhesive. However, the load-rotation curves are quite similar for the stiffness of 200Gpa and 20000Gpa. This means when the stiffness of adhesive was strong enough to ensure the plate attain the load capacity, with the incensement adhesive stiffness, the retrofitted beams may achieve the same strength in the large rotation range.

5. CONCLUSIONS

This paper presents the numerical study of deep coupling beams retrofitted with stiffened laterally restrained steel plate (SLRSP). The main findings are summarized as follows:
This study confirmed that the present NLFEA accurately predicted the load-rotation curves, failure patterns and stress distributions of the SLRSP retrofitted coupling beams. The new model is simple, computationally efficient and able to capture the overall behavior.
The type of bolt connections used is found to have significant effects on the performances of the retrofitted coupling beams. Dynamic set bolt connections with adhesive to fill in the gap between the concrete and bolt can alleviate cracking in concrete, bolt slippage and make the retrofitted coupling beams achieve a desirable seismic response. If the stiffness of adhesive is strong enough to ensure the plate attain the load capacity, with the incensement adhesive stiffness, the retrofitted beams may achieve the same strength in the large rotation range.

ACKNOWLEDGEMENTS

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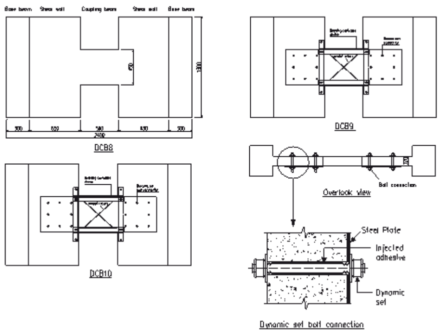


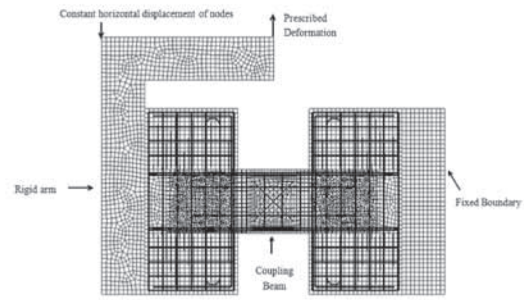


Fig. 1. Details of test specimens

Fig. 2. Finite element model

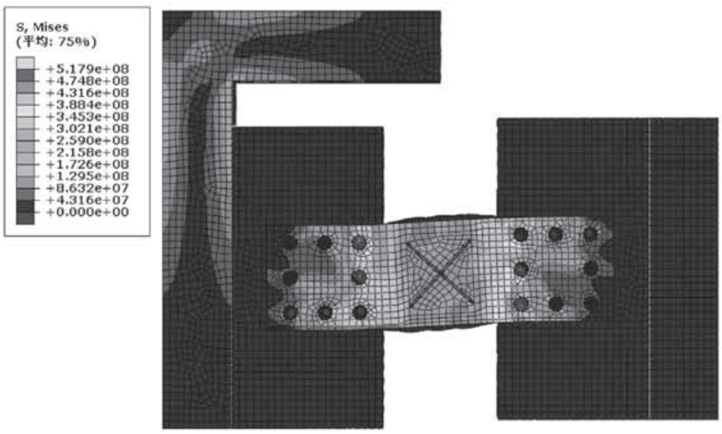
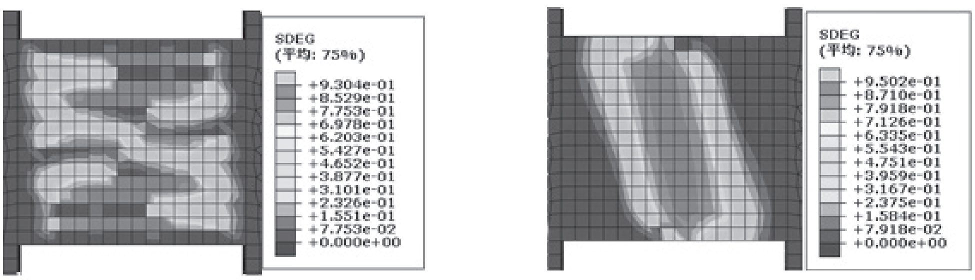


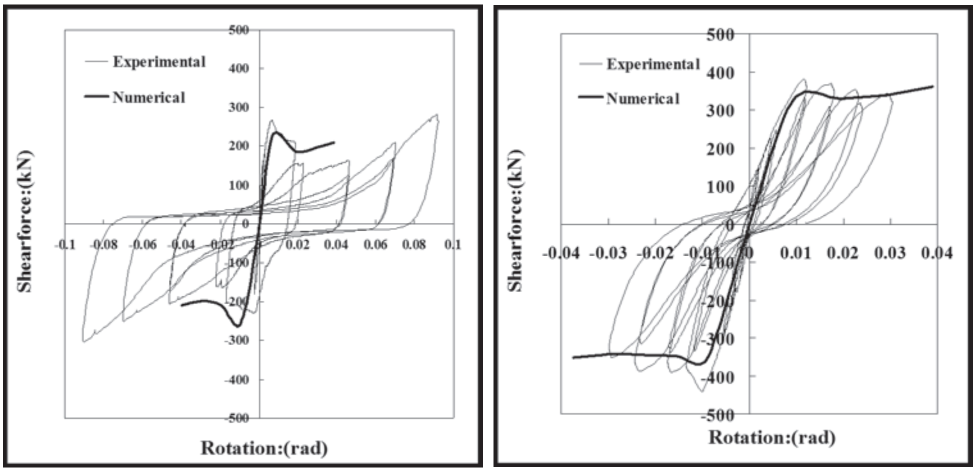
Fig. 3. Deformation and stress distribution of DCB10



(a)

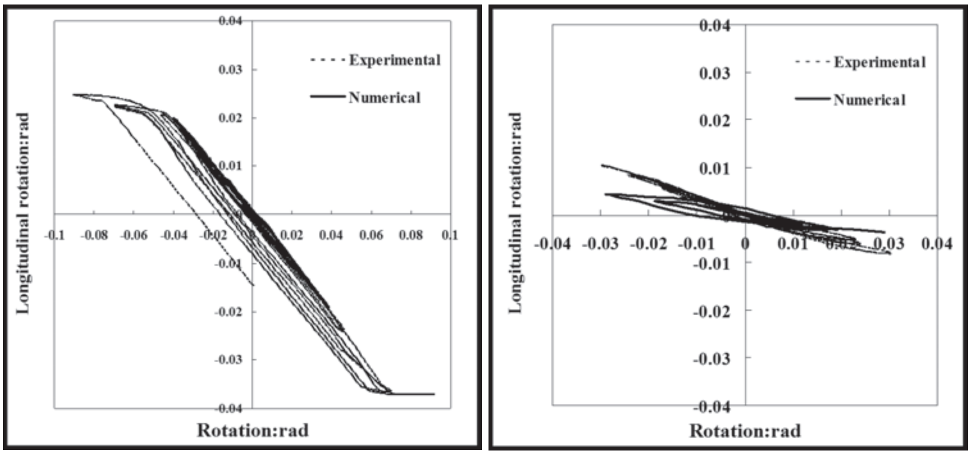
(b)

Fig. 4 SDEG value at the rotation of 0.01rad: (a) DCB9, (b) DCB10



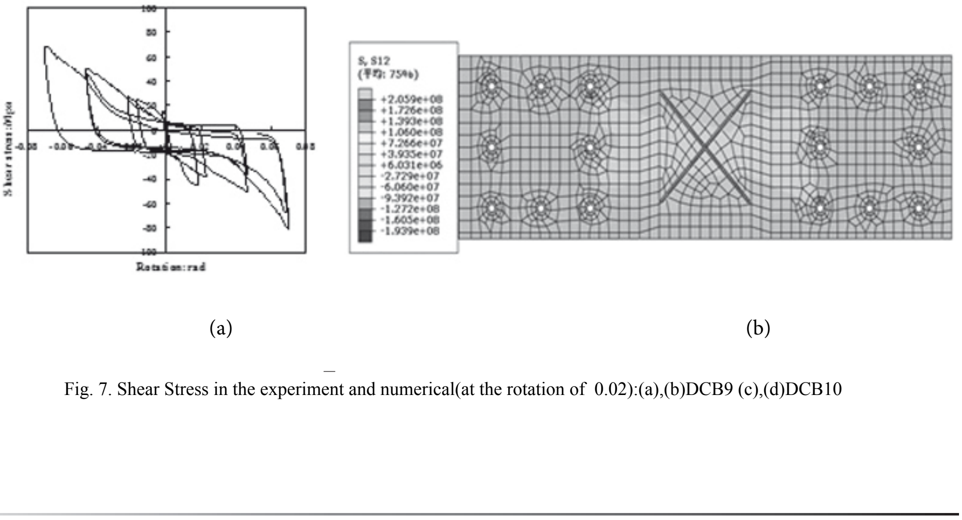
(a) (b)

Fig. 5. Experimental and numerical load-rotation curves: (a) DCB9 (b) DCB10



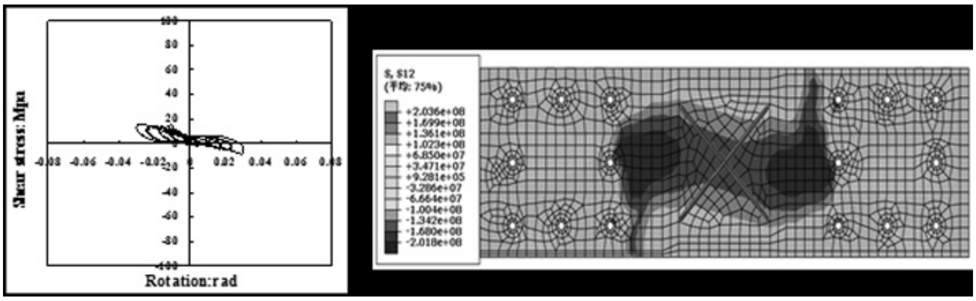
(a) (b)

Fig. 6. Longitudinal rotation of bolt connection: (a) DCB9 (b) DCB10



(a) (b)

Fig. 7. Shear Stress in the experiment and numerical(at the rotation of 0.02):(a),(b)DCB9 (c),(d)DCB10



(c) (d)

Fig. 8. Shear Stress in the experiment and numerical(at the rotation of 0.02):(a),(b)DCB9 (c),(d)DCB10

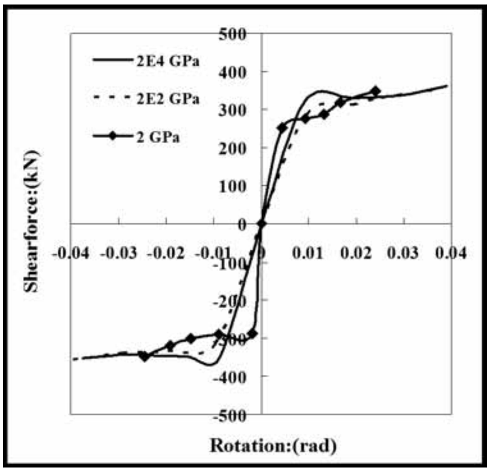


Fig. 9. Skeleton curves in three different kinds of stiffness for DCB10

CALCULATION OF THIN-WALLED PREFABRICATED TYPE SHELLS WITH MODEL OF PLASTIC-RIGID BODY

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Keywords

prefabricated element, plasticity, variation equation

ABSTRACT

In the work are studied the change of load bearing capacity of prefabricated elastic-plastic prefabricated shell type structures accordingly of number of prefabricated elements. The issue of shell type prefabricated structure optimal design at discontinuous solution of prefabricated element and by variation equation of elastic-plastic equilibrium is developed. The dependencies between deformations and loads are obtained.

1. INTRODUCTION

The up-to-date construction is studies the lot of objects, the analysis of that due their complexity, is related with application of analytical and numerical methods, hence it makes certain requirements to designers for implementation of new methods of analysis and design. The theory of thin-walled spatial structures with respect of rheological properties of materials is divided into several parts. In the recent years great attention is paid for to problems of physical non-linearity, plasticity, creeping, durability and strength.

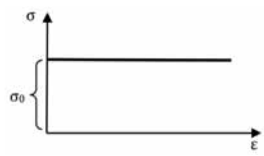
In the case of complex loading in comparison with theory of deformations more perfect result give's the theory of elasticity. Especially will be calculated the construction of yield surface. This and similar specific issues that are related to plasticity properties of shell's materials are considered in lot of works, in particular A.O. Savchuko [1], S.G. Lekhnitski [2], N.M. Beliaes and A.K. Sinitski [3], G.S. Shapiro [4], R.M. Tskhvedadze [5]. In the book of V. Olshak and A. Savchuk [6] are investigated the situations, in that material of shell is linearly viscous-elastic and is in steady creeping, or in elastic-plastic state. In the same book are considered the works of A.A. Ikiushinski [7], I.N. Rakhotnikov [8] and others are considered reinforced concrete shells, in that are studies the limiting state and load-bearing possibilities of shells.

From the review of mentioned literature is clear that in the case of elastic-plastic state of thin-walled structures the problem of analysis is topical and is being in the stage of actively developing.

2. BACKGROUND

In point of engineering view the limiting state of structure is characterized by its so significant change in initial dimensions and shapes that structure the further operation of it makes impossible. It is clear that prior the reaching of limiting state in structure occurs separate scattering plastic areas, the impact of that is still insignificant and the structure would been considered as rigid. But with increase in loading begin the expansion of plastic areas and finally when the external forces reaches the certain "limiting state" that is called as load-bearing capacity of structure , the structure "creeps as whole" that is characterized by infinite increasing of deformation rate.

In the conditions of failure plastic deformation significantly exceeds the elastic ones due that latter would be beglected. From such description we obtain ideal plastic-rigid model of real deformable body (Fig. 1). Exactly this model will be applied at determination of load-bearing capacity.



1). Plastic-rigid model

The origination of single-axis stresses state of plastic deformation is stipulated by reaching of limiting values of according material creeping σ. In the plates and depressed shells, in that the stresses state of elementary layers is planar, the origination of plastic areas is carried out by σxx, σyy normal and σxy shear stresses.
The condition that would be satisfied the stresses in certain point of deformable rigid body to occur in it plastic deformation is known as plasticity or creeping condition. Exist few conditions for the case of complex stressed state. One of them is known as Hoover-Mises conditions that in conditions of planar stressed state will be as [9]

$$f(\sigma_{ij}) = f(\sigma_{xx}, \sigma_{yy}, \sigma_{xy}) = \frac{\sigma_{yy}^2}{\sigma_{xx}^2} - \frac{\sigma_{xx}\sigma_{yy}}{\sigma_{xx}\sigma_{xy}} + \frac{\sigma_{yy}^2}{\sigma_{xy}^2} + \frac{\sigma_{xy}^2}{\tau_x^2} - 1 = 0, \tag{1}$$

where τ – is the yield point of material at shear, σ_{yx}, σ_{xy} – are the yield points at tension accordingly in x and y directions.
When $f(\sigma_{ij})<0$ the material is assumed as non-deformable and when $f(\sigma_{ij})=0$ the material has creeping properties. Grounded only on yield condition is impossible the fully characterizing of mechanical state of plastic-rigid body. Is necessary also to know yield accompanying law. The later commonly implies the existence of equate to yield function $f(\sigma_{xx},\sigma_{yy},\sigma_{xy})$ of plasticity potential.
Therefore is implied the existence of following equalities

$$\dot{\varepsilon}_x = \lambda\frac{\partial f}{\partial \sigma_{xx}}; \quad \dot{\varepsilon}_y = \lambda\frac{\partial f}{\partial \sigma_{yy}}; \quad \dot{\omega} = \lambda\frac{\partial f}{\partial \sigma_{xy}}, \tag{2}$$

where $\dot{\varepsilon}_x$, $\dot{\varepsilon}_y$ and $\dot{\omega}$ are designating the corresponding rates of deformation, λ – is the called as plasticity coefficient is defined by the formula:

$$\lambda = \left[\frac{1}{3}\left(\sigma_{xx}^2 \cdot \dot{\varepsilon}_x^2 + \sigma_x \cdot \sigma_{yy} \cdot \dot{\varepsilon}_x \cdot \dot{\varepsilon}_y + \sigma_{xy}^2 \cdot \dot{\varepsilon}_y^2\right) + \frac{\tau_x^2 \cdot \dot{\omega}^2}{4} + \right.$$
$$\left. + \frac{h}{36}\left(\sigma_{xx}^2 \cdot \dot{\chi}_x^2 + \sigma_x \cdot \sigma_{yy} \cdot \dot{\chi}_x \cdot \dot{\chi}_y + \sigma_{xy}^2 \cdot \dot{\chi}_y^2\right) + \frac{\tau_x^2}{4}\dot{\chi}^2\right]^{1/2} \tag{3}$$

In the case of depressed double curvature shell the determining the parameters of median surface deformations rate will be defined by formulae:

$$\dot{\varepsilon}_x = \frac{\partial \dot{U}}{\partial x} + \frac{\dot{\omega}}{R_1}, \quad \dot{\varepsilon}_y = \frac{\partial \dot{V}}{\partial y} + \frac{\dot{\omega}}{R_2}, \quad \omega = \frac{\partial \dot{U}}{\partial y} + \frac{\partial \dot{V}}{\partial x};$$
$$\chi_1 = -\frac{\partial^2 \dot{\omega}}{\partial x^2} + \frac{1}{R_1}\frac{\partial \dot{U}}{\partial x}; \quad \chi_2 = \frac{\partial^2 \dot{\omega}}{\partial y^2} + \frac{1}{R_2}\frac{\partial \dot{V}}{\partial y};$$
$$\chi = \frac{1}{R_1}\frac{\partial \dot{U}}{\partial y} + \frac{1}{R_2}\frac{\partial \dot{V}}{\partial x} - 2\frac{\partial^2 \dot{\omega}}{\partial x \partial y}. \tag{4}$$

The determination of load bearing capacity of engineering structures represents one of the major tasks of structural mechanics. In this direction is developed lot of methods that rather simplifies the solution of this task. One of such method is developed by M. Mikeladze, B. Mikhailov and G. Kipiani that is related to bilateral assessment of structure's load bearing capacity [9, 11]. Accordingly of this method if we designate as Pst the statically allowable value of ultimate loading intensity and as Pk kinematically allowable value of ultimate loading intensity then the true value of ultimate loading P will be equal to maximal value of statically allowable value of ultimate loading intensity and minimal values of kinematically allowable value of ultimate loading intensity. $P_{st} \leq P \leq Pk$. Accordingly of [10] the load bearing capacity of shell from above will be written down as

$$P < P_{pl} + \frac{2h}{\sqrt{3}}\left(\frac{\sigma_{Sx}^2}{R_1^2} + \frac{\sigma_{Sx}\sigma_{Sy}}{R_1R_2} + \frac{\sigma_{Sy}^2}{R_2^2}\right)^{1/2} \tag{5}$$

where

$$P_{pl} = \frac{\frac{h^2}{\sqrt{3}}\int\left\{\frac{1}{3}\left[\left(\frac{\partial^2\dot{\omega}}{\partial x^2}\right)^2 \sigma_{xy}^2 + \sigma_{xx}\cdot\sigma_{xy}\frac{\partial^2\dot{\omega}}{\partial x^2}\frac{\partial^2\dot{\omega}}{\partial y^2} + \sigma_{xy}^2\left(\frac{\partial^2\dot{\omega}}{\partial x^2}\right)^2\right] + \tau_x\left(\frac{\partial^2\dot{\omega}}{\partial x\,\partial x}\right)^2\right\}^{1/2}}{\int \dot{\omega}dF} \tag{6}$$

is the load bearing capacity of plate the dimensions of that match the covered by shell geometrical dimensions. The load bearing capacity of shell from below will be determined by formula

$$P > \frac{2h}{\sqrt{3}}\left(\frac{\sigma_{Sx}^2}{R_1^2} + \frac{\sigma_{Sx}\sigma_{Sy}}{R_1R_2} + \frac{\sigma_{Sy}^2}{R_2^2}\right)^{1/2} \tag{7}$$

Let's begin from the case when has not the intermediate hinges, for such shell the load bearing capacity will be determined from above by formula (5). In order to simplify the following calculations let's introduce the dimensionless values ξ and η accordingly of following equalities:

$$x = \xi\ell_2 \quad \text{and} \quad y = \eta\ell_2 = \eta k\ell_1 \qquad (\ell_2 = k\ell_1)$$

where $l_{\_1}$ and $l_{\_2}$ represents the lengths of sides in plane. The yield point values $\sigma_{\_xy}$ and τ_x let's express through $\sigma_{\_xx}$ accordingly of following dependencies

$\sigma_{\_xy}=t\sigma_{\_xx}$, $\tau_{\_x}=\sigma_{\_xy}$ $1/\sqrt{3}$.

Accordingly the expression (5) will be as

$$P < P_{pl} + \frac{2h}{\sqrt{3}}\left(\frac{1}{R_1^2} + \frac{1}{R_1R_2} + \frac{1}{R_2^2}\right)^{1/2} \tag{8}$$

where

$$P_{pl} = \frac{\frac{h^2}{3}\frac{\sigma_{xx}}{\ell_1^2}\int_o^1\int_o^1\left[\left(\frac{\partial^2\dot{\omega}}{\partial\xi^2}\right)^2 + \frac{t}{K^2}\frac{\partial^2\dot{\omega}}{\partial\xi^2}\frac{\partial^2\dot{\omega}}{\partial\eta^2} + \frac{t^2}{K}\left(\frac{\partial^2\dot{\omega}}{\partial\eta^2}\right) + \frac{1}{K^2}\left(\frac{\partial^2\dot{\omega}}{\partial\xi\partial\eta}\right)\right]}{\int_o^1\int_o^1\dot{\omega}\,d\xi d\eta} \tag{9}$$

With unlimiting of generality for simplify of further calculations let's assume that t=1 and K=1. In such case the given shell transforms into rigidly supported on contour spherical shell, the calculation of that will be reduced to issue of integration of following differential equation

$$\frac{d^4\omega}{d\xi^4} + \omega = \frac{q\ell^4}{Ey} \tag{10}$$

with taking into account of following boundary conditions:

when ξ=0 and ξ=0 $\omega(0) = \omega(1) = 0$

when $\xi = \frac{1}{2}$ $\omega\left(\frac{1}{2}\right) = 0$

In this case due solution of equation (10) in x direction we will have

$$\omega(\xi) = C(2\xi^3 - \xi^2 - \xi^4); \tag{11}$$

The kinematic field of kinematical allowable deflections will be as

$$\omega = \omega(\xi)\cdot\omega(\eta) = C^2(2\xi^3 - \xi^2 - \xi^4)(2\eta^3 - \eta^2 - \eta^4) \tag{12}$$

Let's define the values $\partial^2\omega/\partial\xi^2$, $\partial^2\omega/\partial\eta^2$ and $\partial^2\omega/\partial\xi\partial\eta$. After the certain calculations the obtained equality for plates (9) gives:

$$P_{pl} = \frac{\frac{h^2}{3}\frac{\sigma_{S1}}{\ell_1^2}\int_o^{1/2}\int_o^{1/2}[\theta^2(\xi)\Psi^2(\eta) + \theta(\xi)\Psi(\eta)\Psi(\xi)\xi(\eta) + \Psi^2(\xi)\theta^2(\eta) + \wedge^2(\xi)\wedge^2(\eta)]^{1/2}d\xi d\varphi}{\int_o^{1/2}\int_o^{1/2}\Psi(\xi)\Psi(\varphi)d\xi d\eta} \tag{13}$$

In the denominator of expression (13) integral is calculated accordingly of Simpson cubature formula [12]

$$\int\int f(x,y) = \frac{h\cdot K}{9}(\sigma_0 + 4\sigma_1 + 16\sigma_2)$$

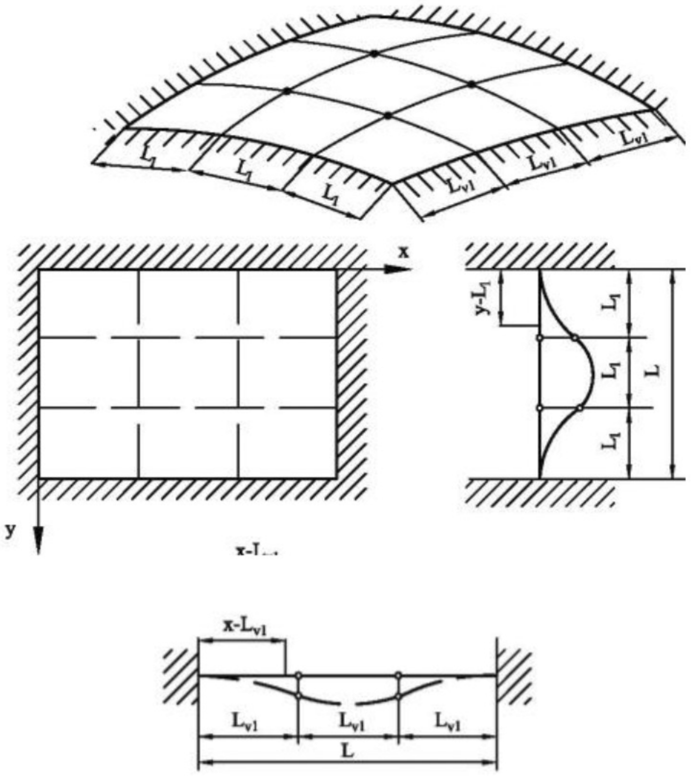


Fig.2 Design scheme of prefabricated shell

where the integration element σ_0 is the summand of in rectangle vertexes; $\sigma_{\_1}$ - is the value of *f(ξ,η)* expression in *F* rectangle sides median points, and σ_2 – is the value of *f(ξ,η)* expression in *F* rectangle center.
Due the calculation upper limit of load bearing capacity for plates will be as

$$P_{pl} = 54.347\frac{h^2\sigma_{xx}}{3e^2}\ kg/cm^2$$

When the shell is performed with taking into account the intermediate hinges (Fig. 2)

In this case the derivatives of deflection function ω(ξ,η) are subjected to break due that for finding of kinematical allowable deflections filed let's apply the discontinuous solution construction method of equation (10) that in this general case will have direction "x" [13-16].

$$EY\omega(\xi) = EY\left[\omega(o) + \xi\dot{\omega}(o) + \sum_m^{\xi} A_m + \sum_r^{\xi} B_r(\xi - a_r)\right] + M_0\frac{1}{2} + Q_0\frac{1}{6} +$$
$$+\frac{1}{2}\sum_k^{\xi} m_k(\xi - a_k)^3 + \frac{1}{6}\sum_\rho^{\xi} P_\rho(\xi - a_\rho)^3 + \frac{1}{6}\int_0^{\xi}(\xi - t)^3 q(t)dt, \qquad (14)$$

where A_m, B_r, m_k, P_p, are the values of *ω(ξ)* function and its derivative, and a_r, a_r, a_p are the accordingly first, second and third order derivatives break points.
In the longitudinal direction at existing of one break point in center the expression (14) will be as:

$$EY\omega(\xi) = M_0\frac{\xi^3}{2} + Q_0\frac{\xi^3}{6} + EYB_1\left(\xi - \frac{1}{2}\right) - q\frac{\xi^4}{24}. \tag{15}$$

In case when elements of prefabricated shell are connected by longitudinal as well as transverse hinges due yet obtained formulae in “x’’ direction for values of deflection we will have

$$when\ \xi < \frac{1}{2}\quad \omega_1(\xi) = C_1(-3\xi^2 + 4\xi^4 - 2\xi^4) \tag{16}$$

As it is obvious from the obtained results it is related on number of prefabricated elements. For obtaining of shell load bearing capacity to plate load bearing capacity will be added dependent of radius of curvature the following constant value

$$\frac{2h\sigma_{xx}}{\sqrt{3}}\left(\frac{1}{R_1^2} + \frac{1}{R_1R_2} + \frac{1}{R_1^2}\right)^{1/2}.$$

3. CONCLUSIONS

At research of elastic-plastic equilibrium of shell type prefabricated structures due discontinuous solutions and variation equations of equilibrium are obtained relations between deformations and loadings.

Are developed the variants of application of discontinuous solution of prefabricated structures. Are analyzed the impact of complete and incomplete hinges on mode of deformation of structure. Is researched the dependency of load bearing capacity of structure on number of constituent elements.

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STRUCTURE STYLE SELECTION OF THE MID-TOWER OF A THREE-TOWERSUSPENSION BRIDGE

POSTER

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Keywords

three-tower suspension bridge, mid-tower, finite element analysis

ABSTRACT

Three tower suspension bridge is a new bridge system, the design of the mid-tower is the key of the whole design of suspension bridge, the longitudinal form of the tower has great effect on the static and dynamic characteristics. Based on the analysis of the Ma'anshan Bridge, a three-tower suspension bridge, the suitable structure form of the mid-tower were analyzed, such as the deflection of the main span and the ant-i slipping safety factor between the main cable and saddle of the mid-tower. I type steel tower, I type steel concrete combined column, herringbone structure tower are analyzed. The analysis based on the finite element method shows that the I type steel concrete combined column and herringbone structure are appropriate. The relevant research results are significant for the design of the similar bridge structure.

INTRODUCTION

Three tower suspension bridge is a new bridge system, compared with the two tower suspension bridge, three tower suspension bridge with main span more than one and one tower, because of this, the static and dynamic characteristics of suspension bridge with two towers are different. Although the three tower suspension bridge has attracted great attention of scholars, and made a lot of research work, but in the research on the tower is not deep enough overall, while the longitudinal beam form tower tower connection mode and the tower has great effect on the static and dynamic characteristics, the article researches the connection according to the tower with the tower and beam method and tower longitudinal form different selected six tower plan, as follows:

1, the longitudinal I shaped steel-concrete composite column scheme, namely Ma'anshan bridge prototype scheme in the tower, the height is 178.8 meters , the horizontal for the door type frame structure, two transverse center spacing between tower, tower 35 meters, the bottom of the tower is 43.5 meters, the middle is provided with two beams. In columns that are divided into two parts: the upper 127.8 meters from adopts full steel tower, under paragraph 40.5 meters using concrete tower, tower 10.5 meters high decoration period, by the tower girder consolidation system.

2, the longitudinal I shaped steel tower in the whole scheme, 178.8 meters high tower wide, lateral to the portal frame structure, two transverse center spacing between tower, tower 35 meters, the bottom of the tower is 43.5 meters, the middle is provided with two beams. Tower transverse size is 6 meters, the longitudinal dimension from the top surface to the bottom of the tower 7 meters changes by 17 meters, tower beam consolidation system.

3, the longitudinal for the humanoid full steel tower scheme, combining with the results of existing bridge in Taizhou, this paper determines the tower up to 178.8 meters in the model, the herringbone tower two oblique leg center line intersection of elevation is above 52.4, the intersection point of intersection of the tower 123 meters high, tower 45.3 meters high, the top decoration section of 10.5 meters high, two oblique legs splayed volume at the bottom of the tower is 30 meters, using tower girder consolidation system.

4, the longitudinal I shaped steel-concrete composite column scheme, namely Ma'anshan bridge prototype scheme, only in the tower between the tower and beam longitudinal match with stiffness of 1000000kN/m elastic cable, tower on each side of a total of two, as, tower and beam separation system.

5, the longitudinal I shaped steel tower in the whole scheme, 178.8 meters high tower wide, and 2 the same, just in the tower between the tower and beam longitudinal match with stiffness of 1000000kN/m elastic cable, tower on each side of a total of two, as, tower and beam separation system.

6, the longitudinal for the humanoid full steel tower scheme, and the 3 the same, just in the tower between the tower and beam longitudinal match with stiffness of 1000000kN/m elastic cable, tower on each side of a total of two, as, tower and beam separation system.

This paper considered under live load, the six schemes on the displacement and internal force of girder, tower Bi-anta displacement and internal force, displacement and internal force of main cable, anti slip and other differences, in-depth analysis for three tower suspension bridge in tower form.

1 EFFECT OF DIFFERENT FORMS OF TOWER IN THE STATIC PERFORMANCE OF STRUCTURE

1.1 The displacement and internal force of main girder

In the suspension bridge system, the main beam is very important component of three tower suspension bridge, the whole rigidity than two tower suspension bridge down a lot, so the nonlinear displacement is significant, large deformations occur under vehicle load, in order to ensure the normal operation of the bridge, the displacement and internal force response analysis of bridge under vehicle load, to ensure the safety of structure. Analysis of girder displacement are as follows:

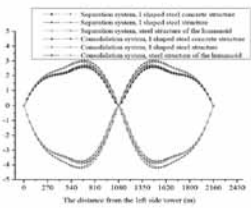

Fig.1-1 The vertical displacement of stiffening girder under different forms of middle tower

Table 1-1 The stiffening girder displacement values under different forms of tower

The form of the tower		Maximum deflection	Maximum upward displacement	Maximum displacement of beam end	Maximum angle
Tower beam consolidation system	I shaped steel-concrete	-3.763	2.566	0.051	0.017
	I shaped steel tower	-4.147	2.928	0.126	0.017
	Humanoid tower	-3.822	2.622	0.052	0.017
Tower beam separation system	I shaped steel-concrete	-3.858	2.686	0.099	0.017
	I shaped steel tower	-4.217	3.019	0.173	0.017
	Humanoid tower	-3.912	2.736	0.101	0.017

As can be seen, consolidation system, I shaped steel girder structure system of mixed all the values are smaller, followed by the humanoid tower structure, the biggest is I shaped steel structure, I shaped steel concrete structure, steel structure of the humanoid maximum deflection and the maximum upward displacement are I shaped steel tower structure 90.7% 87.6%, 89.5%, and 92.2. I shaped steel concrete structure, steel structure of the humanoid maximum deflection and the maximum upward displacement difference of 1.6%, 2.2%, basically equivalent. From the beam end displacement, I shaped steel concrete structure, steel structure gap is humanoid, and I shaped steel structure of the beam end shift compared with the other two system increase by nearly 2.5 times, up to 0.126m; the end of the beam angle of the three 0.017rad. Separation system, the I profile steel girder structure system of mixed all the values are smaller and the second is the humanoid tower structure, the biggest is I shaped steel structure, I shaped steel concrete structure, steel structure of the humanoid maximum deflection and the maximum upward displacement of I shaped steel tower structure respectively 91.4%, 88.9% and 92.7%, 90.6%. I shaped steel concrete structure, steel structure of the humanoid maximum deflection and the maximum upward displacement difference of 1.3%, 1.8%, the gap is very small. From the beam end displacement, I shaped steel concrete structure, steel structure gap is humanoid, and I shaped steel structure of the beam end shift compared with the other two system increase nearly 1.7 times, reached 0.173m, beam end displacement of large, the system is unfavorable to the stress in beam end rotation; three are 0.017rad, can not see the obvious influence on beam end corner tower form. Overall, the consolidation of the values were smaller than the main beam under the system of separate systems, especially the beam end displacement, separation system is almost 2 times the consolidation system.

Analysis of girder moment are as follows:

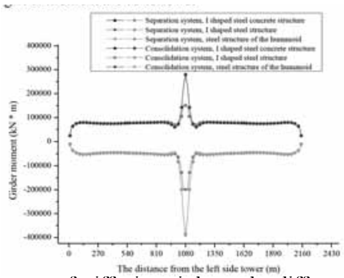

Fig.1-2 The bending moment of stiffening girder under different forms of middle tower

Table 1-2 Bending Moment under Different Forms of Tower

Bending Moment	I shaped steel- concrete (kN*m)		I shaped steel tower(kN*m)		Humanoid tower(kN*m)	
	The maximum value of consolidation system	The maximum value of separation system	The maximum value of consolidation system	The maximum value of separation system	The maximum value of consolidation system	The maximum value of separation system
L/4	76280.26	76430.87	76567.11	76724.91	76309.74	76461.86
L/2	77139.85	77199.1	77750.92	77822.18	77221.09	77284.34
3L/4	80536.12	79898.41	81225.92	80543.71	80668.46	80020.45
Mid-tower	389270.94	202199.55	383930.46	202247.81	387804.58	202169.6
The Maximum Stress (MPa)	88.3	68.1	86.9	68.1	87.8	68.1

As can be seen, consolidation system, L/4 at the moment from the I shaped steel concrete combined column to steel tower to humanoid I shaped steel tower becomes larger, but the difference is not big, mid span moment and 3L/4 moment changes also follow the same rules, the numerical difference is not large; at the moment of tower and variation of the I shaped steel tower structure is different, the minimum, followed by the humanoid steel structure, I shaped steel concrete structure maximum, I shaped tower steel structure and steel structure in the moment of humanoid are I shaped steel concrete structure in 98.5% and 99.6%, I - shaped bending steel tower structure is humanoid tower 98.9%, the gap is very small. Tower beam separation system changing rules of the stiffening girder moment and consolidation of the same system, but can be clearly seen from the consolidation system under the moment ratio separation system under large nearly 2 times, the corresponding stiffening girder maximum stress value is also nearly 30% separation system under the big, but still less than the allowable value of 203MPa stress stiffening girder this is because the tower, girder consolidation system stiffening Liang Jiagao tower is 5 meters, on the whole, the six scheme had little difference.

Through the above analysis, from the stiffening girder internal force and displacement angle, I shaped steel mixed the whole performance of the structure better.

1.2 The displacement and internal force of Mid-tower

In the three tower suspension bridge system, design of tower is the key, the displacement and internal force of tower is very important to the whole suspension bridge, under vehicle load, in the tower will shifts, significantly affect the stress and deformation of stiffening girder, tower displacement and internal force analysis of different form below table, axial force bending moment kN as unit, unit kN*m, displacement for m units:

As can be seen from the table in 1-3, in the action of live load, the axial force of steel structure section is the largest of the humanoid steel structure, structure and I - the maximum axial force of tower structure of basic quite mixed I shaped steel, the maximum axial force of humanoid tower about 5 times as much as the other two kinds of structure; steel structure section bending moment the small humanoid steel tower, the second is I shaped steel concrete structure, the maximum is I shaped steel tower structure, on the whole, the maximum bending moment is I shaped steel concrete structure, I shaped steel concrete mixed structure section stress values in the column beam consolidation and tower beam separation system difference, the maximum value appeared in the binding site of the steel tower and concrete tower, the tension stress can be configured through the control of prestressed steel structure section within 1.83MPa, maximum stress value is 231.7MPa, the corresponding materials does not exceed the allowable stress of 240MPa, the maximum value appeared in the steel tower and concrete tower binding site;I shaped steel tower and the tower of the humanoid maximum tensile and compressive stress difference, which does not exceed the allowable stress of 240MPa, the maximum value appeared in the tower and beam near the binding

Table 1-3 The displacement and internal force of Mid-tower

	I shaped steel- concrete		I shaped steel tower		Humanoid tower	
	Maximum value of consolidation system	Maximum value of separation system	Maximum value of consolidation system	Maximum value of separation system	Maximum value of consolidation system	Maximum value of separation system
Axial force of steel structure	-21349.38	-21336.43	-21349.09	-21336.19	-107119.42	-104963.92
Axial force of concrete segment	-21349.38	-21336.43	--	--	--	--
Bending Moment of steel structure	1966291.2	-1903933.7	2483216.9	2441991.94	1675511.42	1786329.22
Bending Moment of concrete segment	-2690597.63	-2640456.45	--	--	--	--
Maximum tensile stress of concrete segment	3.4	3.3	--	--	--	--
Maximum compressive stress of concrete segment	-6.8	-6.5	--	--	--	--
Maximum tensile stress of steel structure	133.1	125.6	115.6	109.3	95.7	103.8
Maximum compressive stress of steel structure	-231.7	-228.9	-222.5	-219.6	-222.3	230.4
The top displacement	1.374	1.451	1.657	1.722	1.416	1.49

site; from the tower top displacement, consolidation system of I shaped steel concrete structure displacement minimum 1.374m, I shaped steel structure is the largest tower beam separation system, 1.722m. In general, the structure stress better mixed I shaped steel, in moderate stiffness

1.3 The displacement and internal force of Side-tower

The car loads, follows a different form of tower in tower bottom displacement and internal force analysis of axial force, bending moment of the unit is kN, the unit is kN * m, displacement for m units:

Table 1-4 The displacement and internal force of Side-tower

	I shaped steel- concrete		I shaped steel tower		Humanoid tower	
	Maximum value of consolidation system	Maximum value of separation system	Maximum value of consolidation system	Maximum value of separation system	Maximum value of consolidation system	Maximum value of separation system
Axial force	-19525.26	-19554.96	-19516.96	-19543.71	-19524.72	-19554.04
Bending Moment	200605.15	200968.51	200392.82	200735.81	200583.17	200943.9
Maximum stress	-15.2	-15.2	-15.2	-15.2	-15.2	-15.2
The top displacement	0.161	0.161	0.161	0.161	0.161	0.161

As can be seen from the table, six schemes of tower axis below the maximum stress difference, can be ignored; Bianta maximum moment not quite, section stress was compressive stress, and the value is equal to 15.2MPa, no more than the specification requirements of the 22.4MPa, no tensile stress, and the top displacement are equal, for the 0.161m; the maximum values appeared at the bottom of the tower and stress bending moment, from the table can be seen in the form of Bianta effect of tower displacement and internal force is very small.

1.4 Main cable safety factor against sliding

The main cable is an important bearing component of suspension bridge, and its stability directly related to the safety of the bridge, the main cable in between and at the top of the tower saddle anti sliding stability is the key issue, in the three tower suspension bridge system, when a cross loaded and another cross no-load main cable saddle, both sides have a big cable force is poor, if not will produce friction slip, causing the disintegration of the entire system failure, so for three tower suspension bridge tower, requirements in any condition, ensure the main cable without relative slip in the main saddle are to, to ensure that the main cable anti slip safety coefficient reaches the requirement, live load different forms of main cable tower under the anti slip as shown in the following table, the internal force calculation method of unit kN, the front of anti sliding safety factor has been described, here no longer:

Table 1-5 The inter force of main cable of the middle tower and anti-slip safety factor coefficient

The form of the tower		Tight side force	The loose side force	Internal force difference	Safety coefficient	The allowable value
Tower beam consolidation system	I shaped steel-concrete	199304.3	185395.5	13908.8	2.31	≥2
	I shaped steel tower	198604.3	186084	12520.3	2.57	≥2
	Humanoid tower	199187.5	185510.1	13677.4	2.35	≥2
Tower beam separation system	I shaped steel-concrete	200282.6	184627.1	15655.5	2.06	≥2
	I shaped steel tower	199522.9	185355.1	14167.8	2.27	≥2
	Humanoid tower	200154.3	184748.8	15405.5	2.09	≥2

As can be seen from table 1-5, different forms of tower of the main cable anti slip stability influence or larger, consolidated system under the I shaped steel concrete structure on both sides of the difference between the maximum cable force, the second is the humanoid steel structure, I shaped tower cable force in both sides of steel tower structure difference between the minimum safety factor, corresponding to the contrary, I shaped steel the minimum factor of safety of mixed structure, followed by the humanoid I shape steel tower structure, tower structure of the highest safety factor, which reflects the I shaped steel mixing in the tower of the maximum stiffness, I shaped steel tower of minimum stiffness. Tower beam separation system and the consolidation of the same system, I shaped steel concrete structure safety coefficient is the smallest, next is the humanoid tower structure, the biggest is I shaped steel structure, but the safety coefficient of consolidation of pylon beam system is higher than that of the tower and beam separation system. Anti slip from the situation, the six scheme satisfies the requirements of.

2 CONCLUSIONS

Through the above six kind of scheme comparison of static characteristics, six kinds of schemes can satisfy the key control parameters of three tower suspension bridge main cable requirements, namely, anti sliding safety factor is greater than 2, the maximum vertical deflection value is not greater than the span of 1/250 ~ 1/300, the Liang Duan rotation angle of not more than 0.02rad, the conclusions are listed as follows:

(1) from the stiffening girder internal force and displacement angle, consolidation system under the I shaped steel mixed structure better overall performance.

(2) from the tower of the displacement and internal force of point of view, consolidation system under the I shaped steel mixed structure better overall performance.

(3) influence on the displacement and internal force of tower form Bianta is very small.

(4) from the anti slip, tower girder consolidation system is superior to the tower and beam separation system.

Through the above on the static and dynamic characteristics of six kinds of different forms under the tower in contrast, structure and human tower structure stress better mixed I shaped steel, I shaped steel concrete structure of the overall stiffness is slightly larger than the humanoid tower structure, tower girder consolidation system good stress.

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STUDY OF LOW-CARBON AND LOW-ALLOY STEEL RECRYSTALLIZATION WITH THE USE OF PASSIVE FLUX-GATE TEST METHOD

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Keywords

cold plastic deformation, materials technology, non-destructive testing

ABSTRACT

A lot of attention is paid in Russia to the advanced developments in the field of metallurgical technologies and application thereof in different fields. The most acceptable method of providing the fine-grain structure is the recrystallization annealing. The main purpose of annealing is to build a uniform structure providing for better workability of steel products and higher level of mechanical properties thereof. It becomes possible as a result of recrystallization in solid state to correct such a significant defect of steel structures as the coarse-grained structure obtained as a result of overheating. The possibilities of passive flux-gate test method have been studied to check shaping the fine-grained structure in the course of recrystallization annealing. A correlative relationship has been revealed between the temperature of heating and structural changes taking place on the cold-worked low-carbon 08ps and low-alloy 09G2S and 10HSND steels.

1. INTRODUCTION

Presently, there is no universally accepted theory of recrystallization at annealing. Both the recrystallization kinetics and the theory of the recrystallization centers forming are insufficiently investigated. In this connection the relevancy and unlikelihood of the above subject are beyond all doubts. There is a need for further new substantial approaches and assumptions. Paying special attention to the experimental results the authors see the purpose of this article in substantiating emergence of the fine-grain structure in the structural low-tempered steel after recrystallization annealing.

2. BACKGROUND

The main purpose of annealing is the formation of a homogenous steel structure providing for better workability of articles and higher level of mechanical properties. As a result of recrystallization in solid state it becomes possible to correct such an existing defect of the steel structures as the coarse-grain structure obtained as a result of overheating. In this connection the possibilities of passive flux-gate test method have been studied to check for shaping the fine-grain structure in the process of recrystallization annealing.

Thus, the introduction of alloying elements incre ases mechanical properties of the steel and, in particular, reduces the threshold of cold brittleness. In case of grain grinding the strength of hardened low-tempered steel increases, i.e. increases its yield point, yield stress at various deformation values, ultimate strength, hardness and fatigue strength. As a result, a possibility will appear to reduce the weight of structures, ensure required reliability and durability thereof.

3. METHODS

The following were chosen for experimental research: low-carbon steel 08ps and low-alloy steels 09G2S and 10HSND.

This choice was conditioned by the fact that these steels:

• are widely used in various industries;
• have good plasticity characteristics in the field of both standard and low temperatures;
• allow expanding the obtained regularities to all materials with similar composition and properties, and giving substantiated recommendations for them.

In order to carry out investigations the plates 30 mm wide, 150 mm long and 2 mm thick have been cut out of the sheets of structural steels 08ps, 09G2S and 10HSND across the rolling direction that have been subject to fractional cold plastic deformation to a degree =50% (, [epsilon] □ degree of plastic deformation). The samples have been cut out of these plates for subsequent recrystallization annealing at temperatures of 20°C to 800°C and conducting metallographic examinations. Apart from this, in order to assess the influence of equilibrium structure on the magnetic properties of steels, some samples have been subjected to high-temperature annealing at 900°C and 1050°C after the cold plastic deformation.

The beginning and end of recrystallization have been determined by passive flux-gate test method through measuring the strength of stray magnetic fields (Hp) at the tested samples by means of stress concentration magnetometric gauge with dual-channel flux-gate test transducer and by means of microstructural analysis.

4. CASE HISTORY

In the course of steels structure investigation the problems appear that are related to insufficient clarity of recrystallization kinetics (Bhadeshia, H. & Honeycombe, R. 2007; Callister, D.W. & Rethwisch, D.G. 2010; Lobanov, L.M. et al. 2006). One of them concerns an issue, whether the metals get crystallized in the course of deformation or in the wake of hot deformation? According to us a significant reduction of Hp values at temperatures from 150°C to 300°C (Figure 1) is probably related to the course of the first stage of return, the rest, in steels. As a result of the rest, a number of pin hole defects (interstitial atoms and vacancies) gets reduced through annihilation at the edge dislocations. The number of distortions of crystalline lattice also drops.

According to Shackelford & Alexander (2001) no structural adjustments of dislocation structure take place in this case. We suppose that in case of increasing the temperature of heating in excess of 300°C the reduction of Hp values happen due to diffusion processes activation. At that, redistribution of dislocations, annihilation thereof and forming-up excessive dislocations of the same sign into vertical dislocation walls occur, which results in subgrains formation: the polygonization process is in progress. According to Montheillet (2005) they become larger due to dislocation boundaries movement, which brings about the reduction of defects density.

As it was stated before, the kinetics of recrystallization and formation of recrystallization centers provokes many questions due to insufficient knowledge about it. It is considered that recrystallization begins normally at the boundaries of grains at increasing the temperature of annealing. Hence, the presence or absence of recrystallization depends basically on the energy of deformation of the boundaries of grains required for origination of new grains (Panov, D.O. et al. 2013).

However, such a finding needs clarification. We suppose that the beginning of primary recrystallization is characterized by the formation of recrystallization centers in those areas of deformed grains, where the density of dislocations is increased and the crystalline lattice features the worst distortions (Gordienko, V. 2013). They grow as a result of reattachment (diffusion) of atoms thereto from a deformed environment, at that, the boundaries of recrystallization center migrate towards the deformed environment. It should be noted that according to data of metallographic research carried out by the authors the beginning of recrystallization for steel 08ps is observed at 550°C, while for steels 09G2S and 10HSND it is observed at 600°C. In case of magnetic testing not only the recrystallization beginning gets recorded but the return processes as well, which testifies to high sensitivity of the magnetic method.

5. RESULTS

Fig.1 shows a dependence of the magnetic field strength on the temperature of recrystallization annealing for steels 08ps, 09G2S and 10HSND.

Fig.2 presents a change of structure of steels under study 08ps, 09G2S and 10HSND after recrystallization annealing at 900°C and 1050°C.

Fig.3 shows variation of structure of steel 08ps during recrystallization annealing.

Fig.4 shows variation of structure of silicon-manganese-based steel 09G2S after recrystallization annealing.

As Figure 1 shows a sharp reduction of magnetic field strength (Hp) values for all steels under study is observed

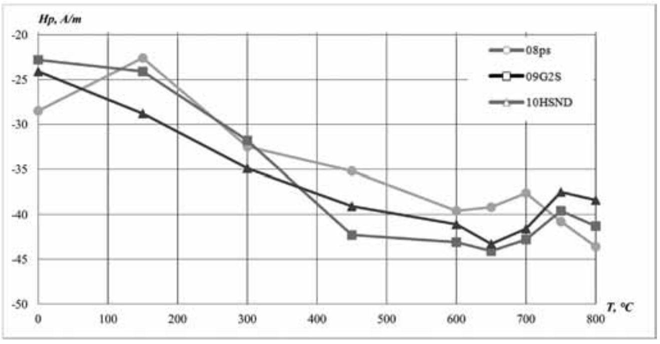

Fig. 1. Dependence of stray magnetic field Hp strength on temperature of recrystallization annealing for steels 08ps, 09G2S and 10HSND.

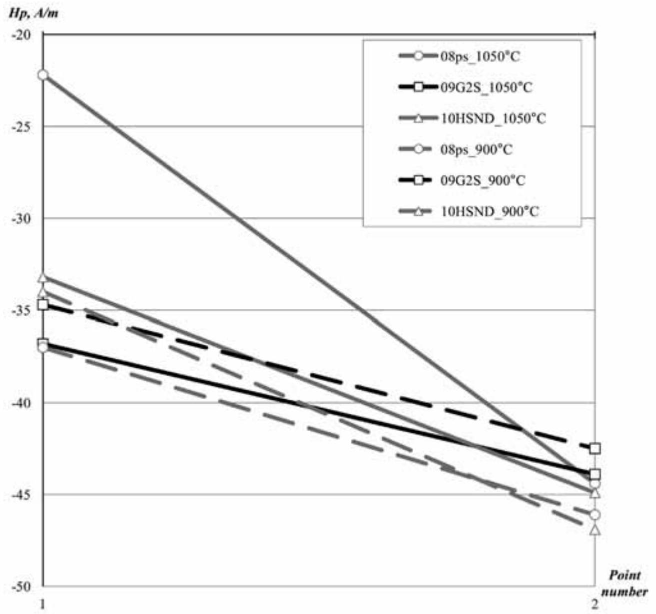

Fig. 2. Variation of stray magnetic field Hp strength in samples of steels 08ps, 09G2S and 10HSND after annealing at 1050oC (continuous line) and 900oC (broken line) axis: 1 – before annealing, axis 2 – after annealing.

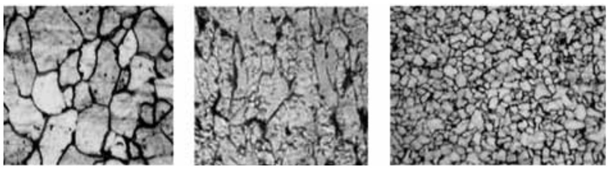

Fig. 3. Variation of structure of steels 08ps during recrystallization annealing, x400: a – as-delivered state, b – after rolling at =50%, c – after annealing at 700°C.

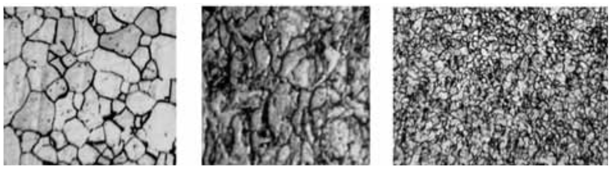

Fig. 4. Variation of structure of steels 09G2S during recrystallization annealing, x400: a – as-delivered state, b – after rolling at =50%, c – after annealing at 725°C.

in the range of temperatures from 150°C to 300°C. As the heating temperature rises in excess of 300°C, a further reduction of Hp values takes place but with lower intensity. The reduction of Hp values stops in the range of temperatures from 600°C to 650°C and then a certain rise can be observed.

The increase of temperature of annealing for the deformed steel from 900°C to 1050°C changes the value of Hp as compared with the original state (Figure 2). At that, the increase of annealing temperature irrespective of the steel grade, contributes to stabilizing Hp values and approximating them to the values commeasurable with the strength of magnetic field of the Earth (±40 A/m= 0.5 Gs).

According to data of metallographic investigation the beginning of recrystallization for steel 08ps is observed at 550°C, for steels 09G2S and 10HSND it is observed at 600°C. The temperature of recrystallization end for steel 08ps at 700°C (Figure 3), for 09G2S and 10HSND – at 725°C (Figure 4). The fine-grain structure with grain size of 8 μm for steel 08ps, 6 μm for steel 09G2S and 5 μm for steel 10HSND is shaped in the process of primary recrystallization. Further increase of annealing temperature brings about an increase of grains size. It should be noted that as the degree of steel alloying, increases, more fine-grain equiaxed structure is shaped, which ensures isotropy of mechanical properties (Campbell, F.C. 2008).

6. CONCLUSIONS

The study of recrystallization of low-carbon and low-alloy steels 08ps, 09G2S and 10HSND helps come to the following conclusions:

1. Preliminary cold plastic deformation and the subsequent recrystallization annealing are the most acceptable methods of obtaining the fine-grain structure in low-carbon and low-alloy structural steels.
2. Registration of quite an early stage of finishing the primary recrystallization in structural steels 08ps, 09G2S and 10HSND makes it possible to attain the fine-grain equiaxed structure, which becomes more particulate in the course of increasing the degree of alloying.
3. At that it is possible to use rather high sensitivity of the stray magnetic field (Hp) strength depending on the temperature of recrystallization annealing for checking quality of low-carbon and low-alloy steels.

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EVALUATION OF TECHNOLOGY APPLYING LIMESTONE POWDER IN ROAD PAVEMENT LAYERS

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Keywords

road construction, travertine powder, road pavement

ABSTRACT

This paper presents a new technology of strengthening road pavement layers from crushed-stone-gravel-sandy mixtures, based on applying waste materials of limestone mines. Testing were done for development parameters of technology. Additional testing were carried out for profitability assessment of applying travertine powder in layers from crushed stone-sand mixtures. Applying travertine powder at optimum percentages in C6 crushed-stone-gravel-sandy mixtures with crushed basalt and crushed gravel sand are equal to applying cement at percentage respectively 3.5% and 2.5%.The suggested technology was introduced with comparative tests of experimental road sections, with simultaneous assessment of the change of rigidity of the road pavement layer. Field testing showed the values of elasticity modulus of C6 mixture and of the new mixture, created by mixing C6 mixture with travertine powder in optimal quantity.

1. INTRODUCTION

The development of road network is one of actual problems in Republic of Armenia. It is based on two important ideas – to increase road construction quality and to enlarge the road network. Requirements to road network are rising due to development of country economy. In consideration of actual conditions, design and construction of durable and resistant road pavements is a way to satisfying current requirements.

Mixtures of aggregates with optimal granulometric composition are widely used in road construction practice, especially in road pavement layers. An example are crushed-stone-gravel-sandy optimal mixtures (hereinafter referred to as ready mixtures), which are used during the recent years also in Republic Armenia's road construction, mainly as base and subbase layers of pavement. However, along with comparatively cheap price, the layers, made from the mentioned material, do not always have the required strength and service life, and the problem of their strengthening with relatively less costly means becomes urgent. Taking into account the high cost of organic and inorganic binders, for the restoration of local roadnet pavements can be applied the strengthening of ready mixtures with the use of various stone powders or industrial wastes. In particular, it is economically perspective to use travertine powder as an additive in ready mixtures, which is available in sufficient quantity especially in Ararat region. Hence, the paper underlines the purpose of developing technology of ready mixtures with optimal granulometric composition, made on the basis of travertine powder, which will ensure high performance of base and surface courses, made from these mixtures, as well as their introduction into the practice of road construction and repair.

2. BACKGROUND

30-ies of the last century began soil stabilization feature have been used in the local roads construction. The practice of reducing volume requirements of construction stone materials and replacing them with strengthened soils for road pavements construction has promoted development of soil treatment technologies and creating more effective variants in UK, USA and European countries. Using of modified and treated soils and aggregates in road pavements layers has been checked by time, and has started applying widely especially in USA (Sherwood Ph. 1995).

Organic and mineral binders are used for strengthening and treatment of soils and aggregates. Strengthening soils and aggregates with mineral binders – cement and lime, are widespread options. Along with the application of mineral or inorganic, organic binders’ use is also widespread. There are many technologies of soils strengthening with complex method, using different types of binders simultaneously. Cement and bitumen mainly are used for complex strengthening of soils and aggregates, different surface-active and structure-forming materials – lime, fly ash, gypsum, other chemical materials are used as additives. The main feature of complex strengthening is to modify the physicomechanical and physicochemical properties in wide range of positive direction by exact selecting binders and their optimal quantity, to increase adhesion properties of binders, to accelerate or decelérate the binding process in strengthening soils.

Different type of industrial wastes are widely used in road pavement layers in many countries. For example, fast hardening mixtures are applying for construction local roads with soil surface in Russia. Water resistant gypsums are used as an additional binders, which are formed from industrial wastes, especially generated during wet magnetic separation of iron quartz. The wastes of metallurgy industry and electrometallurgy are widely used in road bases construction. The new reagent has been developed for decreasing dust formation, which is based on sulphide and limestone powder (Motovilov B.P. 1984).

The big practice of applying industrial wastes in local road pavement layers from aggregate mixtures was formed in India (Tara S., Umesh M. 2010). Realization of industrial wastes and environmental protection are urgent problems for India. Industrial wastes are fly ash, blast furnace dust, cement kiln dust, phosphogypsum, waste plastic bags and foundry sand and colliery sand.

Big amounts of travertine powder, which is industrial waste, was accumulated in travertine or limestone mines of Republic of Armenia. We have done studies for applying travertine powder as an additive-binder in road pavement layers of ready mixtures.

3. METHODS

Laboratory testing have been done for identifying optimal quantities of adding travertine powder as an additive into the composition of ready mixtures, evaluation of strength indexes of mixtures with travertine powder, determining of effectiveness adding travertine powder in mixtures. Testing have been done according to current state standards and other regulatory documents. Especially, physicomechanical and physicochemical properties of two types of sand – basalt and gravel sands, crushed stone and travertine powder have been studied. Field testing have been done on experimental road sections. Dynamic method of measuring modulus of elasticity have been applied using equipment KUAB FWD.

Travertine powder quantity, %	C2		C6		C7	
	With gravel sand	With basalt sand	With gravel sand	With basalt sand	With gravel sand	With basalt sand
0	1.44	1.20	1.15	1.06	1.24	1.07
10	1.89	2.00	1.81	2.47	2.83	1.70
15	-	-	-	3.14	-	-
20	2.63	1.84	2.28	3.94	4.29	2.40
25	3.21	-	2.57	-	-	3.71
30	3.75	1.87	2.55	3.87	4.66	4.28
35	3.42	1.60	2.30	3.29	4.18	3.94

Fig. 1. The mean values of laboratory sample’s compressive strength, MPa

3. CASE HISTORY

The technology of adding travertine powder as an additive into ready mixtures was developed after the examination of three types of mixtures (C2, C6, C7), two of which are intended for the application in base course layers, and the other one is intended for the application in the surface course layers of road pavements (Gyulzadyan H., Voskanyan G., Ter-Simonyan V. 2014). Laboratory tests have been carried out to conduct experimental research, the results of which permit to conclude that the samples of small and big aggregates, preselected by us, can be applied to prepare ready mixtures. A study was conducted of the chemical, mineral compositions of travertine powder and of the structural changes while interacting with water. Optimal quantities of adding travertine powder as an additive into the composition of ready mixtures have been identified depending on the type of sand, used in the mixtures. The optimal quantities of the additive have been identified in the result of analysis of the values of compression strength, obtained during the laboratory testing of dxh=150x150mm cylindrical samples fig. 1.

As a result there have been elaborated recommendations of introduction of travertine powder as an additive into ready mixtures of C2, C6 and C7 types with different types of sands. According to fig. 1 data in case of gravel sand for C2 mixture the optimal quantity is 25-30%, for C6 mixture – 20-25% and for C7 mixture – 20-30 %. In case of basalt sand for C2 mixture the optimal quantity is 10-20%, for C6 mixture – 20-30% and for C7 mixture – 25-30 %. The compressive strength values of samples from C2, C6 and C7 ready mixtures with gravel sand have been increased respectively about 2.42, 2.11, 3.61 times compared with the same ready mixtures without travertine powder. The same data from C2, C6 and C7 ready mixtures with basalt sand are respectively recorded about 1.6, 3.68, 3.73 times.

A study was conducted of the chemical, mineral compositions of travertine powder and of the structural changes while interacting with water. According to this study compressive strength indices of cylindrical samples were increased when travertine powder was added, because the binding mechanism was created in mixtures due to travertine powder low activity pozzolanic property.

5. RESULTS

To assess the cost-effectiveness of using travertine powder in crushed-stone-gravel-sand ready mixture as an additive, additional laboratory tests were carried out. Mixtures with optimal granulometric composition were composed, after cement CEM II 42.5N (M400) was added with percentage 1%, 2%, 3% and 4% of the mixture mass. Laboratory experiments were carried out only for a mixture C6, as it is currently the most common type of mix for RA road con-

Cement quantity, %	C6 (28 days)							
	With gravel sand			Mean values	With basalt sand			Mean values
1	0.77	0.95	0.91	0.88	1.00	0.77	0.81	0.86
2	2.08	1.40	1.62	1.70	2.20	2.40	2.09	2.23
3	3.15	2.72	2.89	2.92	3.22	3.25	3.37	3.28
4	4.30	3.70	3.82	3.94	4.21	4.11	4.09	4.14

Fig. 2. The values of laboratory sample's compressive strength, MPa

struction practice. The results obtained from above mentioned testing are presented in fig. 2 (Voskanyan G. 2014) The results were compared with data obtained from testing of samples with applying travertine powder. The comparison allows us to conclude that applying travertine powder at optimum percentages in C6 crushed stone-sand mixtures with crushed basalt and crushed gravel sand are equal to applying cement at percentage respectively 3.5% and 2.5%. Comparative effectiveness assessment revealed that for C6 ready mixtures with optimal grain size by replacing of cement binder with travertine powder the savings compose up to 21.5% in case of gravel sand, and up to 31% in case of basalt sand. Laboratory testing of samples does not allow to evaluate the influence of adding of travertine powder on values of elasticity modulus of road pavement layer with ready mixtures. For this study, we constructed an experimental road 5 m wide and 120 m long. The first section of road was constructed using crushed-stone-gravel-sandy mixture C6, and the second section was constructed using the same mixture with the treatment of optimal quantity of travertine powder. The constructed experimental road approximately 1 month was maintained under heavy traffic and different climatic impacts. After that dynamic method of rigidity field testing of the constructed road sections has carried out using KUAB FWD equipment. Testing were carried out in dry weather conditions, the air temperature +9° C. During the test were recorded registered data of deflections (f) and calculated with computer program equivalent elasticity modulus (Eeq) values. The recorded are presented in fig. 3.

The estimates values of equivalent elasticity modulus ($E_{\_EST}$) were determined using the mean experimental (E) values, measurement's coefficient of variation (CE) and the value of deviation factor (t=1.64).

$$E_{\_EST}=E\ (1-t\times C_{\_E}), \quad (1)$$

The estimates values of equivalent elasticity modulus calculated by the formula (1) are shown below:
For the subgrade $E_{\_EST}$=108 *MPa* ,
For the pavement layer with C6 mixture $E_{\_EST}$=202 *MPa* ,
For the pavement layer with C6 mixture treated with optimal quantity of travertine powder $E_{\_EST}$=248 *MPa*.

Considering the road pavement as two - layer system, known in theory of elasticity, the elasticity modulus of tested pavement layers were calculated. Calculations revealed that the modulus of elasticity's of C6 ready mixture is

Subgrade			Pavement with C6 mixture			Pavement with C6 mixture treated with optimal quantity of travertine powder		
Chainage	f, micrometer	E_{eq}, MPa	Chainage	f, micrometer	E_{eq}, MPa	Chainage	f, micrometer	E_{eq}, MPa
1+00	1582	101	0+2	902	179	0+55	442	370
1+00	1494	107	0+2	882	183	0+55	419	390
0+90	1359	119	0+10	919	176	0+65	806	200
0+90	1284	126	0+10	889	182	0+65	775	208
0+80	1512	105	0+20	471	346	0+75	412	396
0+80	1444	110	0+20	420	388	0+75	407	401
0+70	1514	103	0+30	944	171	0+85	795	203
0+70	1405	111	0+30	832	194	0+85	751	215
0+60	1465	108	0+40	614	265	0+95	813	197
0+60	1364	116	0+40	548	297	0+95	748	214
0+50	1444	112	0+50	564	289	1+05	784	205
0+50	1337	121	0+50	562	290	1+05	741	217
-	-	-	0+45	493	332	1+10	453	361
-	-	-	0+45	430	381	1+10	407	401
-	-	-	0+35	890	180	1+00	791	204
-	-	-	0+35	821	195	1+00	737	219
-	-	-	0+25	991	161	0+90	800	201
-	-	-	0+25	922	173	0+90	792	203
-	-	-	0+15	919	175	0+80	525	310
-	-	-	0+15	851	189	0+80	513	317
-	-	-	0+8	986	162	0+70	555	292
-	-	-	0+8	845	189	0+70	526	308
-	-	-	0+4	942	171	0+60	798	202
-	-	-	0+4	866	186	0+60	775	208
Mean Values								
-	1438	112	-	771	227		649	268

Fig. 3. The results of field testing

obtained value of 404 *MPa*, and the same values from the treated layer is obtained a value of 648 *MPa*. The ratio of increasing the modulus of elasticity as a result of applying travertine powder reached to 1.6 times.

6. CONCLUSIONS

The optimal quantities of applying travertine powder as an additive in crushed stone-sandy ready mixtures in case of using gravel sand are for C2 mixture - 25-30%, for C6 mixture – 20-25 % and for C7 mixture – 20-30 %. In case of basalt sand the data respectably are for C2 mixture 10-20%, for C6 mixture – 20-30% and for C7 mixture – 25-30 %. The compressive strength values of samples from C2, C6 and C7 ready mixtures with gravel sand have been increased respectively about 2.42, 2.11, 3.61 times compared with the same ready mixtures without travertine powder. The same date from C2, C6 and C7 ready mixtures with basalt sand are respectively recorded about 1.6, 3.68, 3.73 times.

Applying travertine powder at optimum percentages in C6 crushed stone-sand mixtures with crushed basalt and crushed gravel sand are equal to applying cement at percentage respectively 3.5% and 2.5%. For C6 ready mixtures with optimal grain size by replacing of cement binder with travertine powder the savings compose up to 21.5% in case of gravel sand, and up to 31% in case of basalt sand.

The modulus of elasticity's of C6 ready mixture is obtained a value of 404 *MPa*, and the same values from the treated layer is obtained a values of 648 *MPa*. The ratio of increasing the modulus of elasticity as a result of applying travertine powder reached to 1.6 times

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ANALYSIS OF THE INFLUENCE OF REACTIVE POWDERS ON THE CHOSEN HIGH-VALUE CONCRETE PRICES

POSTER

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Keywords

concrete, reactive powders

ABSTRACT

Concrete is a composite whose properties depend on the characteristics of its components (phases), namely aggregate, concrete, additions and contact layer, which is the coarse aggregate - concrete slurry. The weakest link in the concrete is usually the point of contact of the surface of the coarse aggregate and the concrete slurry. In case of high-value concrete it is attempted to strengthen this layer by applying additions (microfiller content), which cause the reduction of porosity of this phase and improvement in aggregate grip to the concrete matrix. The result is rise in mechanical and physical concrete parameter. In this way you can get the concrete, which is very durable and has special properties. Additionally, reactive powders have a positive effect concrete contraction decrease, increase of the chemical aggression resistance and decrease of the amount of emitted warmth during the concrete hydratation. The article presents the research results concerning the influence of reactive powders on compression resistance, absorption, water penetration depth and frost resistance of high-value concrete. The compression resistance research was carried out after 28 and 56 days of the concrete hardening. There was carried out a research of the porosity characteristics of the hardened concrete for the chosen concrete series. The frost resistance research was carried out for 150 cycles of concrete freezing and defrosting. The reactive powders having been used are: siliceous dust, fly ashes, flaked ceramics and flaked pure quartz sand. All reactive powders were dosed in the amount of 10 or 15% of the concrete mass.

1. INTRODUCTION

Nowadays the produced concrete contains some additions in form of reactive powders apart from the traditional components. The reactive powders are taken to be high-value components, which modify the features of concrete mixture and hardened concrete. The use of those powders in the concrete technology is considered to be a part of the balanced development conception, which enables the reduction in the use of the natural fossil resources and the decrease of the environment pollution. The reactive powders modify the concrete structure, what leads to the improvement of the concrete properties and improvement in durability. It is important, that the used reactive powders are not produced on purpose, but that is various industrial waste having its application to the civil engineering sector, especially in the concrete technology. The dynamic industrial development leads to the increasing production of the industrial waste, which should be managed or safely stored. Meeting those requirements is considered to be a big challenge for the scientists. Waste disposal on landfills is not a good solution. It repeatedly leads to creation of enormous disposal surface, protection necessity and the analysis of their environment influence. It is a solution, which in the economic and often environmental respect arouses many reservations and protests of the local inhabitants and ecological activists. Carrying out a recycling process or industrial waste recycling seems to be a rational solution. Concrete is a material, which can be consciously modified by various additions coming from the post-production waste. In this way the applied waste to concrete may not only be managed but also it has the impact on improving the concrete component features. Nowadays there are specific products used as additions to the concrete: fly ashes (as a partial concrete substitute), microsilica, blast furnace slag and other reactive powders, what enables creating the concrete, which is more resistant to the chemical corrosion and frost. What is more, reactive powders limit the reach and porosity of the aggregate contact layer – ITZ (Interfacial Transition Zone) concrete slurry.

2. BACKGROUND

The presence of the aggregate contact layer – concrete slurry in the concrete composites was confirmed by many scientists. Until now they are not unanimous about the reasons of ITZ creation and its influence on decay process of the materials having concrete matrices. First references concerning the aggregate contact layer – concrete slurry are to be found in 1905 (Sabin L.C., 1905). However, first publications concerning the subject of the contact layer presence in concrete date back to the 1950s (Farran J., 1956). The current ITZ knowledge is presented in many publications. Despite different views, it is generally acknowledged that the aggregate contact layer – concrete slurry has higher porosity in proportion to the concrete slurry, which is remote to the grain surface of the coarse aggregate. The highest ITZ porosity level is to be found within the distance of 10-12 μm from the grain surface and it equals to 18-20% (Scrivener K.L., 1996). It means that the point of contact between the grain aggregate surface and concrete slurry is the weakest link in the concrete composite. The aggregate contact layer – concrete slurry influences not only mechanical properties of the concrete but also physical properties like cyclical freezing and defrosting resistance (Sicat E., 2014). The appropriate amount of the reactive powders reduces capillary pores and modifies profitably the ITZ microstructure, improving in this way the parameters of the hardened concrete, compression and frost resistance and absorbability. Nowadays microsilica and fly ashes are generally added to the concrete composite, though there are also used other additions, which influence positively on the concrete properties. Many scientists admitted that microsilica improves the properties of the concrete. It is well-known that an addition in form of microsilica seals the concrete matrix and the aggregate contact layer – concrete slurry, increases the durability as well as concrete resistance and reduces its absorbability. Trilok Gupta and other scientists proved that microsilica improves also impact resistance of the concrete (Gupta T., 2015). Mahmoud Nili and the others proved in their researches that microsilica and nanosilica increase the growth pace of the concrete resistance and modify the aggregate contact layer – concrete slurry (Nili M., 2015). Similar research results were shown in (Mukharjee B.B., 2014), where the concrete hardness and grindability with an addition of silica were proved. An addition in form of microsilica and fly ashes influences positively the chloride corrosion of the concrete. Moreover, fly ashes improve the fluidity of the concrete mixture and its plasticity, thanks to which it is used to the self-compacting concrete (Wongkeo W., 2014). Fly ashes are applicable to the concrete both as a concrete substitute but also as microaggregate. The basic fly influence is connected with the properties of concrete mixture and concerns water demand and plasticity. It influences profitably the plasticity of the concrete mixture, it has plastifying properties, causes the improvement of the solidity and prevents its segregation. Fly ashes have, indeed, a huge influence on the improvement of the mixture concrete tightness and corrosive concrete resistance. In the age of the increased production of industrial waste, some people try to apply various waste material to the concrete, which are treated as microfillers or aggregate. In the work (Rajczyk J., 2014) there were applied granulated waste from grit chamber from the water treatment plant as a partial sand substitute. More often, those are household and sanitary ceramics, which are applied to the concrete composites. Medina and the others (Medina C., 2012). applied household and sanitary ceramics to the concrete as an aggregate substitute. The concrete with the addition of the sanitary ceramics proved to be more resistant to compression and tensile strength that the concrete on the basis of graveled aggregate and they were characterized by lower amount of macropores. It was proved that the ceramics aggregate contact layer – concrete slurry is more compact not as porous as graveled aggregate contact layer – concrete slurry. Ceramics aggregate from recycling was used to the concrete also by Halicka and the others (Halicka A., 2013). They proved in the researched the increased compression resistance and abrasion resistance with an addition of ceramics aggregate in proportion to the concrete with an addition of natural aggregate. They proved that the ceramics aggregate from recycling can be applied to the special concrete, working in high temperatures.

3. METHODS

The aim of the research programme was to determine the influence of the reactive powders on the properties of the concrete mixture: the content of air, consistency and concrete properties: compression resistance after 28 and 56 days, absorbability, the water penetration depth and frost resistance for 150 cycles of freezing and defrosting. There was carried out a research of porosity characteristics of the hardened concrete in accordance with the PN-EN 480-11 norm. This research consisted in pore observation on properly prepared concrete microsections and determining parameters describing the amount, size and distribution of pores i.e. - pore distribution coefficient and A300 – the micropore kontent with the greatest diameter not exceeding 300 μm. it is generally acknowledged that to create a concrete, which would be resistant to frost, the proper air bubbles distance in the hardened concrete should correspond to ≤0,20mm coefficient and the pore content with the diameter not exceeding 300μm (class 18): A300>1,5% Wawrzeńczak J., 2011). The frost resistance research was carried out in accordance with the PN-88/B-06250 norm. The research consisted in freezing the concrete specimens, which were saturated with water in

Components [kg/m³]	Concrete series								
	C	S10	S15	A10	A15	CE10	CE15	SA10	SA15
Concrete	332	332	332	332	332	332	332	332	332
Water	158	158	158	158	158	158	158	158	158
Aggregate	1993	1960	1943	1960	1943	1960	1943	1960	1943
Superplasticizer	6,64	8,3	8,3	6,64	6,64	6,64	6,64	6,64	6,64
Microsilica	-	33,2	49,8	-	-	-	-	-	-
Fly ash	-	-		33,2	49,8	-	-	-	-
Crumbed ceramics	-	-	-	-	-	33,2	49,8	-	-
Crumbed quarto sand	-	-	-	-	-	-	-	33,2	49,8

Fig. 1. The mean values of laboratory sample's compressive strength, MPa

Concrete properties	Concrete series								
	C	S10	S15	A10	A15	CE 10	CE 15	SA 10	SA 15
Compression resistance after 28 days f_{cm} [MPa]	54,5	68,9	77,9	59,9	62,5	55,9	57,2	62,2	65,7
Compression resistance after 56 days f_{cm} [MPa]	56,0	70,3	80,1	63,5	66,0	57,3	59,9	63,3	68,7
Water penetration depth [mm]	88	72	69	92	94	88	87	85	81
Absorbability[%]	4,8	3,5	2,9	4,8	4,7	4,7	4,7	4,0	3,9
Resistance decrease after 150 cycles of freezing and defrosting [%]	12,3	8,8	7,0	11,0	10,7	12,0	11,5	10,1	8,7
Mass loss after 150 cycles of freezing and defrosting [%]	0,01	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00
Pore distance coefficient $\bar{L}$ [mm]	0,21	-	0,18	-	0,18	-	-	-	-
Micropore content A_{300} [%]	2,2		2,5		3,2				
Air content [%]	2,1	2,4	2,45	2,9	3,3	2,3	2,3	2,1	2,0
Cone fallout [mm]	44	60	11	120	165	38	37	30	12

Fig. 2. The values of laboratory sample's compressive strength, MPa

the temperature of -20oC (4 hours) and defrosting the specimens in the temperature of +20oC (4 hours). There were carried out 150 cycles of freezing and defrosting. After those cycles the decrease in concrete resistance and mass loss were stated. The study focused on the control concrete without an addition of the reactive powders and modified concrete: microsilica, fly ashes, crumbed quartz sand and crumbed household ceramics. All of the additions were dosed in quantities: 10 and 15% of the concrete. In the modified concrete the additions did not make any changes to the concrete but there was made a correction in the amount of aggregate. The household ceramics came from the waste , which was created by the ceramic pot production, which had flaws in form of cracks, scratches and glaze damage. The pots were crumbed in the disintegrator. The applied fly ashes met the requirements of the PN-EN 450 norm. Roasting loss of the applied fly ashes: 4,2%. A Portland concrete CEM I 42,5R and liquid additions based on polycarboxylates were applied to the concrete. In the table 1 there were presented the concrete compositions of the researched concrete.

4. RESULTS

For all concrete mixtures there was carried out a air content research in accordance with the PN-EN 12350-7 norm and consistency research of the cone fallout in accordance with the PN-EN12350-2 norm. The compression resistance research was carried out in accordance with the PN-EN 12390-3 norm, water penetration depth research in accordance with the PN-EN 12390-8 norm and absorbability and frost resistance research for 150 cycles in accordance with the PN-88/B-06250 norm. The results of the concrete research were presented in the table 2. For three concrete series: control concrete (C), with the addition of microsilica in the amount of 15% (S15) and with the addition of fly ashes in the amount of 15% (A15) there was carried out a research of porosity characteristics in accordance with the research procedure stated in the PN-EN480-11 norm. The research was carried out with the help of an automatic system, which analyses air pore images in the concrete and computer programme Lucia Concrete. The research results were presented in the table 2. The applied reactive powders influenced highly mechanical and physical properties of the concrete. The concrete with an addition of microfillers reached higher average values of the compression resistance than in comparison with the control concrete after 28 and 56 days. The greatest compression resistance growth was noticed by the concrete with the addition of microsilica (series S10 and S15). The average compression resistance of this concrete was higher by 26% (series S10) after 28 days and 43% (series S15) in comparison to the compression resistance of the control concrete. Analogous this growth 56 days reached the values: for S10 series – 25,5% and for S15 series – 43%. All applied additions caused the reduction in water penetration depth in comparison to the value reached by the control concrete. The concrete with the addition of fly ashes (series A10 and A15) and crumbed household ceramics (series CE10 and CE15) reached similar absorbability values in comparison to the absorbability of the control concrete. Whereas, both the addition of microsilica (series S10 and S15) and crumbed quartz sand (series SA10 and SA 15) caused the reduction in the absorbability in comparison to the control concrete. All types of concrete proved the frost resistance in the range of 150 cycles. In accordance with the PN-88/B-06250 norm the concrete, for which the strength decrease after 150 cycles is lower than 20%, and the mass loss is smaller than 5%, is considered to be a frost resistant concrete. In the research of concrete porosity characteristics the reached values of pore distance amounted from 0,21 to 0,18mm. The micropore content A300 in the control concrete amounted to 2,2% and in the concrete, which was modified with microsiliica (S15) and fly ashes (A15) respectively: 2,5% and 3,2%.

5. CONCLUSIONS

On the basis of carried out research programme and result analysis it was concluded:
- Reactive powders in form of microsilica, fly ash, crumbed household ceramics and crumbed quartz sand are very useful concrete additions. They modify the structure of the hardened concrete, seal the concrete matrix and the

aggregate contact layer – concrete slurry. Moreover, they make better all of the concrete properties, which are: compression and frost resistance, absorbability and water penetration depth.
- Despite the lack of the addition improving frost resistance, the concrete with the addition of the reactive powders was found to have better frost resistance than the control concrete. The greatest pore content in class 18, namely in 285-300μm size, was found by the concrete with the addition of fly ashes (A15). The remaining two types of concrete, for which there was carried out a porosity research i.e. control concrete (C) and concrete with the addition of 15% of microsilica (S15) reached smaller values of micropore content. Nonetheless, all of the researched types of concrete reached the micropore value, which was more than 1,5% and thereby it guaranteed a high frost resistance. All researched types of concrete reached the value of pore distance, which was smaller than 0,2mm, what guarantees a good frost resistance as well.
- Fly ashes applied as an additional concrete component improved both the properties of the hardened concrete and influenced positively the plasticity of the concrete mixture. Concrete mixtures with the addition of fly ashes had greater consistency classes: S3 (for A10 series) and S4 (for A15 series) in comparison to S1 consistency class of the control concrete mixture. Fly ashes can be successfully applied to self-compacting mixtures and to mixtures used by the pumps.
- A very good example of managing of the production waste is also crumbed household ceramics coming from the damaged ceramic pots. The addition of the crumbed household ceramics improved the concrete compression resistance in comparison to the control concrete. After 56 days the concrete with the addition of the crumbed household ceramics had higher compression resistance: by 2,3% (CE10 series) and by 7% (CE15 series) in comparison to the control concrete. The addition of the crumbed household ceramics improved insignificantly the concrete frost resistance, and the absorbability and the water penetration depth reached the same level as the one by the control concrete.
- Crumbed quartz sand turned out to be a very good reactive powder. The concrete with the addition of crumbed quartz sand was found to have a better concrete strength after 28 days: by 14% (SA10 series) and by 20,6% (SA15 series) in comparison to the average strength of the control concrete. Similar conclusions were made for the concrete, which was researched after 56 days. The SA10 series concrete reached a greater concrete strength by 13% and SA15 series concrete by 22,7% in comparison to the average compression resistance of the 56-day-control concrete. The concrete with the addition of crumbed quartz sand had smaller values of the absorbability and the water penetration depth than the control concrete.
- Concrete with the addition of microsilica had the best properties among all of the researched types of the concrete. This addition is suitable for the production of the high-value concrete, which have small absorbability and small water penetration depth. On account of the size of the microsilica grains, concrete having this addition are characterized with higher water demand, what results in the necessity of applying greater amounts of liquid additions.

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APPLICATION OF GREEN CONSTRUCTION TECHNOLOGIES IN XX PROJECT

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Keywords

reinforced concrete structure, building template, four conservations and one protection

ABSTRACT

Developing green buildings using the green construction technology is the fundamental key to improving our living environment, reducing energy consumption in the building industry and solving the energy issues in China. This paper attempts to analyze the application of green construction technology in XX project using the methods of engineering management and systematic analysis. This paper begins with the necessity of applying green construction technology in construction engineering projects, proceeds with the introduction of some green construction technologies, such as the reinforced concrete structure, the building template, "four conservations and one protection" and the selection of green building materials and ends with some possible solutions to problems arising from these applications.

1. INTRODUCTION

The recent progress of science and technology also promotes the development of construction technologies. New technologies, new materials, and new equipments are emerging, pushing forward the development of high-rise residential buildings and office buildings of reinforced concrete structure. Nowadays, sustainable development has become the common pursuit of mankind in the world; China has laid down a new policy of the "scientific outlook on development"; it also requires on the creation of a "resource-saving and environment friendly society". As a result, a "green revolution" is taking place in the building industry, and we hear an urgent call for the green building and the green construction. Green building is the development trend of urban construction at home and abroad, because it makes a comprehensive response to environmental issues, and represents the application of the strategy of sustainable development and the theory of circular economy in the construction industry. As the implementation means of the green building, green construction points out the direction in the future development of the construction field. Urban constructions, especially those of high-rise buildings, need to adopt the method of "green production", that is, to save energy, reduce consumption and reduce the amount of pollutants produced and emitted, in order to reduce the negative impact on environment. Developing and implementing green construction is the main embodiment of the concept of sustainable development in urban construction, and the objective requirement of realizing the sustainable development of the construction industry, establishing an energy-conserving society, and developing the circular economy.

2. BACKGROUND

XX project is located in the northeast corner of the Chao Yangmen Overpass in the East Second Ring Road of Beijing. The area covered is 21673 m2 and the total construction area is 223459 m2, with 26 floors above ground and 4 floors underground. Overall, the project is a well-equipped, 5-A grade high-rise building that covers a large area and has a strong sense of modernity.

3. METHODS: The Application of Green Construction Technologies in XX Project

3.1 Reinforced Concrete Stucture

• *3.1.1 Steel Structure*

In this project, the stressed reinforcements with a diameter of over 12mm all adopt the HRB400 grade steel. There are two reasons for this: 1) Using the HRB400 steel bar can improve the reliability of the concrete structure and is economical. Theoretically, using the HRB400 grade steel can save about 10% - 15% of steel than using the HRB335 steel. Therefore, this measure can improve the utilization of the steel and reduce the total cost. 2) In outlook, the HRB400 steel bars differ very little from the HRB335 steel. As a result, if both of them are used in the project, it would be very difficult to classify them. Even serious accidents may occur if the two kinds of steel bars are mixed together. Therefore, in this project, the stressed reinforcements with a diameter of over 12mm use only the HRB400 grade steel.

Experience tells us that the ultimate tensile strength and yield strength of the HRB400 steel are prone to problems. Therefore, we strictly selected HRB400 steel manufacturers and gave priority to factories with good quality stability, such as Shougang Group. At the same time, we strictly carried out the site acceptance and reexamination after entering the site, in order to prevent the use of unqualified products which can bring great harm to the structure safety.

We managed the reinforcement by following the method of “optimizing reinforcement and comprehensive feeding”. That is to say, according to the reinforcement list optimized and made by the computer, for grade I steel bars, we conducted the cold pulling processing and stretched them by 4%. In this way, we not only removed the rust, but also saved the amount of steel bars. For the connection of steel bars, we use the rolling straight screw connection, reducing the amount of reinforcement. In this project, for the thick steel bars with a diameter $\geq\Phi16$, we use the strip rolling straight screw sleeve connection, which is currently the most advanced and the most commonly used reinforcement mechanical connection method. This method has the characteristics of high strength, simple process, low cost and good reliability.

• *3.1.2 Concrete Structure*

In the premise of meeting concrete strength and various performance indexes, the double admixture of grade one fly ash and granulated blast furnace slag was studied. Fly ash and slag are used to replace some cement, which can dispose of a large amount of industrial waste and at the same time can reduce the consumption of cement.

We control the total content of alkali in concrete, use low alkali active sand aggregate so as to prevent the concrete from alkali aggregate reaction. We control the content of CL- in concrete, so as to reduce the corrosion degree of concrete to the steel bar and prolong the life of concrete. We also control the content of ammonia in concrete, so as to prevent harmful substances volatilizing and injuring the human body. And by controlling the radioactivity of concrete raw materials, we reached the target of reducing the radioactivity of concrete.

3.2 Building Template

In this project, all the frame columns and beam boards adopt the wood keel coated plywood formwork, the bowl buckle type scaffold, and the early removal stigma, which form the quick disassembly system. The early dismantling template system has distinct advantages and features: 1) it is one-time investment and can save nearly 2/3 template and 60% supporting materials. 2) It can shorten the construction period by speeding up the turnover of the template 2-3 times. 3) It can extend the service life of the formwork, reduce labor costs and reduce the on-site transportation costs of the formwork materials.

Coated plywood has a smooth surface, large board size and less seams, and can achieve the effect of clear water concrete construction.

The early dismantling template system boasts of high construction efficiency because it can reduce the plastering workload, improve the turnover efficiency of the templates, save template inputs and its surface can be meet the requirements of the clear water concrete.

3.3 Four Conservations and One Protection

• 3.3.1 Energy Conservation

For exterior walls and interior walls and floors that require insulation, we apply the lightweight and efficient energy-saving insulation materials and adopt the latest technology, making sure that the average heat transfer coefficient K of the building envelop is less than or equal to 0.6w/m2k, so as to meet the third-step energy-saving requirement in Beijing to 65% degree. In this project, large areas of ceilings apply the ultrafine inorganic fiber coating insulation layer. In addition, all the exterior walls and the reflection glass curtain walls in this project adopt the Low-E insulating glass with a 12mm-thick insulating layer and the PA broken bridge aluminum alloy. This is to say, this project walks at the forefront of energy-saving and environment protection by combining the three major energy-saving door and window technologies, i.e. “the bridge section”, “the insulating glass” and “the low radiation rate of glass”.

• 3.3.2 Land Conservation

Within the limit of the project plan, we increase the plot ratio as much as possible, make the top floor into slope roof or back layer and narrow the width and increase the depth as far as possible.

• 3.3.3 Water Conservation

In the construction period, we adopt the water-saving technologies and facilities. We reuse the water as many times as possible, for example, we reuse the water to wash vehicles and spray on-site roads. The amount of water used for the construction is measured and taken down. In room temperature stage, we use sprayer to conserve the concrete, instead of the water hose. At the same time, on-site taps all use water-saving faucet.

• 3.3.4 Materials Conservation

Pipes are used rationally. Long pipes are not used for short purpose. Short pipes are used for processing joints. A certain amount of steel casing is made according to the size and specifications of the reserved holes on the floor. We recycle the steel cases to reduce the amount of wood.

• 3.3.5 Environment Protection

1) Planted roof and earth covering on the roof of the basement: The project has a large-scale greening platform, i.e. the planted roof. In addition, on part of the roof of B1, subsidence earth covering is designed. The total greening area is nearly 20,000 square meters. The water proofing of the planted roof and the irrigation of the subsidence earth covering is also studied.
2) Construction Waste Disposal: We reduce the amount of waste produced in the construction period by classifying, recycling and reusing the waste. We also effectively control the flow direction of the waste and prevent disorderly dumping and secondary pollution.

3.4 Green Building Materials

• 3.4.1 Ready Mixed Mortar

In this project, all the masonry and plastering works use the ready mixed mortar, which is conductive to ensuring construction quality, energy-saving and environment protection. The roof slope layer of the project is nearly 17, 000 square meters and its leveling layer uses the 20-thick DS mortar. The 20-thick DS mortar is a new type of environment protection dry powder, which is mixed and packaged in the factory. It has excellent water-retaining property because the chemical additives prevent water evaporation and eliminate the dry shrinkage crack. It has good bonding with the concrete, so no interface agent is needed and its surface is firm and crack-free. It is non-toxic and has no odor, so it is environment friendly.
Close attention is paid to the vertical flatness of the filler walls because this can reduce a large amount of plastering and therefore save the use of mortar. When we mix mortar on site, we often use fly ash or lime to replace the concrete after we design specific mix proportion and after the design company and the supervision company have approved the proportion.

We reuse the mortar that falls on the ground. If it is fit for use, we put it immediately on the wall. If not, we sieve it and remix it according to the mix proportion. In this way, we save the use of cement and sand.

• *3.4.2 Vapor Pressure Aerated Concrete Block*

The inside and outside filler wall in the project is vapor pressure aerated concrete block wall. Steam pressure aerated concrete block is a new type of porous lightweight wall material, with good fireproofing, heat insulation, and sound insulation; and the product has smooth surface and precise size, with high thermal resistance and light weight, which saves a great deal of masonry mortar and therefore improve the construction quality and speed.

4. RESULTS

Through the application of green construction technology, XX project has achieved good economic benefits. Thanks to the four conservations, the project saves about 500,000 Yuan. Studies have shown that only through the rational use of resources, through the overall control of the construction, through the reform of the construction technologies, through the minimization of the wastes and pollutants produced and emitted, and through the coordination of on-site construction with environment, can we truly achieve the green construction and the sustainable development.

5. CONCLUSIONS

Based on the construction facts, we ascertain the following improvement directions: formulate scientific construction schedule, use environmentally friendly engineering machinery, improve the reuse of engineering machinery and parts, and attach importance to the recycling of construction waste.

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SOME FEATURES FOR STRENGTHENING OF MASONRY BUILDINGS IN SEISMIC REGIONS

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Keywords

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ABSTRACT

This article presents offered more rational method which can be used for the modeling and design of strengthening of building and monuments with masonry wall structural systems. The state of this problem in the given work is presented by the analyses of real bearing masonry wall building (three story public building), that doesn't satisfy existing building codes of Armenia. Analysis of the structures has been carried out in accordance with the valid building codes of RA for strengthening. Static and dynamic three-dimensional analyses of the structural system by LIRA software program based on finite element method were done. In this article a number of extensive parametric investigations were done in order to study the effectiveness of the previously mentioned method, by analyzing the response of a masonry building as a case study. Both static and dynamic analyses considering earthquake load were performed.

1. INTRODUCTION

Among numerous problems of modern urban development the problem of strengthening, retrofitting and reconstruction of existing buildings and constructions in current construction takes one of leading places. Issues are very actual as the majority of different types of buildings constructed in Republic of Armenia are not satisfying requirements of operating building codes. With the global scientific and technological advance of the recent years the earthquake resisting building code of the RA (SNRA II-2.02-2006) have undergone to certain changes, as a result of which buildings and constructions were erected years ago do not meet the current demands of operating building codes. The current demands of seismic code have been made strict, so the bearing systems of the many public and civil buildings, erected in the period of the USSR, are subject for strengthening and reconstruction.

Object of the work presented herein, is the investigation of structural behavior in action of static and dynamic loads of the existing public building with masonry walls by FEM analyses (Cardoso, R., Lopes, M., Bento, R. 2005, Gorev V.V., Fillipov V.V., Tezikov N.Yu. 2002). Images of an investigated building are presented in figure 1. The building's structures was designed in the years 1960 - 1970 in accordance with the structural concepts of that period. It was designed for earthquake loads, according to the provision of old codes, much lower than those require by current codes. The study building has a tuff masonry structure and develops on three stories. The general sizes of the building are 16,5x27,5 m. The expertise of the building has shown that the building has continuous foundation without reinforcing with a width 70 cm. The columns of building were made from precast RC units with individual footings and have the dimensions of 160x160 cm. The bearing walls were made from "midis" type of masonry, having thickness of 50 cm, without any type of in-situ reinforced concrete zones. The floors were made from precast panels, having thickness of 22 cm. The grade of concrete used in bearing elements was B20, B25.

Fig. 1. The existing condition of the building

Fig. 1. The existing condition of the building

During the research the following structural deficiencies were identified:

- the foundation of columns and walls are not connected to each other,
- in the bearing walls there are no RC cores,
- on the walls there are no inseparably seismic zones,
- there are some missing intermediate bearing walls,
- precast floor panels are arranged close to each other without the required in-situ RC zones,
- roofs steel columns instead of based on bearing walls, are placed on the precast slabs,
- there are many structural cracks in bearing walls.

In this situation it is required to modernize the public building in contemporary office building which will be enough safe for new functional requirements (Karapetyan L., Avetisyan M. 2012). For changing of exploitation conditions or a functional purpose of the building it is required to carry out additional calculations: for bearing system with existing conditions and after strengthening (SNiP 2.01.07-85. 1996, SNRA I-4.02-99. 2000).

2. METHODS

The method for analyses and strengthening of the bearing system of the building will be developed by means of FEM analyzing of structures (Edward L. Wilson. 2010, Graham H. Powell. 2010).

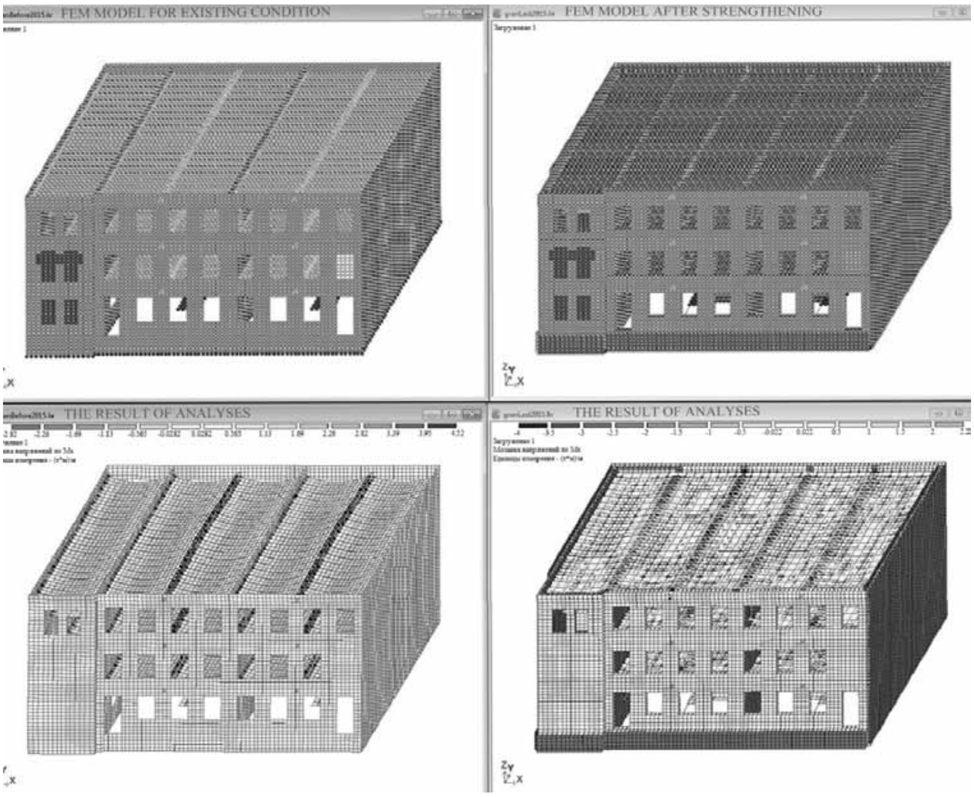

Fig. 2. Structural analyses of the building by *LIRA* software program

Strengthening solutions were established on the basis of interpretation of the results achieved with dynamic analysis of LIRA software program. The final element model and the results of the structural analyses of the building for two different conditions (1st – for existing condition without structural cracks in bearing walls, 2nd – after strengthening) are presented in the figure 2.

Stone masonry old buildings have complex structural behavior which is usually difficult to be analyzed because of the irregularity of the constructive materials as well as the construction techniques. It can be different in each country. The "midis" masonry one of the typical types of walls has used in territory of Armenia. It consists in a double layer of stone, filled with a mortar of lime and aggregates of various sizes, often connected by horizontal stones (Hovhannisyan, K.L. 1978, Hacagorcyan Z.A. 1959).

In this work all parameters for FEM modeling have taken under consideration in order to receive the best and correct numerical model of the building for a realistic simulation of the loading bearing structure. The bearing system of the building has modeled as 3D, the walls as multilayer shell elements and the floor plates as one layer shell elements. In case of the strengthened structures, the strengthening additional structures have been modeled as different layers elements with own characteristics. As to a results from the numerical analysis for gravity load, it is clear that all the stresses are in normal conditions. The situation is more differ for actions of seismic loads. The seismic stability of the building should be increased. The structures are not safe under seismic loads, meaning that in the case of an earthquake they will be damaged and will experience partial collapse.
In this article a number of numerical models and extensive parametric investigation was done in order to study the effectiveness of the chosen FEM models.

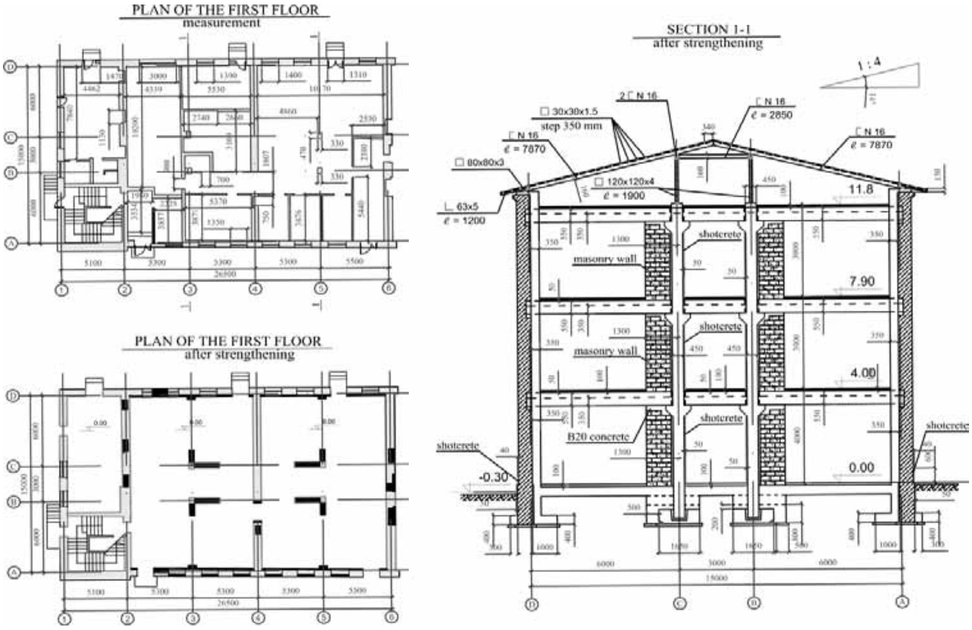

Fig. 3. Strengthening and reusing project for the building

3. RESULTS

The part of reusing and strengthening project presented in figure 3.
Having in mind the type of bearing system, the category of their deficiencies and the required seismic stability criteria, structural consolidation and seismic strengthening has been designed on the base of using new shotcrete layer for bearing walls to sustain tensile stresses that develop in the walls under seismic actions and new bearing structures from RC.

4. CONCLUSIONS

Selecting the boundaries of research is caused by presence of the large number of masonry wall buildings in Armenia. At the same time, it is a priority direction for modeling and calculation of architectural monuments since most of them also have a stone bearing system.
The paper presents a method of strengthening for the buildings which are being located in zones with high seismicity, by modification of bearing structures and whole structural systems. The main advantage of this method is that the presented engineering and technical solutions allow strengthening with minimal interventions in architecture of building. Also, the FEM analysis was performed on a detailed refined numerical model. It has been shown that the FEM can predict and capture the structural behavior of the building, thus resulting in a powerful tool to interpret and to have a clear knowledge of the deficiencies of bearing structures and it potentially allows the bearing system behavior under different types of load to be checked.
The practical importance of the results of researches consists in real possibility of use of the offered method for modeling of bearing systems with stone buildings and constructions for practical designing in the project of strengthening taking into account real conditions and architectural and building features.

NOTE

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EXPERIENCE WITH THE USE OF RISK ANALYSIS METHODS FOR WORKING FORENSIC EXPERT AND AN ALTERNATIVE METHOD OF DETERMINING THE VALUE OF THE COEFFICIENTS

POSTER

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Keywords

expert witness, risks analysis, alternative method

ABSTRACT

Expert witness work requires the use of sophisticated methods and procedures in an effort to achieve a result. That objective is build conclusions of the report and answer any questions the court or the police. For this reason, it is necessary that the expert witness had valid survey work in related areas of legal experts and obligatory knowledge in their profession. This area also includes methods of risk analysis.
One of the methods that are currently used to determine the estimated value of the forensic expert in the real estate industry (focusing on the economy, real estate prices and estimates), the comparative method. In this method applies, inter alia, the coefficient K6, which reduces or increases the estimated final price determined by expert opinion. Determination of the coefficient K6 is implemented as an expert professional estimate. This price adjustment has its upper and lower limit and is dependent on external factors. The authors provide an alternative method of determining this coefficient method that can significantly eliminate subjective perception and help determine the value of this coefficient.
To determine the method was applied risk analysis and SWOT analysis.

1. INTRODUCTION

Risk analysis methods are used worldwide. They are used primarily for management and control of companies and corporations. In the last years to meet the application method Management risks also in construction. First, we meet with these methods in project management of large buildings, but also in areas that have not been developed methods of risk management.
In the previous period were made several successful attempts to use methods designed to analyze risks in the work expert witness and experts. From risk analysis methods have become sophisticated alternative methods that can be used forensic experts and experts in construction for evaluation of building materials, structural components or technologies. At the same time it is possible to apply the method to the evaluation of the project documentation or to determine the coefficients of static calculations.
Working with these methods are newly introduced into teaching at universities.

2. BACKGROUND

As an alternative method of expert activities for assessment of building construction and evaluation of materials and also for the work expert witness were verified the following methods:

- UMRA - The universal method of risk analysis
- SWOT analysis

Furthermore, the methods of multi-criteria analysis data using partial methods:

- WSA - method of the weighted sum
- TOPSIP method (Technique for Order Preference by Similarity to Ideal Solution)

• CDA method of compliance and non-compliance (Concordance Disconcordance Analysis)

For fine the determination of weights of individual factors are used mathematical models:

• The order method
• Fuller method (method of paired assessment)
• Saaty method of the determination of weights of the criteria
• DEA - Data Envelopment Analysis (method of data analysis of packaging)

1. INTRODUCTION

When using a comparative method to value a property, it is possible to take advantage of the SWOT analysis when determining, for example, coefficient K6. The problem is well-known (Bradáč, 2009). This coefficient which is used to multiply the price expressing the current condition of the property in relation to the estimate of imperceptible impacts on the view of an expert. In order to ensure that an expert opinion suffers as little as possible from subjective errors, the SWOT analysis method can be used as an alternative method to determine the coefficient. Matrix features are gradually defined in individual sub matrixes, which are as stated above:

• strengths = positives of the subject matter of the estimate Si
• weaknesses = negatives of the subject matter of the estimate Wi
• opportunities = possibility to increase attractiveness (positives), i.e. valorisation of the subject matter of the estimate Oi
• threats = possible negatives, i.e. devaluation of the subject matter of the estimate Ti

The defined features of these four sub matrixes may be any non-zero number; numbers do not have to be identical (nS ≠ nW ≠ nO ≠nT).

$$S_i \to i \in \langle 1; n \rangle \quad (1)$$

$$W_i \to i \in \langle 1; n \rangle \quad (2)$$

$$O_i \to i \in \langle 1; n \rangle \quad (3)$$

$$T_i \to i \in \langle 1; n \rangle \quad (4)$$

Importance, i.e. weight, is attributed to individual features of the sub matrix. This makes this evaluation a multi-criteria evaluation.

Weighing individual elements, i.e. criteria for the actual evaluation, enables to include into the selection unequal criteria (contrary to other similar methods. The problem is well-known (Kubečka, 2009), (Kubečka. 2010). However, weighing must be done responsibly by an expert. The following principle applies to all four sub matrixes - the total weight of individual criteria of the sub matrix S, W, O and T must equal 1, i.e. 100%.

The evaluation of individual criteria is up to the expert. Practice showed that the four point scale evaluation is the minimum, and six point the maximum. To demonstrate, we can use the same evaluation as "if at school", i.e. a scale from 1 ÷ 5 for positive evaluation where 1 is the least and 5 is the most, and a scale from -5 ÷ -1 for negative evaluation, where -5 is the lest and -1 is the most. This means using a standard line division to the right and left from zero. The weight and evaluation of each of the criteria of individual sub matrixes is multiplied. The problem is well-known (Vlček 2012).

$$K_M = V_M \cdot E_M \quad (5)$$

KMi = ith criterion of sub matrix M (1), (2), (3), (4)
VMi = Weight of the ith criteria of the submatrix M
EMi = Evaluation of the ith criterion of sub-matrix M

It must be valid that the total weight of all criteria in the sub matrix must equal one (100%). The sum of products of weights and evaluation of internal criteria and the sum of products of weights and evaluation of external criteria are used for the next calculation.

$$I = \sum \prod_{i=1}^{n} K_M = \sum \prod_{i=1}^{n} K_S + \sum \prod_{i=1}^{n} K_W \tag{6}$$

$$E = \sum \prod_{i=1}^{n} K_M = \sum \prod_{i=1}^{n} K_O + \sum \prod_{i=1}^{n} K_T \tag{7}$$

I = internal value is the sum of products (5) of sub matrixes S and W
E = external value is the sum of products of (5) sub matrixes O and T
When used for risk analysis and determining indicators used in forensic science, it is a base for the recalculation of a specific required indicator value (for example the coefficient).

$$A = \sum_{I}^{E} V = \sum \prod_{i=1}^{n} K_S + \sum \prod_{i=1}^{n} K_W + \sum \prod_{i=1}^{n} K_O + \sum \prod_{i=1}^{n} K_T \tag{8}$$

In order to determine the K6 coefficient, we must first determine the scope of its validity. If we determine that the coefficient is lower than 1 and higher than zero (10), the final price will be decreased, and vice versa, if the coefficient is bigger than 1, the final price will increase. The problem is well-known (Vlček, 2012), (Kubečka, 2009).

$$k6 \in \langle 0;1 \rangle \tag{9}$$

$$k6 \in \langle 1;\infty \rangle \tag{10}$$

Undoubtedly, decreasing the price to “zero” as stated in the lower boundary condition (10) does not make sense, just like increasing the price “high above the value of one”.(11) Therefore, it is essential to determine the scope of validity. It can be determined statistically by comparing the carried out estimates or easily by determining the value using a professional estimate. It can be stated that the K6 coefficient will be in the range of ± 20% of the usual price range (a higher value is considered as usury, a lower price is undervaluation). Therefore, the K6 coefficient will be between 0,8 and 1,2. The problem is well-known (Vlček 2012), (Kubečka, 2009), (Tichý, 2006).

$$k6 \in \langle 0.8;1.2 \rangle \tag{11}$$

However, if the expert (valuer) uses a sophisticated calculation to prove that the value is outside these boundaries and his justification is realistic, the range can change.

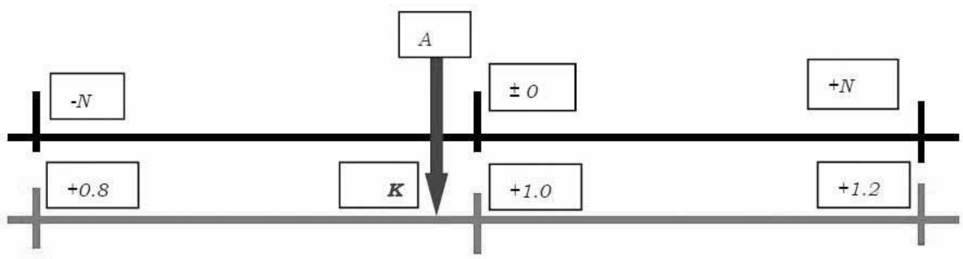

Fig. 1. The relation between the calculated value A on the number axis (minimum limit- N, maximum limit +N) and coefficient K6 for the selected range

Under these conditions (12) and in accordance with the selected scale of criteria evaluation (as “if at school”, i.e. a scale from 1 ÷ 5 for positive evaluation where 1 is the least and 5 is the most, and a scale from -5 ÷ -1 for negative evaluation, where -5 is the lest and -1 is the most.) the results must (6) be (7) within the interval I=E… <-4;+4> ad the result is (8) A □<-8;+8>, according it must be valid that –N = -8 and +N = +8. In terms of the K6 coefficient, for N = -8 the value is K6 = 0,8 and for N = +8 the value is K6 = 1,2.
We are working with a linear function which, depending on the values of result (8) “A” will be able to reproduce the financial sum of K6 coefficient. The function will be defined as the equation of the line defined by two points

in an orthogonal coordinate system, i.e. by the starting point A [-8, 0.8] and point B [+8; 1,2].

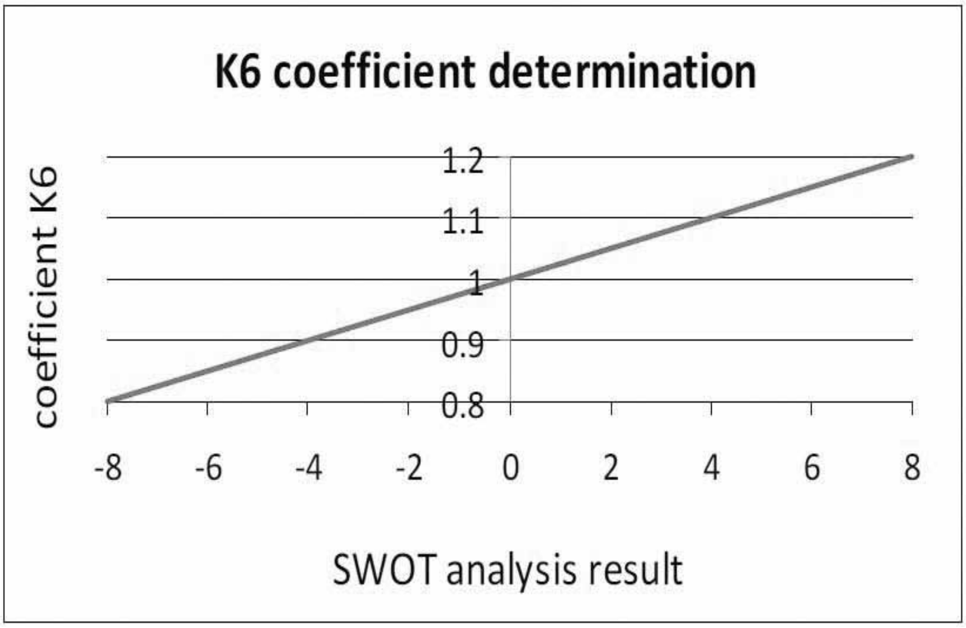

Fig. 2: The relationship between the calculated value A on the number line (minimal limit-N, the maximal limit + N) and K6 coefficient by the selected range.

Vector $\vec{u}$ is defined by points An, B and the normal vector is $\vec{n}$ perpendicular.

$\vec{u} = B - A \Rightarrow \vec{u} = (16\ ; 0,4)$ and normal vector $\vec{n} = (0,4; -16)$

General line is defined by the following relation: $ax + by + c = 0$

If we substitute coordinates of a normal vector into the line

We have p: $0,4 \cdot x - 16y + c = 0$, B × p⇒0,4×8 - 16×1,2 + c = 0 c = 16

The resulting equation of the line for the established scope of validity of the K6 coefficient, providing that for K6 = 0,8 the final value of evaluation is at -8 and for K6 = 1,2 at +8, is:

$$0,4x - 16y + 16 = 0 \Rightarrow y = \frac{0,4x + 16}{16} = 0,025x + 1 \qquad (12)$$

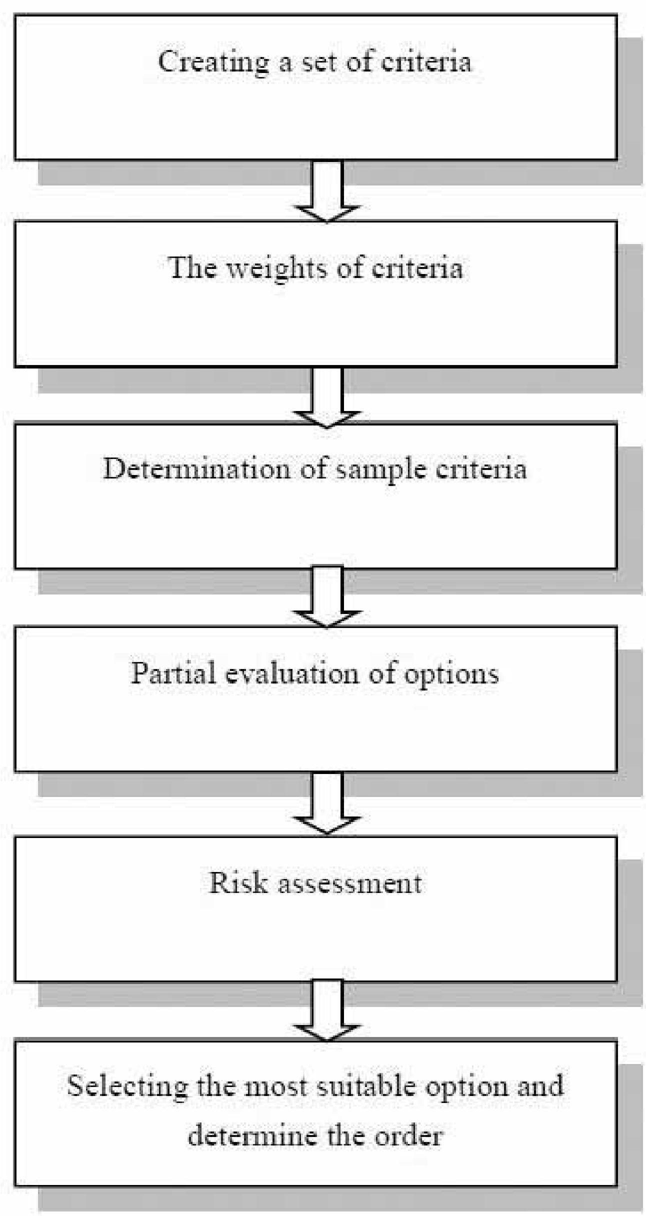

Fig. 3. General procedure of multicriterial evaluation of alternatives

NONLINEAR METHODS

With the application of modern methods of multi-criteria analysis can encounter across the spectrum all technical disciplines. Is used to evaluate various options for solving the problem, selecting an effective and therefore optimized solution. It also offers a comparison between proposed alternatives in a wide range of view. They can easily serve to introduce new assessment of technical elements, materials and designs.

CONCLUSIONS

It is mentioned in many publications are alternative methods of risk analysis methods appropriate for the work of experts in construction and expert witness. The application is general and broad. Presumably more wide application and use.

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LOAD-CARRYING CAPACITY OF TIMBER STRUCTURE BOLT CONNECTION SUBJECTED TO DOUBLE UNEQUAL SHEARS WITH THICK PLATES AS OUTER MEMBERS

POSTER

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Keywords

timber structures, steel, bolt connections, unequal double shear

ABSTRACT

The paper deals with load-carrying capacity of bolted connections subjected to unequal double shears with thick plates as outer members and inner timber member. There are derived equations which describe the load-carrying capacity of this connection type in the ultimate limit state.

1. INTRODUCTION

For calculation of design load–carrying capacity of timber structure bolt connections subjected to double shear with thick plates as outer members and inner timber member is nowadays possible to use equations which were derived by Johansen (Johansen, K.W. 1949). These Johansen´s equations are also used in EN 1995-1-1 and they can be also found for example in (Porteous, J., Kermani, A. 2007) and (Koželouh, B. 1998), where the main principles of their derivation are also presented. These equations assumed that the loads are the same on both sides. It means Fd1= Fd2 according to Fig. 1. For case Fd1≠ Fd2 there is no method how to calculate the design load

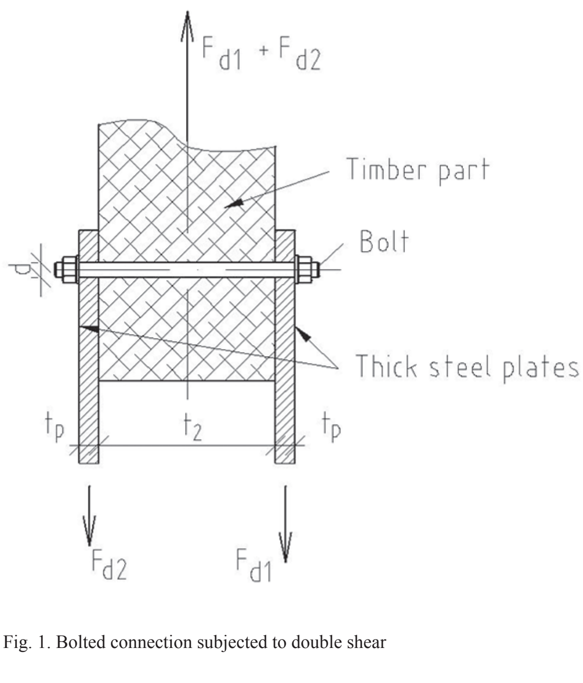

Fig. 1. Bolted connection subjected to double shear

carrying capacity. Formulas for design load-carrying capacity and reliability of a connection where the thin plates as outer members are used were derived and shown in (Musilek,J., Kubečka, K. 2015).

2. BACKGROUND

The formulas derived by Johansen (Johansen, K.W. 1949) for connection loaded by equal loads on both sides are derived for situation, when the connection is ultimate limit state.

3. METHODS

For connection which is not loaded by equal loads on both sides, the similar principle is used for derivation of the formulas, but the different loads are taken into account.

4. CASE HISTORY

For derivation we assume that $F_{d1} > F_{d2}$ and $_{tp} \geq d$ according to Fig. 1. We further assume that the tolerance allowance for the bolt hole is less than 0,1*d*. The last two assumptions classify the outer plates as thick according to (Porteous, J., Kermani, A. 2007). F_{d1} and F_{d2} are design loads, $_{tp}$ is thickness of outer plates and *d* is diameter of bolt.

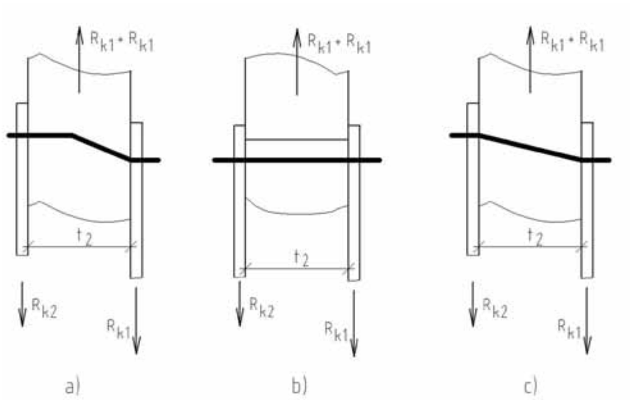

Fig. 2. Considered failure modes

For the determination of the design load–carrying capacity we have to consider different failure modes in ultimate limit state. Let's consider three possible failure modes according to Fig. 2.
Failure mode according to Fig. 2 a) is caused by creating of the two plastic hinges in the bolt. We can expect that the plastic hinges will occur on the side with the higher load (on the side with R_{k1}). Then the characteristic load–carrying capacity R_{k1} (it means the load when the plastic hinges occur) is possible to calculate in the same way like for the connection in single shear loaded only by R_{k1}. So we can use for determination R_{k1} formula for example (10.14) in (Porteous, J., Kermani, A. 2007)
Failure mode according to Fig. 2 b) is caused by reaching the embedment strength in the timber member without plastic hinges in the bolt. For this mode the following equation can be written:

$$R_{k1}=f_{h,2,k}\cdot d\cdot t_2-R_{k2} \tag{1}$$

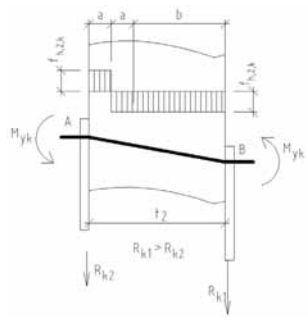

Fig. 3. Scheme for the determination of the characteristic load–carrying capacity

Failure mode according to Fig. 2 c) is caused by creating of the two plastic hinges in the bolt which occur at the outer plates. The formulas for the characteristic load–carrying capacity we can derive according to Fig. 3. Moment equilibrium condition to the point B can be written:

(2)

After calculation a, and related modifications, we will get the following quadratic equation:

$$b^2 + 2 \cdot t_2 \cdot b - \left(t_2{}^2 + \frac{8 \cdot M_{yk}}{f_{h,2,k} \cdot d} + \frac{4 \cdot R_{k2} \cdot t_2}{f_{h,2,k} \cdot d}\right) = 0 \qquad (3)$$

From the Eq. 3 we can get the dimension b:

$$b = \sqrt{2 \cdot (t_2{}^2 + \frac{4 \cdot M_{yk}}{f_{h,2,k} \cdot d} + \frac{2 \cdot R_{k2} \cdot t_2}{f_{h,2,k} \cdot d}}) - t_2 \qquad (4)$$

In accordance with the force equilibrium condition must be fulfilled:

$$R_{k1} + R_{k2} = f_{h,2,k} \cdot d \cdot b \qquad (5)$$

By substitution and related modification we get the formula for Rk1:

$$R_{k1} = f_{h,2,k} \cdot d \cdot \left(\sqrt{2 \cdot \left(t_2{}^2 + \frac{4 \cdot M_{yk}}{f_{h,2,k} \cdot d} + \frac{2 \cdot R_{k2} \cdot t_2}{f_{h,2,k} \cdot d}\right)} - t_2\right) - R_{k2} \qquad (6)$$

In the Eq. 6 the load-carrying capacities are characteristic. For static calculations and checks, we need to work with the design load-carrying capacities. The relation between the design load-carrying capacities and the characteristic load-carrying capacities are given by following formulas:

$$\cdot a^2 + f_{h,2,k} \cdot d \cdot \frac{b^2}{2} - R_{k2} \cdot t_2 = 0 \qquad (7)$$

When we substitute Eq. 7 into the Eq. 6 and make some mathematical equation editing, we get the formula for the design load-carrying capacity R_{d1}:

$$R_{d1} = \frac{k_{mod}}{\gamma_M} \cdot f_{h,2,k} \cdot d \cdot \left(\sqrt{2 \cdot \left(t_2{}^2 + \frac{4 \cdot M_{yk}}{f_{h,2,k} \cdot d} + \frac{2 \cdot \gamma_M \cdot R_{d2} \cdot t_2}{k_{mod} \cdot f_{h,2,k} \cdot d}\right)} - t_2\right) - R_{d2} \qquad (8)$$

5. RESULTS

The dependence of the R_{d1} on the R_{d2} is shown in the Fig. 4 Errore. L’origine riferimento non è stata trovata.. It is calculated for the following parameters: *$f_{h,2,k}$ =26,174MPa, t_2 = 60mm, d = 16mm, k_{mod} = 0,8, γM = 1,3, fu,k =*

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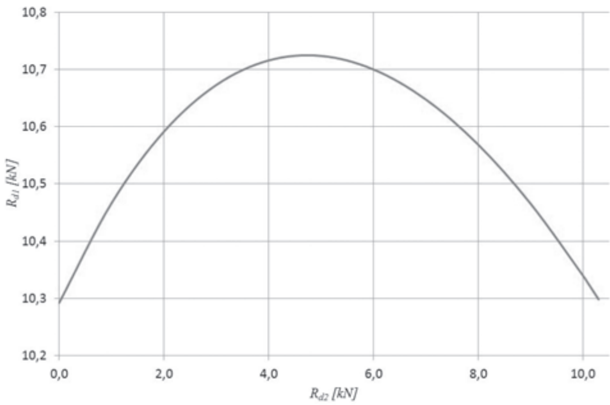

Fig. 4. Dependence R_{d1} on the R_{d2}

360MPa:

6. CONCLUSIONS

The formulas for design load-carrying capacity of bolted connection subjected to unequal double shear with thick plates as outer members and inner timber member were derived.

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BIODEGRADATION OF COMPOSITE SYSTEMS APPLIED ON THE CLADDING OF PANEL BUILDINGS

POSTER

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Keywords

buildings, cladding, biodegradation

ABSTRACT

The article deals with the issue of biodegradation of composite systems applied on the siding of panel buildings. Composite systems used for the cladding of panel buildings sometimes suffer from biodegradation of the composite, resulting in less durability and significantly reducing the aesthetic appearance of the building as a whole. The prediction of defects and failures as a result of the biodegradation are based on the evaluation of a coherent set of panel buildings with cladding. The purpose of research is to prevent possible architectural and structural deficiencies in the cladding of panel buildings. Also the environmental aspects of the issue of biodegradation of claddings are relevant.

1. INTRODUCTION

The biological impacts on the cladding of buildings in the form of algae, fungi and lichen not only negatively influence the aesthetic look of the building as a whole, but may also deteriorate durability and functionality of certain building materials and structures. The problem of the biodegradation effects in the last decade claddings of buildings, on which composite systems have been installed for thermal-technical and energetic reasons.

2. MICROORGANISMS AND GENERAL BUILDING PHYSICAL CONTEXTS

The heat penetration index from 1960 to 2015 changed greatly. If the value of the heat penetration index through the peripheral structure in the year 1964 was UN =1,40 W/m2.K, then in 2011 it was UN =0,30 to 0,25 W/m2.K, i.e. approximately 5 times less compared to 1964. It is obvious, that demands on peripheral structures regarding thermal-technical parameters have increased significantly. Also the thickness of thermal insulation has increased. Nowadays the thickness, based on contemporary thermal-technical requirements, is as much as 120 to 200 mm, when installed on a single layer reinforced concrete peripheral wall. I.e. there is less heat leaving the building, but less heat can get in direction to external surface and the surface therefore becomes colder. A colder surface creates condensation in due course. As a result a convenient microclimate is created for the growth of lichen, moss and algae, because all microorganisms need moisture for their life. The condensation inside the plaster creates a suitable microclimate allowing microorganisms to settle and grow, and later on they colonize the plaster totally or partly. Other reasons for lower surface temperatures are for example a location in the shade, small thermal absorption, minimum absorption of heat etc.

3. STRUCTURAL DETAILS IN THE CLADDING

There are sometimes specific structural details in the cladding, which may predict thermal bridges. Humidity is more likely at these thermal bridges. It occurs for example, when structures are placed in front of the facade. These structures require perfect solution in the design, as well as precise technological performance. Examples of problematic structural details – see Fig. 1 and Fig. 3. Fig. 1 shows a critical structural detail - skirting of flat roofing at the entrance to the building, connected to the cladding of the building. Fig. 3 shows a change of thickness in the cladding and the cranked shape of the cladding. If we take thermal measurement of these details, a localised humidity increase will be identified. Compare Fig. 1 to Fig. 2. and Fig. 3 to Fig.4. Detail attack plaster cladding

and microorganisms be seen in the picture Fig. 5 and Fig. 6. Bad workmanship occurred at the skirting of the entrance roof. The defect was identified in a technical evaluation – the skirting is not sealed and not anchored into the plaster. Rain creates humidity in the plaster over time and suitable conditions and climate in the incorrect detail of skirting for settlement and growth of microorganisms. We can see similar problems where thickness of the cladding changes. The corner in the cladding is wet and therefore suitable for the settlement of microorganisms.
Considering the surroundings of the building - the protected natural area Poodří contains natural water sources, where algae and blue-green alga are present, and therefore the probability of attack on additionally insulated external walls is considerable and is even greater in the proximity of trees. Blocks of flats located near water sources and woods – see Fig. 7. Conditions for growth of microorganisms are predictable already before we begin to install additional contact heat insulation. Basic life conditions, especially with relation to water and humidity, exist. See Table 1.

Fig. 1. Part of the roof construction and piping

Fig. 2. Thermographic detail in focus Figure 1

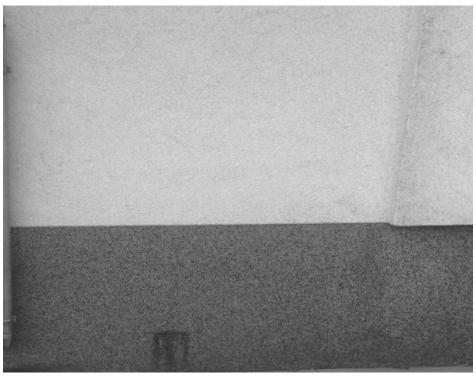

Fig. 3. Part of the envelope

Fig. 4. Thermographic of the envolope

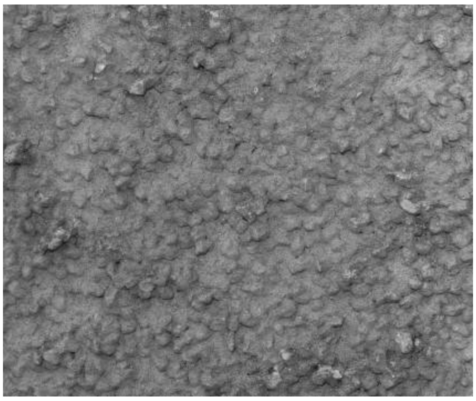

Fig. 5. Structure of the plaster

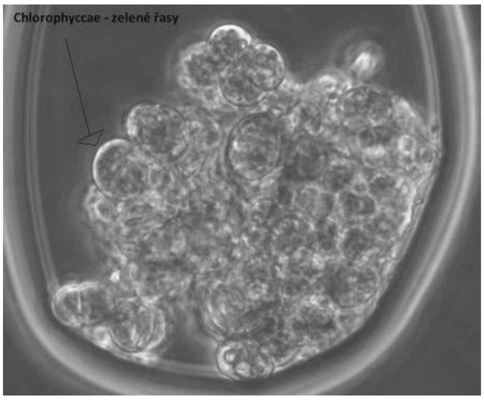

Fig. 6. Microorganisms - algae

Microorganisms	Temperature [C°]	Water - humidity	pH value
Algae	-7 až 75	necessary	1.0 až 11.5
Fungi and Lichen	0 až 50	necessary	1.5 až 11.0

Table 1. Conditions for growth of algae, fungi and lichens

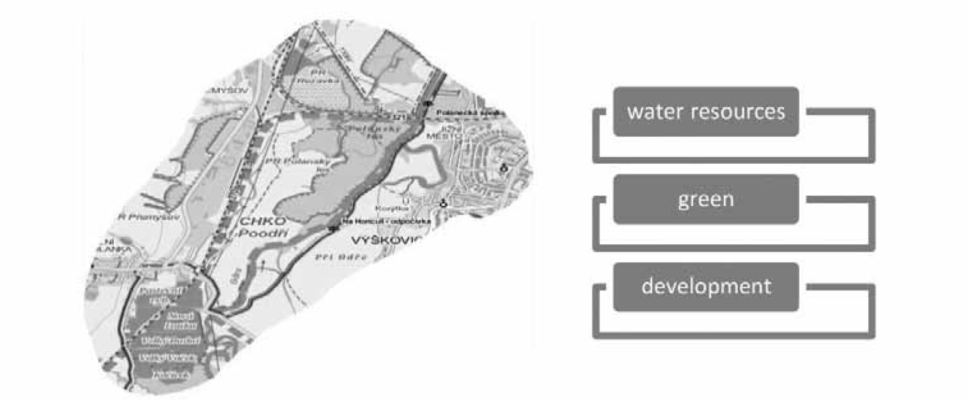

Fig. 7. Natural protected area with the installation of residential buildings, environmental aspects

3. CONCLUSIONS

To eliminate problematic details and thus also humidity needs to be resolved in the design phase, when these details can be solved by modelling with the help of software applications 2D or 3D. Thus is not sufficient to calculate only the heat penetration index through the peripheral structure and following proposal of the thickness of the thermal insulation, but it is necessary also to resolve critical details in the cladding by 2D or 3D thermal field and eliminate thermal bridges. The evaluation of the lowest internal surface temperature and possible surface condensation in problematic details, and assessment of accumulation features of the structure, are integral part of design. It is also necessary to take into consideration the orientation of the building to the cardinal points and nearby woods and water sources.

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DISCUSSION ON SEGREGATION AND BLEEDING PROBLEMS AND THE STABILITY MODEL OF FRESH CONCRETE

POSTER

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Keywords

cement slurry suspension, bleeding mechanism, stability model

ABSTRACT

Segregation and bleeding of concrete occurs at various seasons as raw materials of concrete being changed. In this study, the formation mechanism and affecting factors of concrete bleeding and segregation was discussed, the movement dynamics of water was analyzed in terms of bleeding passage, bleeding press and bleeding water resources. Then the improved measures for solving segregation and bleeding problem of concrete, a comprehensive evaluation method of concrete bleeding and the concrete stability model to describe the sedimentation process and mechanism of fresh concrete were put forward.

1. INTRODUCTION

Concrete is one of the most widely used building materials. Due to the emergence and application of high performance water reducer, the revolutionary change of modern concrete materials has taken place, raw materials change from the traditional four components into six components. High performance water reducer and mineral admixture have become essential components of modern concrete[1]. The construction technology and engineering practice of the modern construction require high performance concrete with high flow. The problem of segregation and bleeding of concrete has seriously restricted the healthy development of concrete industry, so bleeding and segregation problems of concrete has also become the focus of domestic and foreign academic and enterprise circles of concrete research and attention.

The reason of concrete bleeding and segregation is very complex, it is associated with each link of concrete production, including the quality of raw material, mix design, mixing technology, construction technology, the type of additive and admixture [2]. The aggregate shortage of resources, declining quality and higher clay content often lead to segregation and bleeding and slump loss phenomenon of the concrete, making workability can't meet the construction requirements. Using concrete admixture technology to solve the problem of concrete bleeding is necessary for concrete industry to transform into technology industry, at the same time it is a economical and practical method also [3]. Concrete is actually a dynamic composition of complex distributed system, and the cement paste fluidity and stability have decisive effect on the workability of concrete. Therefore, researches on the workability of concrete often get started from rheological behavior of cement paste [4]. Cement paste is a kind of unstable system, and the stability study is one of the most effective ways to understand the problem of segregation and bleeding of concrete, but the present research still has many problems. In this paper, the formation mechanism of segregation and bleeding of concrete (influencing factors etc.), improvement measures and evaluation methods were deeply discussed the concrete stability model and some research directions about concrete segregation and bleeding problems was put forward.

2. FORMATION MECHANISM OF CONCRETE BLEEDING AND SEGREGATION

2.1 Cement paste suspension system

The cement paste is an unstable suspension system of high solid content with cement as the dispersed phase and water as dispersing media. Cement particle dissolution and hydration and consolidation settlement have effects on the rheological properties of suspension system [5]. The stability of fresh cement paste can be described as its ability to remain homogeneous over time. Instability in the form of sedimentation and bleeding occurs for various reasons related to the material composition.

Cement paste and the other suspension have lots of in common. First of all, the cement paste is a kind of heterogeneous material, including the super plasticizer and active cement particles with large size, so it has a high solid content. Secondly, due to the dissolution and hydration of fresh cement paste among the component, the viscosity and yield stress varies with time[6].The theory of Stokes thinks that rheology of suspension system has a strong relation not only with The liquid phase of suspension system, but also with the inter force between particles. Super plasticizer and viscosity modifier are often added to improve the performance of cement paste; they also have a great influence on the sedimentation of particles and the bleeding rate [7]. In the cement paste with additive, different kinds of ions and additives exit in liquid, so the rheological performance has big difference with water. Richardson-Zaki formula and the Kynch theory [8-9] proposed a conceptual model to explain the rheological characteristics of cement paste mixed with chemical admixture and its consolidation sedimentation process.

2.2 bleeding of cement paste

Kynch proposed a particle sedimentation theory based on the conservation of particles during sedimentation. It was assumed that the settling rate at any position in a column of suspension would be only a function of the concentration at that point, without consideration of dispersion or flocculation [10]. Tiller [11] showed that the Kynch theory is too simplified and can be corrected or extended to cover the case in which a subjacent compression zone is formed. Then Fitch [12] simplified Tiller's procedure by considering the relationship that follows the Kynch theory and explained how the suspension–sediment interface rises with time for compression zones, as Fitch's paragenesis diagram shows in Fig.1. It can be seen that sedimentation types for cement pastes vary with time and position during the entire sedimentation process, depending on the solid concentration and particle flocculation state at that relative time and position.

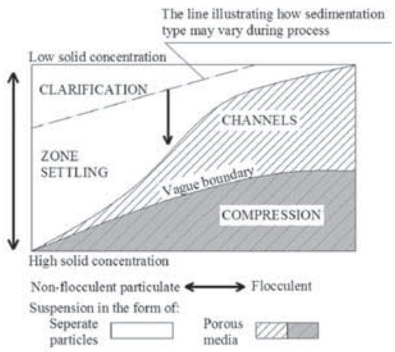

Fig. 1. Fitch's paragenesis diagram showing types of sedimentation

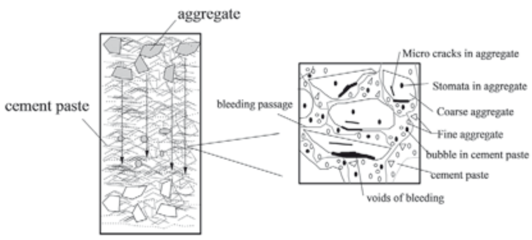

Fig. 2. Conceptual model for sedimentation and bleeding of concrete

2.3 Formation of concrete bleeding and segregation

During the process of stirring, pouring and vibrating of concrete mixture and before it's setting and hardening, because of the sinking of solid particulate material, the concrete layers and the water floats to the surface, this phenomenon is called the bleeding and segregation of concrete[13]. Concrete bleeding mainly occurs before the initial setting, and concrete gets through transporting, pouring and vibrating after the mixing is completed. Aggregate subsides downwards due to gravity, which causes the distance and gap between each other become smaller, so cement paste and water are extruded to the surface resulting in bleeding, as shown in Fig 2. The bleeding channel left in the concrete during the process of water floating has a great influence on the concrete strength and durability, in the coarse aggregate side and beneath the water sac exits [14].

3. INFLUENCE FACTORS OF CONCRETE SEGREGATION AND BLEEDING

Factors affecting concrete bleeding are very complex, and from microscopic mechanism it can be divided into three main categories, they are respectively bleeding channel, bleeding water sources and bleeding pressure. Concrete bleeding is generally not a result of one single factor, but a result of lots of different factors.

3.1 Bleeding channel

The water that secrets to the concrete surface must pass through a long distance, micro bleeding channel is formed in the process of concrete bleeding; the factor that greatly influences the water bleeding is mainly the length and size of bleeding channel. All kinds of aggregates have influence on the segregation of concrete bleeding, aggregate is more smooth and said, the bleeding passage is harder to form, so it can effectively reduce concrete bleeding [15]. at the same time. The smaller the fineness of cement is and more C3A it contains, the faster the hydration speed is, and hydration product can effectively block the bleeding passage, preventing the occurrence of bleeding phenomenon [16]. The gradation and type of aggregate also have an impact on the stability of bleeding, concrete containing a large number of regular size particles has a better stability. Water consumption increase to improve the increase the workability of concrete will increase concrete bleeding [17]. Pozzolanic mineral admixture such as common coal gangue, zeolite powder and fly ash, can reduce the bleeding of concrete, their particle gradation is good, they can also carry out two hydrations, and the products can cut off the bleeding channel [18].

3.2 Bleeding water sources

According to the existing state, the water in concrete can be divided into bound water, free water and wetting water. Free water in concrete plays a lubricating role in concrete, this part of the water has associated with solid materials, so it can easily secrete from the concrete [19]. High performance water reducer has great influence on concrete bleeding, especially sensitive super plasticizer, it can damage cement particle flocculation structure and release inside water, so more free water exits, but too much volume or its bad compatibility with cement can cause serious bleeding and segregation[20].Adding air entraining agent has an inhibitory effect on the bleeding of concrete, with the increase of air content of concrete, it helps to reduce the concrete bleeding, but the concrete strength decreased[21]. The research shows that the low strength concrete has a relatively high water cement ratio, in the concrete with high water cement ratio, hydration of cement can’t consume all the free water, so more water exits in the system. Compared with the high strength concrete, low strength concrete is more susceptible to segregation and bleeding phenomenon [22]. Unilateral water content of concrete has a greater impact on concrete bleeding, the more the unilateral water is, the more moisture the water filling space of concrete has, the worse its stability is and the greater the possibility of generating bleeding is[23].

3.3 Bleeding pressure

According to the principles of hydrodynamics, the movement of moisture migration needs water pressure to provide power. In addition to moisture migration pressure produced by aggregate weight, major bleeding pressure comes from artificial operation in the transportation and construction process. Concrete mainly undergoes three processes from mixing to construction including transportation, pumping and vibration. Longer transport distance is more prone to cause bleeding. because of the pump pressure, the aggregate in concrete can easily absorb more water, when it is pump out, the pressure disappears and losing more water causing bleeding[24].The water in filling space of cement paste is more easily squeezed out under the pressure. In concrete pouring and vibrating, the longer distance the vertical drop is, more easily it leads to bleeding. Excessive vibration can cause the separation of aggregate and mortar in concrete [25].twice vibrating before the final setting of concrete can effectively reduce the bleeding. Actually it can better fill the bleeding channel and water sac, improve concrete bond strength and reduce the internal pores and cracks [26].

4. IMPROVEMENT MEASURES

4.1 Slow release type super plasticizer

The cement hydration reaction makes a part of the free water packaged by cement particle and it can reduce the concrete slump retaining ability that the volume of mud in aggregate is too high [27-28].By free radical polymerization of (meth) acrylic acid methyl ester and unsaturated fatty acids, adjusting the monomer ratio and synthesis temperature and other conditions, a slow-release water reducer is synthesized. it can occur Hydrolysis of the ester bond in the cement hydration liquid phase of alkaline conditions, so that water reducer molecules can produce new molecules which can disperse in cement paste, a sustained release of super plasticizer molecular structure as shown in Fig3[29].

4.2 Air entraining agent

Concrete air entraining agent is mainly composed of hydrophobic groups and hydrophilic groups, on the interfaces of cement, water and air, the hydrophobic group adsorb to the air side direction, dear water-based adsorb the cement particles and water particle phase, as shown in Fig4[30]. The air entraining agent in the multiple interfaces significantly reduces the surface tension of water, so that it can introduce a large number of gas bubbles in the mixing process of concrete.

The bubble introduced by air entraining agent has excellent dispersing and wetting effect, so that the air entraining agent can improve the concrete bleeding.

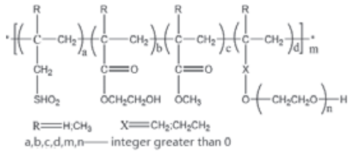

Fig. 3. Structure of a slow-release super plasticizer molecular [29]

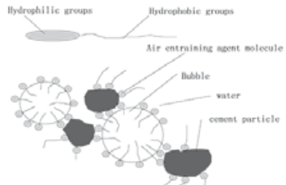

Fig. 4. Mechanism of air entraining agent [30]

Concrete without air entraining agent, has gas content of about 0.5%~2%. Along with the increase of the concrete air content of concrete, it can reduce the bleeding, as shown in Fig5 [31]. Air entraining agent can make bubble delicate, uniform, regular shape, spherical shape, the spherical bubble such as ball, lubricates, also can fix water stably, at the same time reduce bleeding and make the working performance of concrete greatly improved [32].

4.3 Water thickener

According to the flocculation theory of polymer, adsorption functional water retaining agent molecular structure has adsorption type group, which can be adsorbed on the surface of cement particles, so that the cement particles can reach a good dispersion. The repulsion force from adsorption layer overlapping makes the cement particle disperse, so it can reduce the happening of consolidation settlement and improve the stability of concrete [33]. Non adsorption type water retaining agent mainly acts on the free water, it can increase the aqueous system viscosity by the molecular chain self winding each other, making bleeding more difficult to occur [34]. The cement slurry consistency increases in the concrete mixed with addition of water thickener, while it can minimize bleeding of concrete mixture ratio and reduce the working performance of concrete, as shown in Fig 6.

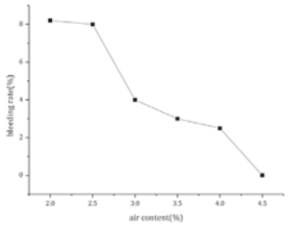

Fig. 5. gas content influence on concrete bleeding type

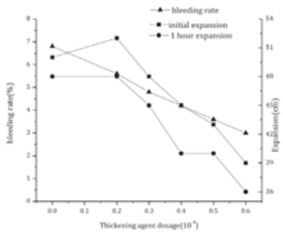

Fig. 6. Effect of thickening agent on concrete bleeding rate

4.4 Admixtures

Fly ash, pulverized slag, silica fume are active admixture, containing a large number of active silica and alumina. Compared with cement, the particle is rounder, its surface is smoother and size is finer [35]. Admixtures mainly have three functions as following: First, its smaller particle can increase the solid packing density, Refine Pore in the concrete, reduce bleeding channel, increase channel distance, and hinder water secretion. Second, its specific surface area is much larger than the cement, so the adsorption of moisture is much strengthener, the concrete can reduce urinary free water; Third, it has a lower density, compared with the cement particles, it's not easy to produce slurry settling of segregation and it has a better uniformity which is conducive to reducing the bleeding [36].

5. EVALUATING METHODS

5.1 L type flow test

L type flow meter can be used to detect concrete workability and reinforced through capacity. The experimental apparatus is shown in Fig7. At the first, concrete mixture should be added to the vertical portion of L type flow meter box body, then keep static for 30s, open the movable door handle, at the same time, the time of 200mm and 400mm flow of the concrete were recorded, measurement of H1 and H2 height. After the stationary time prolonged to 10mins, and comparison test can evaluate anti bleeding and segregation performance [37].

5.2 V type funnel test

This test can used to determine the filling ability of concrete. fill V type funnel with concrete mixture and smooth the surface. Then open the bottom cover, record the outflow time of concrete mixture from the bottom, the shorter the time is, the better the filling ability of concrete mixture is. Through keeping the funnel static for 5mins, and then test outflow time of concrete mixture, contrast the data before and after to determine anti segregation and bleeding capacity of concrete mixture[37].

5.3 U type box test

This method is aimed at testing the capacity of concrete mixture to go through the clearance. Tester model is as shown in Fig 9, the instrument is composed of two boxes, obstacles and active interval in the middle is arranged at the door. First close the compartment doors, fill room A with concrete mixture, after keeping static for 1min, open upwards the interval doors, concrete flows to the B room, after cessation of flow, record the height from top surface of concrete to top of room B, the smaller the height is, the better the going through ability is[37].

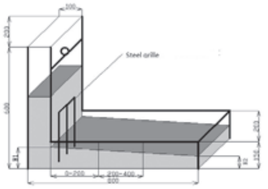

Fig. 7. model diagram of L type flow meter

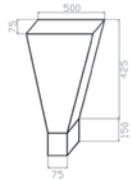

Fig. 8. Model diagram of V type funnel

6. STABILITY MODEL OF CONCRETE

The rheological properties of concrete are mainly determined by the rheological properties of the mortar in concrete structure. With good stable fluidity, coarse aggregate should be uniformly and stably suspended in cement mortar, it can be further accepted that mortar sand is stably suspend in the cement paste, as shown in Fig 10 (a). According to the system equilibrium theory and hydration product filling theory, concrete bleeding and segrega-

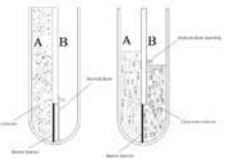

Fig. 9. Model diagram of U type tester

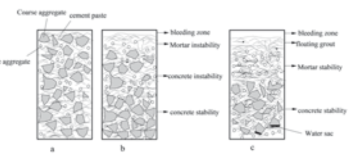

Fig. 10. Stability model of concrete

tion can be divided into three stages, as shown in Fig 10. Fig a is the first stage, coarse aggregate is uniformly suspended in mortar system, fine aggregate in mortar system in cement paste is in homogeneous suspension. Due to self weight of aggregate or the external and internal effect produced by construction, the balance system shown in Fig a is broken, the system start to change from unstable to stable, from unbalanced to balance, causing the concrete bleeding and fresh concrete pressure [38].

Due to free water excretion, the distance between the particles become smaller and larger particles sinks, small particles floats, concrete began to appear layered phenomenon, as shown in Fig b. The phase of concrete can be mainly divided into four parts, they are respectively the bleeding area and mortar unstable area and unstable area and concrete stable area. In concrete unstable area, the coarse aggregate settle downward, the cement mortar emerges after it fills the gap, the boundary between different areas is not mutation, a boundary transition region exits.

Finally the concrete can achieve a relatively stable state before the initial setting, as shown in Fig c, this stage can be divided into four regions, they are respectively the bleeding area, laitance region and stable region and stability region of concrete mortar. Unstable concrete exits bleeding and stratification in the process transforming to the stable concrete, in the process of water constantly moving, the concrete evenness variation and strength absolute value and difference value of hardened concrete will be affected, the uniformity of the intensity can not be well guarantee, bleeding channel makes the impermeability of concrete decline.

7. CONCLUSIONS

Bleeding of concrete has become a- practical problem in concrete materials science, in order to promote the development of the whole concrete material industry technology from low to high, more in-depth study in the mechanism of concrete bleeding process is needed. The formation mechanism of concrete bleeding and segregation was discussed, the affecting factors of concrete segregation and bleeding were also deeply analyzed and classified from the angle of water dynamics in terms of bleeding channel, bleeding press and bleeding water resources. A comprehensive evaluation method of concrete bleeding was put forward in reference of evaluation method of self compacting concrete. By dividing concrete bleeding and segregation process into stages according to timing dimension, a stable model of concrete was established, mechanism of concrete bleeding and segregation was revealed, it had great significance for solving the stability of concrete bleeding and segregation.

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EXPERIMENTAL STUDY ON COMPATIBILITY OF STONE POWDER AND SUPERPLASTICIZIER IN CONCRETE

POSTER

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Keywords

poly carboxylic acid water reducing agent, compatibility, clay modifier

ABSTRACT

Selecting limestone powder(CSF) and sandstone powder(SSF) of different lithology, according to the ratio of 1:1 to combine them into a composite powder, use the powder in the preparation of cement mortar and concrete with different proportion of replacement of cement, through adding the high performance polycarboxylate superplasticizer PCE and clay modifier SMA, the compatibility problems caused by composite powder incorporation can be well improved.The results show that it has a great influence on the concrete work when the content of composite powder reached 10% of cement, adding 5% clay modifier SMA, the initial fluidity and the loss of fluidity of the cement paste with the powder content lower than 15% of cement can reach requirements; mortar has better fluidity and greater strength; concrete workability is good, the strength of various age is the highest.

1. INTRODUCTION

China has enjoyed economic growth and rapid development in the construction industry in recent years, the large number of using commercial concrete leads to a serious shortage of sand resources, manufactured sand has taken the place of natural sand of main materials of modern concrete, but its high mud content and high stone powder content leads to large concrete slump loss, affecting the performance and quality of construction and concrete[1]. Polycarboxylate superplasticizer is a kind of new type water reducer, it has high water reducing rate, the slump loss is small, it's green environmental protection makes it widely used in market, but because of the powder and poly compatibility problem of carboxylic acid superplasticizer, concrete performance and quality have been greatly challenged[2]. Research has shown that the technique of compound of polycarboxylate based superplasticizer can effectively improve the aggregate effect of clay on the polycarboxylate superplasticizer[3]. The present study is mainly focused on the design of water reducing agent of targeted molecular, reduce influence of mud content on the dispersion of polycarboxylate superplasticizer and the ability of cement of adsorbing water reducing agent, so that it can reduce the impact on the rheological properties of concrete[4]. These studies have reference good effect on the in-depth analysis of the mud content of poly carboxylic acid water reducing agent dispersing ability and mechanism[5]. The studies on the concrete mixed with stone powder is already very mature, it also has been applied in engineering practice, the modifier of concrete aggregate of the clay is to modify clay to improve its adsorption behavior on the water reducing agent molecules, to reduce its impact on the strength of concrete, so that more high mud content sand raw materials can be obtained by using [6].

This research selects limestone powder and sandstone powder of different lithology, according to the ratio of 1:1 and combined into a composite powder, use the powder in the preparation of cement mortar and concrete with different proportion of replacement of cement, At the same time, homemade clay modifier SMA is added in concrete, clay modifier effects on concrete related properties of different composite powder content are studied.

2. MATERIALS AND METHODS

1.1 materials

(1) Jinyu PO42.5 ordinary portland cement, the relevant chemical composition as shown in table 1:

table 1. chemical composition of cement

Component	Loss	SiO_2	Al_2O_3	Fe_2O_3	SO_3	CaO	MgO	K_2O	Na_2O
w/%	3.82	24.08	4.72	2.46	2.31	58.24	1.95	1.02	0.27

(2) CSF is from Changping Shangyuan powder factory of Beijing . SSF is from the Beijing area samples, after (2) the preparation of SSF includes screening, drying, grinding, passing 0.075mm zeolite, then used as experimental admixture . Powder chemical composition as shown in table 2.

table 2. chemical composition of CSF and SSF(w/%)

	Loss	SiO_2	CaO	MgO	Fe_2O_3	Al_2O_3	K_2O	Na_2O
CSF	38.6	4.28	50.4	1.6	1.71	0.94	0.31	0.02
SSF	5.75	61.07	4.55	1.7	4.97	13.39	2.77	0.124

(3) self-made polycarboxylates high-performance water reducing agent PCE and clay modifier SMA

1.2 methods

(1) experiment of cement paste

fluidity and fluidity keeping performance of cement paste refers to "Application of concrete admixtures technical specification of cement paste fluidity and fluidity keeping" (GB50119-2003) adaptive appendix A concrete admixture on cement detection method.

(2) experiment of cement mortar

Fluidity test of cement mortar Cement mortar refers to "test method for fluidity of cement mortar" (GB/T2419 - 2005). Methods of testing cement mortar strength refers to "test the strength of cement mortar (ISO method)" (GB/T17671 - 1999), specimen after stripping in water conservation to a fixed age, measured 3 day and 28 day strength.

(3) experiment of concrete

Concrete experiment refers to "standard test method for performance of ordinary concrete mix" (GBT50080-2002), the slump and expansion degree are tested under standard condition maintenance. Standard test method of mechanical properties of ordinary concrete test refers to "the mechanical performance of the concrete" (GB/T50081-2002) . Compressive sample size is the 150mmX150mmX150mm cube, each group has 3 blocks, 7d and 28d strength are tested. The concrete experimental mix design as shown in table 3.

Table 3 mix design of concrete experiment

NO.	cement (kg)	Fly ash (kg)	Powder (kg)	sand (kg)	Gravel (kg)	Additive (kg)	water (kg)	SMA (kg)	SMA (%)	Composite powder (%)
S1	131	80	119	832	1018	6.93	175	0.00	0.0	5.00
S2	131	80	119	832	1018	6.93	175	8.25	2.5	
S3	131	80	119	832	1018	6.93	175	16.50	5.0	
S4	131	80	119	832	1018	6.93	175	42.75	7.5	
L1	131	80	119	832	1018	6.93	175	0.00	0.0	10
L2	131	80	119	832	1018	6.93	175	8.25	2.5	
L3	131	80	119	832	1018	6.93	175	16.50	5.0	
L4	131	80	119	832	1018	6.93	175	42.75	7.5	
M1	131	80	119	832	1018	6.93	175	0.00	0.0	15
M2	131	80	119	832	1018	6.93	175	8.25	2.5	
M3	131	80	119	832	1018	6.93	175	16.50	5.0	
M4	131	80	119	832	1018	6.93	175	42.75	7.5	

2. RESULTS AND DISCUSSIONS

2.1 Effects of SMA on cement paste

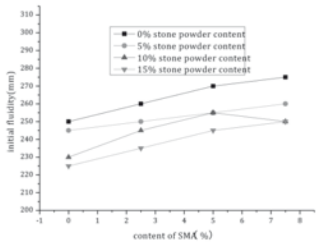

Fig. 1. Influence of SMA on initial fluidity of cement paste with different content of stone powder

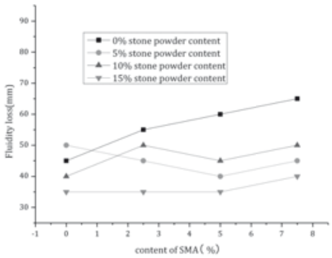

Fig. 2. Influence of SMA on fluidity loss of cement paste with different content of stone powder

Powder content in cement paste has a great influence on the adaptability of superplasticizer and cement , under the same amount of SMA, with increase of powder content, powder can adsorb more superplasticizer and effective water reducer in the cement paste decreases, so initial fluidity of cement paste declines (Figure 1), 1H fluidity loss of the paste becomes larger(Figure 2). From the SMA side, its main function is to improve the micro surface of SSF reducing the adsorption capacity of cement on water reducing agent. With the increase of SMA content, the fluidity of cement paste increases (Figure 1), 1H cement paste fluidity loss becomes smaller (Figure 2), powder which influences the adaptability of water reducing agent and the cement is the adsorption of SSF, and water demand of CSF is small, it can effectively improve the fluidity of cement paste, SMA can effectively improve the adsorption of SSF on the water reducing agent.

2.2 Effects of SMA on cement mortar

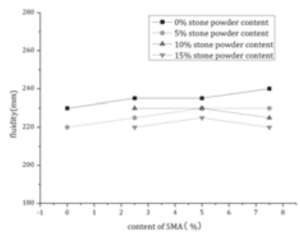

Fig. 3. Influence of SMA on initial fluidity cement mortar with different content of stone powder

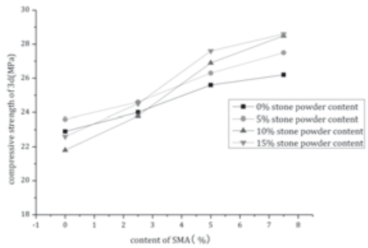

Fig. 4. Influence of SMA on 3 day compressive strength of cement mortar with different content of stone powder

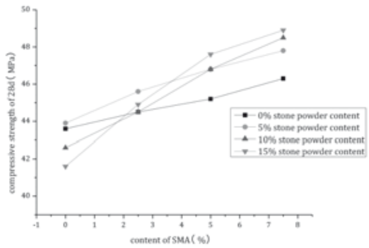

Fig. 5. Influence of SMA on 28 day compressive strength of cement mortar with different content of stone powder

Cement mortar fluidity declines with the increase of powder content , but with the increase of SMA clay modification agent content, fluidity decrease of cement mortar with different content of powder slows down significantly, especially in the powder content of 10%, the fluidity increases effectively (Figure 3). SMA can stimulate the strength of cement mortar, by modifying the SSF in powder, it can make better use powder filling effect of the CSF , with the increase of SMA, 3 day and 28 day compressive strength value of cement paste increase (Figure 4~5). On the composite powder's side, the proper addition of appropriate amount of the compound powder makes cement mortar more compact, effective to filling the void in concrete, thereby improving the strength. Because the stone powder content increases, the water demand increases , if the water flow remains unchanged, the Cement mortar fluidity declines.

2.3 Effects of SMA on concrete

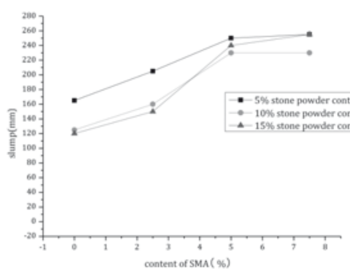

Fig. 6. Influence of SMA on slump of concrete with different content of stone powder

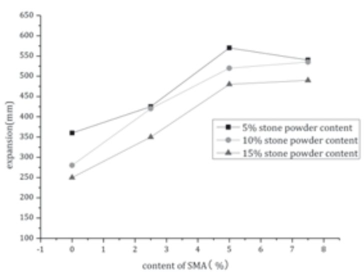

Fig. 7. Influence of SMA on expansion of concrete with different content of stone powder

Under the same concrete mix ratio, when the amount of SMA is less than 5%, slump and extension of concrete increase with the SMA increase (Fig6~7), the concrete mixture is in good condition. when the addition content of SMA is beyond 5%, the slump and expansion degree decreases, and concrete has segregation bleeding phenomenon, that too much SMA has adverse effects of on workability of concrete; slump decreases with the increase of powder content , especially the mud content exceeds 10%, the decline was particularly rapid.

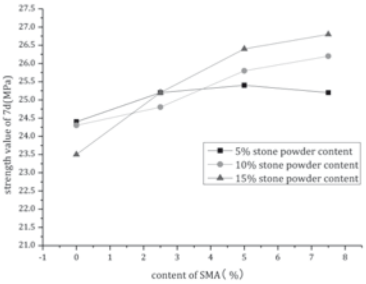

Fig. 8. Influence of SMA on 7 day compressive strength of concrete with different content of stone powder

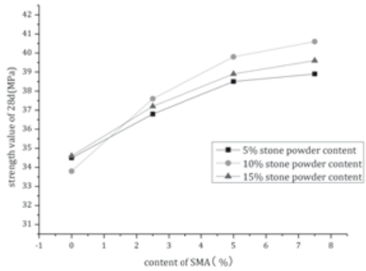

Fig. 9. Influence of SMA on 28 day compressive strength of concrete with different content of stone powder

Calcium compound in the SMA can form spherical complex in water, this material can fill the pore structure of concrete and SSF , so that the compactness of concrete increases, and thus the strength improves. The 7d, 28d compressive strength of concrete increase with increase of SMA content. When SMA clay modified admixture agent content is 5%, the concrete strength has dramatically improvement(chart 8~9). With the increase of SMA content, the early strength of concrete improves. Powder can adsorb superplasticizer molecules onto it's powder surface, impeding the reaction with cement, so as to effectively reduce the retarding effect of water reducing agent.

3 CONCLUSIONS

(1) according to th results of cement paste fluidity and concrete properties , the optimal dosage of SMA is 5% , too much SMA can easily lead to bleeding and segregation. It has an excellent improvement effect on under 15% powder content with 50% SSF. Cement mortar fluidity declines with the increase of powder content, SMA can slow the decrease of fluidity of cement with different powder content.

(2) SMA can effectively improve the strength of cement mortar and concrete. The 3 day and 28 day compressive strength value of cement mortar increases with the content of SMA, 7d compressive strength of concrete can reach about 70% of standard strength, and the strength values of different ages of concrete increased with the SMA content. When SMA content is 5%, concrete strength improves dramatically.

(3) SMA has water reducing effects, it can improve the intensity of concrete in the admixture of 5%, especially in the CSF and SSF ratio of powder content is less than 7.5% in the case of 1:1. When powder content is more than 7.5%, the improvement of concrete strength decreases obviously.

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APPLICATION OF HYPERELASTIC MURNAGHAN MATERIAL TO THE CALCULATION OF STEEL STRUCTURES USING ADINA SOFTWARE

POSTER

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Keywords

murnaghan material, FEM, steel structures

ABSTRACT

The initial part of the paper presents the basic formulas for performing calculations assuming that the compressible continuum of material is modeled as hyperelastic medium described by Murnaghan elastic potential. For the assumed initial deformation of the medium the analytical calculations were made and the stress-strain dependence, which allows for the declaration of the material in the numerical environment of the ADINA software, for two considered metal (i.e. steel and aluminum) has been obtained. In this paper the declaration of the material in the calculating environment of the ADINA software, for the purpose of numerical benchmark tests for the simple elastic structures has been discussed in detail. Calculated stress were compared for the linear and non-linear material, steel and aluminum. The results are shown in the graphical form, and conclusions of numerical analysis are given in the summary of the paper.

1. INTRODUCTION

Physical relationships describing the behavior of different types of materials subjected to deformations, were the subject of discussion at the beginning of the twentieth century. The behavior of the particulate material under the influence of external effects is described by constitutive equations that describe the relationship between strain and stress or strain and energy. Constitutive equations for hyperelastic materials are obtained based on the equations of mechanical energy balance. In the late 30's Murnaghan defined constitutive relationship for nonlinear compressible elastic material (Murnaghan, F.D.1937), then in the 40's and 50's the first attempts to determine the constitutive relationships for rubber and rubber-like materials was taken (Mooney, M. 1940, Rivlin, R.S. 1948). The model of material is adopted depending on the factors that are of essential importance to behaviour of the specific medium. Therefore, constitutive equations define an arbitrary selected model of material which describes its actual behaviour (better or worse) in a particular are of changes in these factors.

2. MURNAGHAN MATERIAL

According to the study carried out by Murnaghan (Murnaghan, F.D. 1937), elastic potential that determines non-linear material of the second order, which is currently termed Murnaghan material, is expressed by the equation

$$W(I_1,I_2,I_3)=\frac{l+2m}{24}(I_1-3)^3+\frac{\lambda+2\mu+4m}{8}(I_1-3)^2+\frac{8\mu+n}{8}(I_1-3)-\frac{m}{4}\ (I_1-3)(I_2-3)+ \\ -\frac{4\mu+n}{8}(I_2-3)+\frac{n}{8}(I_1-1) \qquad (1)$$

where
- specific elastic energy in the reference configuration,
- elastic energy accumulated per mass unit
- mass density in the reference configuration,
- invariants of the deformation tensor,
- Lamè constants,
- elastic constants of the second order.

Constitutive equation (1) describing the elastic energy in the case of an isotropic compressible material can be used to perform the calculations for moderate strain. The elastic constant for the analyzed in this study two metals, i.e. steel and aluminum are presented in Table 1) based on the study (Hauk, V. 1997).

3. ANALITYCAL CALCULATIONS

In the established and covering Cartesian coordinate systems $\{x^i\}$ and $\{X^\alpha\}$ we consider deformation, which can be described by the following relationships

$$x^1 = \lambda_1 X^1 \qquad x^2 = \lambda_2 X^2 \qquad x^3 = \lambda_3 X^3 \tag{2}$$

where $\lambda_1, \lambda_2, \lambda_3 = cons.$. A Cartesian system of material coordinates $\{X^\alpha\}$and Cartesian system of spatial coordinates$\{x^i\}$parametrize the same space and are mutually covered. Deformation gradient for such a description is independent of the coordinate x and time *t*. We assume that the considered elastic medium is subjected only to stretch (or compression) in one direction, then

$$\lambda_1 = 1 \qquad \lambda_2 = 1 \qquad \lambda_3 = 1 + \varepsilon_{33} \tag{3}$$

For assumed deformation, gradient deformation and the deformation tensors are

$$\left[x^i{}_\alpha\right] = \begin{bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix} \qquad \left[B^{ij}\right] = \left[C_{\alpha\beta}\right] = \begin{bmatrix} \lambda_1{}^2 & 0 & 0 \\ 0 & \lambda_2{}^2 & 0 \\ 0 & 0 & \lambda_3{}^2 \end{bmatrix} \tag{4}$$

The invariants of the deformation tensors are

$$I_1 = \lambda_1{}^2 + \lambda_2{}^2 + \lambda_3{}^2 \qquad I_2 = \lambda_1{}^2\lambda_2{}^2 + \lambda_2{}^2\lambda_3{}^2 + \lambda_1{}^2\lambda_3{}^2 \qquad I_3 = \lambda_1{}^2\lambda_2{}^2\lambda_3{}^2 \tag{5}$$

Based on the study (Wesołowski, Z. 1978) it is possible to determine the analytical value of stress on the established direction of stretch (or compression). Wynosi ona odpowiednio

$$T^{33} = 2\rho\sigma_1\lambda_3{}^2 + 2\rho\sigma_2\lambda_3{}^2\left(\lambda_1{}^2 + \lambda_2{}^2\right) + 2\rho\sigma_3\lambda_1{}^2\lambda_2{}^2\lambda_3{}^2 \tag{6}$$

where

$$\sigma_1 = \frac{1}{\rho_R}\left[\frac{l+2m}{8}(I_1-3)^2 + \frac{\lambda+2\mu+4m}{4}(I_1-3) + \frac{8\mu+n}{8} - \frac{m}{4}(I_2-3)\right]$$

$$\sigma_2 = -\frac{1}{\rho_R}\left[\frac{m}{4}(I_1-3) + \frac{4\mu+n}{8}\right] \qquad \sigma_3 = \frac{1}{\rho_R}\cdot\frac{n}{8} \tag{7}$$

Because the invariants I_1, I_2, I_3 are independed on coordinates x^i, then σ_1, σ_2, for the isotropic body do not depend on coordinates too, wherein

$$\rho = \frac{\rho_R}{\lambda_1\lambda_2\lambda_3} \tag{8}$$

Assuming that the deformation $\varepsilon_{33} = 0.2$ mm the following values of stress were obtained in steel: 4.377•107 Pa and aluminum: 2.218•107 Pa.

4. DECLARATION OF MURNAGHAN MATERIAL IN THE ADINA SOFTWARE

After preparing a .txt file with the stress-strain data, we need to make a definition of the material by selecting: *Model – Materials – Manage Material…*, then press button in the section *Elastic – Nonlinear*. In the opened window, press button *Add…* and in the box *Description* enter the name of the material, then in the box *Poisson's Ratio* enter the value of Poisson's ratio. To import the exported data column press button *Import.* You will get another window in which you should to indicate the location of your file. To import the data into the appropriate column (*Strain or Stress*) press the column header. After entering the data, press button *Save*, in order to save a new material for the needs of current work with ADINA software.

5. NUMERICAL CALCULATIONS IN THE ADINA SOFTWARE

To the numerical calculations static analysis was assumed. Rectangular prism model 4 cm high and with dimensions of base equals 2 x 2 cm was adopted. One of the base is fixed. The load of a second frontal plane of the analysed elastic structure was represented by forced displacement 0.1mm equal. The model to MES calculations was obtain by declaring a regular schedule of nodes in the grid of 0.2 cm, as results 3381 nodes of grid was obtained. For such division it possible to obtain a more regular (cubic) 8-node elements, which for analysed example we obtain 2000. The results of analysis are shown in Figures 1) and 2).

6. SUMMARY

On the basis of numerical calculations made in the ADINA software has been demonstrated distinct differences between the distributions of stresses in the linear and nonlinear mediums described by Murnaghan potential. For the steel in the linear medium effective stress are within the range from 2.790•107 Pa to 7.043•107 Pa – see figure 1a), then in the nonlinear Murnaghan medium in the range from 3.693•107 Pa to 9.324•107 Pa – see figure 1b). For the aluminum in the linear medium effective stress are within the range from 0.827•107 Pa to 2.430•107 Pa – see figure 2a), then in the nonlinear Murnaghan medium in the range from 1.312•107 Pa to 3.853•107 Pa – see figure 2b). The percentage difference in the resulting values of effective stress between linear and non-linear medium described by Murnaghan potential foro steel ~24.45% for the minimum value and ~32.38% for the maximum value, then for aluminum it is ~36.96% and ~36.93% respectively. It is worth emphasizing that in analytical calculations we obtain values of stress in the steel adequately 4.377•107 Pa, then in aluminum it is value 2.218•107 Pa. The values obtained in the analytical method are in the range of effective stress obtained by the numerical calculations in the ADINA software.

Material	Lamè constants [GPa]		Elastic constants of the second order [GPa]		
	λ	μ	l	m	n
Steel	120	79	-179	-496	-628
Aluminum	61 ± 1	25	-47 ± 25	-342 ± 10	-248 ± 10

Table 1. Elastic constants

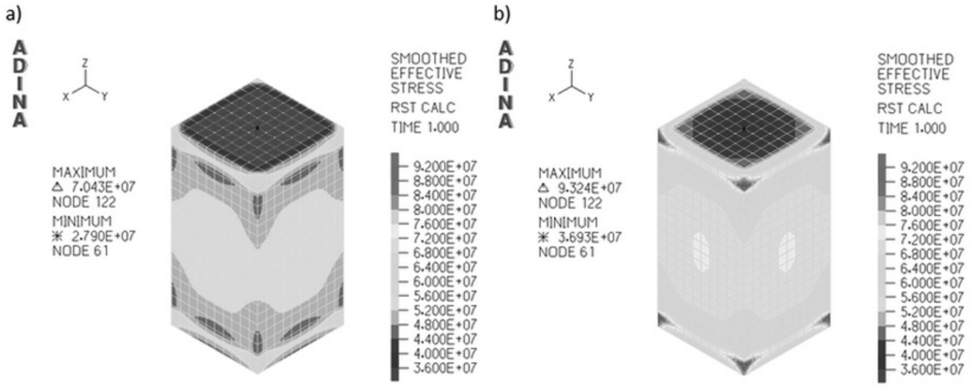

Fig. 1. Comparison of stress distribution in steel modeled as: a) linear, b) non-linear Murnaghan material

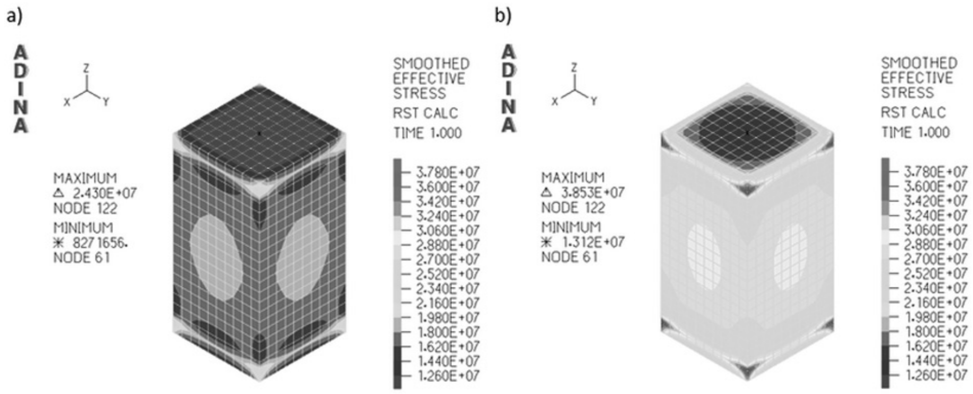

Fig. 2. Comparison of stress distribution in aluminum modeled as: a) linear, b) non-linear Murnaghan material

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CLIMATE CHANGE AND WATER RESOURCE MANAGEMENT OF NAGORNO-KARABAKH

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Keywords

construction, ground dam, filtration

ABSTRACT

From urban and agricultural water supplies to flood management and aquatic ecosystem protection, global warming is affecting all aspects of water management in Nagorno-Karabakh. Proffesionals of the field and elected officials must act now to adapt to the effects of the warming that have already occurred or are unavoidable. Nagorno-Karabakh is one of the countries of the Transcaucasus Region with extremely limited water resources. Although there are over 100 small lakes and reservoirs in Nagorno-Karabakh, with total areas ranging from a few square meters to tens of hectares, these are generally shallow with an average depth of less than or equal to10 m.
The Askeran region of the Republic of Nagorno-Karabakh is rich in water resources. For effective usage and management of the resources there have been built plenty of small and big reservoirs on the rivers and streamlets of the Republic of Nagorno-Karabakh.
The reservoirs under investigation including Khndzistan, Hilis, Noragyugh-1, Noragyugh-2, Khanabad, Kaputan, Karmir Gyugh, Qrasni and Sarushen reservoirs were built in 50-80th of the past century. After passing to exploitation this kind of structures the regular monitoring of the parameters like settling, filtration flows, firmness, landslide and stability is mandatory.
This article contains the results of the complex analysis of the technical data of hydro-system's main constructions. The investigation of the constructions' technical data and the implementation of the resulting developments will result in exploitation condition improvement and will extend their lifetime.

1. INTRODUCTION

Targeted use of Nagorno-Karabakhs Surface streams is a strategic task that can supply the population with energy, food and security security. It is necessary to create favorable conditions for the balanced development of agriculture.
Subject to a comprehensive study of small reservoirs operated by Khndzristan, Noragyugh 2, Khanabad, Kaputan, Red Village, Krasnii and Sarushen reservoirs that require repair. Over the years wash was accumulated in the reservoirs. (Stage 3, Book 3).
Surface flows harvests are intended to be used directly in agricultural development. Only the targeted expansion of area under crop horticulture and vegetable crops can create demand for irrigation water.. This is the most important sector of the economy, which can provide economic benefits.
Perennial observations showed that the earth dam breakthrough occurs mainly in the filtration of large flows. When the filtration flows exceeds the permitted limits in the body of the dam soil washing takes place, which is accompanied by a process of constant development. Over time crack sizes are growing so much that collapse of the dam may happen.
Dam collapse in other cases, wall washing and wall collapse at the expense of water discharge. Leaked waterflow wash the soil from the dam, causing a discharge crack: Over time, the crack size, ground-laundering as a result of increases in the base of the dam up to the parent aparnerin. At the same time increase the size of the side walls occurs in the direction that increases the size and issued toghantski exit.

2. BACKGROUND

For reduction of filtrational losses of water through the basis of the dam two options were considered:

- a wall in soil of 15 m in depth;
- drooping from loam.

The plane-parallel stationary filtration through a body of a dam and the basis in a case is considered when water level is in a reservoir on NPU mark. Calculation is perfromed by means of the SEEP/W program from a package of the applied GEO-SLOPE programs. Office 5. Settlement cross section of a dam and basis was approximated by the grid consisting of 6298 knots and 6710 elements (triangular and quadrangular). The settlement area of a filtration, for a case dejectedly with a length of 40 m (Fig.1).
Calculations are carried out for four settlement cases:
1. Length is dejectedly equal 40 m;
2. Length is dejectedly equal 60 m;
3. Length is dejectedly equal 80 m;
4. Under the screen of a dam the wall in soil of 15 m in depth is arranged.

As a result of calculations for these cases sizes of expenses of water through a body and the basis of a dam on 1 m of length (q, m3/sec./1m) and sizes of filtrational gradients on all area of a filtration are received. Sizes of filtrational expenses through a body and the basis of a dam for all considered cases (Fig.2).

3. METHODS

Stability of slopes of a dam has to be checked on possible surfaces of shift with finding of the most dangerous prism of a collapse characterized by the minimum relation of the generalized limit jet forces of resistance to the active shifting forces.
Criterion of stability of slopes of a dam is observance of a condition (SNIP 2.06.05-84),

$$\gamma_c F \leq (\gamma_c / \gamma_n) R \qquad (1)$$

which can be written down with use of dependence for coefficient of stability of Ks in a look

$$K_s = R/F \geq \gamma \ (\gamma_n \ \gamma_{lc})/ \ \gamma \ \gamma_c \qquad (2)$$

where F- the calculated value of the generalized power influence determined taking into account reliability coefficient by γ_f loading (depending on a method of calculation of stability of slopes of F – equally effective forces or the moments of these forces concerning a shift surface axis);
R- a calculated value the generalized construction basis determined taking into account the safety coefficient by γ_g soil, i.e. the generalized calculated value of forces of limit resistance to shift bearing abilities of system on the considered surface;
γ_c , γ_n , γ_{lc} – coefficients of working conditions, responsibility of a construction, combination of loadings.
In case of use of engineering methods of calculation coefficient of operating conditions of =0,95. The size of coefficient of responsibility of a construction depends on a construction class. For a construction of the II class =1,20. The coefficient of a combination of loadings is equal:

- in case of the main combination of loadings of γ_{lc} =1,00;
- in case of a special combination of loadings of γ_{lc} =0,90;
- for the construction period of γ_{lc} =0,95.

At an assessment of stability of slopes of the Chiri-Yurtsky dam the minimum values of coefficient of stability of slopes are equal:

- for the main combination of loadings – Ks ≥ 1,20*1,0/0,95 =1,26;
- for a special combination of loadings – Ks ≥ 1,20*0,90/0,95 =1,14;
- for the construction period – Ks ≥ 1,20*0,95/0,95 =1,20.

At calculations of stability of slopes of dams, it agrees), it is necessary to consider the following cases.

For a local slope:
a) settlement case 1 (main): in the top byef the NPU normal retaining level, in a dam body – the established filtration;
b) a settlement case 2 (main) at open spillways (without locks): retaining level and level of the lower byef define to the maximum expenses carried to the main combinations of loadings and influences;

c) settlement case 3 (special): in the top byef – the forced retaining water level (FTUU), in the lower byef the maximum depth of water the relevant FTUU.
For a riding slope:

d) settlement case 1 (main): the maximum possible decrease in water level in a reservoir from NPU or from the retaining level corresponding to the admission of the maximum expense carried to the main combinations of influences with the greatest possible speed thus filtrational forces of the unsteady filtration are considered;

e) settlement case 2 (construction period): water level is in the top byef on the mark answering
to filling (0.2-0.3) hj where hj – slope height;

f) settlement case 3 (special): the greatest possible decrease in water level in a reservoir from FTUU with the greatest possible speed, thus filtrational forces of the unsteady filtration are considered;

g) settlement case 4 (special): seismic influence in case of long standing of NPU;

h) settlement case 5 (special): seismic influence in case of fast decrease in water level in a reservoir from NPU to the lowest operational case.

4. CASE HISTORY

Calculations of stability of slopes of a dam were carried out with use of the kompyuterny SLOPE/W program from a package of the applied GEO-SLOPE programs. Office 5.
In models the depressionny curve in a body of a dam is accepted conditional. It is necessary to resort to this reception in cases of dams with the screen. It is connected with feature of the SLOPE/W program of the horizontal coordinate of a surface of a depression demanding continuous increase.
Calculation of stability of slopes of a dam was made on Spencer, Morgenshterna-Price and Bishop’s methods. Spencer and Morgenshterna-Price’s methods meet all three conditions of balance (∑X=0; ∑Y=0; ∑M=0;).
Bishop’s method meets two conditions of balance (∑Y=0; ∑M=0;). Results of calculations showed that the sizes of coefficients of stability received on these three methods are very close. Considering this fact, the sizes of coefficients of stability received on Spencer’s method are given further.

5. RESULTS

Dependence of filtrational expenses from the protivofiltatsionnykh of actions (Fig.2).
Detailed results of calculations are given in (Fig.3) in the form of a hydrodynamic grid (isolines of equal pressures and lines of currents) and pressure gradients.
The results of calculations given in tab. 2.2 allow to come to conclusion that loamy понур with minimum of 40 m is optimum option. With growth of length dejectedly filtrational expenses through a body and the basis of a dam increase slightly. So at increase in length dejectedly twice (from 40 m) the expense increases to 80 m by 1,5 times, and the size of an expense isn’t critical.
As for option with a wall in soil, in comparison with 40 meter dejected expenses decrease approximately by 8 times. However it is necessary to consider that fact that the construction of a concrete wall of 15 m in depth in gravelisto-pebble soil is a complex and expensive engineering problem. Besides it is necessary to consider that fact that over time there will be a kolmatation of soil at the bottom of a reservoir and filtrational expenses through the basis will decrease (Volkov I.M., P.F. Kononenko and I.K. Fedichkin. 1968).

5. CONCLUSION

Thus, we come to conclusion about expediency of application in this case of option with dejected the 40 m long. Check of filtrational durability of material dejectedly and the screen is made with use of the condition given in (SNIP 2.06.05-84).

$$\text{Jest, m} \leq \text{Jcr, m}/ \qquad (3)$$

where Jest, m - the operating average gradient of a pressure in settlement area of a filtration;

Jcr,m - the critical average gradient of a pressure accepted on the basis of researches of soil in the conditions answering to real service conditions of a construction; in predesigns and in the absence of necessary researches of value Jcr, m can be accepted according to the available analogs.
 - reliability coefficient on responsibility of a construction.

• for dejectedly from loam Jcr,m =10;

• for the screen from loam Jcr,m =8.
Taking into account reliability coefficient on responsibility of a construction of =1,2 (as for a construction of the II class) we have:

• for dejectedly from Jcr loam, m/ =10/1,2 = 8,33;

• for the screen from loam Jcr, m/ =8/1,2 = 6,67.

From results of the calculations given on (Fig.3) it is visible that the condition is carried out in all cases.

Filtration systems have shown for several decades their behaviour in dams. Based from this long feedback, filtration design rules and products have been optimized to increase their long term performance. These filtration systems combined to monitoring solutions, such as the Geodetect early warning system, give now a high level of safety to these hydraulic works.

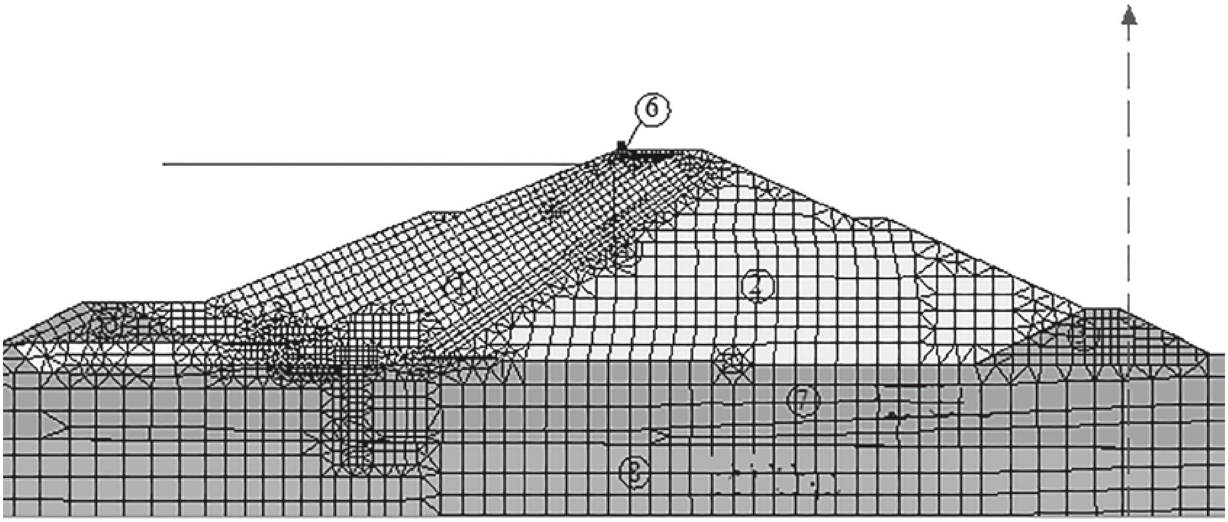

Fig. 1. Finite element mesh of the basic fragment
within the province of filtration with the length of ponur 40m.

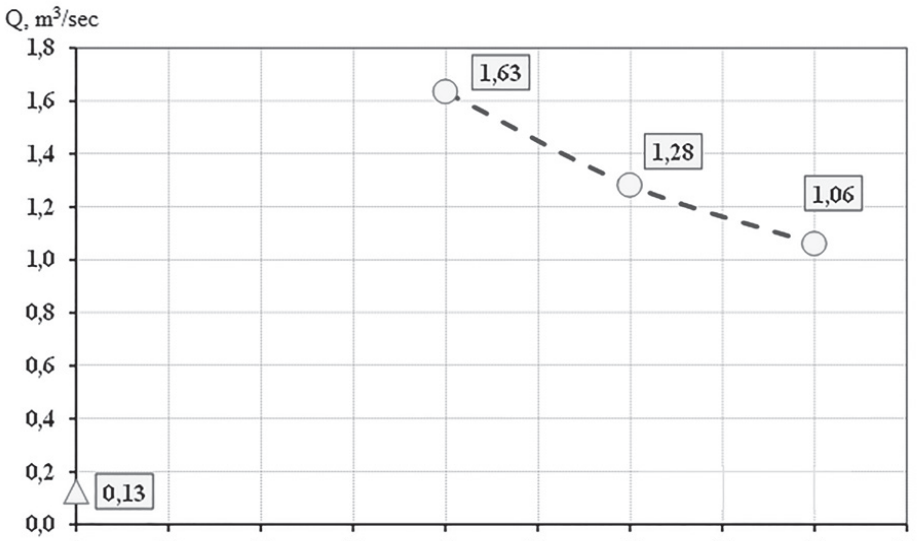

Fig. 2. Filtration expenses in dependence
of antifiltration follow-up works (b-40, q-1.63; b-70,Q-1.28;b-80, Q-1.06).

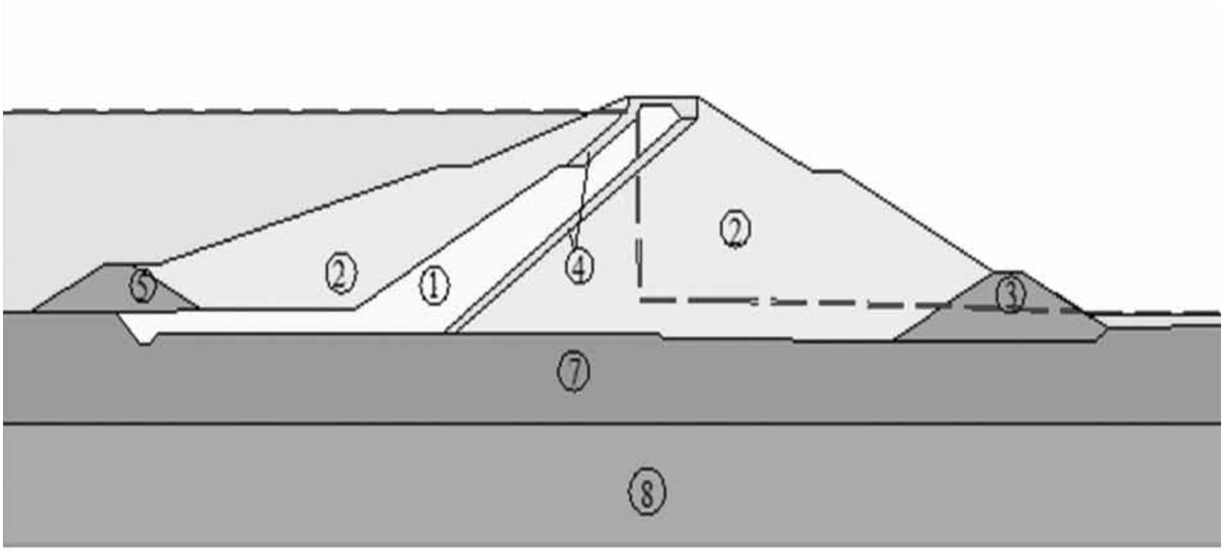

Fig. 3. Rated diameter of platina for the splay stagger classing.

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CALCULATING METHOD OF LOAD-CARRYING CAPACITY FOR RECYCLED CONCRETE SQUAT WALLS FAILED IN MIXED FLEXURE-DIAGONAL COMPRESSION

POSTER

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Keywords

flexure-diagonal compression, recycled concrete, squat wall; load-carrying capacity, load-transferring mechanism

ABSTRACT

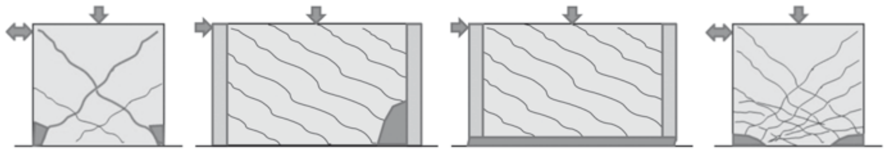
To calculate the ultimate load-carrying capacity of recycled concrete squat walls, four typical failure modes and load-transferring mechanism of squat wall are firstly analyzed. It is found that part of the lateral load applied at the top of a cantilever wall can be transmitted directly to the foundation by diagonal compression between inclined cracks. Secondly, the results of six recycled concrete squat wall specimens tested under cyclic loading are reviewed. Based on the test results, a mixed flexure-diagonal compression mechanism for predicting the ultimate load-carrying capacity of recycled concrete walls and its calculating method are proposed. Moreover, empirical values of parameters in the model are suggested. The study shows that the proposed model can accurately predict the ultimate load-carrying capacity of the test specimens when rational values of parameters are used, which can be taken as reference for calculating the capacity of squat walls in future.

1. INTRODUCTION

Squat walls are commonly used in low-rise buildings since they show good performance in lateral load resistance and drift control. Paulay et al (Paulay, 1982) summarized three typical shear failure modes when lateral load such as earthquake load is applied, namely, diagonal tension, diagonal compression and sliding shear failure, as shown in Fig.1. Diagonal tension failure, characterized by a corner to corner cracking, often occurs when insufficient horizontal reinforcement is provided. Adding horizontal reinforcement can prevent diagonal tension failure and lead to diagonal compression failure, characterized by crushing of concrete struts near the base of the wall. This type of failure is common in walls with stiff boundary elements or with a high axial load. It usually attains a high shear stress. Sliding shear failure differs from diagonal tension or compression, characterized by resisting shear force by aggregate interlock in the compression zone and dowel action of the vertical reinforcement at base section. It occurs in walls with adequate horizontal reinforcement to prevent diagonal tension failure, with low axial loads and no stiff boundary elements so that diagonal compression failure would be avoided, or in walls with light vertical reinforcement. It is found that a significant portion of lateral load introduced at the top of a cantilever wall could be transmitted directly to the wall base by compressive struts between inclined cracks (**Barda, 1977**). After providing reasonable amount of vertical and horizontal reinforcement, pure shear failure can be avoided, and squat walls are often failed in a mixed flexure-shear mode (Fig.1 (d)). It is characterized by sufficient yielding of vertical reinforcement before the ultimate load-carrying capacity is achieved. However, the post-yielding behavior is hard to accurately predict. This paper only discusses the case of mixed flexure-diagonal compression. In this mode, the ultimate load-carrying capacity is achieved when the concrete is failed by flexure and diagonal compression. It exhibits similar phenomenon of flexural failure. However, the lateral load resistance would be the combined contribution of flexural and diagonal compression mechanisms rather than only the flexural mechanism.

2. EXPERIMENTAL PROGRAM

The tests of six recycled concrete squat walls under cyclic loading were conducted by authors before (Youkai Peng, 2015). Table 1 shows the parameters of specimens and Fig. 2 shows the details. The main variables are



(a) diagonal tension (b) diagonal compression (c) sliding shear (d) mixed flexure-

Fig.1 Failure machanisms.

axial load level, the amount of vertical and horizontal web reinforcement. All specimens have a length of 1800mm and a height of 1600mm (hw/lw = 0.89), and a thickness bw of 180mm. The height from wall base to the action point of lateral loading (H) is 1800mm. The length of boundary element lc is 360mm, which is two times the thickness or 20% of the overall length of wall specimen. The boundary element of all specimens was vertically reinforced with six hot rolled ribbed bars D14 (diameter = 14mm), constituting a longitudinal reinforcement ratio ρ of 1.4%; and transversely reinforced with hot rolled plain bars D10 (diameter = 10mm) hoops and ties spaced at 75mm (D10@75). The details in boundary element meet the requirements of Chinese code. Hot rolled plain bars D8 (diameter = 8mm) spaced at 180mm (D8@180) were used as the vertical web reinforcement of specimens RCSW-1 through RCSW-4, and hot rolled plain bars D10 spaced at 135mm (D10@135) were used as the vertical web reinforcement of specimens RCSW-5 and RCSW-6, constituting vertical web reinforcement ratios ρv of 0.310% (minimum requirement 0.25%) and 0.646%, respectively. The horizontal web reinforcement ratio ρh varies from 0.186% to 0.873%. Specimens RCSW-1 through RCSW-6 were horizontally reinforced in web region by D10@100, D10@150, D10@150, D10@300, D8@150 and D8@300, respectively. In order to prevent a premature sliding shear failure at wall base, four hot rolled ribbed bars D14 with a length of 700mm were added as dowel reinforcement for all specimens. The length of the dowel bars extended into the foundation and into the wall section was 400mm and 300mm, respectively. The axial load ratio of specimens RCSW-1, RCSW-3 and RCSW-4 was 0.13 while that of specimen RCSW-2 was 0.064, and the axial load was not applied for specimens RCSW-5 and RCSW-6. The measured vertical reinforcement strains across the base section of specimen RCSW-1 at different loading stage are shown in Fig.3. It can be observed that the strain of vertical reinforcement varies linearly across the base section of the wall at small drift levels. However, the plane sections assumption does not valid after the wall developed obvious plastic deformations due to the yielding of reinforcement and cracking or spalling of concrete, such as in the stages shown in Fig. 4(b) and Fig.4(c). The lateral force to drift ratio response is shown in Fig. 5. Although different final failure modes occurred, the peak loads of all specimens were achieved when the crushing of concrete at the toes of walls was observed after sufficient yielding of vertical reinforcement. Note: hw = the height of squat wall; l_w = the length of squat wall; l_c = the length of boundary element; b_w = the width of squat wall; f_{cu} = average compressive strength of three 150mm cubs; f_c = average compressive strength of three 150mm×300mm prisms; f_t =splitting tensile strength; ρ = reinforcement ratio in boundary element; ρ_v = web vertical reinforcement ratio; ρ_h = web horizontal reinforcement ratio; N = axial load; $N/(A_c f_c)$ = axial load ratio; $A^c = l_w b_w$.

Table 1 Parameters of specimens

Specimen	h_w, mm	l_w, mm	l_c, mm	b_w, mm	f_{cu}, MPa	f_c, MPa	f_t, MPa	ρ, %	ρ_v, %	ρ_h, %	N, kN	$N/(A_c f_c)$
RCSW-1	1600	1800	360	180	50.3	42.0	2.26	1.4	0.310	0.873	1792	0.13
RCSW-2	1600	1800	360	180	50.3	42.0	2.26	1.4	0.310	0.582	870	0.06
RCSW-3	1600	1800	360	180	51.9	43.2	2.16	1.4	0.310	0.582	1818	0.13
RCSW-4	1600	1800	360	180	51.0	42.5	2.16	1.4	0.310	0.291	1791	0.13
RCSW-5	1600	1800	360	180	53.4	44.0	2.16	1.4	0.646	0.372	—	—
RCSW-6	1600	1800	360	180	49.3	46.7	2.16	1.4	0.646	0.186	—	—

3. PROPOSED MODEL FOR MIXED FLEXURAL-DIAGONAL COMPRESSION MECHANISM

The flexural strength of specimen is calculated based on plane sections assumption in many codes as illustrated in

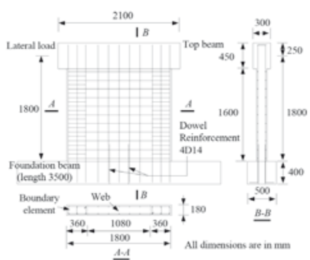


Fig. 2 Details of specimens.

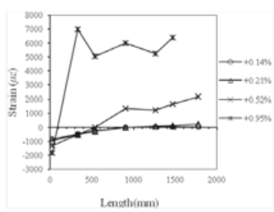


Fig. 2 Measured strain across the base section of RCSW-1.

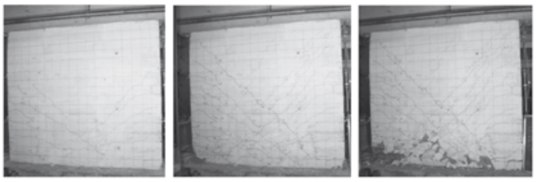


Fig.4 Crack pattern of RCSW-1 at various drift ratios: (a) 0.52%; (b) 0.95% (peak load) ;(c) final failure

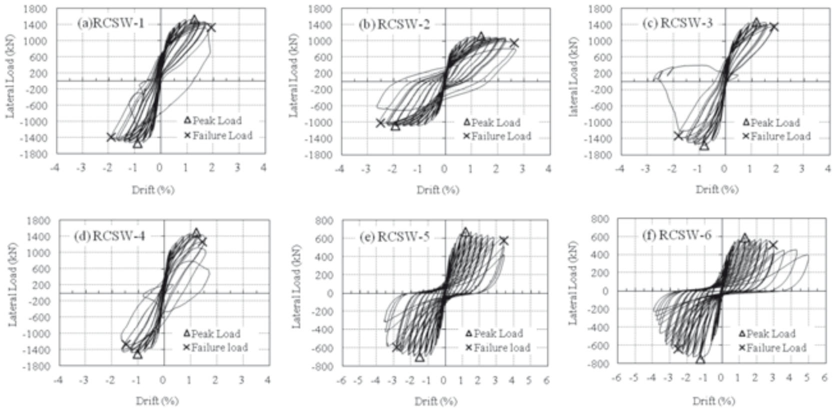


Fig.5 Hysteresis loops of specimens.

Fig. 6(a), where Tf represents tension force, Cf represents compression force, and Vf represents shear resistance. This is valid in tall walls. However, plane sections assumption will be questioned in squat walls since diagonal compression mechanism will disturb the linear distribution of section strain. When diagonal compression mechanism dominates the behavior of squat walls, the load transferring mechanism could be the case as shown in Fig. 6(b), where Td is tension force, Cd is compression force, Vd is shear resistance, and θ is the angle of inclined concrete struts. For most specimens, a mixed flexural-diagonal compression mechanism may dominate their behavior as shown in Fig. 6(c), where T is total tension force and V is total shear resistance.

Based on the assumption as shown in Fig. 6(c), the analytical lateral load resistance of specimens (Vanalytical) could be expressed as Eq. (1), where Vflexural and Vdiagonal are the contributions of the two mechanisms, respectively. It is assumed that the peak load is achieved when the crushing of extreme compression fiber due to the contributions of the two mechanisms occurs.

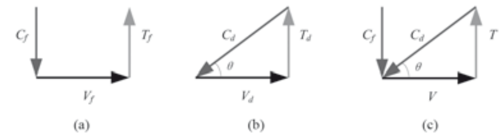


Fig.6 Load-transferring mechanisms: (a) flexural; (b) diagonal compression; (c) mixed flexural-diagonal compression.

$$V_{analytical} = V_{flexual} + V_{digonal} \tag{1}$$

For the tested squat walls, the load resistance mechanism is shown in Fig.6. The equilibrium of vertical forces at the base section gives Eq. (2).

$$N + V_{diagonal}\tan\theta = \alpha_1 f_c b_w x + \sum A_{si}'(f_{si}' - f_c) - \sum A_{si} f_{si} \tag{2}$$

where θ is the inclined angle of the effective compressive struts (taken as 45 degree in this study), $V_{diagonal}tan\theta$ is the total vertical component of compressive force in effective compressive struts, $x = \beta 1xn$ is the depth of the equivalent rectangular stress block, xn is actual depth of compression zone, α_1 and β_1 are the coefficients of rectangular stress block (taken as 1.0 and 0.8, respectively), Asi is the area of tension bar i, fsi is the stress of tension bar i (taken as the yield stress), di is the distance from the extreme compression fiber to the centroid of tension bar i. Since the contribution of diagonal compression to the peak load ($V_{diagonal}$) will not produce moment at the center of rectangular stress block (Fig.7c). The equilibrium of moments at the center of rectangular stress block gives Eq. (3).

$$V_{flexural}h_w - N(0.5l_w - 0.5x) = \sum A_{si} f_{si}(d_i - 0.5x) - \sum A_{si}' f_{si}'(d_i - 0.5x) \tag{3}$$

For simplicity, the vertical reinforcement in compression (Asi′) in Eq. (2) and Eq. (3) is ignored in the calculation. The reason is that the component Asi′fsi′ (di□0.5x) has little influence on Eq.(3) since the vertical reinforcement in compression are symmetrical to the center of compression zone in most cases. Another reason is that when the contribution of vertical reinforcement in compression is ignored in Eq. (2), the component Vdiagonaltanθ will not be overestimated for a given x. Since it is not possible to get the four unknowns x, Vflexural, Vdiagonal and Vanalytical through Eq. (1) to Eq. (3), the analytical results give a best fit to the experimental results (assume Va-nalytical equals tested peak load Vpeak). The analytical results are shown in Table 2. It is shown that 13% to 25% of peak load could be transferred by diagonal compression mechanism. Particularly, it is found that the lateral load resistance of flexural mechanism for all specimens is nearly 95% of the ideal flexural strength (Vif) (MOHURD, 2011), so that Eq. (4) can be gained.

$$V_{flexural} = 0.95\ V_{if} \tag{4}$$

The equation will be quite useful in the prediction of the peak load. Because if the flexural component Vflexural is determined, the compression zone x, Vdiagonal and Vanalytical can be obtained from Eq. (1) to Eq. (3).

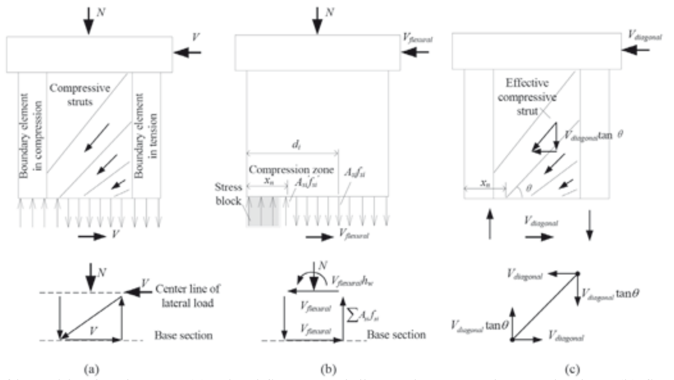


Fig.7 Mechanisms of lateral load resistance: (a) mixed flexure and diagonal compression mechanism; (b) flexural mechanism; (c) diagonal compression mechanism

Table 2 Analytical results based on mixed flexural-diagonal compression mechanism

Specimen	x_n, mm	x, mm	θ	$V_{flexural}$, kN	$V_{diagonal}$, kN	$V_{flexural}/V_{if}$	$V_{flexural}/V_{analytical}$	$V_{diagonal}/V_{analytical}$	$V_{analytical}/V_{peak}$
RCSW-1	466	373	45°	1142	385	0.95	0.75	0.25	1.00
RCSW-2	294	235	45°	834	266	0.96	0.76	0.24	1.00
RCSW-3	453	362	45°	1159	358	0.95	0.76	0.24	1.00
RCSW-4	454	363	45°	1148	346	0.95	0.77	0.23	1.00
RCSW-5	172	138	45°	582	103	0.95	0.85	0.15	1.00
RCSW-6	160	128	45°	585	89	0.95	0.87	0.13	1.00

4. CONCLUSIONS

Based on the analyses of the lateral load-carrying capacity of six recycled concrete squat walls, findings are as follows.

1) A mixed flexural-diagonal compression model is proposed to reflect the lateral load resisting behavior of squat walls, which can accurately predict the ultimate load-carrying capacity of six recycled concrete squat walls when the flexural component is assumed to be 95% of the ideal flexural strength. It is found that 13% to 25% of peak load can be directly transferred to the wall foundation by diagonal compression according to the proposed analytical model in this study.

2) The proposed model may be used for the similar squat walls failed in a mixed flexural-diagonal compression mode characterized by sufficient yielding of vertical web reinforcement and crushing of concrete at the toes of walls. However, more investigation is also needed.

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REUSE OF INDUSTRIAL AREAS CONVERSION OF THE METALLURGICAL TOWER TO A RESTAURANT WITH PANORAMIC VIEWS

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Keywords

reconstruction, conversion, historical and industrial buildings

ABSTRACT

Brownfields are one of the most important problems that must be solved by today's cities. The topic of this article is description of developing a comprehensive transformation of post-industrial area of the former iron factory national cultural heritage Lower Vítkovice. City of Ostrava used to be industrial superpower of the Czechoslovak Republic, especially in the area of coal mining and iron production, after declining industrial production and mining in the 80s left many unused areas of former factories generally brownfields and backfields. Since the late 90s we are observing how the city officials or private entities seeking to remedy this situation. Regeneration of brownfields is a very expensive and long-term process. The area is now rebuilt for tourists and residents of the city in the entertainment, cultural, and social center. It was necessary do the reconstruction of the industrial monuments. Equally important was the construction of new buildings, which helped reusing of the entire complex. This is a unique example of transformation of technical monuments and completion of necessary new objects, so that the area could start working again and reintegrate back into the urban system.

1. INTRODUCTION

Lower Vítkovice area is situated in the grounds of Vítkovice ironworks it is a 200 years old industrial area near the historical center of the city of Ostrava. Lower Vítkovice area occupies an area of 253 ha there are situated supreme industrial era buildings there. Two hundred years old ecological ballast of the urban organism is nowadays newly popular pride of Ostrava region, whose gates passes half million visitors per year. Now it is a seat of the main cultural and educational events in the surroundings. The intention of the City hall of Ostrava was to build a historical open-air museum here. Joint stock Vítkovice Company then clearly emphasized that they will not participate on the open-air museum, therefore it was recommended to implement the recovery program for industrial and technical heritage by the Architectural heritage preservation programme.

This industrial monument is a symbol of the city of Ostrava and the whole Moravian-Silesian region. In 2003 the new majority shareholder of the Vítkovice company Ing. Jan Světlík entered into discussions and the grounds of the national cultural heritage became a part of the privatized Vítkovice Company as a whole. During this time begins to implement the Lower Vítkovice area vision, allowing public access to the entire complex and to use this space for leisure activities and education. In March 2009 developed an architectural planning study by an architect Josef Pleskot developed. The study also addressed the accessibility to the blast furnace No. 1. The blast furnace No. 1 is a symbol of the Vítkovice area. It is also called "The oldest lady" or "Steel Temple".

2. BACKGROUND

The blast furnace No. 1 is a symbol of the Vítkovice area. Its history dates back to the year 1871, when the first blast furnace of Scottish type was built. In 1010-11 the furnace was completely revised and there was built inclined elevator there powered by a steam engine. In 1988 was given the final shape of the blast furnace. It was a unique technological and construction work in whole Europe. Last tapping was in September 27 in 1998 and since then the furnace was extinguished for good. There raised questions how to maintain and use this vast territory and property, which was of the value of 100 million euros at the time. There was discussed the last day method or controlled

technical ruin.
The forerunners and pioneers of industrial archaeology managed even before the Second World War, in a time of accelerated progress, to defend the existence of outmoded artefacts and persuade the steel age of the beauty of cast iron. In this country, too, they managed to direct attention towards monuments of technical labour, but it must be added that it turned out to be impossible to maintain this visionary head-start. In Czechoslovakia industry was still striving to meet new benchmarks at a time when the world was already peering at the demise of industry and beginning to take an interest in the remains of the industrial heyday, while in the industrial 'open-air museum' of the Czech lands these 'remains' were still in service. Thirty years ago some here were already beginning to think and talk about the relics of industry. Yet even today we are still confronted with their demise. (Beran. L. 2010)

3. METHODS

Since then there arose many projects and proposals there, but only the project from the year 2009 was implemented. It was an urban concept of the Lower Vítkovice Area created by the architect Josef Pleskot. The project includes the blast furnace No. 1 reactivation, energy switchboard No. 4 reconstruction, and the gasholder conversion into a multipurpose hall. In 2011-2012 there was built new-guided tour on the blast furnace No. 1. A skip lift became a part of the recovery, which drove the feed stone material to the furnace's throat. On the original skip's bridge construction there was fitted glass fronted cab of the new lift with the original lift machine with a new control unit of the dimensions of 3x2,5 m. Within the treatments of the blast furnace it was necessary to ensure the visitors' safety, who move along the route of technological material flow. The second sightseeing lift was built on the place of the original technological lift, where there is partly used the original lift shaft construction, which is extended and increased to the capacity of evacuation lift up to 60 m.
In 2010 when the first studies for the Lower Vítkovice area were created, there was planned that the blast furnace will get an extension, but no one new which form will it take. The main inspiration of Josef Pleskot, the court architect of the Vítkovice campus and the urban concept of the area, was Russian constructivism, to place the crown in the form of the missing fire element, over its top it always burn and went out in the late 90s, however not forever. In 2014 the extension look was designed by an architect there.

4. CASE HISTORY

There was developed a special hanging construction for the new glass fronted extension, which is really worked out in detail composed into the current blast furnace construction consists of 32 rods. The extension was constructed from 3 steel tubes which were first assembled on the ground and then they were fitted by the special crane on the prepared rod on the top of the tower. From the view of statics it was a courageous and in detail worked out hanging construction. The new extension construction begins at the high of 55m, it consists of 3 floors and it rises to a high of 77,85 m, thus it became the highest observation tower in Ostrava. The extension was glazed afterwards. In the final there were spirally fitted outdoor hanging walkways with floor grates, which makes an illusion of levitation. With the help of light installation it is made visible, it makes complete the dominant of the Lower Vítkovice area, which can be seen from many places of Ostrava.
On the top there is installed a steam explosion which is effectively lighted and evokes operation, life, function of the blast furnace at that time. The helix is a symbol of light which flamed above the furnaces and it was a genius loci of this place. (Architekt, 2015)
The entrance floor consists of presentation hall, which is a part of the guided tour, in the second floor there is situated a café there, and in the third floor there is a VIP club. There is a sightseeing terrace above it. The café offers the visitors basic refreshments, the club is mainly for forum organizing and lectures, and roof sightseeing terrace provides visitors commented views and panoramas of Vítkovice and the whole city of Ostrava and in favorable conditions there is a view into the distant surroundings of the Beskydy Mountains.
With a concept symptomatic to the uniqueness of the campus, when there we have on a relatively small place the whole information flow from coal mining to iron production, the visitors motion copies the material motion.
While in the past there were moving about 10 people on the blast furnace, 3 melters, 3 slaggers and 1 crane driver, farther melter foreman and 2 dispatchers in the control room, this number is minimally 20- time higher today, thus at that moment approximately 200 people- 10 guides on the blast furnace, 2 operators on the skip lift, 16 visitors in the skip lift, about 70 people on the guided tour and at least 100 people waiting in a line for a guided tour. (Pavliňák, P. 2012).

5. RESULTS

The reconstruction of the national historical landmark, overall, the price climbed to about 60 million CZK. 85% of costs is raised from European Regional Development Fund through the Regional Operational Programme NUTS 2 Moravskoslezsko. It is a project Blast furnace No. 1. Remaining 15% pays the interest association of artificial person The Lower Vítkovice area.

The extension is constructed inside from three steel tubes, in one of them there is set a hydraulic evacuation lift, in the second tube there is situated a stairway and in the third there are all of the installations. The evacuation plan is consistently handled in the object. From the point of view of the fire is object equipped with a Sprinkler system. All of the installations are brought by an exterior attachment to the supporting structure of the blast furnace and are guided in the tube. The toilets are placed in a space between the extension's floors. Tanks and pumps are located outside the extension object. The heating and cooling is dealing with comprehensively, through the new built energocentre, which is the main technical knot for the Lower Vítkovice Area.

6. CONCLUSIONS

An unique project New Vítkovice, in which are sensitively composed technical sights, it is completely original and it doesn't have equivalent in the world. By the architect's unique approach there have been underlined the whole campus importance with the extension, which is situated in the city centre. Today is the campus freely accessible to visitors. The campus transformation can become a good example, how to approach to the objects whose original contents is very far from the human use.

Visitor is in the same position, in which went the technological material in the blast furnace. Visitors will first gather in the area of the crane track on the axis of the skip bridge, in which was ingeniously put glass lift, which is able to transport at once 12 to 16 people to the very neck of the blast furnace, to the place of batch. It is a strong experience, one quickly gets close to monstrous buildings from which there could blow out her boundless energy. It is here that the furnace is filled with coke, iron ore and other impurities. The way continues then either vertical lift or on the stairs, where it is possible to climb up to the observation deck at the 60 meters high. (Volf P., 2013)

The historical buildings conversion is usually a combination of several working methods with space and constructions. The intention usually requires structural and historical research clarifying historically valuable structures and the object parts and then the study works with filling the space with new functions. (Peřinková, M. 2012)

Fig. 1 The blast furnace No.1 extension.

Fig. 2 The blast furnace No.1.

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NEW LASER RANGE FINDER FOR THE HIGH-PRECISION LINEAR MEASUREMENTS

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linear measurements, accuracy, paraphase method

ABSTRACT

Possibility of creation of a high-precision laser range finder on the basis of identical modulation demodulation of light with application of a paraphase method of linear measurements is considered. At what paraphase signals are formed in the optical way by turn of a phase plate on Thus increase of accuracy of linear measurements in comparison with a compensation method takes place. The expected size of an error of definition of a phase lies in limits = 0.03…0.05mm.

1. INTRODUCTION

By a compensating measurement method of electro-optical modulation of light increase of accuracy of measurement of the microwave optical range finder in foreign development is realized by introduction of a reversing of position of a minimum (RPM) of the demodulated light and by small deviation of frequency of modulation in the microwave optical range finders ME-3000 and Geomensor of GR-204 (Ruger J.M. and Ciddor P.E., 1987) at frequencies of modulation of 500 MHz the error of definition of the residual part of a phase cycle equal m_φ=0.25 of mm is considerably reduced. Application of the indicated optical range finders on various linear measurements and results of the researches ДВСД-1200 by employees of the Dresden Technical University (Potthoff H.,1980**)** and ДВСД-1200M and Central Research Institute of Geodesy, Aerial photography and Cartography (Weinberg V. Ya., Shirov F.V. 1983) confirm that by a compensation method at a frequency of modulation of 500 MHz fixing of provision of minima of light provides the accuracy of measurements of m_φ = 0.4…0.5 mm, and at a frequency of 1200 MHz of m_φ=0.2…0.25 of mm.

2. BACKGROUND

Recently the precise optical rangefinders such as Mekometer ME-5000 and ME-300 are successfully applied while studying the movements of Earth's crust. The accuracy of the mentioned devices is over the range 0.4 to 0.5 mm (Zippelt K., 2003, Kozirev A.A. and others, 2009).
The presented work considers possibility of creation of new microwave optical range finder on the basis of results of the measurements taken by the СД-1200 model in the accelerator of Serpukhov when the error of the phase definition made m_φ = 0.035 mm (Beglaryan A.G. and others, 2011). The design of a new optical range finder is based on identical modulation demodulation of laser radiation in the electro optical modulator on crystals of KDP and by a paraphase method (PM) of phase measurements. Periodically arriving paraphase signals are formed in the optical channel with shift of phases on 180°. By a PM equality of intensity of the modulated streams is fixed. Formation of paraphase signals requires switching of length of a way of reception light at a size $_m$/4 which can be realized turn or one of crystals of the KDP modem of light round optical axis Z (Gyunashyan K.S. and others,1986) or a phase plate (PP) of λ_m /2 on the way of the modulated light (Gyunashyan K.S., Hayrapetyan Ye.H., 1990).

3. METHODS

In all cases consideration of a PM can be carried out on the basis of expression of a compensation method (CM)

$$\bar{I}_1/I_0 = \frac{1}{2}\left[1 - J_0\left(2\pi\frac{U}{U_\pi}\mathrm{Cos}\frac{2\pi D}{\lambda_m}\right)\right] \quad (1)$$

where – Bessel's function a zero order, U/U_π - light modem diet, D – the measured distance, λ_m-wavelength of modulation of light.

Differentiation (1) on variables D and U/U_π we will receive dependences of the relation of I/I0 on sizes of key parameters of D and U/Up.

$$\frac{\partial \bar{I}_1/I_0}{\partial D} = \frac{2I_0\pi^2}{\lambda_m} U/U_\pi \cdot J_1\left(2\pi \frac{U}{U_\pi} \mathrm{Cos}\frac{2\pi D}{\lambda_m}\right) \cdot \mathrm{Sin}\frac{2\pi D}{\lambda_m}, \tag{2}$$

where $J_1(2\pi U/U_\pi \cdot \mathrm{Cos}2\pi D/\lambda_m)$- Bessel's function the first order.

Under a condition $\frac{\partial \bar{I}_1/I_0}{\partial D} = 0$ or $\mathrm{Sin}\frac{2\pi D}{\lambda_m} \cdot J_1(x) = 0$ provisions the main maxima of the demodulated light and a zero diet of the light modem

are defined. At $\mathrm{Sin}2\pi D/\lambda_m = 0$, $D=N\cdot\lambda/2$; $N=0,1,2,\ldots$ we receive coordinates of the maximum relation of de-pending on the relation U/U_π. At $J_1(x)=0$ we have or on these points of the light minima don't depend on U/U. The diet of the light modem taking place at the second maximum of the J0 (x) =-0.4 function when argument or U/U_p =0.61 follows from a condition $J_1(2\pi U/U_\pi) = 0$. The received results show that by a compensation method big sizes of the modulation power $(U/U_\pi)^2 = P_M/P_\pi$ and the low steepness at the level of registration of points for definition of provision of a minimum of the demodulated light which frequency is equal to $\lambda_m/2$are characteristic. By a PM the specified sizes follow from the decision $\partial I/I_0$ on $\partial U/U_\pi$.

$$\frac{\partial \bar{I}_1/I_0}{\partial U/U_\pi} = -\frac{2I_0\pi^2}{\lambda_m} \cdot \mathrm{Sin}\frac{2\pi D}{\lambda_m} \cdot \left[J_1(x) + J_1'(x) \cdot x\right]. \tag{3}$$

The solution of expression $J_1(x) + J_1'(x)\cdot x = 0$ defines essence of a PM, $J_1(x) + x\cdot J_0(x) - J_1(x) = 0$ $x \cdot J_0(x) = 0$; at $x=2.4$ $J_0(x)=0$ means transition to the middle of the relation of I/I0, i.e. regularity of change of the relation of I/I0 with increase in x→2.4 remains, then in process of increase x>2.4 changes. On the middle of the relation of I/I_0 curves of paraphase signals are crossed (points M' and N',fi gl) ,t he re i s a ne qua lityof $\mathrm{Sin}2\pi D/\lambda_m = \mathrm{Cos}2\pi D/\lambda_m = 0.7$ taking place on points $D=\lambda_m/8$, i.e. points of intersection of curve paraphase signals are on the middle of these curves until takes place x ≤ 2,4. From these conditions for a modem diet by a PM we have $2\pi U/U_\pi \cdot \mathrm{Cos}\pi/4 = 2.4$; $U/U_\pi = 0.54$. The maximum steepness of curve paraphase signals is in this mode on □m/8 points. For comparison of sizes of the steepness on $\lambda_m/8$ points, i.e. by a PM, with the steepness on points for definition of a minimum of light by a CM at the power of laser radiation of 1mWw he n $I/I_0 = 1\cdot10^{-3}$ for argument of the $J_0(x)$ function we receive

$$1\cdot10^{-3} = \frac{1}{2}\left[1 - J_0(x_n)\right];\ J_0(x_n) = 0.998;\ x_n = 0.09, \tag{4}$$

xn – value of argument of $J_0(x)$ for points at the threshold level at which the observed signal by a compensation method is fixed.

The relation of steepness at xn=2.4,xn= 0.09 makes $\left[0{,}54\cdot J_1(2{,}4)\cdot \mathrm{Sin}0{,}894\right]/\left[0{,}61\cdot J_1(0{,}09)\cdot \mathrm{Sin}0{,}99\right] = 8$. ation for a signal which amplitude moves in one party. At two-phase signals the difference of amplitudes doubles and dependence of □I/I0 on □D will increase twice. If to recognize that increase in the steepness of curves it is pro-portional to reduction of m□, the expected reduction has to make 4 times. It is visible on graphics of dependence of I/I0 from D constructed at the modulation frequency of 1200 MHz at the modulation power of the providing U/ $U/U_\pi=0.54$,(fig.1). In the mode =0,54 he size of $\bar{I}/I_0$ becomes equal $\bar{I}/I_0 = 0.5[1 - J_0(2\pi\cdot 0.54)] = 0{,}5(1+0{,}362) = 0{,}68$.is the steepness of curves doesn't decrease and there is no need of increase in the relation from 0,54 to 0,61 to provide size $\bar{I}/I_0 = 0{,}7$ with increase of the modulation power from 125 to 160 W. The error of definition of the fractional part in comparison with compensation method (CM) decreases by PM from increase in a differential signal of □I2 more, than twice. Therefore on PM a difference of signals at identical shifts the greatest, $\Delta\bar{I}_3 > \Delta\bar{I}_2 > \Delta\bar{I}_1$ (fig.1), and reduction of m_φ is more than reduction of the relation. . In models of light of range finders of СД-1200 at the modulation power of 120 W real reduction of mφ by PM about 8 times. Follows from fig. 1 also that by a PM reduction of periodicity of points of equal intensity takes place twice and will make *lm/4*. For a measurement formula it is reflected in a look

$$D = N\frac{\lambda_m}{4} + \frac{\lambda_m}{8} \quad N=0,1,2,\ldots \tag{5}$$

The accounting of all opportunities connected with reduction m_φ and m_k can be expected that m_φ of paraphase light of a range finder really will be equal m_φ = 0,015÷0,02 mm.

4. CASE HISTORY

The schematic diagram of a paraphase laser range finder is given in (fig. 2) which work to some extent differs from work of known light range finder.

The linearly polarized emission of laser ЛГН-207А by mirrors 2 goes to the modulator 4, constructed on the biaxial resonator (Khachatryan K.Kh. and others, 2011), on KDP 3 crystal set at an end face is coaxial with the internal conductor offset from a resonator axis on 8 mm. Phase-modulated light the transferring optics 5 with a diameter of lens about 20 mm goes to the reflector set at the end of the measured line. The central part of the reflected light stream 6 is condensed with reception optics in a parallel light stream with a diameter of 2..5 mm and through the free volume of the resonator 4 goes to optical delay line (ODL) constructed on a semi-prism 7 angular types which movement in limits 75mm is provided directing 9 with the carriage 8 on which the lath 11 connected with a worm gear 12 is established. Position of the light modem is fixed on a digital board 14. The reflected light stream from a prism 7 is displaced from a reception stream on 8-10 mm and sent to a crystal of the 15 demodulator installed on the second conductor of the resonator is symmetric to the first. At the exit of a crystal 15 the analyzer 16 and a PP on $\lambda/2$ 17 is installed. Switching of a phase plate 17 mechanism 18 from the demodulated light after the analyzer to modulated at the exit of a reception lens leads to transition to a PM. Points of the light minima at introduction of a PP on $\lambda/2$ after a reception lens of a modulation phase move on 180° and instead of minima of the demodulated light on the photo electronic ФЭУ-86 multiplier (PEM) 21 there attack maxima of the modulated light. By movement of a prism 7 at $\lambda_m/4$ length light maxima observed on the screen 20 become minima, i.e. on the way of a prism 7 equal $\lambda_m/8$ intensity of the arriving paraphase signals shifted on a phase become equal. Shift of ODL from this situation linearly changes amplitudes of the reception signals equal to a half of full intensity of light.

5. RESULTS

Thus, reduction of a way of ODL takes place twice, increase of intensity of reception light and linear dependence on the enclosed tension on a demodulation crystal sharply increases sensitivity of definition of situation the fixed signals. The paraphase method in small limits reduces the power of the microwave modulation and the most important within 10 times reduces an error of the phase definition up to the size m_φ=0.02…0.025 mm. For the ligth range finder constructed according to the scheme in fig. 2 self-certification on 4…5 pieces of one line is applicable.

5. CONCLUSIONS

Laser range finders with an accuracy of measurements of distances from $1\text{-}10^{-6}$ to $5\text{-}10^{-7}$ will find the application also when studying earth movements and open new prospects of increase of accuracy and frequency of measurements of horizontal distances and movements. High precision light range finders can serve as the intermediate link for transmission of length unit from a standard to working means of linear measurements. The high-precision light range finder can be applied in the special geodetic works demanding the high accuracy of linear measurements.

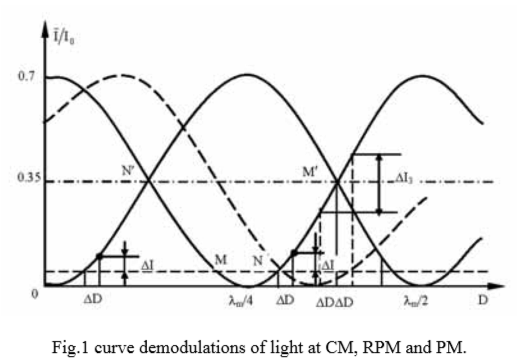

Fig.1 curve demodulations of light at CM, RPM and PM.
ΔI_1 – Change of a signal from ΔD at CM, ΔI_2 –increase in sensitivity at RPM, ΔI_3 – the same at PM.

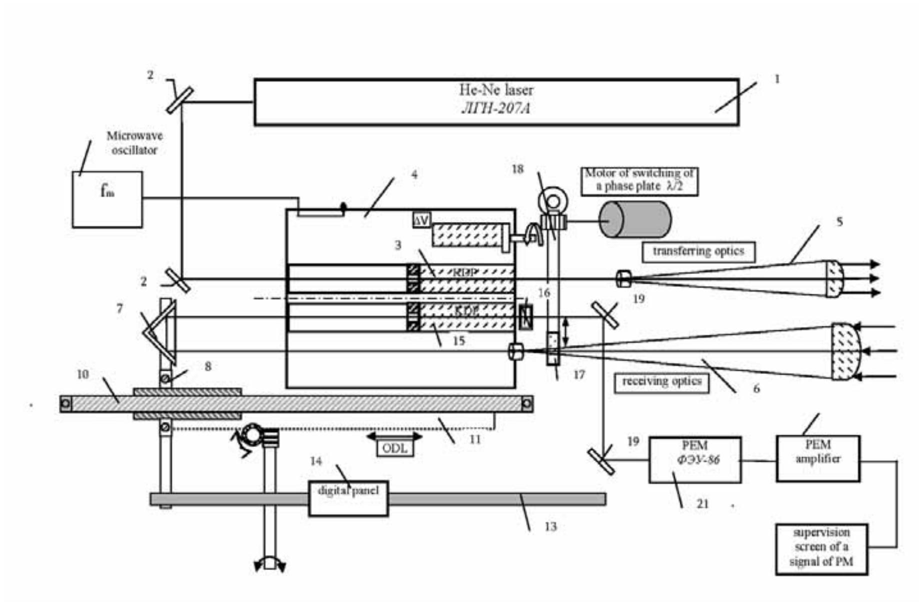

Fig. 2. Schematic diagram of the paraphase light range finder

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STRATEGIC PLANNING: INFRASTRUCTURE DEVELOPMENT OF SAINT PETERSBURG BASED ON DYNAMIC MODEL

POSTER

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Keywords

strategy, infrastructure, sustainable development economy

ABSTRACT

Solving economic and social problems is a priority in the development of Saint Petersburg. Modern good practice in management is using strategic planning as an efficient method for solving such problems, which makes it possible to keep the balance between the marketing management of the regional market in Saint Petersburg and a stiff system of centralized planning. All this makes it possible to define strategic objectives and tasks of the social-economic development of the city, use economic incentives in making solutions, select alternative variants of development, efficiently act in the market economy. The present article contains a detailed investigation into the issues of developing power supply and engineering infrastructure for determining the perspectives of stability of power supply and engineering system of the city.

1. INTRODUCTION

The history of territorial strategic planning in Russia starts in 1997, when the first Strategic plan in the Russian Federation was developed for Saint Petersburg [1]. Until April, 2003, Saint Petersburg was the only one of the 12 largest cities in the RF that had a complete strategy plan for development. By early 2001, over 200 cities in the RF used some elements of strategic planning. It was then that it became clear that participation of the general public and social structures (local communities) was being under-estimated, and defining missions and tasks was carried out in a formal and unprofessional way. Now, only those issues shall be implemented that correspond with the interest of the urban community and is included into the Strategic plan after consultations and negotiations [2].

In 2004, large-scale activity was started in Saint Petersburg to form a new system of State planning. Its main difference is that it was intended to replace the passive approach, which is planning on the basis of an achieved level, with a detailed feasibility evaluation and substantiation of costs and results, defining concrete responsibility of the authorities before the population, businesses and organizations of the city. One of the most important stages of this work was organizing professional and public discussions of the projects of the authority policies in Saint Petersburg [3-4].

More than 700 people representing almost every branch of the economy and social sphere in the city participated in the discussion of Strategy development of Saint Petersburg (2013) The proposals accepted in the new Strategy (2014) were focused on the issues of stability of power supply and the engineering infrastructure. Unsolved issues in the infrastructure have long been one of the factors that have negative impact on the pace of the stable development of Saint Petersburg.

2. METHODS

The methodological basis of the investigation was the results of the investigations carried out by Saint Petersburg university of Architecture and Construction: “Methodological Problems of Efficiency of Investment-Construction Activity in the Non-Industrial Sphere” [5], “Methodological Problems of Efficiency of Regional Investment-Construction Complexes as a Self-Organizing and Self-Regulating System” [6]. The used methods were: the system, situational and expert analysis [7-8].

In the process of forming, traditional models BCG, GE/McKinsey, ADL matrix and others are used. The analysis of many scenarios, strategic alternatives for development of power supply and engineering infrastructure was done with the help of the following instruments:

- Method of cognitive maps (solution trees);
- Expert evaluations;
- Situational approach for developing different courses of action.

3. CASE STUDY

In order to implement the main task of urban development, which is the development of the urban infrastructure and environment, we chose the variant of engineering infrastructure and environment development strategy that implies forming detailed programs and projects [9-10].

The process of planning of power supply and engineering infrastructure development is based on considering external (competition conditions, market, technologies etc.) and internal changes (changes in organization, skills etc.) and it includes three stages: developing, implementing and evaluating the result of strategic planning. The stage of strategic plans development includes four stages: preparation, analysis, development and coordination.

The basis of the modern state of the social-economic development of the city is the infrastructure approach, with the highlight on some key infrastructure elements – civil engineering, transport and power supply. The purpose of the investigation is determining the demand for them and the capability of the economy to meet that demand. Basing on the obtained results, various scenarios (variants) were devised for future development of the city and their SWOT-analysis was carried out (analysis of strength and weaknesses, threats and opportunities).

In order to improve objectivity, a large number of experts were involved, and they provided professional evaluation of the materials prepared by the planners. The Strategic plan was approved after public discussion and correction of weak points [11].

The Strategic plan for the city accepted on December 1, 1997 was the first one in the Russian Federation. Its main purpose was to form Saint Petersburg's integration into Russian and world economy as a multi-functional city with high standard of living and industry. This formula not only specifies the objective, but also indicates the main ways of achieving it – integration into the world and Russian economy and improving the urban environment and social climate. A developed power supply and engineering infrastructure is required.

In order to successfully develop the power supply and engineering infrastructure, on the basis of the analysis of dependence of these indexes across time, the new development Strategy for Saint Petersburg provides for a complex of measures in the following directions [12] (Fig. 1).

For development of central heating systems, it is provided to ensure coordinated development of heat transfer networks from boiler rooms with capacity above 50 GCal/h during their reconstruction, with decommissioning morally and physically obsolete equipment (to be done mainly before 2020); construction of new heat supply stations with vapor-gas and gas turbine equipment in the regions that have shortage of power supply; construction and reconstruction of local sources of central heating n the regions where centralized central heating is impossible or impractical; sectioning and cross-feeding of heat supply networks and manifolds of central heating sources in order to improve reliability of central heating systems [13].

In order to provide stable supply of drinking and industrial water, it is necessary to: increase the net capacity of the existing water-collecting facilities and water-supply stations up to 3 million 733 thousand m3 of drinking water per 24 hours by 2015 with consideration of the existing and perspective consumers in Saint Petersburg; construction and reconstruction of boost water supply pumping stations; construction and reconstruction of power supply pipelines with adequate capacity; construction of interlink water pipelines between water station zones, which makes it possible to redistribute loads in emergency situations; replacement of all the reinforced-concrete water pipelines by 2015; reconstruction and applying internal coating on all the steel water pipelines and replacement of all the defective sections of such pipelines by 2020; reconstruction of worn carbon steel water pipelines by 2025.

Regarding the water-discharge system, the following shall be done: construction and reconstruction of tunnel manifolds of adequate capacity; improving reliability of tunnel manifolds; commissioning the main sewage water manifold in the Northern part of Saint Petersburg (by 2020); ceasing discharges of sewage water into water bodies by means of implementation of the program of switching direct discharges (by 2020); construction and reconstruction of sewage pipeline systems using modern technologies, with restoring their water-tightness and capacity;

construction of surface-water control systems for collecting surface water in the regions where sewage systems are not separated; construction of a plant for burning hard sediment in sewage facilities in the village Metallostroi for recycling the entire volume of sewage sediments by burning (by 2015); implementation of sewage water de-activating equipment (by 2020).

Regarding gas supply systems, the following shall be done: increase the coverage of Saint Petersburg territory with gas distribution networks (GDN) to supply gas to perspective residential areas and transfer all the existing consumers to gas fuel; construction of main sources of gas supply systems GDN to ensure an increase in gas consumption and improving reliability of gas supply systems, including construction of particular GDN's for supplying gas to new heat supply stations; improving reliability and stable operation of gas supply systems of the city due to additional cross-feeding of gas distribution networks, construction of new sources of gas supply systems in Saint Petersburg – high-pressure gas-regulating stations.

Implementation of the above-mentioned directions for development of the infrastructure and power supply systems of the "Northern capitol" will make it possible to achieve the following results by 2030: the infrastructure and power supply systems will fully comply with the effective normatives; the polling of the population will show 90% satisfaction with the quality of housing and public services; the transformer capacity of the 110 kV network shall be increased to 21 356.0 mWA; the installed heat capacity of the sources of central heating shall be at least 31 003.2 GCal/h; the capacity of the main facilities of the water supply system shall be 2 800.0 m3/day; the capacity of the water discharge system shall reach 2 444.5 m3/day.

4. CONCLUSIONS

The dynamic model for development of power supply and engineering infrastructure, which is the basis of strategic planning, is a complex iteration process; its main stages are:

1. Monitoring and analysis of the main indexes of activity on the basis of integration of data from multiple sources;
2. Strategic analysis of the external and internal environment of the region;
3. Defining the purpose and mission of regional development with consideration of the preferences of the engineering infrastructure;
4. Generating strategic alternatives;
5. Dynamic scenario analysis on the basis of the possibilities of development of the power supply and engineering infrastructure;
6. Selection of the strategic alternative;
7. Implementation of strategic and operative plans by the main functional indexes of the regional economy;
8. Correcting and specifying the plans with consideration of the dynamics of the changes in development of Saint Petersburg.

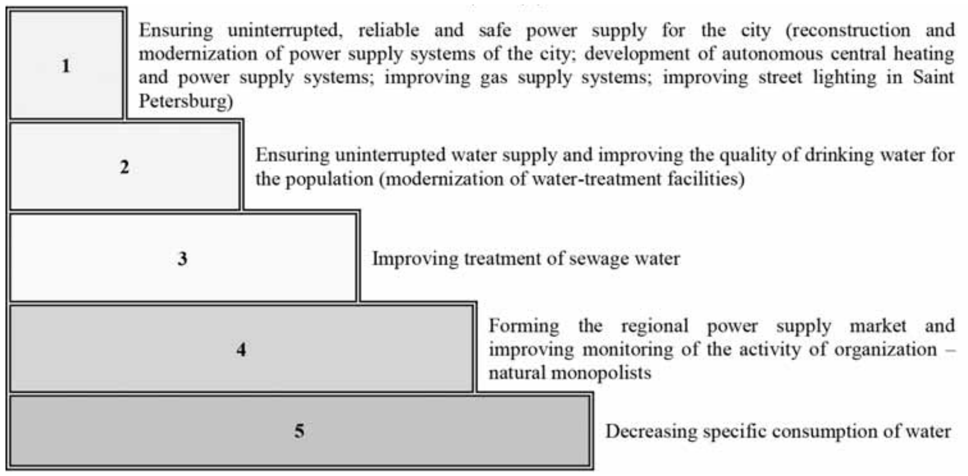

Fig. 1. A complex of measures for development of power supply and engineering infrastructure according to the improved Strategy of development (2030)

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CONTEMPORARY BUILDINGS OF FILIAL CATHOLIC CHURCHES IN POLAND

POSTER

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Keywords

sacral architecture, filial churches, archdiocese of Czestochowa

ABSTRACT

The architecture and construction of contemporary buildings of filial catholic churches of the Archdiocese of Czestochowa are presented in the paper. These are objects which are not the main church, are situated within areas of extensive territorial parishes. Selected examples of filial churches are described and illustrated by photos. Several types of filial churches were identified and analyzed on the basis of these examples. This analysis allowed conclusions to be drawn about the specifics of these small sacral objects, which have not yet been studied and reported in the literature.

1. INTRODUCTION

There are 310 parishes in the archdiocese of Czestochowa and 159 parish churches have buildings erected after 1945. There are also filial churches in some of these parishes. These are objects situated in the parish area, which are not the main church. Priests from the parish celebrate masses here usually only on Sundays and holidays. Filial churches were erected, especially in territorially large parishes, to shorten the travel time for the faithful to worship. Large distances from church cause particular difficulty for elderly and young parishioners.
The functional plan of filial churches is generally poorer than in parish churches and the buildings are smaller. Most of the filial churches in the archdiocese of Czestochowa are reletively new objects. This research was conducted on churches built between 1945 - 2005. Most of them were erected in the 80s and 90s, when, after many years of great difficulty, it became easier to obtain building permits for the construction of religious facilities. Many of these objects were designed as catechism bulidings as it was easier to obtain planning permission for such facilities. During construction, a number of changes to the building plans were introduced to have a larger space for the sacral part. As a result, the architecture of such structures is often quite random and the functional system is far from optimum. However, there are also some very interesting buildings in terms of their form and functional solutions, especially those later realisations, erected around the turn of the century. The Archdiocese of Czestochowa is divided into four pastoral districts: Czestochowski, Radomszczanski, Wielunski and Zawiercianski. Within the four districts, 74 filial churches and chapels were documented during this research. This represents 32% of the 234 churches built between 1945-2005 in the Archdiocese of Czestochowa. In the Czestochowski region of the Archdiocese of Czestochowa 85 new church buildings were erected after 1945, of which 76 are parish churches and 9 (12%) filial. There are many more filial churches in the other, less urbanized pastoral districts of the Archdiocese of Czestochowa. The greatest number were erected in the Wieluński region, where agricultural land predominates. Here, there are 51 new church buildings in total, including 26 parish churches and 25 (49%) filial churches. The Radomszczanski region comprises 61 church buildings erected after World War II. Of these 33 are parish churches and 28 (46%) filial. The Zawierciański pastoral region has the least number of churches built after World War II - only 37. Of these 24 are parish churches and only 13 (35%) are filial churches.

2. FILIAL CHURCHES IN ARCHDIOCESE OF CZESTOCHOWA

The development of sacral architecture, especially Roman Catholic churches, in post-war Poland correlates strongly with the changing political situation in the country. In the years 1945-1970 new sacral buildings were created mainly during short periods of political “thaw”. Throughout the communist time, a series of deliberately planned measures were put in place to obstruct investment in and the design process of churches. There were huge difficulties in obtaining planning permission for churches. It was slightly easier to obtain such permission for catechism bulidings instead of parish churches, so some objects were designed as such facilities. It was also very difficult to obtain building materials for churches during the process of construction. The supply of building materials was regulated by the state and church investments were outside this system of distribution. The technical documentation of sacral buildings was based on the knowledge and patterns from the past, limited rather to the category of art. Textbooks about designing churches practically did not exist in communist Poland. Sacral buildings were also not covered by building regulations. As one can see different external factors had an enormous influence on the final shape, size and localization of churches.

The input of such adverse conditions can be seen in the number of churches built. Between 1945-1950 in the whole country only 59 new churches were built. Between 1951 and 1955 only 57 objects. Thanks to changes in the political situation after 1956 to 1960 about twice as many churches were built: 94. After that short thaw the restrictions were reintroduced: in 1961-1965 it was 63 objects and in the years 1966 to 1970 only 37. The situation of religious architecture slowly underwent improvement in the seventies and specially in the 80s. (Siwek,S.1986)

It is for these reasons that filial churches were not erected in the post war period. A few projected in the years 1945-1970 became parish churches. Also in the years 1970-1980, although the number of churches under construction generally increased, filial objects were practically not built. A large number of such buildings began to be designed and built after 1980. Most filial churches created in the 80s were multifunctional objects. Relatively, the easiest way to get permission for building was to design its as catechetical objects with usable area less than 600 m2. At that time a lot of such objects were built in Poland. In the design phase lots of catechetical classrooms and auxiliary rooms with a small chapel for mass were shown on drawings and presented for approval at state planning offices. Having obtained permission the object was erected differently from the designed. Often part of the walls were removed, increasing the chapel and reducing the number of catechetical halls. Sometimes the external dimensions of the entire facility also were enlarged. The effects of these actions had unexpected results. The external form of the church often left much to be desired, sometimes it is difficult to discern the true nature of the object.

Typical examples of this process are the churches of St. George in Wólka Prusicka (1983 - 1991, designers: J. Zadworny, fig.1) and St. Maximilian Maria Kolbe in Tomawa (1982-1984, designer J. Sobierański, fig.2). They resemble residential buildings and only the cross placed on the roof identifies them as sacral object. The aesthetics of these facilities is far from optimum.

Now religious education in Poland takes place in schools, and catechetical classrooms are not used for their original purposes. Some of them are generally not used at all. This is especially true in large multifunctional objects. An excellent example of such a case is the filial church of St. Matthew in Bobrowniki in the parish of Działoszyn (1982-1990, fig.3,4). A large multi-purpose building housing a small chapel in which, despite the small width, has inside columns which divide this small space and greatly hinder the visibility of the congregation. The remaining part, divided into small rooms, no longer has a designated function.

At the same time filial churches without the catechetical part were also erected. Today these churches are much better adapted to their present functions. The sacral part: the nave and the chancel are the largest part of the building. There is no need to maintain unused catechetical rooms. All these churches were created in very different ways. Part of them were spontaneously erected by local residents, often without any project, based on the taste and experience of the local community of the faithful. Examples of churches that were built without design, and of course without official approval are the church of St. Luke the Evangelist in Zalesiaki, the parish of Działoszyn (1981-1994, fig.5) and the church of the Blessed Honorat Kozminski in Niwiska, the parish of Pajeczno (1980-1982, fig.6). Both objects have fairly conservative aesthetics, although they differ significantly. In Zalesiaki the main body of the church was simplified, while in Niwiska historical changes were restored. Builders erected on it two towers, trying to add a dignity to small object.

Most of the filial churches were built, of course, based on construction projects, but this did not always guarantee a high level of aesthetic. In the eighties, even some churches designed by architects do not possess great aesthetics value. Parish churches were more important so these buildings were generally given more interesting realizations. Filial churches were treated less well, the reasons being, among other things, economic. Definitely, limited funds for the design and implementation led to worse results. Besides, surely it is harder to project smaller objects than large and monumental ones. Examples of controversial objects are the church of Divine Mercy in Krzywanice, in the parish of Wiewiec (1987 -1992, designer B. Piech, fig.7) and the church of the Nativity of the Blessed Virgin Mary in Wilkoszewice, the parish of Rozprza (1982 - 1984, designer J. Sobierański, fig.8). These buildings were built in different styles. The church in Krzywanice features Polish modernist hipped roof. This roof, however, covers only the front section and the back part of the object does not seem to fit the front. The back elevation is

a prismatic construction with a pitched roof reminiscent of housing. The eclectic nature of the structure provides a whole bay for a statue. The church of the Nativity of the Virgin Mary seems to be based on a regional style, especially because of the details: window frames are a characteristic signature. These elements, however, do not seem to fit with very simple body of the building. A small roof above the main entrance also does not make the best impression.
However, a simple main body may be an advantage of a sacral object if creative detail is then applied. Examples of such buildings are the churches of Visitation of the Blessed Virgin Mary in Ożegow, in the parish of Siemkowice (1988 – 1990, fig.9) and Our Lady of Czestochowa in Załęcze Wielkie, in the parish of Dzietrzniki (1980-1982, fig.10). In both cases there is no record of the designers. The body of first object is very simple and basically resembles some churches presented above. However, the use of narrow tall windows and a rosette in the gable facade clearly differentiates the church from residential buildings. A small turret at the top of the building emphasizes the character of the building. One can have reservations about the position of the front door, but the whole building offers clear associations with sacral architecture.
The second object is even more interesting. It seems to be almost identical to the main body, with a regular rhythm of long narrow windows and a small turret above the chancel. In the front elevation an openwork tower was placed, which is also the roof over the main entrance. Both objects represent, in the opinion of the author, an unpretentious, simple but not simplistic architecture of small sacral objects.
Filal churches are generally small objects, but sometimes large buildings, the size of parish churches, were erected. Everything depended on the size of the village, the possibility of the church being by people from several nearby villages and the wealth of the parish. The architecture of these objects is much more diverse. Examples include the churches of St. Maximilian Kolbe in Chojny, the parish of Chojny (1983-1999, designer L. Białkiewicz, fig.11); Blessed Virgin Mary, help of Christians in Zajączki Pierwsze, the parish of Danków (1988-1991, designer Z. Jędrzejkiewicz, fig.12) St. Anthony of Padua in Rębielice, the parish of Danków (1988-1990, designer Z. Jędrzejkiewicz) and St. Albert Chmielowski in Stobiecko Szlacheckie, the parish of Radom (1985-1987, designer H. Niezabitowska). Regardless clear differences in style and the artistic evaluation of the individual churches, the desire of designers to give the objects a sacral character is clear.

2. CONCLUSIONS

Filial churches of the Archdiocese of Czestochowa do not represent a uniform style and each one of them has an utterly individual character. Not only in terms of their architectural style but also in terms of their interior furnishings and fittings. The majority are, however, small objects, constructed appropriately to reflect the financial capacity of the local community of the faithful. A large number of them, despite the passage of ten years from the start of their use, are completely not finished. Most often it is the lack of external plaster, because this does not interfere with the normal use of the building. In all the objects the interiors are plastered and there is always a floor. Sometimes it is a temporary floor e. g. PVC flooring, which in future will be replaced with stone or ceramic tiles. The furnishings of the tested objects are very different. Some of them are completely furnished, including comfortable church benches with hassocks, others have simple benches or even simple chairs. Most churches are furnished very modestly. However, regardless of size, style and its furnishings and fittings these local religious centres play a very important role in their local communities.
Such local religious buildings are of great benefit to the people from small villages: they do not have to travel as far as the parish church for religious celebrations. The usefulness of the existence of such buildings is proven. But they also bring some other, non-material benefits. These are sometimes the only place for collective meetings in the village, and as such have great importance in creating the local community. The faithful often organize themselves around such a centre: forming various prayer groups. It seems that in the future these objects could also be used for other cultural purpose, not in conflict with their primary function. Filial churches could be ideal places for occasional music concerts, exhibitions and film screenings, enabling local communities greater access to culture and the arts.

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Fig. 1. Church of St. Georgein Wólka Prusicka

Fig. 2. Church of St. Maximilian Maria Kolbe in Tomawa

Fig. 3. Church of St. Matthew in Bobrowniki

Fig. 4. Interior of the church of St. Matthew

Fig. 5. Church of St. Luke the Evangelist in Krzywanice

Fig. 6. C hurch of B lessed H onorat K ozminski i n N iwiska

Fig7.C hur chof D ivi ne M ercyi nZ alesiaki

Fig. 8. C hurch of Nativity of the Virgin Mary in Wilkoszewice

Fig. 9. Church of Visitation of the Virgin Mary in Ożegów

Fig. 10. Church of Our Lady in Załęcze Wielkie

Fig. 11. Church of St. Maximilian Kolbe in Chojny

Fig. 12. Church of Blessed Virgin Mary, help of Christians in Zajączki Pierwsze

CHALLENGES IN COASTAL AND ISLAND DESIGN, CONSTRUCTION AND DEVELOPMENT

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Keywords

environment preservation, sustainable building, coastline designing

ABSTRACT

The focus of study is the coastal development in the island of Coron, Palawan, Philippines, with the results yielding new measures for exposing high-risk areas of development and creating a new building code/guideline for sustainable and ecologically centric communities. Foremost in the objectives are: To provide quantitative and qualitative parameters for building development
To conduct regular tests for: embankment, shoreline, water, seabed, sand areas, mangroves, forests, ground cover, air quality and auditory levels.
To present contemporary approaches in using solar energy, wind power and use modern technologies with local materials; waste management measures at all stages of construction to include construction activity pollution prevention; storm water catchment and to identify green innovations for water filtration, supply management, desalination and sewage treatment to be integrated into island developments that are hardly accessible, its marine life and coastal preservation.

1. INTRODUCTION

By a compensating measurement method of electro-optical modulation of light increase of accuracy of measurement of the microwave optical range finder in foreign development is realized by introduction of a reversing of position of a minimum (RPM) of the demodulated light and by small deviation of frequency of modulation in the microwave optical range finders ME-3000 and Geomensor of GR-204 (Ruger J.M. and Ciddor P.E., 1987) at frequencies of modulation of 500 MHz the error of definition of the residual part of a phase cycle equal m_φ=0.25 of mm is considerably reduced. Application of the indicated optical range finders on various linear measurements and results of the researches ДВСД-1200 by employees of the Dresden Technical University (Potthoff H.,1980**)** and ДВСД-1200M and Central Research Institute of Geodesy, Aerial photography and Cartography (Weinberg V. Ya., Shirov F.V. 1983) confirm that by a compensation method at a frequency of modulation of 500 MHz fixing of provision of minima of light provides the accuracy of measurements of m_φ = 0.4…0.5 mm, and at a frequency of 1200 MHz of m_φ=0.2…0.25 of mm.

2. BACKGROUND

If specific and measurable guidelines for monitoring the environment – sea water quality, sea bed, marine life quality and quantity, shoreline, sand purity, potable and fresh water table, wildlife, trees and foliage, natural animal habitats, architectural and engineering, air quality - will be implemented, then sustainable communities can be built along the coast. These communities will cover residential, commercial, hotel and resort developments. If tools and processes for monitoring can be taught to both external builders and residents, then potenatial island degaradation will be reduced. In the contemporary world, with increasing populations, climate change and many layers of natural environment disturbed - from forest cover, to mangroves, to marine life, reefs and coastal surroundings, design solutions must guide future development.

3. METHODS

The municipality of Coron is part of the Calamianes Group of Islands specifically located within 11.7—12.47oN and 120.0—120.4oE at the northern region of Palawan Island, Philippines. The large island of Busuanga is also a part of this area. It includes 24 smaller community units and 32 islands covering a total of 628 square kilometers of land area. It is bounded by a deep and natural harbor, where the town proper and the port are located.

Tourism is the principal source of livelihood. Its island destinations are accessible via small, motorized outrigger boats used as the most common form of transportation. It has some of the last virgin forests in SE Asia, and is rich in marine life, volcanic springs, coral reefs and some of the best historical shipwreck diving sites of the world - sunken Spanish trade galleons, British, Japanese and American warships. It is home to colonies of fruit bats, sea turtles, meter-long monitor lizards and other wildlife.

Coron is exposed to extreme hurricanes, or typhoons and reversing monsoons. It was one of those island provinces damaged during the Hurricane Haiyan in 2013. With its environmental fragility and frontline exposure to severe weather disturbances, the guidelines resulting from this study will form the framework for the preservation of not just human life but natural habitats as well. Small islands dot the northern and southern portions of the municipality.

Much of the island settlers are local, indigenous Filipinos belonging to the native tribe of Tagbanua. There is a growing number of migrants from other parts of the country. Foreign nationals in large numbers have also opted to live in the islands, with many of them engaging in businesses related to hotel operations, food industries and diving operations.

Mangroves are among the most endangered coastal sections of Coron. In a Presidential Proclamation (P.P.) numbered 2152, it was declared that all mangrove areas are forest reserves. Much of these areas are public land but small-scale and sustainable utilization of forest resources are allowed. Commercial and large-scale utilization and conversion to other land uses such as fishponds however, are strictly prohibited. Upon observation, recent census and monitoring surveys however, it has been evident that mangrove forests inside the reservation areas have been constantly cut, burnt, then cleared and developed into fishponds.

Mangrove wood has also been rampantly used for fuel, charcoal, construction and fencing materials and implements. Thus, the density of the mangrove forests was severely compromised. It was noted that typhoon Haiyan in 2013 decimated Coron's mangrove forests with tidal surges and extremely high velocity winds.

Forest cover is generally over low inhabited areas comprising local fruit-bearing species and tropical hardwood including various types of mahogany and endemic examples. Such areas have long been subjected to the Kaingin method or the slash-and-burn activities farmers do to clear portions of untitled land for agricultural purposes. Such degradation has already resulted not just in a decrease of natural habitats for birds and other forest wildlife but has also contributed to increased landslides and downstream flooding in low-lying areas. Part of the study shall institute a tree-tagging system to identify trees according to level of further propagation, preservation or use, and review of logging laws.

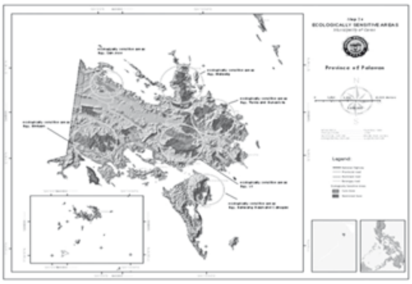
Coastal areas used for residential, commercial and hotel/resort operations are the most significant in land use. These account for 65% of the land areas that are to be relocated and recessed backwards for safety against the shoreline surges. These are also the most developed sections of land, requiring most stringent rules on design and construction. Its adjacency to the sea requires the creation and implementation of regulations pertaining to human and solid artificial waste matters that are dumped directly or indirectly into the sea.

The coral reefs account for much of the attractions in the municipality. Previous decades of blast fishing have resulted in severe damage, however. The regeneration of coral species is beginning, but tourist and local damage require interventions in education and massive public information campaigns. Such reefs are breeding areas for tropical marine life. A total of 342 species distributed among 47 families of reef and reef-associated fish were recorded throughout the survey. Included were an unidentified species of rabbitfish (Siganidae), eagle ray (Myliobatidae), snapper (Lutjanidae), bream (Lethrinidae), soldierfish (Holocentridae), sweetlips (Haemulidae), anchovy (Engraulidae), pufferfish (Tetraodontidae), filefish (Monacanthidae), wrasse (Labridae), cardinalfish (Apogonidae); and several species of parrotfishes (Scaridae, n = 5), jacks (Carangidae, n = 2) and damselfishes (Pomacentridae, n = 3).

A resurgence in eco-tourism even among the locals has paved the way for much conservation activities. Sea mammals, turtles and rare Dugong or sea cows are being monitored and tagged by marine scientists. Islands of certain dimensions and non-living coral formations must not be built upon.

Equally fragile in the underwater environment are the ship wrecks that are popular spots for divers. These historical, warfare mementoes and vestiges of colonial heritage need measures for preservation as chemical pollution and damage brought upon by untrained divers calls for policy integration.

Architectural developments must be set back at 40 meters, as per a recent law after the typhoon Haiyan 2013. Construction activities must be restricted so that debris during hauling and construction stages will not seep into



Construction and development in an island with coastal and environmental senistivity

the sea waters.

Land and soil quality have long provided for lush vegetation. Implementation of energy-saving features and design technologies are to be encouraged. Any construction however, must simply embrace the earth and not subdue it. Creating authentic eco-lodges in the form of resorts and hotels must help in the conservation of the surrounding flora and fauna. Only secondary tagged trees could be cut. The careful use of soil and water resources must be established with minimum use of the water table. Any swimming pool design must incorporate the use of filtered and recirculating seawater. Land use and foundation built up must correlate by imposing only low-rise structures that follow natural slopes and contours. The appropriate handling of solid waste must consider not just land infiltration but also the possible contamination of any existing water source. Respect for natural habitats of wild life must be prime in any development in these kinds of islands. Traditional construction methods will also be combined with contemporary means of providing shelter, needs and comfort for all forms of building utilization.

3. METHODS

In providing proposed coastal development designs and building guidelines, methods for monitoring environmental quality were established, alongside the National Building Code. Constant sampling of sea water, natural spring water and waste water was done.

For trees, forests and any vegetation, the density of cover, diameter of the trees or plants, level of vulnerability will impact on building distance from these flora and fauna. Thus tagging methods and measurements were standardized. Mapping on tree surveys was deemed vital for preservation. For mangrove areas, the method of enrichment planting and assisted natural regeneration was applied. Ranking of plants and trees was standardized prior to design. Innovations, avoidance and distance encroachment were considered as walls and building elements gave way to plant life. The ranking was based on qualitative description of the mangrove areas such as stand growth, density, stature and existing pattern of utilization that are supported with data based on stand volume, mean diameter, height and mean regeneration (seedlings and sapling).

The dominant species for each site were determined based on the importance value (IV). The IV is the sum of the relative density, relative frequency, and relative coverage in trees and plant cover.

Monitoring protocol for water, soil and land quality with emphasis on non-disturbance to the environment included policy interventions divided into: Zero tolerance, Permissible with measures and Encouraged/allowable. Education and training campaigns were effective methods to establish systems with the existing residents and construction workers, towards enhancing living and improving hygiene/sanitation. The summary of checklists for safety/health and environment standards for phases of construction prior to building, during, post-construction and post-occupancy was one of the mist documented methods. Daily Site inspection survey – charting existing conditions, wildlife presence, recording data on temperature, clarity, chemical infiltration, pollution, organic growth for water, soil and air was done, alongside imposition of milestone studies.

4. CASE HISTORY

Typhoon Haiyan, in November 2013, brought damage to the Philippine coastlines. Coron, Palawan was one of the devastated towns but it received secondary attention compared to other areas. Future destruction will decrease with risk mitigation measures, monitoring methods, implementation of coastal design, development and building guidelines, and the empowerment of local government. In January 2015, the proponent of this study was given authority to study the coastline and propose measures. An actual resort project commencing on May 11, 2015 and to end on February 12, 2016, was undertaken with the imposition of standards and tests.

5. RESULTS

As the study is ongoing, current results yielded the effect of non-disturbance to general marine life, turtles hatching on the loading path of construction materials. Low intensity building methodology and ongoing sampling of sea water, fresh drinking water and soil quality continue to be tools in monitoring the natural environment. Rehabilitation of the natural habitats continue. Construction activities are flourishing but with implementing policies in place.

6. CONCLUSIONS

The establishment of core zones for building, the provision of temporary staging areas during construction and the effective monitoring protocol have been successful in environmental preservation even as contemporary building technologies have been introduced. It is possible and highly appropriate for development projects to utiulize sustainable and energy-efficient design strategies in these tropical islands. Looking for more cost-efficient means to introduce such technologies allows for more low-impact interventions in building. The sensitive and fragile ecosystems are thus minimally disturbed. These guidelines will then be a model for development standards in the rest of the Philippines.

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SEVERAL ISSUES ON PROTECTION OF UNDERGROUND SECTIONS OF BUILDINGS AND STRUCTURES AGAINST MOISTURE AND WATERLOGGING WITH GROUNDWATERS

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Keywords

moisture, groundwater, capillary water

ABSTRACT

The goal of this work is to develop methods of moisture transfer, forecasting fluctuations in capillary and underground water levels and relevant engineering measures to insure the long term and safe exploitation of the structures and areas. The peculiarity of the work is that there are simple solutions provided herein for the stationary movement of capillary waters, moisture, which may be used in the construction and agriculture.

1. INTRODUCTION

In various regions on the planet, as well as in the Republic of Armenia there are ongoing processes of water logging (flooding) and formation of marshes in the territories of towns, settlements, industrial companies and agricultural lands, having adverse impact on the stability, seismicity of the buildings and structures and on the productivity of agricultural lands.

2. BACKGROUND

The exploitation practices of buildings and structures show, that following some period of time after exploitation the soil parameters, leakages from utilities, filtration losses from water pipes and other for other reasons the level of ground and capillary waters gradually increase, as a result of which the subfoundations, bases, basements and in some cases the aboveground sections of the structures are exposed to the adverse impacts of water logging and moisture. There are numerous cases when the rise of ground water level has been the cause of stability loss of the structure. High moisture is also one of the main factors causing the buildings and structures to undergo physical depreciation earlier. It stimulates deterioration and corrosion of stone, reinforced concrete and metal structures, decay of wood items and most importantly the reduction of bearing capacity of subfoundations and structures.

The influence that moisture has is continuous and its nature and intensity depends on the geological, hydrogeological conditions of the area, atmospheric and weather factors, arrangement of the underground sections of the structures.The level of moisture also depends on the design solutions of the structure, i.e. arrangement of individual section on the plan, selection of construction material, quality of the performed work and exploitation conditions of the structure, etc. There are numerous cases of negative influence by ground and capillary waters in Yerevan, Dilijan, Gyumri and other towns.

Designers, constructors and operators always have one concern on how to ensure the waterproofing and appropriate conditions for the long term exploitation of the newly constructed structures or the rehabilitated ones.

The existence of capillary moisture in the aeration zone of soils has a negative impact on buildings, structures and facilities located in such structures and human health. High level of ground water leads to overdamping of agricultural lands and formation of marshes. In case of mineralization the lands undergo salination, which drastically reduces the productivity of crops.

Fighting against the negative impact of dampness implies finding out the rising level of capillary waters, velocity value, processes of moisture formation and removal, developing methods for forecasting its dynamics thus enabling development of protection measures against the negative impact of soil moisture of structures and agricultural lands.

3. METHODS

Absorption pressure and water content capacity are important characteristic of the soils. Absorption pressure ψ s described by capillary sorption forces depending on the soil moisture. They force the water particles to rise through the soil interspace above ground water level and settling in the form of layer. Height of water column equivalent to absorption pressure is called absorption height (Klimentov P.P, Kononov V.M. 1985).

$$h = -\frac{\psi}{\rho_w g}, \tag{1}$$

where ρ_W is water consistency, g-is the free-fall acceleration.
For the completely water saturated soils $\psi = 0$, but in less damp soils it may reach 1…10 MPa, ψ -is especially high in clay soils.
Maximum rate of capillary rise in loamy soils is determined through Kozeny's approximate empirical formula:

$$h_k = 0.446(ed_e)^{-1} \tag{2}$$

d_e -is the existing diameter of particles, cm, e - is the coefficient of porosity.
If assumed, that water movement in individual capillaries of soils takes place according to Darcy's law, the equation of real movement of water in the capillary will have the following form:

$$\frac{dz}{dt} = \frac{k}{n} \cdot \frac{h_k - z}{z}, \tag{3}$$

Where k-is soil filtration coefficient, n- is porosity, z-is the coordinate point above the ground water level, t-is the time.
(3) Integrating the equation within t=0, z=0 և t>0, z>0 we shall have:

$$t = \frac{n}{k} h_k \left(\ell n \frac{1}{1-\eta} - \eta \right), \qquad \eta = \frac{z}{h_k} : \tag{4}$$

Using (4) equation it is possible to determine the time required for the water to rise up to point z and the average speed of capillary rise.

Identifying $\bar{t} = \frac{tk}{nh_k}$ and $\ell n \frac{1}{1-\eta} - \eta = f(\eta)$ we shall have:

:

$$\bar{t} = f(\eta) : \tag{5}$$

The fig.1 provides $\bar{t} = f(\eta)$ function graph. The graph shows, that the velocity of capillary rise is considerably high in its initial phase.
Several authors have (Likov A.V (1954); Bondorenko N.F 1975) studied the dynamics of capillary movement by experimental methods and have revealed that capillary rise takes place faster in sandy soils, but it is slow and takes larger scope in clay soils.
Moisture transfer influenced by gravitation, capillary and sorption forces is the main feeding source of underground waters. Water movement in soil interspaces takes place under the influence of molecular, capillary and gravitation forces.
Experimental studies proof, that moisture transfer under the influence of capillary-sorption and weight forces is described by the following connection proposed by L.A. Richard (Klimentov P.P, Kononov V.M. 1985).

$$V = -k(w) gradH, \tag{6}$$

Where $k(w)$ is the moisture transfer coefficient, which mostly depends on the soil moisture of aeration zone and is determined S.F. Averyanov (Klimentov P.P, Kononov V.M. 1985).

$$k(w) = k_0 \overline{W}^m = k_0 \left(\frac{W - W_0}{W_n - W_0} \right)^m, \tag{7}$$

here k_0-is the soil filtration coefficient, W_0- and Wn are minimum and maximum depths, m-is the coefficient depending on the types of soil, it is m=3…4 for the homogenous soils.

(6) the absorption pressure concept is observed in the formula instead of hydrostatic pressure, which is determined as follows:

$$H = -h + z, \tag{8}$$

where h -is the water column height equivalent to the absorption pressure.

Relation of absorption pressure height to the moisture is called the main hydrophysical description of soils, which in the within the interval of complete moisture transfer of soils up to the minimum may be presented as follows: (Kats D.M., Shestakov V.M. (1981); Sargsyan V.S., Khachatryan A.E. 2013).

$$h(w) = -H_K \ell n \overline{W}, \tag{9}$$

where H_k -is the given capillary pressure height, and $\overline{W}$ - is the saturation of capillary moisture.

Placing (8) in (6) we shall get vertical moisture transfer speed:

$$V = k(w)\left(\frac{dh}{dz} - 1\right), \tag{10}$$

When moisture moves from top to down , where transfer takes place from top to down . Axis z is directed up from ground waters. To get the patterns of moisture transfer direction it is necessary to solve the equation (10), when and functions are known. Accepting these dependences in (7) and (9) forms and placing in (10) we shall get:

$$-\frac{V}{k_0} = H_K \overline{W}^{m-1} \frac{d\overline{W}}{dz} + \overline{W}^m : \tag{11}$$

By separating the variables and considering the edge conditions we shall have.

$$\int_1^{\overline{W}} \frac{\overline{W}^{m-1} d\overline{W}}{\overline{W}^m + (V/k_0)} = -\frac{1}{H_{|K}} \int_0^z dz : \tag{12}$$

Integration of (12) expression will result into

$$V = k_0 \frac{e^{-\beta h} - e^{-\beta z}}{e^{-\beta z} - 1} = k_0 \frac{e^{-\beta z} - \overline{W}^m}{1 - e^{-\beta z}}, \qquad \beta = \frac{m}{H_K} : \tag{13}$$

In aeration zone having the moisture transfer known values it is possible to determine moisture and absorption height values:

$$W(z) = W_0 + (W_n - W_0)\left[\left(1 + \frac{V}{k_0}\right)e^{-\beta z} - \frac{V}{k_0}\right]^{\frac{1}{m}}, \tag{14}$$

$$h(z) = -\frac{1}{\beta} \ell n\left[\left(1 + \frac{V}{k_0}\right)e^{-\beta z} - \frac{V}{k_0}\right] : \tag{15}$$

1. CASE HISTORY

Bases of structures and utilities in any region, depending on the depth of location, may occur to be under temporary or permanent influence of underground waters. Permanent influence of the water occurs, when bases of structures are located lower than the lowest level of underground waters, and temporary influence occurs, when the bases are located above the seasonal or annual fluctuation levels. Even in this case, when the ground water level is located below the bases of structures, the latter may undergo also temporary or permanent influence of capillary waters resulting into high moisture in the structures and basement floors of the latter (Abramov S. K. 1973).In order fight such negative phenomena a drainage system needs to be designed and implemented.

5. RESULTS

Calculations to determine moisture transfer and absorption height in the aeration zone have been carried out by (14) and (15) formulas for the following baseline parameters:

$V/k_0 =$0, -0.1, -0.15, 0.1, 0.15, $m=$2.5, H_k=2.5m., β=1: Calculation results are summed up in the table 1.

Measurement of absorption of pressure height at any point in aeration zone by tensionmeter $h(z)$ and comparing it to the height of point above the ground water table makes it possible to determine the direction of moisture movement.

6. CONCLUSIONS

Calculation results show, that even a minimum rising speed of capillary water (0.003 m/sc) exceeds the observed speed of ground water movement which is crucial point for water logging (flooding) occurrence.
The given formulas may be used to determine the ground water feeding amount in the aeration zone and evaporation amount from the latter, as well as to determine moisture reserve in soils.

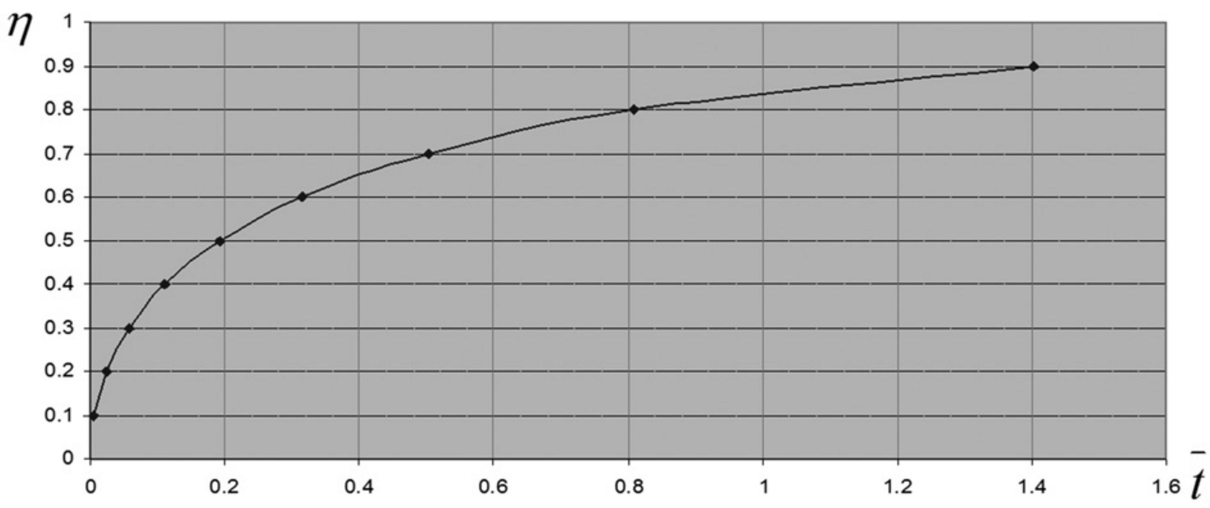

Fig. 1. Capillary water rise $\bar{t} = f(\eta)$ gr aph.

z	$W(z)$	$h(z)$	$W(z)$	$h(z)$	$W(z)$	$h(z)$	$W(z)$	$h(z)$	$W(z)$	$h(z)$
	$V/k_0 = 0$		$V/k_0 = 0{,}1$		$V/k_0 = 0{,}15$		$V/k_0 = -0{,}1$		$V/k_0 = -0{,}15$	
0	1,0	0	1,0	0	1,0	0	1,0	0	1,0	0
1,0	0,67	1,0	0,62	1,19	0,59	1,3	0,71	0,84	0,73	0,77
1,5	0,55	1,5	0,46	1,93	0,41	2,24	0,62	1,20	0,65	1,07
2,0	0,45	2,0	0,30	3,02	0,13	5,18	0,55	1,51	0,59	1,33
2,5	0,37	2,5	-	-	-	-	0,50	1,75	0,55	1,52

Table 1. Moisture transfer and absorption height values in aeration zone.

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INTERPRETATIONS OF WASH OUT PROCESS OF EARTH DAM BODY

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Keywords

earth, washout, maximum flow

ABSTRACT

Interpretations of wash out process of earth dams' bodies in addition to their important practical significance are of intense theoretical interest. It is most important for determination of opening dimensions formed in the dam body, which is necessary for estimation of the maximum flow running through that opening. The paper describes the process of dam body soil wash out and its transportation mechanisms in case water flows over the dam body. On the basis of available interpretations of occuring physical phenomena a mathematical simulation was developed to obtain regularities of the opening dimensions formed in the dam's body, volumetric flow passing through that opening, space-time variation of the water volume available in the reservoir. These regularities enable to determine maximum flow passing through the opening and estimate consequences of the dam collapse.

1. INTRODUCTION

The main reason of earth dams failure are impermissible amount of filtration streams flowing through a dam body which in the course of time wash out soil particles resulting in more intense filtration streams. Therefore, in operation of such structures filtration streams and position of the depression curve are under constant monitoring. In case of necessity purposeful engineering measures are developed designed to prevent occurrance of undesirable phenomena. Dams damages frequently take place by such acts of man as act of sabotage, marked indifference, operation error or unpredictable overflow when spillway structures do not provide safe discharge of water. Similar phenomena are available in a number of reservoirs of which dams have been torn due to water running over the crest of the dam body. In similar situations it is very important to study peculiarities of dam body's soil wash out phenomenon based on wash out process development interpretations, build a mathematical simulation which will enable to find out the regularity of space-time change of opening dimensions of the opening formed in the dam body. It can enable to calculate the maximum flow through opening which in the downstream will cause a hazardous run-off and large inundated areas.

2. BACKGROUND

Water overflow wash out soil of the earth dam's body causing a dynamic crack. With time running water continues its more intense washing out process widening the size of the crack and thus reaching parent rocks of the dam foundation. Simultaneously occurs further increase of the crack dimensions, thus widening cross-section area of the crack and intensifying the flow.

It is a very important to obtain space-time regularity of the opening dimensions and the flow change whereby it can be found out that maximum flow formed during the dam tearing leading to dangerous, catastrofic situations and final failure of the dam. Selection of initial dimensions of the opening stipulated by emergency conditions. If wash out is conditioned by impermissible rise of the reservoir level and running of water over the crest of the dam, then initial dimensions of the opening in the soil of the dam's body washed away by runnig water are assumed m. In emergency situations and natural disasters the initial dimensions of the opening can be different (RA 03-607-03, M.2003).

3. METHODS

Overflowing stream washes away soil of the dam gradually widening and deepening the opening. Increase in crosswise direction is determined by the increase of the depth

$$\Delta b_i = \Delta y_i \frac{y_i}{y_i + \Delta y_i}, \qquad (1)$$

where $\Delta b_i -$ is the increase of the opening width in case the depth increase is Δy_i.
The increase of the dam’s body soil wash and the opening dimensions depeneds on capacity of the stream. The more soil mass is torn off and carried away by the stream the quickly dimensions of the opening are increased resulting in fluid outflow increase. This in its turn wil cause acceleration of washing process and increase of outflow. As a result of continuation of these two tendencies the flow through the rupture will reach to its maximum and creating dangers in the downstream.
The main problem related to wash away of the dam is to finde out regularity of space-time change of the water flow amount passing through the openning, hence, to obtain the maximum amount of outflow. It is important for determining boundaries of inundated area of downstream and evaluating dimensions of the risk belt. The amount of washed away and transported mass of soil by outflow fluid depends on the degree of cohesion of soil, its granulometric curve, velocity of outflow water flow etc. If the velocity of stream is lower from boundary critical velocity then wash away can not occur, as for high concentration, soit transportation, in the main, occurs in the form of bottom sediment. It contributes to intense wash away cohesive sections of the dam’s body. Separated particles of that cohesive soil entering intergranular space of the loose soil they build up water-soil fluid mass of which viscosity, depending on percentage of suspended clay particles, can vary within wide range up to viscosity of viscose-plastic fluid. The mass of water-soil fluid developed as a result accelerate the process of the dam destruction and development of tearing wave.

Depending on the dam body dimensions and physical and mechanical properties of soils the concentration of washing streams may vary within wide range. It depends on outflow velocity, kind of the soil, opening dimensions, etc. Making use of the stream’s capacity and known formulae of wash away maximum speed, values of probable concentrations of washed away soil can be obtained.
The main mass of earthen dam’s body is built of loose pebble-and-gravel soil and the dam core consists of cohesive loamy soil. In such conditions during the dam’s body washing process the outflowing fluid within upstream boundaries is saturated by deposited sediment.
Rolling bottom sediment passing through the core create good conditions for desintegration of the cohesive soil and its quick wash away. As a result the dam core becomes unable to resist wash away process of the dam body. Therefore, it is assumed that during the dam body wash through the opening runs a stream saturated with rolling sediment. On these assumptions to obtain the ratio of volumes of passing through the opening fluid and washed away soil let us consider turbulent mudflow hard sediment carrying capacity.
A research team of “Hydroengineering and water Problems” Institute after academician I.V.Eghiazarov as a result of its long time investigations has obtained the below criterial equation for turbulent mudflow carrying capacity

$$S = \frac{0.53}{\rho^{/}} \left(\frac{d}{\Delta \cdot j} \right)^{1/6} \left(\frac{V^2}{\Delta \cdot g} \right)^{0.3} \cdot i^{1.4}, \qquad (2)$$

where S is a dimensionless carrying capacity of a stream

$$S = \frac{Q_{\text{тв}}}{Q},$$

$Q_{\text{тв}}$ is the flow of solid sediment in m3/s, is the general flow of the stream in m3/s, is relative density of sediment

$$\rho^{/} = \frac{\rho_{\text{тв}} - \rho}{\rho},$$

p - is the density of solid sediment, d - is the average diameter of sediment, j - is Kramer coefficient of nonuniform distribution of sediment in the stream, $\Delta -$ is the average size of the channel asperities, V - is the average speed of the stream, i - is the riverbed slope angle.

Formulas on stream capacity have been suggested by M.A.Velikanov (Velikanov M.A. 1955), I.V.Eghiazarov (Eghiazarov I.V. 1963), Petroli, Graph-Oghoroghlu, P.H.Baljyan (Baljyan P.O. 1978) etc. From among formulas suggested by the above researchers the one proposed by P.H.Baljyan can be single out which provides results of acceptable accuracy and is applicable for mudflows of high concentration (Baljyan P.O. 1978).

$$S = \frac{Q^{0.15} \cdot i^{1.625}}{\rho' d^{0.375} \left(1 + 0.85 S^{1/3}\right)^{0.45}}, \tag{3}$$

4. CASE HISTORY

In high concentration mudflows stream capacity to transport solid sediment in the above mensioned formulas depends on the riverbed geometrical slope and flow passing through it. Depending upon these parameters solid sediment quantitative proportions in mudflow with reference to fluid mass of the stream can vary in a wide range. In isolated cases the amount of solid mass exeeds the fluid mass. Movement of the developed mixture is of a peculiar nature to which Newtonian fluids movement regularities are not applicable. P.H.Baljyan's criterial equation describes such kinds of mudflow to which Newtonian fluids movement regularities are applicable. According to the derived formula regularities of the mudflo wmovement are subject to the Newtonian fluids movement regularities where . This means that half of the mudflow volume takes fluid mass and the other half - solid mass. to judge by these thoughts one can arrive to a conclusion that during wash of earth dams the developed concentration of flood flow can vary in a wide range. Therefore, based on a certain calculation formula and taking the obtained results as a base we have not actual interpretations of real phenomenon.
To this end to get realistic interpretations on the dam wash phenomenon we proceed from results of our observations of the wash out process and respective conclusions.

5. RESULTS

Earth dams body soil wash out visual and instrumental studies testify that rupture of the dam and wash out of the soil run most quickly compared with the time period obtained by the above design formulas. Therefore, to form a realistic idea on the dam body soil wash out process it is necesary to carry out computerized experimental research to clear up dimensions of the opening, flow passing through the opening, duration of wash and regularities of space-time change of the maximum flow formed as a result.
To achieve this aim conclusions formed by authors on solid mass volumes transported by the stream and multy-element experimental observations have been used.
On the logical basis of the problem the fact is placed that the flow passing through the dam body because of great slope grade is of srong saturated composition. In its volumes proportions of fluid and solid masses variy from 0.5 to 100. Based upon possible values of fluid and solid flow volumes proportions computerized experimental calculations have been made to reveal the Sarsang dam body soil wash out space-time development. Calculations have been made for the following parameters: the dam crest level – 730m, the dam crest width - m, impounded water level – 726m, slope coefficients of higher and lower faces are 2.5 and 1.9, repectively, dam body soil – pebble-and-gravel, average granulometric composition - d=(2 - 100)mm, core is clay loam, average granulometric composition - d=(0.005 - 5)mm (Book 1, Yerevan, 2012). Washing of the dam occurs on the dam crest 725.5m level of m initial width through the break in the dam. Calculations were made for different concentrations of solid flows, when fluid and solid flows volumes' ratios are equal to 0.5, 1,2, 5, 10, 50, 100. Based on the obtained results time-dependent graphs of flow passing through the opening (Fig.1) and the reservoir's volume (Fig.2) have been plotted.
Given this data it is necessary to detemine boundaries of overflow area of the downstream and obtain the pattern of their placement in the area.

6. CONCLUSIONS

Analyzing and summing up the curves variation nature the authors have arrived at the following conclusions:the more is washed out and carried by stream soil concentratio, the sooner the opening is developed and the maximum outflow measure comes nearer to the maximum flow when there is no dam (Fig.1):

• the faster the opening developed, the sooner the reservoir is empted causing widening inundated area at the downstream and reducing propagation time of the shock wave (Fig.2);

• it is suggested to accept ration of fluid and solid masses volumes of the dam’s wash stream within 0.7 to 2.5;

• in case of the ratio 1:2 of the Sarsang dam washing stream space-time parameters change (Fig.2) and we get that the maximum flow is developed in s and equals 210.000 m3/s and the reservoir is empted in 7850s;

• the reservoir emptying time was calculated without taking into consideration water lavel change in the downstream. as a matter of fact the maximum flow in outflow time in the downstream an essential depth is developed which influences upon free outflow decreasing outflow and increasing actual emptying time of the reservoir.

Dam body soil wash away rate and space-time change of the avulsion dimensions under formation depends on grnulametric composition of the body soil, its physicomechanical properties, dimensions of the dam and reservoir. The suggested methodology has made it possible to compute opening dimensions developing in the body of the earth dam and the maximum flow through it which is necessary for determining boundaries of overflow area in the downstream.

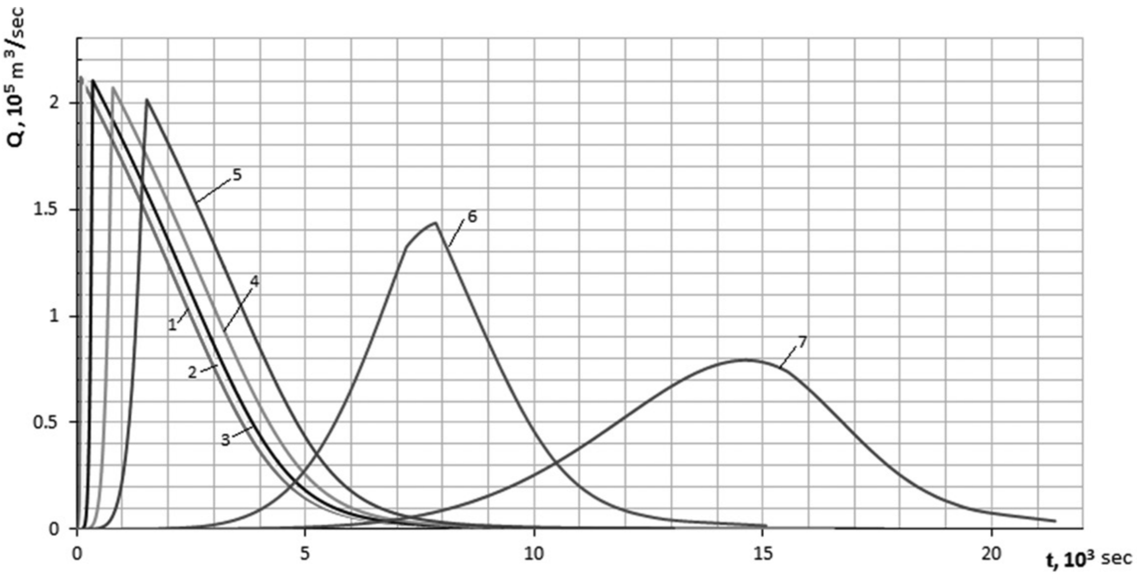

Fig 1. Outflow change through the opening

(1- $Q_L = 0.5Q_S$, 2- $Q_L = Q_S$, 3- $Q_L = 2Q_S$, 4- $Q_L = 5Q_S$, 5- $Q_L = 10Q_S$, 6- $Q_L = 50Q_S$, 7- $Q_L = 100Q_S$)

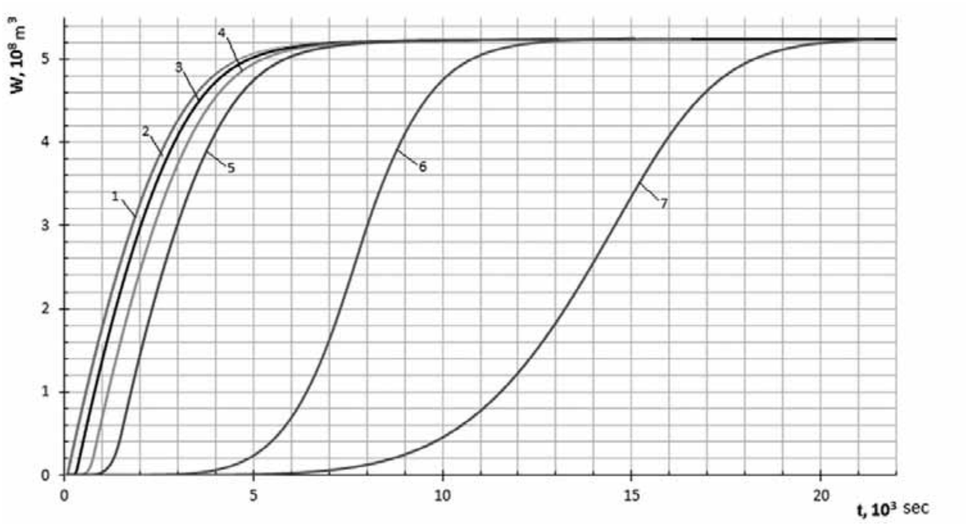

Fig 2. Time-dependent change of outflow volume from the reservoir

(1- $Q_L = 0.5Q_S$, 2- $Q_L = Q_S$, 3- $Q_L = 2Q_S$, 4- $Q_L = 5Q_S$, 5- $Q_L = 10Q_S$, 6- $Q_L = 50Q_S$, 7-

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CREATION AND WORK WITH ARCHITECTURAL AND CONSTRUCTION TERMS GLOSSARY

POSTER

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Keywords

architecture, construction, glossary

ABSTRACT

The value of English in today's world can hardly be overestimated. In fact, it is impossible pay no regard to the choice of more than 1 billion people who use it. And if for the half of them it is a native, then about 600 million have chosen it as a foreign language, including the population of Kazakhstan. Of course, the range of the English spread in the modern world is so great that this language may not be identical in different areas of activities.

In various countries, the reality is different, and it is not enough to make a direct translation from one language into another. And here, an important role plays the language and technologies adaptation to the needs and conditions of individual regional markets, linguistic and cultural nature and peculiarities of the region, in particular Kazakhstan.

For that reason, we decided to classify a special technical English terminology required for effective communication and successful implementation of projects, investigate the features of texts of scientific and technical style in the field of architecture and construction, including "green construction" and draft a common special-purpose glossary.

1. INTRODUCTION

Prompt growth of quantity of terminological units at the turn of the century, insufficient study of architectural, design and construction lexis and existence of a number of discrepancies and inaccuracies of translation in special dictionaries caused the necessity to streamline and unify the terms and terminology in an integrated manner by creation of the specialized and unified glossary in the context of Expo-2017 project. The key task of drafted glossary consisted in finding of meaningful Russian analogs that are in full concordance with the norms of original language.

2. BACKGROUND

The architectural and construction lexis reflects one of the most ancient fields of knowledge making an integral part of human experience. The increasing interest in the linguistic analysis of special lexis of separate areas of knowledge: architectural, design, construction, engineering and some other areas of knowledge is observed for the last decade in the study of language.

Scientific and technical texts, in particular project design documentation, find out a number of grammatical features. The most typical lexical sign is the text saturation with the terms and terminological phrases and word combinations, as well as availability of lexical structures, patterns and abbreviations.

3. METHODS

Technical translation of project design documents and drawings in the sphere of architecture and construction is the translation of technical and specialized documents, one of the most difficult types of translation requiring a special approach. Technical translation differs from the usual language translation in specific terminology and style of statement.

The translation of project design documents, including all design disciplines is a very sensitive sphere of creative activity, in which the professional performance of work is achievable only by highly qualified technical translators side-by-side working with the technical experts involved into the project design. The technical translator making the translation has to know perfectly the subject area and its specific terminology and what's the most important - to be able to state properly the thoughts, without leaving from an essence and style of the original. The important feature of scientific and technical progress is mutual penetration of special terminology from one fields of knowledge into others. And this means only one: the translation of project design documents and drawings for each specific project requires the creation of general and uniform glossary for the use by all project design participants.

Methods of translation are subdivided on automated (computer-aided translation) and manual. Some users try to apply computerized tools for technical translation of texts due to a large number of programs - "translators" being developed up to date and due to existence of Web sites offering translation services online. But most often such attempts are doomed to a failure. There is still no such a program which could make the translation at a level of the qualified specialist. And therefore, the work with a language during technical translation of project design documents is not limited to the use of certain, even the widest dictionary and established linguistic designs. There arises acute need for creation of general and uniform glossary.

2. CASE HISTORY

The term "Green Construction" increasingly sounds for a variety of reasons, as well as in connection with the expected and milestone event for the entire Kazakhstan - the opening of EXPO-2017 Center in Astana, Kazakhstan, the author of the architectural concept of which is an American company Adrian Smith & Gordon Gill Architects (AS + GGA). The exhibition will be held under the slogan "Future Energy" and will highlight one of the most relevant issues of concern to the international community - alternative sources of energy. Speaking of EXPO-2017, the subject matter of "Green Construction" is as relevant as ever. The general "Future Energy" concept of the exhibition involves the construction of facilities of the entire exhibition center in accordance with "Green Construction" regulations and international standards for energy conservation and green construction, namely the reduction in the level of energy and material resources consumption throughout the life cycle of a building: site selection, design, construction, operation, repair, maintenance and demolition of building.

The exhibition will be held from June 10 to September 10, 2017 and will take in about 100 participating countries and 10 international organizations. For Kazakhstan EXPO-2017 will be a landmark event: the international exhibition of such large-scale has been never held in the countries of Central Asia and CIS. The total cost of EXPO-2017 will exceed $3 billion. The project involves about 17 leading foreign companies. KAZGOR Design Academy actively assists AS + GGA in design, consulting services, adaptation and translation of the design documents for EXPO-2017 project.

The team of in-house, professional translators with extensive experience and side-by-side working with highly qualified experts in each design discipline has been involved to ensure the high quality technical translation of EXPO-2017 design documents and drawings. This team clearly realized that the creation of uniform, specialized glossary is the key to effective communication between all project participants and timely and successful implementation of EXPO-2017 project.

Relevance and urgency for development of the specialized glossary for EXPO-2017 project was caused by the fact that 75% of time spent for the translation is taken by the translation of just the terms according to available statistics data. Therefore the problem of comparison of terminologies for improvement of quality of the terms translation gains the increasing relevance, and constant interest of translators and terminology experts in establishment of reliable equivalents of terms in translation and inter-lingual dictionaries or glossaries of special lexis is non-casual and random.

5. RESULTS

The glossary includes the contrastive-comparative description of architectural and construction lexis of the English and Russian language and is a document which is advantageously used by all EXPO-2017 project participants for successful implementation of the project of great significance for Kazakhstan.

The theoretical and practical importance of this glossary is the availability of the main architectural and construction terminology and collocations.
The glossary contains and systemizes the key terms for all project design disciplines, which have been repeatedly checked and edited. In addition, the phrases that are specific to this project have been identified and correctly translated.

6. CONCLUSIONS

The practical importance of this EXPO-2017 project glossary consists in the possibility to use the obtained data in the practice of translation of texts on various project design disciplines, including architecture and construction, as well as to use it as educational material of a special course on a terminology study, and explicitation of interlanguage correspondence of terms. Not less important is the fact that this Glossary can be used for the solution of one of the most important and actual terminological problems of the translation of scientific and technical literature - a problem of selection of compliances with foreign-language terms in the course of dictionaries drafting.

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P.S. At this stage, the 2nd updated edition of Glossary is issued on June 10, 2015 which contains more than 1 120 terms on the following subject:

VIII.
I. Project specific terminology
II. Engineering - general
III. Architecture / design / landscape
IV. Civil & structural
V. Mechanical, electrical, plumbing
VI. Technology / equipment / materials
VII. Safety – general
a. Fire safety
VIII. Established phrases, abbreviations

Fig.1. "Green energy" Logo.

Fig. 2. Overall view of Expo-2017 complex in Astana, Kazakhstan

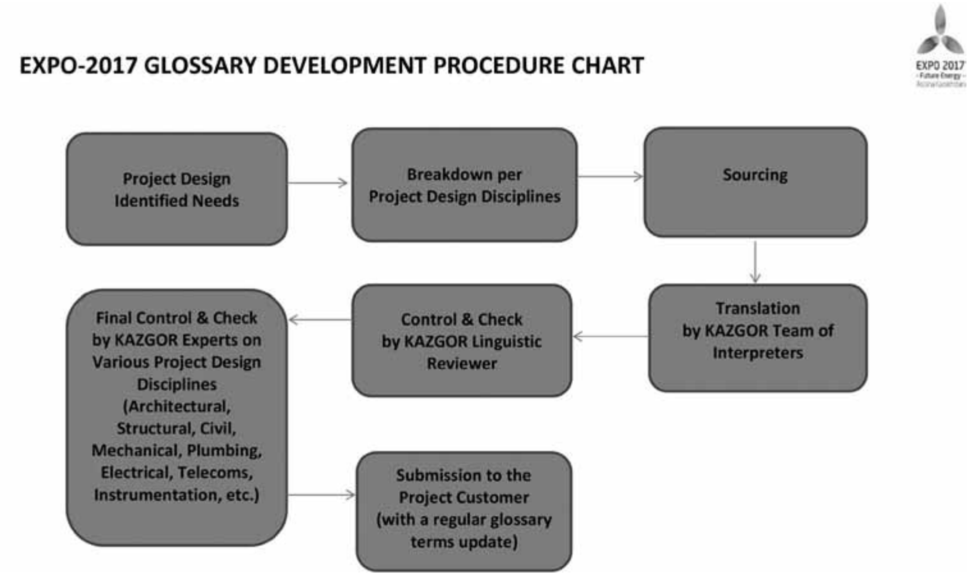

Fig.3. Expo-2017 Glossary development procedure chart.

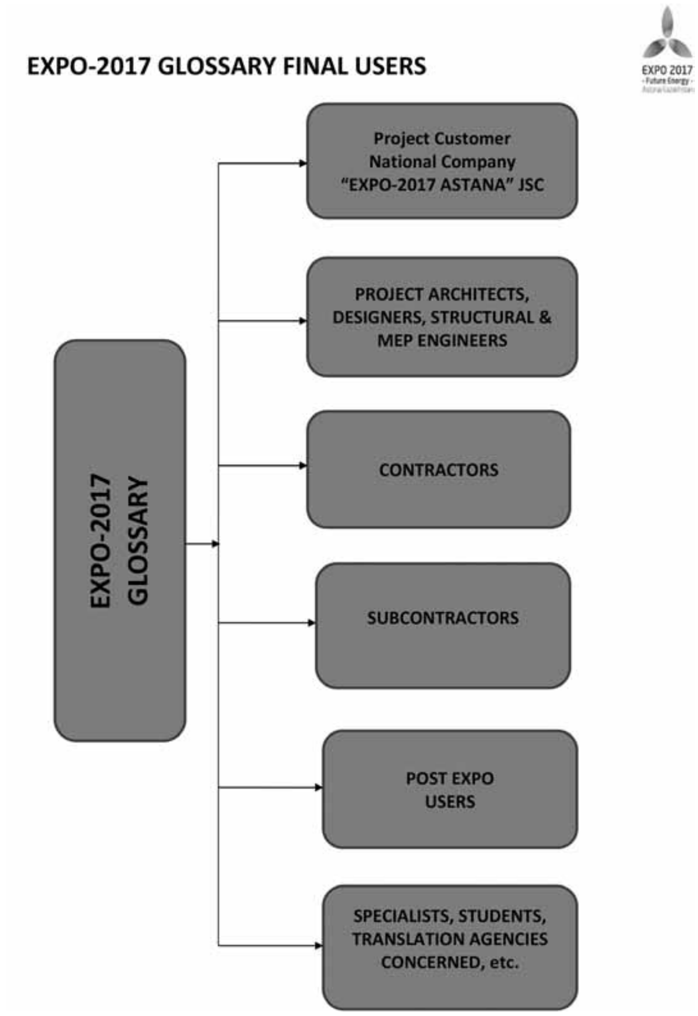

Fig.4. Final users of Expo -2017 glossary.

THE INFLUENCE OF COVERING OF INDUSTRIAL CONCRETE FLOORS WITH SELECTED CHEMICAL AGENTS ON THE IMPROVING OF THEIR PERFORMANCE PARAMETERS

POSTER

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Keywords

concrete floors, performance parameters

ABSTRACT

Concrete floors are common types of floor in the industrial buildings, warehouses, commercial buildings, car parks and garages. Depending on the load and requirements resulting from the way of using the floor, its upper surface is prepared. Leaving of the concrete surface only floated smoothly, without any additional enhancing treatments, decreases the floor durability, its usability and aesthetic values.
Depending on the exploitation requirements, there are used various methods of curing the upper layer of the floor.
The most common way of enhancing the upper layer of the floor is surface curing with the use of some chemical agents. The hardeners increase i. a. abrasion resistance of a concrete floor. What influences the effectiveness of the surface curing the floors is the qualitative comparison of the results of abrasion tests with the use of Bohme shield conducted on the surface covered with the hardener and without it.

1. PREPARATION OF THE RESEARCH MATERIAL

Concrete mixture with consistency S3 was thickened with the use of a surface compactor. Then with the use of a floating machine into the binding concrete surface, a curing topping was floated.
After bonding and maturation period, the concrete surface was divided into three experimental parts:

1. The first part, unprotected concrete – is a type of concrete floated smoothly, not subjected to further treatments. The sample taken from this part will be marked as UC.

2. The second part, applied concrete – is a concrete type a surface of which was covered with a chemical agent called „Sil+". A sample taken from this part will be marked as AC.

3. The third part, polished concrete with application of „Sil+" – is a type of concrete subjected to the process of grinding and polishing with the use of suitable tools, next subjected to the application of „Sil+". A sample taken from this part will be marked as PC.

From each of the above mentioned parts there were taken three cubic samples. In the abrasion resistance test of these samples, unprotected concrete (UC) will be the reference point for further analyses as concrete not subjected to any treatment. Properties of this particular sample will be compared to the applied concrete and polished concrete with application of „Sil+".

2. ANALYSIS OF THE RESEARCH RESULTS

Abrasion resistance

The samples for the abrasion resistance test conducted with the use of Bohme shield were presented in the introductory part of this elaboration.
The samples have cubic shape and their weight was measured with the use of electronic scales.
For analysis of the results there was accepted an average of the three measurements of the height and weight of each sample after 4, 8, 12 and 16 cycles on the Bohme shield test (1 cycle – 22 rotations of the Bohme shield). An average loss in height, mass, and volume in every sample after 16 cycles of the shield was presented in table 1.

Table 1. Results of the average loss in height, mass and volume after 16 cycles [2]

Sample	Average loss in height after 16 cycles [mm]	Average loss in mass after 16 cycles [g]	Average loss in volume after 16 cycles [mm3]
Unprotected concrete (UC)	4,0	36,71	16100,96
Applied concrete (AC)	3,0	31,72	13628,61
Polished concrete with application of „Sil+" (PC)	2,4	24,73	10283,69

On the basis of the results of the losses in height, mass and volume for the samples after 16 cycles it may be concluded that in case of concrete type UC, AC and PC the losses:

- In height are respectively at the level of: 6%, 4%,3%.
- In mass are respectively at the level of: 4,4%,4%,3%,
- In volume are respectively at the level of: 4,5%, 4%,3%

Comparing the loss in height with particular samples it may be noticed that:

- For applied concrete (AC) –the loss in height is lower for about 25% than in case of an unprotected concrete.
- For polished concrete (PC) –the loss in height is lower for about 40% than in case of an unprotected concrete.

On the basis of the loss in height in the samples it may be concluded, that the process of grinding and polishing connected with chemical application causes that the concrete floor increases its durability by increase in abrasion resistance for 40%.

In table 2 the percentage relation of the loss in mass [%] was presented for each sample after 4,8,12,16 of the cycles.

Cycles	4	8	12	16
Unprotected concrete	14,39	22,33	28,08	36,71
Applied concrete	6,55	13,19	22,67	31,71
Polished concrete with aplication „Sil+"	7,55	11,51	17,75	24,73

Table 2. Comparing of the abrasion of the samples in the cycles from 4 to 16.

3. ANALYSIS OF THE DYNAMICS OF THE WEIGHT LOSS

The aim of the analysis is to compare the level of the loss in weigh for particular samples, together with the increase in the number of cycles and rotations on the Bohme shield. In other words, analysis will check the dependency of the loss in weigh and the number of cycles.

Initially, the dynamics of the loss in weigh from one cycle to another was tested, it means how many percent of the total weigh were lost. The data is presented in table nr 3.

Samples	Number of cycles			
	4	8	12	16
UC	100	55	26	30
AC	100	101	71	40
PC	100	52	54	39

Table 3. Dynamics of the loss in weight after particular cycles [%].

It is worth noticing that together with the number of cycles, regardless some irregularities- the percentage growth rate of the weight loss decreases. The greatest percentage weight loss may be noticed for the sample AC. Thus, after 8 cycles the loss is for 101% greater than after 4 cycles, after 12 cycles for 71% greater than after 8, finally after 16 cycles for 40% greater than after 12 cycles.
Table 4 presents the percentage loss in weight for the samples of AC and PC
in particular cycles, with reference to the weight loss in a sample of UC, it means for how many percent is the loss smaller than the weight loss in sample of UC in each cycle.

Samples	Number of cycles			
	4	8	12	16
AC	54	40	19	14
PC	47	48	36	32

Table 4. Dynamics of the loss in weigh with reference to the sample of UC [%].

It may be easily noticed that together with the number of cycles, the percentage difference in the weight loss with reference to the sample UC for both, samples of AC and PC decreases. For sample AS after 16 cycles the loss in weigh is almost for 14% lower than decrease in weigh for sample of UC, but for sample PC the loss is lower for 32%. It means that covering of the floor with a curing agent before/ after mechanical treatment together with an increase in the number of cycles – looses its meaning.
On the basis of the analysis of the table nr 2 it may be concluded that together with the increase in the number of cycles, the loss in weight also increases. Interdependence of these values may be presented in a form of a linear regression equation (y- loss of weight, x- number of cycles).

For sample UC: $y=7,2+1,82x$

For sample AC: $y=-2,71+2,12x$

For sample PC: $y=0,94+1,44x$

Correlation coefficient for all the equations is equal 0,99, extermination coefficient equal 0,98. It means that there exists a very strong interdependence of these two factors.
Evaluation of adjusting of the regression function in case of a sample of AC is presented in table 5.

Number of cycles	4	8	12	16
Intentional loss [%]	6,55	13,19	22,67	31,71
Calculated loss [%]	5,79	14,28	22,78	31,27

Table 5. Adjusting of the regression function for the sample AC.

3. CONCLUSIONS

Abrasion marked as a loss in weight after 16 cycles with the use of Bohme shield is an invasive test, as 16 cycles of 22 rotations each cause for the sample its attrition even for 4 mm of its height.
Nevertheless, as the research results show, by using the process of grinding and polishing connected with the chemical application, even in case of a significant integration in depth, the sample maintains its very high abrasion parameters.
Improving of the abrasion parameters causes that the floors made with the use of the agent „Sil+" will be characterized by greater resistance in the process of using them, which is especially important in case of an extended pedestrian traffic, or forklift traffic in the utility rooms.

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THE COMPARATIVE ANALYSIS OF DIFFERENT CALCULATION METHODS OF THE LONG CANTILEVER PLATE OF BEAM BRIDGE

POSTER

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Keywords

long cantilever plate, JTG D62-2004, ABAQUS

ABSTRACT

In this paper, a long cantilever plate of a beam bridge was calculated in different methods. These methods include Sawko's formula, Baider Bahkt's formula, Chinese code for reinforced concrete and prestressed concrete bridge and culvert design (JTG D62-2004) and ABAQUS (shell element and solid element are both used to analysis the model). By comparing and analyzing the calculating results, the following conclusion is drawn: 1) The calculation results of 5 different calculation methods from minimum to maximum are: Chinese code, Baider Bahkt's formula, ABAQUS (C3D20R), ABAQUS (S3R5), Sawko's formula. Chinese code calculation result is the smallest, but after multiplied by the coefficient (according to Chinese code) the calculation result is reasonable. 2) The calculation results of Baider Bahkt's formula and ABAQUS (C3D20R) are close. The calculation results of both are small, so is dangerous when we use them to calculate long cantilever plate. 3) The calculation results of ABAQUS (S3R5) and Sawko's formula are close. The calculation results of both are bigger, so is safe when we use them to calculate long cantilever plate.

1. INTRODUCTION

At present, with the bridge construction technology developing rapidly, some bridges with long-span and wide deck were built .With the increasing of bridge deck width, the length of the bridge flange plate also constantly become longer. So the concept of long cantilever plate come up, it is generally believed that when the length of the flange plate is more than 2.5 m, it can be considered as long cantilever plate .In our country, the code for reinforced concrete and prestressed concrete bridge and culvert design (JTG D62-2004) (hereinafter referred to as the Chinese code) caculate the internal force of the cantilever plate using the method of effective distribution width of the load. The concept of effective distribution width is to calculate plate as beam, which cover the two-way force characteristic of the plate. And because the effective distribution width is calculated from the the outer edge of the wheel load block, so the calculated reinforcement is less. If the cantilever length is more than 2.5 m, the calculated reinforcement of Chinese code may be close to the constructional reinforcement, which is not reasonable and also can't guarantee the safety of the cantilever plate. The result of Chinese code calculation method for long cantilever plate are not satisfied, so the Chinese code in article 4.1.5 indicates: when the distance between the load outside edge to the cantilever plate root is more than 2.5 m, the calculation result of cantilever plate root bending moment should be multiplied by the coefficient of 1.15 ~ 1.30. Then we want to know that is the Chinese code actually reasonable or unreasonable? The author tried to solve a numerical example using different calculation method and then illustrate the rationality of the Chinese code by comparing and analysing different results calculated by different method. Effective width calculation mode have been used by our country, the Soviet Union (Russia), the United States and other countries for a few years and some countries are still using it. But Canada Ontario bridge specification (OHBD) have adopted Baider Bahkt's formula, namely direct calculation formula. For a long time, many experts and scholars around the world put forward many kinds of practical formula for computing the long cantilever plate . Because each formula has advantages and disadvantages , now we will use different calculation method to calculate 2.5 m ,3.5 m, 4.5 m, 5.5 m cantilever plate respectively, and compare the results of different calculation methods to illustrate the rationality of Chinese code and the pros and cons of various calculation methods.

2. CANTILEVER PLATE PRACTICAL CACULATION INTRODUCTION

• *2.1 SAWKO'S FORMULA(FROM UK UNIVERCITY OF LIVERPOOL)*

Sanko-bakht had used the finite element method to solve the rectangular cantilever plate with infinite width , and had compared his study result with Jaramillo, Westergaard and Reissman & Cheng's study results . The Sawko's formula is presented as follows:

$$\mathrm{m}_x = f(o,y) = -\frac{P}{\pi} A' \frac{1}{ch\left(\frac{A' y}{a_0} \Big/ \frac{\varepsilon}{a_0} \right)} \tag{1-1}$$

2.2 BAIDER BAHKT'S FORMULA

Baider Bahkt(Canada) had analysed long cantilever plate with edge beam and variable thickness ,and he got the following expressions of unit wide plate bending moment:

$$m_x = \frac{-PA^*}{\pi} \left[\frac{1}{ch(\frac{A^* y}{\varepsilon - x})} \right] \tag{1-2}$$

2.3 CANTILEVER PLATE CACULATION METHOD IN CHINESE CODE (JTG D62-2004)

• *2.3.1 THE EFFECTIVE WIDTH CACULATION METHOD IN CHINESE CODE (JTG D62-2004)*

The width of wheel load distribution in vertical direction of the cantilever plate span should be calculated according to the following formula (when c is not more than 2.5 m):

$$a = (a_1 + 2h) + 2c \tag{1-3}$$

$$m_x = \frac{\sum P\varepsilon}{a} \tag{1-4}$$

The wheel load distribution is suitable when c is not more than 2.5 m, when c is greater than 2.5 m, negative bending moment of cantilever plate root should multiplied by 1.15 ~ 1.30 times.

2.4 ABAQUS FINITE ELEMENT SOFTWARE CALCULATION METHOD

As a famous international general finite element software ,ABAQUS has a large number of users in the international scope .Compared with other similar software, ABAQUS has more cell types . it has as many as 433 kinds of unit, which can provide users with more choices .And can reflect more subtle structural differences between phenomenon and phenomenon.

3. A NUMERICAL EXAMPLE OF CONSTANT THICKNESS CANTILEVER PLATE

Four cantilever plates with cantilever length of 2.5 m, 3.5 m, 4.5 m, 5.5 m and thickness of 0.375m ,we will try to solve its maximum negative moment of unit width .We will use calculation methods of Sawko's formula , Baider Bahkt's formula ,Chinese code and ABAQUS software , and Poisson's ratio = 0.15.

• *3.1 CACULATION RESULTS OF SAWKO'S FORMULA*

When the cantilever length a_0 (l_0) = 2.5 m , ε = 1.7, $\frac{\varepsilon}{a_0}$ = 0.68, look-up table (1-1) A' = 1.24.

Use formula (1-1), calculated m_{xo} = 45.64 KN·m/m.

The calculation results are shown in table 1 :

Calculation results of Sawko's formula Table 1

a_0 (l_0) (m)	2.5	3.5	4.5	5.5
m_{xo} (KN•m/m)	-45.64	-87.43	-107.38	-122.95

• *3.2 CACULATION RESULTS OF BAIDER BAHKT'S FORMULA*

Because the thickness of this example cantilever plate is a constant (0.375m), so $\frac{I_B}{I_S}$ = 1.When the cantilever length a_0 (l_0) = 2.5 m , $\frac{\varepsilon}{a_0}$ = 0.68, $\frac{t_2}{t_1}$ = 1, $B = \frac{x}{a_0}$ = 0, look-up table (1-2) A^* = 1.07. Use formula (1-2) ,calculated m_{xo} = -41.42 KN·m/m.

The calculation results are shown in table 2:

Calculation results of Baider Bahkt's formula Table 2

a_0 (l_0) (m)	2.5	3.5	4.5	5.5
m_{xo} (KN•m/m)	-41.42	-80.79	-98.18	-111.78

• *3.3 CACULATION RESULTS OF CHINESE CODE*

When the cantilever length a_0 (l_0) = 2.5 m , ε = 1.7, a_1 = 0.2 m, h = 0.1,, c = 2.1 m. Use formula (1-3) ,calculated a = 4.6 m, m_{xo} = 39.67 KN·m/m.

The calculation results are shown in table 3 :

Calculation results of Chinese code Table 3

a_0 (l_0) (m)	2.5	3.5	4.5	5.5
m_{xo} (KN•m/m)	-39.67	-75.88	-93.36	-108.24

3.4 CACULATION RESULTS OF ABAQUS SOFTWARE

Use ABAQUS shell element, when the cantilever length a_0• (l_0)= 2.5 m, the cantilever heel boundary condition is consolidated, while the remaining three sides are free . The unit type is S8R5 with side length of 0.2 m and the cantilever plate is divided into 1800 units .Through calculation, the maximum stress $\sigma_{\max}$ =2.257 e+6 Pa ,that occurs on the unit no. 864, no. 225 nodes . By the formula , we calculated m_{xo} = -52.81 KN•m/m. Division of the units and the calculation results are shown in table 4.

Calculation results of ABAQUS shell element Table 4

a_0 (l_0) (m)	2.5	3.5	4.5	5.5
m_{xo} (KN•m/m)	-52.81	-88.17	-88.17	-120.32

Use ABAQUS solid element, when the cantilever length a_0 (l_0)= 2.5 m, the cantilever heel boundary condition is consolidated, while the remaining three sides are free The unit type is C3D20R with side length of 0.2 m and the cantilever plate is divided into 3600 units .Through calculation, the maximum stress σ_{max} =2.102e+6Pa ,that occurs on the unit no. 1287, no. 373 nodes .By the formula $\sigma = \frac{M}{W}$, we calculated m_{xo} = -49.19 KN•m/m. Division of the units and the calculation results are shown in table 5.

Calculation results of ABAQUS solid element Table 5

a_0 (l_0) (m)	2.5	3.5	4.5	5.5
m_{xo} (KN•m/m)	-49.19	-82.09	-99.33	-113.93

4. CONCLUSIONS

For convenience of analysis, we use Origin drawing software draw the Different method calculation results of m_{xo} into two-dimensional figure, as shown in figure 1.

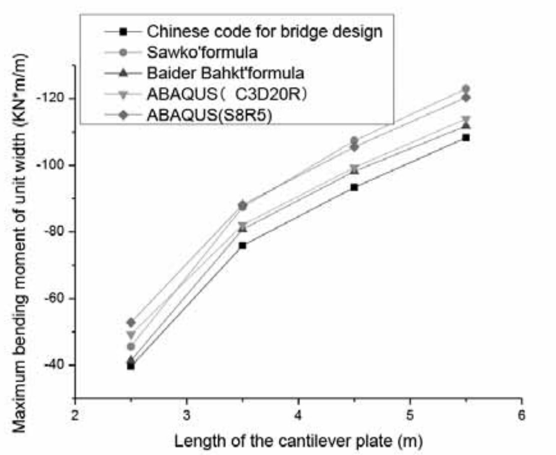

Fig. 1. Different method calculation results of m_{xo}

By comparing and analyzing the m_{xo} in figure 1, we get the following conclusion:

1, The calculation results of 5 different calculation methods from minimum to maximum are: Chinese code, Baider Bahkt's formula , ABAQUS (C3D20R), ABAQUS (S3R5) , Sawko's formula.

2, The result calculated using the Chinese code is the smallest, it shows that when the cantilever length is more than 2.5 m, the result of Chinese code is relatively small .There is a instruction of China code: when cantilever plate length is more than 2.5 m, the negative bending moment of cantilever roots should be multiplied by the co-efficient of 1.15 ~ 1.30 .If the result of Chinese code is multiplied by 1.15~ 1.30, the calculation results as shown in figure 2.As you can see, after the result of Chinese code multiplied by the coefficient of 1.15 ~ 1.30 , it's not less than the results of the other four calculation methods .Therefore, according to the Chinese code, when the calculated result multiplied by the coefficient of 1.15 ~ 1.30 , the of Chinese code is reasonable.

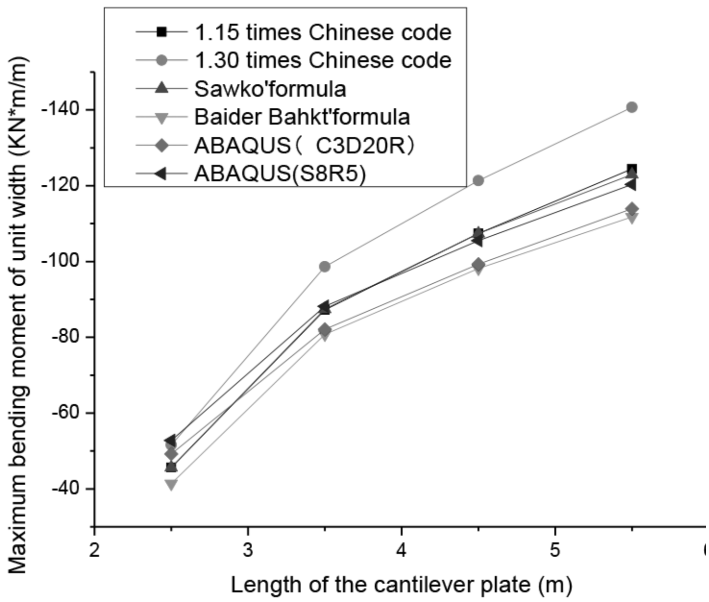

Fig. 2. m_{xo} of Chinese code multiplied by the coefficient of 1.15 - 1.30

3, Bach's formula is suitable for variable cross-section cantilever plate , when calculating the constant cross-section cantilever plate, its calculated result is small ,so is not recommended.

4, The calculated results of ABAQUS solid element is similar to the results of Bach's formula, its calculated result is small ,so is not recommended.

5 Sawko's formula is suitable for constant cross-section cantilever plate, in this example, it's calculation result is bigger and safe, so it is recommended to use .In addition, the results of ABAQUS shell element and Sawko's formula are close, this shows that when use ABAQUS software to analyze long cantilever plate , it is recommended to use the shell element to simulate.

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TEMPERATURE-MOISTURE PROBLEMS OF EMBADDED WOODEN CEILING

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Keywords

moisture condensation, embedment of ceiling beams

ABSTRACT

A change of use of a building increases the risk of water vapour condensation at the place of embedment of wooden ceiling beams in masonry. This is particularly due to the limitation of airing, an increase in interior ambient temperatures and relative humidity. These factors increase the risk of rot. 3D computer simulation models are used to show the impact of today´s living standards on the course of humidity at the place of embedment. A simulation of humidity is also carried out at the time of the construction of buildings with wooden beam ceilings.

1. INTRODUCTION

Wooden ceilings are a traditional construction element of buildings built in the past few centuries. In some ceiling beams rot occurs at the beam ends (Bednářová, P. 2009). The rot is caused when the wooden structure is wet enough for fungi to grow. Beams attacked by rot are not limited to those that form ceilings under roofs, it also includes those beams that form ceilings between floors where no leaks are expected from any source of liquid moisture (Bednářová, P. 2012). This means that the temperature-moisture problem is most probably caused by condensation of water vapour in the beams.

2. DESCRIPTION OF THE EXISTING SITUATION

2.1 CONSTRUCTION

Ceilings were originally made either with open ceiling beams covered by decking from wooden planks and further floor elements, or as so called log ceilings whereby the beams were laid close together. These construction solutions were later abandoned, in particular because of Fire Regulations issued by Empress Maria Therese under which combustible surfaces in interiors were banned.

Ceilings were later usually built in two ways, namely as a semi-fireproof beam ceiling (see 1.1) according to (Bednářová, P. 2012), or as a semi-fireproof beam ceiling with reed lathing (see 1.2) according to. (Bednářová, P. 2012).

The space around the beam ends, as indicated in Figures 1.1) and 1.2), is very important in terms of water vapour condensation at the ends of wooden beams. According to bricklayer regulations this space should be 2 – 3 cm wide around the whole beam end.

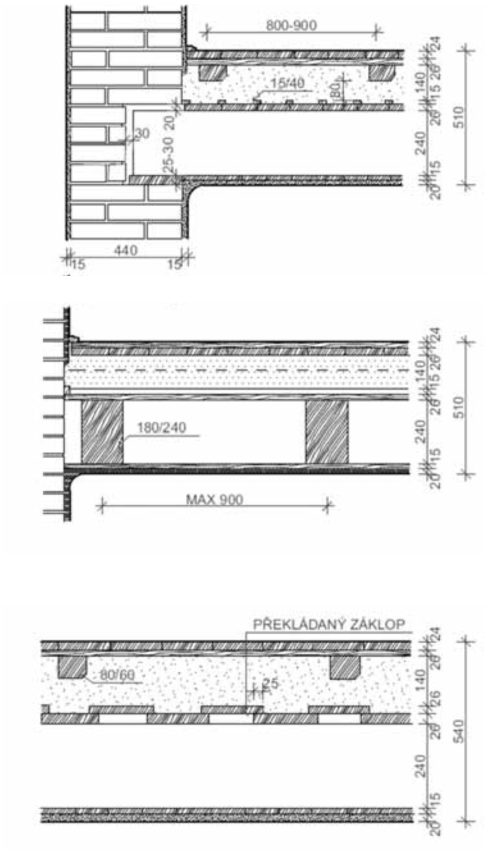

Fig. 1.1 Semi - fireproof beam ceiling

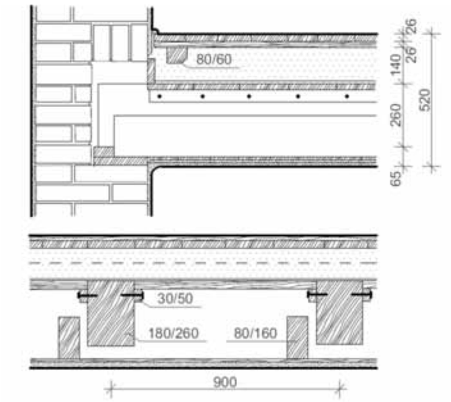

Fig. 1. 2 Semi-fireproof beam ceiling with reed lathing

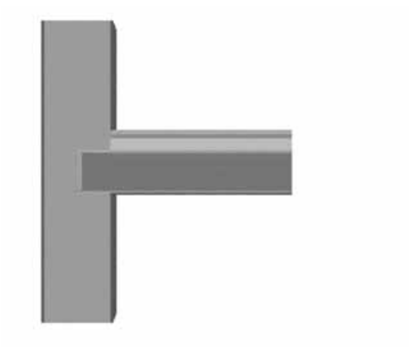

Fig. 2. Detailed cross-section of embedded beam

2.2 TEMPERATURE

The masonry is thinner at the place of the ceiling beam. A point thermal bridge thus occurs. The temperature course can be seen in a 3D model. The results of a computer simulation of temperature distribution under stabilized temperature conditions are given in Figures 2) – 7).

- 2) Detail cross-section of embedded beam
- 3) Simulation of temperature distribution in stationary condition – horizontal section.
- 4) Simulation of temperature distribution in stationary condition – ceiling beam section.
- 5) Simulation of temperature distribution in stationary condition – axonometric projection with identification of the place where temperature is plotted on Figure 7.
- 6) Simulation of temperature distribution in stationary condition in masonry – axonometric projection, with omission of the ceiling beam.
- Graph on Figure 7 Course of temperatures along the lines marked in Figure 5.

It is clear that in the considered stationary state the surface temperature of both the beam and the masonry is well below the temperature of the ambient dew point for the interior of residential buildings (whereby the designed interior temperature during winter season □i = +20 °C and the relative humidity of the interior air φi = 50 %). The corresponding dew point temperature is 9.3 °C. The calculations were performed under the assumption of stationary state whereby marginal conditions were □e = -15 °C and the interior temperature □i = +20 °C.

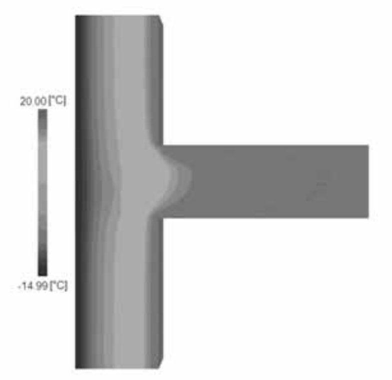

Fig. 3. Simulation of temperature distribution in stationary condition – horizontal section

Fig. 4. Simulation of temperature distribution in stationary condition – ceiling beam section

Fig. 5. Simulation of temperature distribution in stationary condition – axonometric projection

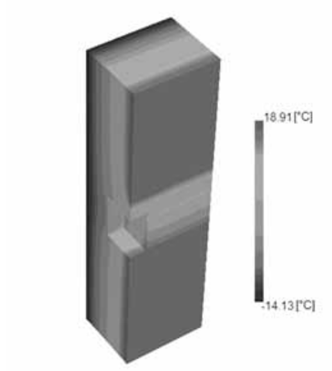

Fig. 6. Simulation of temperature distribution in stationary condition in masonry – axonometric projection, with omission of the ceiling beam

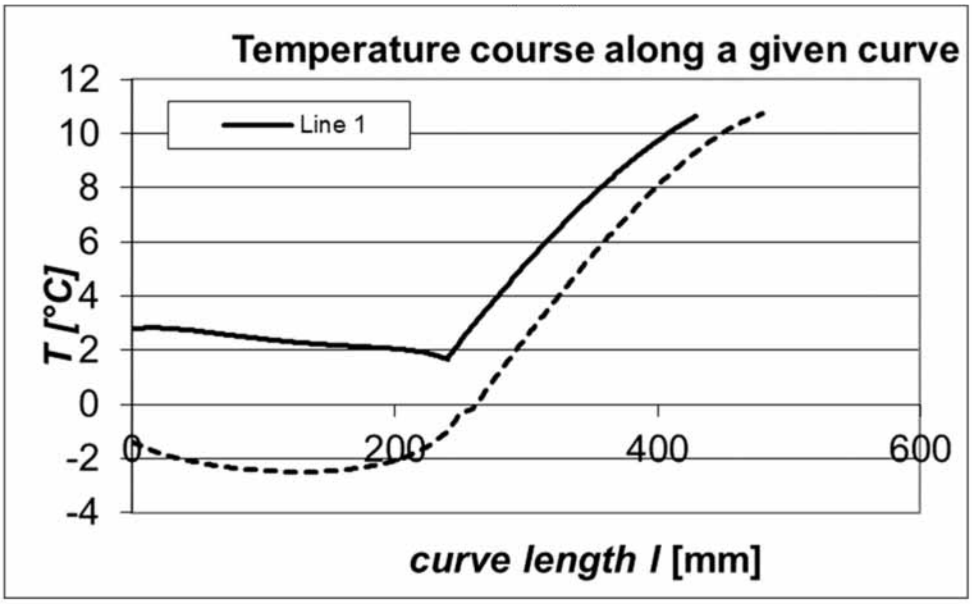

Fig. 7. Course of temperatures along the lines marked in Figure 5

2.3 HUMIDITY ISSUES

The previous section dealt with design values of residential spaces. However, this study deals with historic wooden ceilings. For this purpose it is not only useful to characterize the microclimate using calculated values, but to also try to estimate the environment of the past.
The microclimate today is characterized by the limited ventilation of buildings, relatively high room temperatures (+20 °C and higher) and relatively high relative air humidity due to the numerous sources of internal moisture which did not exist in the past. These sources include large quantities of flowers in flats, the presence of hot running water and the subsequent frequency with which people wash and shower, and laundry drying which used to be done outside but is now done with automatic washing machines and dryers.
From the temperature-moisture point of view the constructions of the past were safer, namely because the air at the time was remarkably drier. There used to be substantially less sources of moisture in flats and rooms used to be aired more intensely.
The values of the interior temperatures to which rooms were heated in the past are unfortunately unknown, as is the relative humidity. We may only proceed on the basis of estimations or calculations based on estimated input values. There is no doubt that the temperature in rooms fluctuated more because they were heated by local stoves. The limited levels of stoking resulted in the stoves going out during the nights which caused temperature drops in the interiors. We may also safely assume that the temperature in flats was substantially lower due to the high price of fuel and the logistical problems associated with fuel transport and the disposal of the ashes.
What follows below is a calculated model of the relative humidity of the air in the interior of a model room from the late 19th century:

Basic data

Room description: the room is in the middle of a building i.e. surrounded by heated space on 5 sides. The dimensions of the room are 3.6 x 5.4 m, the inner height is 3.6 m. The dimensions of the door leading to the corridor are 0.9 x 2.1 m. There are two windows leading to the exterior, both are 1.2 x 2.1 m.
Room purpose: the room is resided in by 3 people with water vapour production 42 g H2O/p.p.p.h (per person per hour). There is an average source of additional moisture in the form of cooking and occasional washing. This source is estimated to be 30 g H2O/hour.
The whole moisture source is therefore 156 g H2O/hour.
Airing: hypothetically the airing is by means of chimney draft. In the times when wooden ceilings were built, rooms were nearly exclusively heated by local stoves which were also used for cooking. We can assume that heating was with either wood or coal with air excess of approximately ten times and an effectivity of 80 %. (The air excess would probably be even higher in practice, as a result no infiltration airing is considered.)
The thermal loss of the sample room is approximately 1.65 kW at an interior temperature of +20 °C and an exterior temperature of -15 °C.
The calorific value of wood is between 3.3 and 5 kWh/kg of fuel.
The quantity of air necessary for combustion is therefore approximately 30 m3/hour depending on oxygen excess in the combustion products.

The gas concentration in the air can then be calculated according to the following equation:
dy1/dt = - r/V * y1 + r/V * y2 + 1/V * y3
where:
r is flow velocity;
V is the volume of the examined object;
y1 is the concentration inside the examined object;
y2 is the contamination taken in by air exchange;
y3 is the contamination from the internal source.

For the absolute exterior air humidity 1.3 g H2O/m3 we get to the calculating level of the absolute exterior air humidity of air of 6.5 g H2O/m3. This corresponds to a relative air humidity a = 35 % at an interior temperature ai +20 °C. The subsequent dew point temperature is 4.1 °C.

A calculated 2D model (vertical section through the ceiling beam) was prepared for verification of the temperature

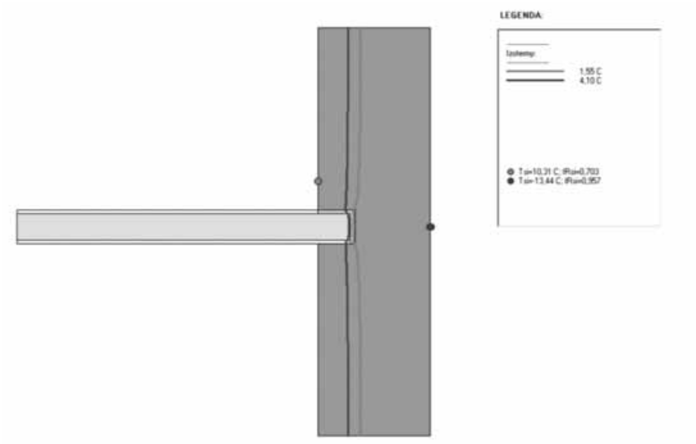

Fig. 8. Calculated model of temperature distribution at the end of the ceiling beam

and humidity course.

Figure 8 shows a calculated model of the distribution of temperatures at the end of the ceiling beam. An isotherm of + 1.5 °C is identified which corresponds to the lowest surface temperature of the ceiling beam of + 4.1 °C, which is the dew point temperature for the calculated interior and exterior temperatures.

Figure 9 shows the resulting area of water vapour condensation in the structure.

On the basis of the calculations for the assumed relative air temperature in 19th and early 20th century buildings, the above figures show that there is slight water vapour condensation at the embedment of the ceiling beams. Under the calculated conditions we understand □ai = +20 °C and □e = -15 °C. Nevertheless, if we were to consider a higher exterior temperature, the temperature on the beam would exceed the dew point. This exterior temperature, whereby the temperature at the ceiling beam does not drop below +1.5 °C in stationary heat conduction, is □e = -10.1 °C. The temperature between -10.1 and -15 °C is quite exceptional in the annual cycle. If it occurs it is only for a short period of time. As a result, water vapour condensation might occur in the ceiling beam end. However, when taking into consideration the previously dry state and the small amount of water, this would not initiate rot growth.

3. CEILING BEAM ENDS AND RECONSTRUCTION

As the analysis shows, water vapour condensation was negligible in buildings with wooden ceiling beams at the times when they were was built. This is why the constructions were safe.

A change of use of a building increases the risk of water vapour condensation at the place of embedment of wooden ceiling beams in masonry. This is particularly due to the limitation of airing, an increase in interior ambient temperatures and relative humidity. These factors increase the risk of rot. There are numerous examples of houses to illustrate this.

For the trouble-free use of houses with wooden ceiling beams it is advisable to adhere to the following:

use the house under the original conditions i.e. use local heating and limit the humidity source to its original level (this solution is acceptable for museums and similar institutions where local heating can be provided to achieve authenticity of the interior);

use controlled forced ventilation with sensors which respond to relative air humidity, whereby the maximum acceptable relative humidity in the winter season is 35 %;

ensure adequate temperature of the ceiling beam ends by means of insulation from the exterior;

ensure adequate temperature of the ceiling beam ends by means of an additional heat source (electric heating cables or suitably arranged central heating distribution);

ensure sufficient intensive flow at the ends of the ceiling beams (this may be provided for example in ceilings without boarding by suitably arranged heating or by airing so as the air can flow around the ceiling beams at their embedment).

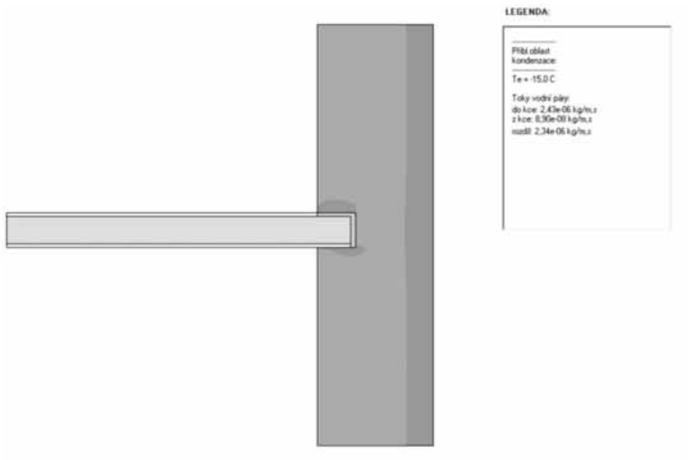

Fig. 9. Area of water vapour condensation in the structure.

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A NUMERICAL METHOD FOR COMPUTING THE THERMAL CONDUCTIVITY AND TERMAL DIFFUSIVITY OF THE BUILDING MATERIALS

POSTER

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Keywords

bulk material sample, thermal conductivity, thermal diffusivity

ABSTRACT

The thermal conductivity and thermal diffusivity of the building materials is an important indicator to measure its heat transfer properties. At practice, we measure them base on plane one-dimensional unsteady state conduction principle, that is in the infinite medium, under the initial thermal equilibrium state, plane heat source will produce the dynamic temperature field inside the medium after it suffers the instant heating pulse, then we can obtain the temperature data which was produced by the heat conduction process of the samples, Thus we can get the excess temperature of materials center point. This paper constructs an iterative algorithm base on Gauss-Newton method for the bulk building material, and this algorithm use these excess temperature to data fitting, then we can get the function which the temperature will rising along with the time changes, and then we can calculate the thermal conductivity and thermal diffusivity of materials. Then, the algorithm is going to be applied to the bulk glass material samples and the massive steel material samples to calculate the thermal conductivity and thermal diffusivity of the two kinds of materials, it further verifies the effectiveness of the algorithm.

1. INTRODUCTION

In order to represent the heat transfer properties of bulk building materials, we need to measure its physical parameters-thermal conductivity and thermal diffusivity. Nowadays, there are many kinds of measuring methods, such as Hot Disk, plane heat source method, and transient plane heat source method in references [1-4].

In reference [5], it describes the transient plane heat source method which is used to measure the thermal conductivity and thermal diffusivity of materials, its principle is based on the plane one-dimensional unsteady state conduction principle, that is in the infinite medium, under the initial thermal equilibrium state, plane heat source will produce the dynamic temperature field inside the medium after it suffers the instant heating pulse, then we can obtain the temperature data which was produced by the heat conduction process of the samples, Thus we can get the excess temperature of materials center point. Then, we can fit the curve of the function, as well as calculate the thermal conductivity and thermal diffusivity of the sample. When testing, we apply the constant DC power to the heat source, the temperature of the surface of the heat source rising and the resistance will increase too, it makes bridge test system imbalance to produce potential variation, through it we can get the function whose temperature is valued with the time changes. When we heat the sample, we always take the probe structure which is shown in Fig. 1.

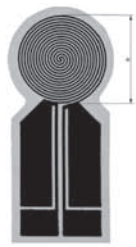

Fig. 1 Probe structure.

The relationship between the excess temperature which is measured by the transient plane heat source method and time are $\Delta T = f(t, \lambda, t_c, a)$, where, t represents time, λ , t_c and are unknown parameters, they respectively represent the thermal conductivity of materials, correction time and the thermal diffusivity of materials. This paper will introduce the process of how to solve the parameters in detail.

2. GAUSS-NEWTON METHOD

First of all, assume $y = f(x, \grave{\mathbf{e}})$ in which $\grave{\mathbf{e}} = (\theta_1, \theta_2, \cdots, \theta_p)^T$ is the p-dimensional unknown parameter, then according to the data $(x_i, y_i), i = 1, 2, \cdots, n$ which are measured by the probe, we can look for the $\grave{\mathbf{e}}$ with the least square method, so that

$$s(\boldsymbol{\theta}) = \sum_{i=1}^{n} [y_i - f(x_i, \boldsymbol{\theta})]^2 \tag{1}$$

can reach the minimum.

In order to find out , firstly we give an initial value $\boldsymbol{\theta}^{(0)}$, then expand $F(\boldsymbol{\theta})$ at $\boldsymbol{\theta} = \boldsymbol{\theta}^{(0)}$ with the Taylor series. Because of the computing's need, only take the first two of the expansion terms. That is

$$F(\boldsymbol{\theta}) = F(\boldsymbol{\theta}^{(0)}) + J(\boldsymbol{\theta}^{(0)})(\boldsymbol{\theta} - \boldsymbol{\theta}^{(0)}) \tag{2}$$

Where $F(\boldsymbol{\theta}) = (f(x_1, \boldsymbol{\theta}), f(x_2, \boldsymbol{\theta}), \cdots, f(x_n, \boldsymbol{\theta}))^T$, $J(\boldsymbol{\theta}^{(0)})$ is the Jacobian matrix of order $n \times p$

$$J(\boldsymbol{\theta}^{(0)}) = \begin{pmatrix} \frac{\partial f(x_1, \boldsymbol{\theta})}{\partial \theta_1} & \frac{\partial f(x_1, \boldsymbol{\theta})}{\partial \theta_2} & \cdots & \frac{\partial f(x_1, \boldsymbol{\theta})}{\partial \theta_p} \\ \frac{\partial f(x_2, \boldsymbol{\theta})}{\partial \theta_1} & \frac{\partial f(x_2, \boldsymbol{\theta})}{\partial \theta_2} & \cdots & \frac{\partial f(x_2, \boldsymbol{\theta})}{\partial \theta_p} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial f(x_n, \boldsymbol{\theta})}{\partial \theta_1} & \frac{\partial f(x_n, \boldsymbol{\theta})}{\partial \theta_2} & \cdots & \frac{\partial f(x_n, \boldsymbol{\theta})}{\partial \theta_p} \end{pmatrix}_{\boldsymbol{\theta} = \boldsymbol{\theta}^{(0)}} .$$

Let

$$\boldsymbol{\theta}^{(1)} = \boldsymbol{\theta}^{(0)} + [J^T(\boldsymbol{\theta}^{(0)}) J(\boldsymbol{\theta}^{(0)})]^{-1} J^T(\boldsymbol{\theta}^{(0)}) [y - f(x, \boldsymbol{\theta}^{(0)})] \tag{3}$$

If $\left\| \grave{\mathbf{e}}^{(1)} - {}^{(0)} \right\| < \delta$,i nw hicht hei st hegi vene rrorl imit, thenw ec ange tt hepa rameter ,i fnot ,w ew illa ssignt o $\boldsymbol{\theta}^{(1)}$ to $\boldsymbol{\theta}^{(0)}$, and repeat the iteration, until the accuracy requests were met.

3 ALGORITHM

We can get the mathematical model of the thermal conductivity and thermal diffusivity of the bulk building materials.

$$\Delta T = f(t, \lambda, t_c, a) = \frac{P_0}{\pi^{3/2} r \lambda} \cdot D(\tau) \tag{4}$$

$$D(\tau) = [m(m+1)]^{-2} \int_0^{\tau} \sigma^{-2} [\sum_{l=1}^{m} l \sum_{q=1}^{m} q e^{\frac{-(l^2+q^2)}{4m^2\sigma^2}} I_0(\frac{lq}{2m^2\sigma^2})] d\sigma \tag{5}$$

In the formula

$$\tau = \sqrt{\frac{t - t_c}{r^2 / a}}$$

Where $P_0(\mathrm{w})$ is the output power of the probe, is the radius of the outermost layer of the probe which is the double spiral structure $\Delta T(\mathrm{k})$, is a function that material surface's temperature will rising with in the testing process , *m* is the total ring number of double spiral structure's probe, is the testing time, is the correct Bessel function of order zero, $\lambda(\mathrm{w}/(\mathrm{m}\cdot\mathrm{k}))$, $t_c(\mathrm{s})$ and $a(\mathrm{m}^2/\mathrm{s})$ are the required parameters mentioned as before.

We can respectively get the excess temperature $\Delta T_1, \Delta T_2, \cdots \Delta T_n$ and time $t_1, t_2, \cdots, t_n$ which are based on the measuring, in which $\grave{\mathbf{e}}^{\mathbf{T}} = (\theta_1, \theta_2, \theta_3)$ is required parameter, and let $\dfrac{P_0}{\pi^{3/2} r\lambda} = C$, $\theta_1 = C, \theta_2 = t_c, \theta_3 = a$.

Next, we will give the algorithm of how to calculate the thermal conductivity and thermal diffusivity of the bulk building materials with Gauss-Newton method.

The first step: give initial value $\grave{\mathbf{e}}^{(\mathbf{0})}$, the requirement of error is , and let $k = 0$.

The second step: calculate Jacobian matrix $J(\grave{\mathbf{e}}^{(\mathbf{k})})$.

We will respectively solve the partial derivatives of parameters $\theta_1, \theta_2, \theta_3$ for the formula (4), and get their expressions.

$$\frac{\partial f(t,\boldsymbol{\theta})}{\partial \theta_1} = [m(m+1)]^{-2} \int_0^{\tau} \sigma^{-2} \left[\sum_{l=1}^{m} l \sum_{q=1}^{m} q e^{\frac{-(l^2+q^2)}{4m^2\sigma^2}} I_0\left(\frac{lq}{2m^2\sigma^2}\right) \right] d\sigma$$

$$\frac{\partial f(t,\boldsymbol{\theta})}{\partial \theta_2} = C[m(m+1)]^{-2} \sigma^{-2} \left[\sum_{l=1}^{m} l \sum_{q=1}^{m} q e^{\frac{-(l^2+q^2)}{4m^2\sigma^2}} I_0\left(\frac{lq}{2m^2\sigma^2}\right) \right] \frac{-\sqrt{a}}{2r} (t-t_c)^{-\frac{1}{2}}$$

$$\frac{\partial f(t,\boldsymbol{\theta})}{\partial \theta_3} = C[m(m+1)]^{-2} \sigma^{-2} \left[\sum_{l=1}^{m} l \sum_{q=1}^{m} q e^{\frac{-(l^2+q^2)}{4m^2\sigma^2}} I_0\left(\frac{lq}{2m^2\sigma^2}\right) \right] \frac{a^{-\frac{1}{2}}}{2r} (t-t_c)^{\frac{1}{2}}$$

Then we will get the Jacobian matrix, that is

$$J(\boldsymbol{\theta}^{(\mathbf{k})}) = \begin{pmatrix} \dfrac{\partial f}{\partial \theta_1}(t_1, \boldsymbol{\theta}^{(\mathbf{k})}) & \dfrac{\partial f}{\partial \theta_2}(t_1, \boldsymbol{\theta}^{(\mathbf{k})}) & \dfrac{\partial f}{\partial \theta_3}(t_1, \boldsymbol{\theta}^{(\mathbf{k})}) \\ \dfrac{\partial f}{\partial \theta_1}(t_2, \boldsymbol{\theta}^{(\mathbf{k})}) & \dfrac{\partial f}{\partial \theta_2}(t_2, \boldsymbol{\theta}^{(\mathbf{k})}) & \dfrac{\partial f}{\partial \theta_3}(t_2, \boldsymbol{\theta}^{(\mathbf{k})}) \\ \vdots & \vdots & \vdots \\ \dfrac{\partial f}{\partial \theta_1}(t_n, \boldsymbol{\theta}^{(\mathbf{k})}) & \dfrac{\partial f}{\partial \theta_2}(t_n, \boldsymbol{\theta}^{(\mathbf{k})}) & \dfrac{\partial f}{\partial \theta_3}(t_n, \boldsymbol{\theta}^{(\mathbf{k})}) \end{pmatrix}$$

The third step: calculate $F(\boldsymbol{\theta}^{(\mathbf{k})})$.

$$F(\boldsymbol{\theta}^{(\mathbf{k})}) = \theta_1^{(k)} \times [m(m+1)]^{-2} \int_0^{\tau} \sigma^{-2} \left[\sum_{l=1}^{m} l \sum_{q=1}^{m} q e^{\frac{-(l^2+q^2)}{4m^2\sigma^2}} I_0\left(\frac{lq}{2m^2\sigma^2}\right) \right] d\tau \tag{6}$$

The fourth step: calculate parameter ,

.

$$\boldsymbol{\theta}^{(\mathbf{k+1})} = \boldsymbol{\theta}^{(\mathbf{k})} + [J^T(\boldsymbol{\theta}^{(\mathbf{k})}) J(\boldsymbol{\theta}^{(\mathbf{k})})]^{-1} J^T(\boldsymbol{\theta}^{(\mathbf{k})}) [\Delta T - f(x, \boldsymbol{\theta}^{(\mathbf{k})})].$$

The fifth step: if $\left\| \boldsymbol{\theta}^{(\mathbf{k+1})} - \boldsymbol{\theta}^{(\mathbf{k})} \right\| < \delta$, then let $\boldsymbol{\theta} = \boldsymbol{\theta}^{(\mathbf{k+1})}$, if not, let $k = k+1$ let , and turn to the second step.

The sixth step: because of $\theta_1 = C, \theta_2 = t_c, \theta_3 = a$, we can put the C of the θ_1 into the $\lambda = \dfrac{P_0}{\pi^{3/2} rC}$, ,then we can get the all parameters λ, t_c, a .

4. EXAMPLE

We get the bulk glass material and the massive steel material's excess temperature and time in industrial actual measurement. Now, we will fit the two sets data with Gauss-Newton method described above. In the third step of this method, there is an integral about $F(\grave{\mathbf{e}}^{(\mathbf{k})})$, we can calculate the integral according to the quadrature formula of the three point Gauss Legendre, the result is

$$F(\boldsymbol{\theta}^{(\mathbf{k})}) = \theta_1^{(k)} \times [m(m+1)]^{-2} \times D(\tau_k) \tag{7}$$

$$\begin{aligned} D(\tau_k) = {} & \frac{\tau}{2} \left\{ 0.55555556 w_1^{-2} \times \left[\sum_{l=1}^{m} l \sum_{q=1}^{m} q e^{\frac{-(l^2+q^2)}{4m^2 w_1^2}} I_0\left(\frac{lq}{2m^2 w_1^2}\right) \right] \right\} \\ & + \frac{\tau}{2} \left\{ 0.55555556 w_2^{-2} \times \left[\sum_{l=1}^{m} l \sum_{q=1}^{m} q e^{\frac{-(l^2+q^2)}{4m^2 w_2^2}} I_0\left(\frac{lq}{2m^2 w_2^2}\right) \right] \right\} \\ & + \frac{\tau}{2} \left\{ 0.88888889 w_3^{-2} \times \left[\sum_{l=1}^{m} l \sum_{q=1}^{m} q e^{\frac{-(l^2+q^2)}{4m^2 w_3^2}} I_0\left(\frac{lq}{2m^2 w_3^2}\right) \right] \right\} \end{aligned}$$

Where $w_1 = \dfrac{\tau}{2} + \dfrac{\tau}{2} \cdot 0.77459667, w_2 = \dfrac{\tau}{2} - \dfrac{\tau}{2} \cdot 0.77459667, w_3 = \dfrac{\tau}{2}$.

We calculate the parameter values of the bulk glass material and massive steel material as shown in Table 1. The glass material's initial value is taken as $\mathbf{è^0} = [0.5, 0.5, 0.5]^T$, the steel material's initial value is taken as $\mathbf{è^0} = [4.9, 0.2, 7]^T$. We can see that the excess temperatures' residual sum of squares are both less than from the following table.

δ	materials	t_c(s)	$a(\mathrm{m}^2/\mathrm{s})$	$\lambda(\mathrm{w}/(\mathrm{m}\cdot\mathrm{k}))$	$s(\boldsymbol{\theta})$
10^{-6}	glass	-0.35524×10	0.34354×10^{-6}	0.68666	0.43046×10^{-3}
10^{-6}	steel	-0.20294×10	0.85074×10^{-5}	0.32245	0.87031×10^{-3}

Table 1 Materials' parameter values

When the error is $\delta = 10^{-6}$, we can see that the bulk glass materials and massive steel material's excess temperature ΔT which is measured by the probe and the excess temperature which is obtained by fitting with Gauss-Newton method, as shown in Fig. 2 and Fig. 3.

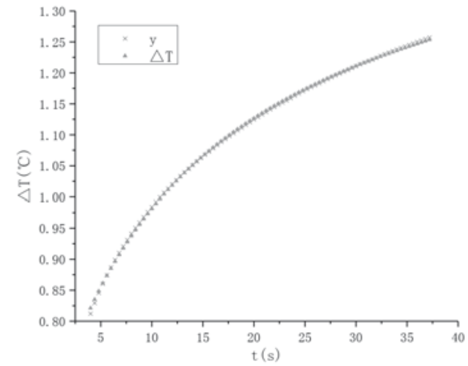

Fig. 2 $t - \Delta T$ diagram of bulk glass

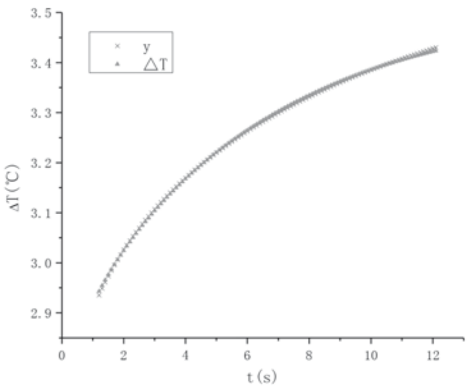

Fig. 3 $t - \Delta T$ diagram of massive steel

At the same time, we also fit out the relationship between and of these two materials are and , the diagrams of their relationship as shown in Fig. 4 and Fig. 5.

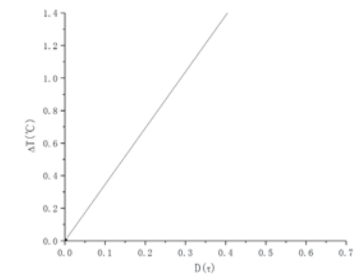

Fig. 4 ΔT=2.4604$D(\tau)$ of bulk glass

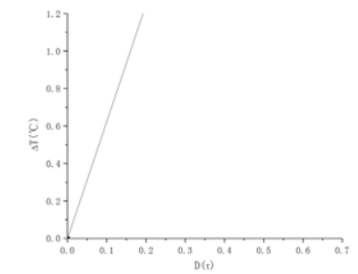

Fig. 5 ΔT=5.2364$D(\tau)$ of massive steel

In order to find out the fitting effect in the curve when the correction time is not fixed, we discuss the situation when the correction time parameter is fixed, and the initial value of the glass material is taken as , correction time is taken as .The initial value of the steel material is taken as , correction time is taken as . We can see their parameter values and we also know that the excess temperatures' residual sum of squares are both less than , as shown in Table 2.

fixed t_c	δ	materials	$a(\mathrm{m}^2/\mathrm{s})$	$\lambda(\mathrm{w}/(\mathrm{m}\cdot\mathrm{k}))$	$s(\boldsymbol{\theta})$
-3	10^{-6}	glass	0.38216×10^{-6}	0.69836	0.62349×10^{-3}
-2.1	10^{-6}	steel	0.82116×10^{-5}	0.32186	0.74985×10^{-3}

Table 2 the parameter values of materials

5. SUMMARY

From the results above, we can get the following conclusion:

1) We can see from Table1 and Table 2, when we use the Gauss-Newton method to solve bulk building materials' thermal conductivity and thermal diffusivity, we can get excess temperatures' residual sum of squares which is very small, regardless of whether the correction time parameter is fixed.

2) This paper, we fit the bulk building materials' thermal conductivity and thermal diffusivity with Gauss - Newton method. From Fig. 4 and Fig. 5, we can see that the results are very good when the correction time parameter is not fixed.

3) We can see that the relationship between ΔT and $D(\tau)$ are linear relationship, which is consistent with actual measurement's. It proves our measurements' correctness.

4) This paper calculate the thermal conductivity and thermal diffusivity of bulk building materials, it also can be applied to the sheet materials.

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COMPLEX PROJECTS MANAGEMENT IN DESIGN ACTIVITIES FOR ARCHITECTURAL AND ENGINEERING COMPANIES

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project, project management, process

ABSTRACT

Today's effective Project Management (PM) - is the same asset as finances and tangibles. This asset allows to manage projects proficiently, including projects of high complexity, quickly identify weaknesses and beneficial effect on the design services outcomes. The report covers the project management tools, which are introduced into practice and which are used in the consistent manner in the key phases of

- *the project life cycle:*
- *project initiation phase;*
- *project Planning phase;*
- *project execution phase;*
- *project completion phase.*

The above Project Management tools and methodology are fundamental to the corporate project management system of Kazakhstan's leading design company KAZGOR DA LLP. As practice shows, all of these tools are characterized by their practical effect and facilitate the efficient implementation of complex projects, which in turn, contribute to higher economic maturity of the company, and play a key role in company's progress management.

1. INTRODUCTION

Project Management (PM) allows fast reaction to ever-changing market environment, control over all aspects of corporate activities. In the modern context strong companies aiming at more effective implementation of their projects, introduce corporate project management systems (PMS) in their practice1. KAZGOR Design Academy is among them.

KAZGOR Design Academy is the largest design company in Kazakhstan, which is a leader in civil design. KAZGOR works together with leading design companies in neighboring countries and beyond, currently the Design Academy is implementing large projects, which will contribute to industrial and innovative development of Kazakhstan (Construction of the EXPO-2017 international exhibition facility, construction of Aktogai mining and processing plant, etc.).

2. BACKGROUND

Effective implementation of large multiple-purpose projects envisages highly-qualified management, ensuring the application highly effective tools and processes. Application shall be on regular basis and economically feasible, and the sequence of application of these tools and processes, as well as analysis of the results obtained shall be organized within a single large-scale business process. Building and maintaining of multi-purpose PMS is a very labor-intensive and versatile process, demanding involvement of efforts of many specialists ranging from top management to designers. But this is a case where the end justifies the means, as the successful implementation of multi-purpose projects is earnest of balanced professional and economic growth of a company.

3. METHODS

Comprehensive analysis of operation of companies rendering PMS implementation services showed that in our specific case formation of corporate PMS shall be carried out self-facilitated in the light of specific nature of design activities, experience and knowledge database of the Academy and its specialists. Project Management Team was establishes for this purpose, which consisted except the Academy management of specialists with technical and economic education, who have experience in actual projects. The task that faced the formed group was to integrate internal procedures and business processes on rendering design services with best practices and approach of design management under corporate PM system. World class international standard for project management PMBoK was used as such approach. Currently all design service projects implemented in KAZGOR are provided with PMS. The process is implemented by a PM team with the assistance of discipline managers and key staff with the strong support of KAZGOR's management, who takes part in the outcome analysis and identification of new priorities and prospects for further development of PMS.

4. CASE HISTORY

In the course of PMS formation were identified and suggested tools and processes currently in use in the progress of project implementation. The tools and processes are divided into four groups (see fig. 2), matching the key phases of the project life cycle such as:

- project initiation phase;
- project planning phase;
- project execution phase;
- project completion phase.

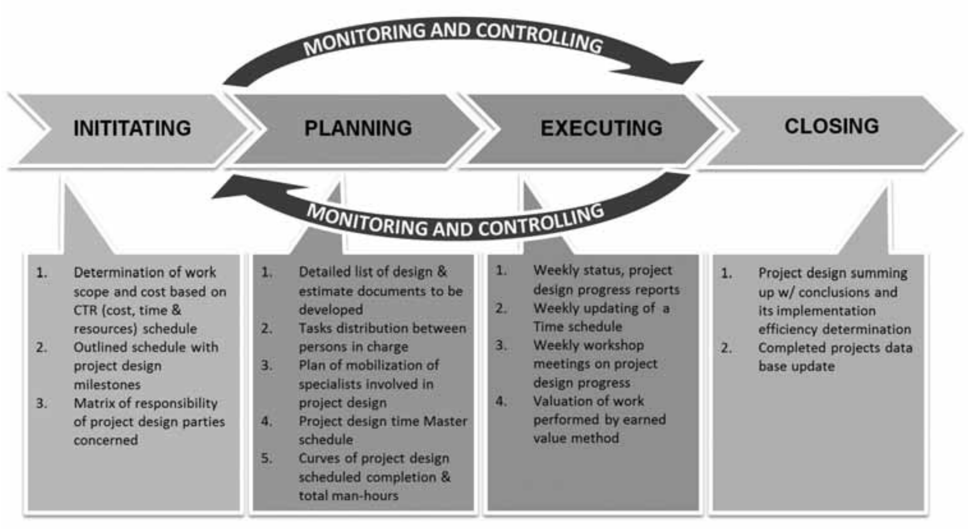

Fig. 1. Tools used in the key phases of the project life cycle

Each tool and process forming PMS has its own entries and ways out as it is specified in PMBoK. Application of these tools in pilot projects and output evaluation proved that selected tools characterized by their practical and economic efficiency.

1. Tools used at project initiation phase.

PM aims at achievement of predetermined objectives within limitations known beforehand under viable recourse management and risk response2. Project objections and limitations affecting the final outcome of the project shall be identified and analyzed at project initiation phase, when feasibility study is carried out. At project initiation phase project planning is based on expert evaluation, three tools which allow to reply to the question to the extent reasonably practicable to accept the challenge.

The first tools is CTR (Cost, time and resources). CTR allows to estimate the cost of design services activities. The basic principle of CTR cost estimation is done according to the following formula:

$$(A \times B) \times C \quad (1)$$

where, A – project task duration rate;

B – number of documents or works;

C – hourly rate of a specialist, who will be busy with the task.

So at the stage of signing of a contract CTR serves not only as a tool to prepare a price quotation, but to determine preliminary design package and quantity of the required recourses.

The second tool is a general time schedule or time schedule of 2nd level. The time schedule is based on identification of project milestones according to customer's requirements. A general time schedule allows to forecast the project duration and evaluate for which period shall the required recourses be allocated. Time schedule is prepared by a PM team specialist and a project manager based on the study of initial project data provided by a customer. It generally reflects summary tasks to be implemented in the course of project implementation and preliminary commencement and completion dates are fixed.

Second level time schedule forms an integral part of the detailed project time schedule (Time Schedules of 3rd or 4th level), which emphasizes the project milestones so that the parties concerned have the opportunity to evaluate the project on track by themselves its compliance with the schedules date. (see Fig. 3).

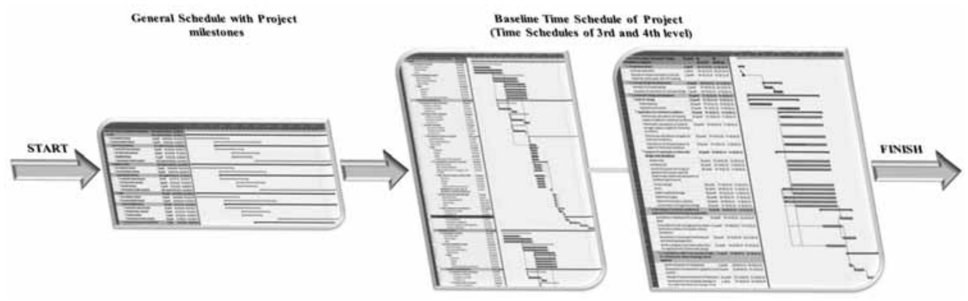

Fig. 2. Application of General and Baseline Time Schedules during project implementation

The third tool is a Responsibility Matrix of concerned parties. Matrix identifies responsibilities of each concerned party for the performance of tasks within the project. This document is prepared by a project manager and approved by a customer at project initiation phase to avoid problematic situations when concerned parties shift the responsibility on one another thereby having an adverse impact on project deliverables. Responsibility Matrix is prepared in the following cases:

- very large project and several contractor companies are involved;
- when a project is under special state control and subject to tough requirements of regulatory agencies, who will approve critical decisions at all phases of project implementation;
- rendering design services by a contractor company at all project phases depends on the data, which shall be submitted or clarified by external agency, which in its turn is also a project stakeholder.

In this cases the document can be included in the contract as an addendum in order to avoid disputable matters. The document envisages the role of state agencies who approve a design upon completion, and authorize the commencement of construction and installation activities.

The accuracy of expert evaluation of design timing and budget at project life cycle initiation phase can be +/– 30%3. At project planning phase all the listed data is clarified, and detailed project plan development process is carried out.

2. Tools and processes used at project life cycle planning phase.

The main objective of processes implemented during project planning phase is accurate planning of project work-task performance techniques, so that each task is splitted among responsible engineers specifying time limits and quality restrictions of performed activities. Planning process outcome results have direct impact on the implemented project efficiency factor. In order to completely describe the project planning process, let's turn out attention to tasks performed by PM team and project managers:

1. Project managers shall clearly define the project scope. On the basis of scope analysis project implementation recourses are allocated. Namely, a project manager is assigned, and a team is built;
2. Tasks specified in scope of work and included into CTR are detailed. That is each project discipline study initial data and define objectives (Design and estimate documentation) based on expert evaluation. The list of documents to be submitted to PM team.
3. PM team specialists include the detailed list of sign and estimate documentation into the detailed project execution plan. Responsible specialists are assigned from dedicated recourses, and they are personally responsible for execution of a specific work. The list can be corrected and amended during the project execution, all the changes and updates are reflected in the detailed project execution plan on timely basis.

What is included into the detailed project execution plan for development of design and estimate documentation, which tools is project planning system based upon. First of all, it is an activity progress chart. It is the key management tool, which helps clearly track key project milestones and control key performance indicator variances. At a planning stage PM team uses detailed time schedule, time schedule of the 3rd and 4th level, key milestones are reflected in milestone schedule of the 2nd level (see Fig. 2).

Baseline time schedule details the scope of work up to tasks within each project discipline. The schedule shall be calculated by critical-path method, it shall also be detailed up to the level, when clear relations between the tasks within each design discipline are indicated, which determine actual changes when one or another task is changed. On the basis of the detailed time schedule the planned progress curve, overall man-hour curve and mobilization plan of the project is developed. These curves clearly demonstrate planned completion percentage at all times during the project development and consequently the amount of the man-hours required to increase the progress. Mobilization plan allows to make a qualitative forecast of the number of specialists to be involved to the project at its different phases, overall and for disciplines in the form of histograms (see Fig. 3).

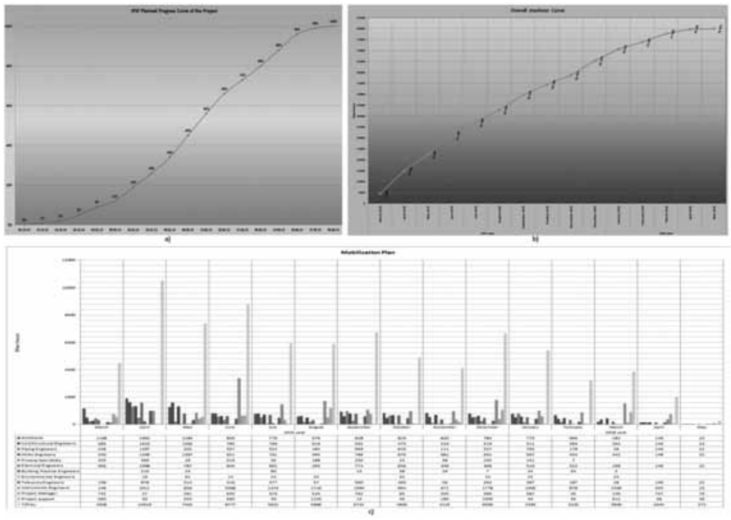

Fig. 3. Examples of diagrams and histograms: a) – Planned progress curve of the project; b) – overall man-hour curve; c) – Mobilization plan.

High-skilled project planning is one of the key criteria for the project success. The planning quality affects the management quality. It is easy to manage the project when everything is well-organized in the detailed project execution plan. Given the importance of this process, all forms which are used at planning phase, unified and used in a consistent manner in all current projects.

3. Tools and processes used at project life cycle execution phase.

Project execution phase is a group of processes, which includes coordination of manpower and resources, their integration in task execution in order to achieve project objectives in compliance with project management plan4. The project execution is performed by skilled and coordinated project team. That is why at this project phase it is required to manage the team in a good manner, carefully control employee performance, aid them to fulfill technically complicated tasks, motivating them on timely basis to effective project execution.

What we need to turn attention to at project execution phase? To answer this question a careful analysis of the management and project stakeholder requirement project was carried out. Based on this analysis the parameters and indexes, which specify how effectively the project is executed, were selected. All these indexes visually reflected in regular project status reports. Status report prepared in a good manner is the main tool, which allows to evaluate the current project status effectively, find out the areas which need to be paid special attention. Also the status report allows to see the difference between the planned and actual project status, see the dynamics of progress increase from the commencement date of the project to the current and based on these indexes make a forecast for the further phases (see Fig. 4).

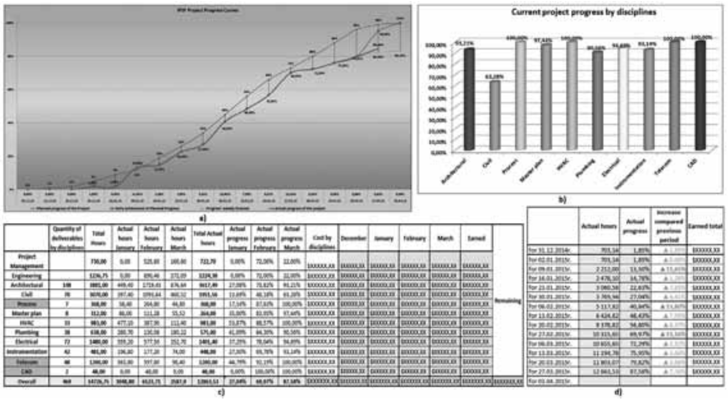

Fig. 4. Example of progress reporting: a) – planned, current and forecast project progress curve; b) – current project progress by disciplines; c) – earned quantity by month; d) – weekly dynamic patter of the earned quantity.

Indexes to emphasize in weekly status reports are as follows:

- Actual project status with due regard to the earned quantity. Based on data provided by the project stakeholders status reports are prepared on weekly basis, in which we can see the actual completion percentage for a certain period, and to what extent the actual status differs from the planned. Status report is detailed to the maximum, i.e. it provides the information not only for project disciplines, as well as there is data on each task within the project. Besides, status reports reflects the earned amount of man-hours and consequently of finance. In other words, status report provides the information about which level the project status is on, which amount of man-hours were provided from the total amount of budgeted man-hours to increase the progress for a certain date, and what is really important, how much this work costs in terms of money. Such status report is not only effective for the arrangement of the provided service for monthly invoicing purpose, but also it is useful as well for the customer. This approach was admitted effective many times from our client-side.
- Duration of the project. To be specific, how the current project progress affects the planned dates. In order to see that a time schedule with tasks for each project discipline and phase is updated on weekly basis. Time schedule indicates the percentage completion of each task based on the project status report and its actual commencement date. The received data is associated with the baseline time schedule. Comparison of the actual time schedule with the baseline allows to see actual deviation (days, hours) from dates, fixed in the baseline time schedule.

Status reports and project time schedule is updated on weekly basis and provided to all project stakeholders, including the customer. During weekly tool-box meetings status reports are actively used to identify tasks with deviations to identify deviation causes further and take corrective measures, to eliminate and minimize to the maximum the risks of actual deviation of project dates from the planned

4. Processes used at project life cycle completion phase.

Logical project completion is the acquisition of a unique product, complete package of design and estimate documentation, as a result of project services. When all project activities are completed, and all contractual obligations with all project stakeholders are complete and the final product is transferred to the customer, it is required to carry out qualified finalizing of the project.

Project evaluation is the key process of the project completion phase and is carried out within the context of the architecture and science and engineering board of the Academy, which consists of the management staff and all key specialists involving personnel involved in the project execution. Within the project evaluation the manager and PM team prepare a volumetric material, where the following is discussed in detail:

- technical project issues, indication of all project benefits and negative moments and problem root causes, as well as outputs of working with concerned parties of the project, including the customer and state regulatory agencies. Upon completion of the project a satisfaction check-list is received from the customer representatives, where the satisfaction is estimated by the scoring method, which is also discussed during the project evaluation;
- project execution efficiency factor. Based on the results of the project an actual amount of man power is determined, their correspondence with the planned factors, the comparative analysis of the project parameters is carried out with similar projects executed. Besides, the most and the least efficient project disciplines are communicated based on status reports, and final project economics is calculated. Project economics is determined as correlation of net project profit, which considers all the costs, such as payment to labor, tax and recourse deductions for project service costs.

After demonstration and discussion of all above-mentioned project factors final conclusions are made and define core project benefits, i.e. that had an positive or adverse effect on the performance, that we need to armed with and which we need to avoid when executing the further projects. During project evaluation expert commentaries about not only the key project members but also points of specialist views, who were directly involved into the project, what significantly increases the value of such analysis.
Upon completion of the project evaluation all basic project documentation, including conclusions and benefits fill up the PM team executed projects database, to use them as a template when executing the similar projects in future.

5. RESULTS

When forming PM system architecture in PM team specialists, as well as the Academy management, who are actively involved in PMS, employed integrated PM philosophy. Every PMS tool used in all project life cycle phases combines several functions of the processes described in international PM standards. CTR, responsibility matrix, detailed project execution plan, time schedules and progress reports – all of these are integrated and effective tools, which represent a volumetric data package consisting of information about all project key figures.
Evaluation of outcome when unified tools and process are used in the course of implementation of current projects allows for the conclusion that the efficiency of projects provided with PM tools and processes increases in comparison with the earlier projects as the Academy develops its PM system. Thus, actual man-hours for project implementation don't exceed the planned man-hours more than by 20%, which ensure the required minimum project profitability of 30% and higher. And personal task assignment within the project among particular performers, regular monitoring and progress status supervision via status reports and time schedule updates allows to supervise and maintain project timing unless external negative factors are involved.
One of the major priorities when implementing PMS was to create a project-oriented designers' team, whose efforts are aimed at the achievement of specific outcome – effective and quality implementation of the project. And at the moment there is significant implication which allows for the conclusion that the PM system fulfills this task and there is a constant progress on this matter as the Academy develops and improves its corporate PMS.

6. CONCLUSION

In conclusion it should be mentioned that whatever be the PM system features in companies differing in level and line of activity, there are three key elements on which any PM system is based. These key elements are as follows5:
1. Manpower possessing suitable skills and experience to fulfill set out tasks.
2. Complex of information systems, providing effective implementation of project processes.
3. Effective decision making techniques embodied in the company regulations and standards.

Day-to-day work on formation of PM structure, based on the above-listed components, routine work on error correction and constant development of skills and PM tools allowed to move to a new level and among the first design companies in Kazakhstan provide implemented multi-purpose projects with robust PM system.

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THE STUDY OF CRACK PROPAGATION ATTACHED TO THE BASE OF THE HARD SECTION STRUCTURE HAVING DOUBLE-CONNECTIVE BOUNDARY LINE

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Keywords

project, project management, process

ABSTRACT

The study of plain problem of crack propagation is observed inside the section attached to the base of concrete dam having trapezoidal cavity. The choice of section is propositioned by saving rather a large concrete volume, left inside the structure thanks to cavity, and was formed by emergence of additional building inserted for different means of hydropower rock machines in different large spaces. Fact is even more highlit by study of the chance of crack propagation. Because of the large scale structures and the features of working conditions, the plastic deformation emergence is often averted into a deformative body, in consequence of which the advisable redistribution is eliminated by the body volume and between its structural components: the tensions and the deformations; local tensions, preliminary micro-cracks and intensions of their further development are emerged. This process is finished by microscopic crumbly deterioration of the structure. In the period of crumbly deterioration the calculation of the structure must save it from crumbly deterioration, and define the permissible sizes of preliminary cracks.

1. INTRODUCTION

The additional pressure is absent inside the walls of emptiness exisiting in the trapezoidal concrete dam being constructed on hard base, and the water pressure influences on the external boundary pressure line of the dam (Fig. 1). The following boundary conditions having double domain are

$$\begin{aligned}
&\sigma_x = -\gamma y, \quad \tau_{yx} = 0, \ \left(x=0,\ 0\le y\le H\right),\\
&\sigma_y = -\gamma H, \quad \tau_{yx}=0, \left(0\le x\le \ell_0,\ y=H\right),\\
&\sigma_y=0, \quad \tau_{xy}=0 \quad \left(y=H+h,\ 0\le x\le B\right),\\
&\sigma_\alpha = 0, \tau_\alpha = 0 \quad \left(\text{on slant boundaryline}\right).
\end{aligned} \tag{1}$$

It's impossible to solve the problem of the possibility of preliminary crack distribution and to decide the problem of changeable size by analytical way, and especially for such a complicated domain.
The variational methods are used for solving such problems under such conditions and the approximate digital methods being developed on the base of them (Chernovsko F.L., Banichuk N.V. 1973).

2. BACKGROUND

The minimum principle, among the well-known principles of the theory of elasticity, is used for solving the problem of stressed-deformative state of deformative domain. The solution of the crack distribution problems is getting so complicated as much, as we deal with the changeable domains having a boundary line. The variation methods are the best results for solving the problems by such methods. In this regard, the use of the external method of elasticity theory is become the most resultative way for getting true destination.

3. METHODS

The local variation method is chosen among the numerous variational methods of solution of the problems studied in the stressed-deformative states of the changeable boundary line domain, which is detached by selection of base functions and in the case of converge problem solution the choice of preliminary functions, has no significant influence.

4. CASE HISTORY

The local variation method is chosen among the numerous variational methods of solution of the problems studied in the stressed-deformative states of the changeable boundary line domain, which is detached by selection of base functions and in the case of converge problem solution the choice of preliminary functions, has no significant influence.
The values are presented by immeasurable forms for suitability of solving of problem.

$$\begin{gathered} X = \frac{x}{h_*},\ y = \frac{y}{h_*}, u = \frac{yE}{h_* \sigma_*}, \\ y = \frac{yE}{h_* \cdot \sigma_*}, \varepsilon_x = \frac{E \cdot \varepsilon_x}{\sigma_*}, \varepsilon_y = \frac{E \cdot \varepsilon_y}{\sigma_*}, \\ \gamma_{xy} = \frac{E \cdot \gamma_{xy}}{\sigma_*},\ \sigma_x = \frac{\sigma_x}{\sigma_*},\ \sigma_y = \frac{\sigma_y}{\sigma_*}, \tau_{xy} = \frac{\tau_{xy}}{\sigma_*}. \end{gathered} \tag{2}$$

The expression of energo-system comes to the following form by making equals for growth of replacements.

$$Э = 0.5 \int_D \left(\delta\sigma_x \delta\varepsilon_x + 2\tau_{xy} \cdot \delta\gamma_{xy} + \delta\sigma_y \cdot \delta\varepsilon_y \right) dxdy + \int_c \delta q \cdot \delta y dX, \tag{3}$$

$$\delta Э = 0.5 \int_D \left[a\left(\varphi_x^2 + \psi_y^2\right) + 2b\varphi_x \cdot \Psi_y + 0.5c\left(\varphi_x + \psi_y\right)^2 \right] dxdy - \int_L \psi q dx \cdot \tag{4}$$

The immeasurable curves of the growth of tensions and deformations are expressed by the following formulae.

$$\begin{gathered} \delta\sigma_x = a\varphi_x + b\psi_y, \\ \delta\sigma_y = b\varphi_x + a\psi_y, \\ \delta\tau_{xy} = \frac{c}{2}\left(\varphi_y + \psi_x\right). \end{gathered} \tag{5}$$

4. CASE HISTORY

The researchers have moreover intensively started to deal with the study of problems of crack propagation since the second half of the century, and later studied the branch of building constructions. Multi researches are done today concerning the qusetions of concrete structures of deterioration and hardness. (Parton V.Z., Morozov E.M. 1985), (S.M. Mkhitaryan 2014).

According to the minimum principle of elasticity theory in the balance state of deformative systems, the full energy of the system reaches the minimal value (Cherepanov G.P., 1974)

$$a = \frac{1-\Im}{(1+\Im)(1-2\Im)}, b = \frac{\Im}{(1+\Im)(1-2\Im)}, c = \frac{1}{1+\Im} \tag{6}$$

Here D is the elastic deformative domain, *L* is the length of preliminary crack, *a, b, c*, is the coefficient of the material being expressed by elastic constants.

$$\delta \text{э} = 0.5\int_D \left[a\left(\varphi_x^2 + \psi_y^2\right) + 2b\varphi_x\psi_y + 0.5c\left(\varphi_x + \psi_y\right)^2\right]dxdy - \int_L \psi q dx \tag{7}$$

So, the problem of deformative system of full energy minimal decision is solved by every maximum case of preliminary crack. Receiving the components of transference, corresponding to the minimal value of full energy, (φ, ψ) the deformative and tension components are determined by corresponding formulas.

5. RESULTS

The acting tensions in the vertical direction of the crack plain, around the crack plain, according to Vestergard solutions, are received in the following form.

$$\sigma_y = \frac{k_I}{\sqrt{2\pi r}} \cos\frac{\theta}{2}\left(1 + \sin\frac{\theta}{r} \cdot \sin\frac{3\theta}{2}\right). \tag{8}$$

If it is taken into account that for the points arranged in the direction of the crack continuation in this case the expression of is the coefficient of the intensivity of tensions in the case of deterioration of snatch, which comes to the following form.
In order to decide the existing changeability of crack, the coefficient value of tension intensity in the top of crack must be compared with the critical gauge of the coefficient of concrete's tension intensity, which is brought to corresponding tables as a fixed material. At the top of the crack, the intensity coefficient of tensions are determined by the following formula

$$K_I = \frac{\sqrt{2\pi r}}{f_{ij}(\theta)}\sigma_{ij}. \tag{9}$$

where $f_{ij}(\theta)$ is the combinations of trigonometric functions, which in the case of chosen directions of axis get the following final aspect:

$$K_I = \sigma_y\sqrt{2\pi r} \tag{10}$$

where r-is the polar coordinate $(\theta = 0)$ in the small environment of the crack's top.
So, solving the problem of elasticity theory and getting tensions in the environment of crack's top, we determine the coefficient values of tensions intensity in the direction of the crack's distribution. (Fig. 2).

6. CONCLUSIONS

Solving the problem of elasticity theory in cases of different values of crack, the fields of stressed-deformative states are received, the coefficient values of tensions' intensivity in direction of crack propagation, and in the small environment of the noted coefficient and the crack's top dependent from the distance have been constructed. Taking into account the border line values of coefficents of concrete tension intensity being constructed by formula, we can determine the size of crack propagation. For example, if the given concrete mark , then that value being inserted in the graphs we may decide the preliminary crack propagation according to the preliminary different sizes.

$$If\ \ell_0 = 0.1m, r = 0.5cm, r = 0.5cm, if\ \ell_0 = 0.25m, r = 0.39cm, if\ \ell_0 = 0.5$$
$$r = 0.3cm, \ell_0 = 1.0m, r = 0.1cm$$

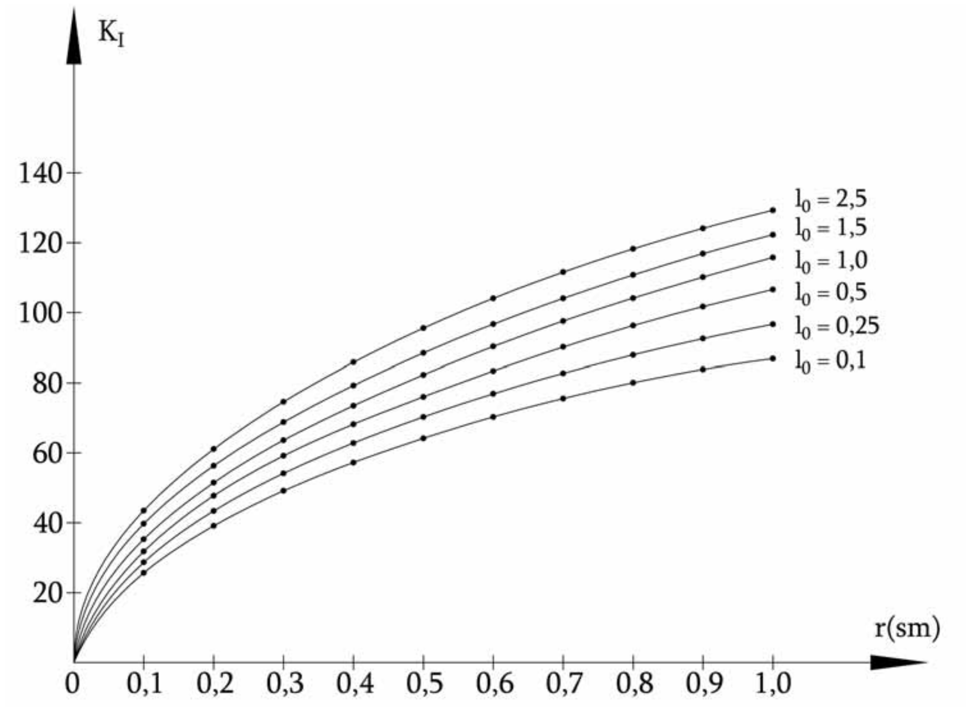

Fig. 1 The aspect of the section and the notes of the boundary line sizes.

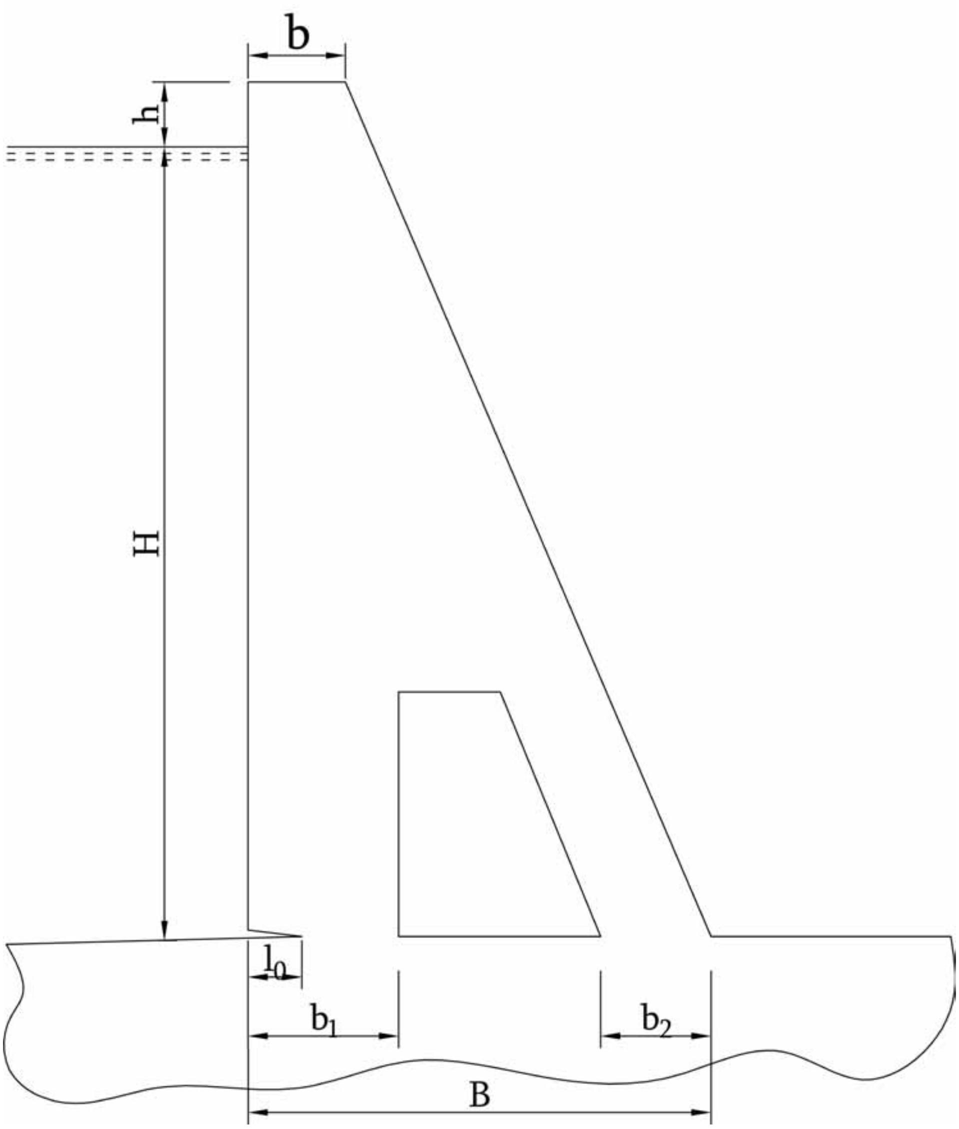

Fig. 2 The dependence of the coefficient of tension intensity and the initial length of crack.

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ANALYSIS OF INFLUENCING FACTORS AFFECTING CABLE TENSION TEST BASED ON FREQUENCY METHOD

POSTER

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Keywords

cable-stayed bridge, cable force, frequency method

ABSTRACT

According to cable force monitoring of cable-stayed bridge on construction some kinds of cable tension testing methods are introduced in this paper. Combining with the example of Xinzao Pearl River Grand Bridge, the factors which affect the accuracy of testing cable force based on frequency method are analyzed, and the corresponding solutions are presented. A spacial finite element model is established by finite element software MIDAS for contrasting measured cable force with theoretical one, and the factors affecting the test of cable tension are explored. The corresponding conclusions are applied to the practical engineering, which guides the other cable-stayed bridges monitoring. The results show that the precision of cable force tested by frequency method is somewhat influenced by the factors including bending stiffness, cable sag and boundary, but some factors could be neglected under certain conditions, which also satisfies the design requirements and applies to the cable tension test of the same type of bridges on construction.

1. INTRODUCTION

A German company, DEMAG, builts a cable-stayed bridge named Stromsund in Sweden in 1955, which means that the first cable-stayed bridge comes into the world. With the rapid development of the bridge technology, the cable-stayed bridge has become the main type of bridges during half a century. They have been built in our country since the 1970s, and more than 100 cable-stayed bridges have been completed. The cable-stayed bridge composed of the pylons, piers, girders and cables is an indeterminate structure with high degrees. The changing of each cable force affects the distribution of internal forces of the girders, which means that cable tensioning is one of the most important factors in bridge design and construction. So in the process of construction, it is the most important standards to evaluate internal force. At present there are five test methods in common use: pressure gauge method, pressure sensor method, magnetic flux method, Fiber Bragg Grating method and frequency method. In China, frequency method is nearly only one way for measuring the cables which have been installed on construction. Many results of applications and researches of specialists show that the deviation caused by measuring in field is so small that design requirements can be satisfied. But factors influencing accuracy of measuring still exist on construction, the relationship between force and frequency under certaion conditions should be further researched.

2. RELATIONSHIP BETWEEN FORCE AND FREQUENCY

Suppose that the axial force on a certain section is T, the direction along the cable is the x axis, the y axis is perpendicular to the cable, and each point on the cable vibrates along the y axis. Then the infinitesimal segment of cable is analysed.

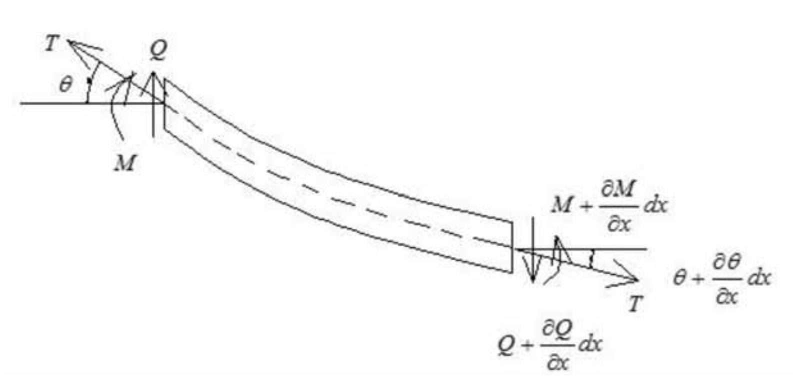


Fig 1. Force diagram of infinitesimal segment of cable

Considering the bending deformation and neglecting the influence of shear deformation□ moment of inertia and sag-extensibility, the equilibrium equation is written as follows:

$$EI\frac{\partial^4 y}{\partial x^4} - T\frac{\partial^2 y}{\partial^2 x^2} + m\frac{\partial^2 y}{\partial^2 x^2} = 0 \tag{1}$$

where *x* denotes the coordinate along the cable. The terms *y, EI, T, M* denote vibration displacement, flexural rigidity, axial force and mass density respectively.

Suppose that the ends of the cable is hinged, the formular for calculating the axial force of the cable is given by Eq. (4)**:**

$$T = 4ml^2(\frac{f_n}{n})^2 - \frac{n^2 EI\pi^2}{l^2} \tag{2}$$

Then

$$f_n = n\sqrt{\frac{T}{4ml^2} + \frac{n^2 EI\pi^2}{4ml^4}} \tag{3}$$

where n denotes the order of natural frequency. The terms f_n, l denote the n th natural frequency in hertz, length of cable. Because the second term is much smaller than the first one in the square root, the second one can be neglected. Eq. (3) is transformed by

$$f_n = n\sqrt{\frac{T}{4ml^2}} = nf_1 \tag{4}$$

where f 1 denotes the first natural frequency named fundamental frequency. Eq. (6) can be conveniently written by

$$T = Kf_1^2 \tag{5}$$

where *K* is the proportion coefficient denoted by

$$K = 4ml^2 \tag{6}$$

3. INFLUCENCING FACTORS

3.1 INFLUENCE CAUSED BY BENDING STIFFNESS

Considering flexural rigidity, Eq. (5) can be conveniently written by

$$f_n = n\sqrt{\frac{T + n^2 D}{4lm^{\,2}}} \tag{7}$$

where D is a constant coefficient denoted by

$$D = \frac{\pi^2 \boldsymbol{E}}{l^2} \tag{8}$$

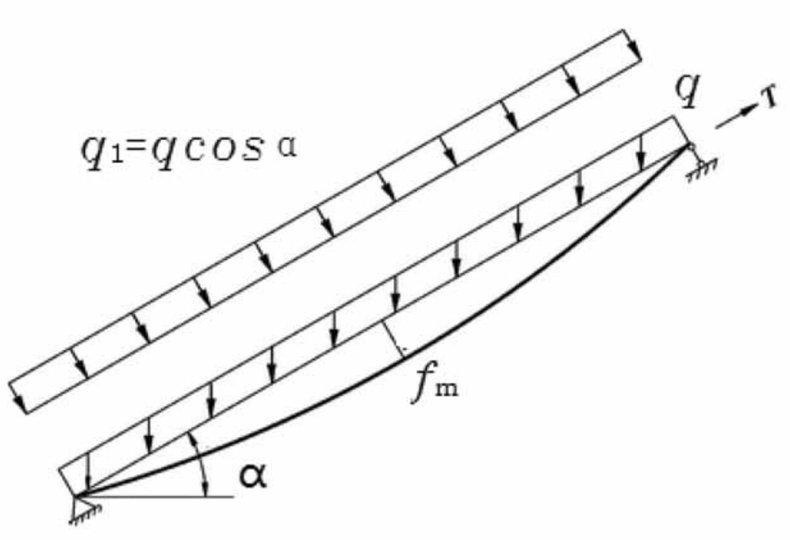
fn/n is no longer a constant, but it is monotonically increasing with the increase of n. For the short cable, the error of the cable force which is calculated by Eq. (5) is relatively big. So, it does not meet the requirement of the accuracy. In this case, in order to reduce the error, cable force should be calculated by low-order frequency instead of the fundamental frequency.

3.2 INFLUENCE CAUSED BY SAG-EXTENSIBILITY

Considering the influence caused by sag-extensibility, the line style of the cable is catenary. The total elongation of cable equals the one caused by elasticity plus the one overcoming the sag when the cable is tensioned. The effect of sag can be considered into the formular of elastic elongation.

When the influence of sag is considered into long-span cable-stayed bridges, the equivalent elastic modulus can be calculated by the Ernst Formular.

As shown in Fig. 2), assume that the self-weight of cable is uniform load whose intensity is q, and the deflection in the middle of the cable is f_m.



2). Force digram of stay cable

$$T \cdot f_m - \frac{1}{8} q_1 l^2 = T \cdot f_m - \frac{1}{8} q \cos\alpha \cdot l^2 = 0 \tag{9}$$

Then

$$f_m = \frac{ql^2}{8T} \cdot \cos\alpha \tag{10}$$

where T denotes cable force. The terms l, denote the length of the cable and the angle between the axis and the horizontal line respectively.

Because the value of f_m is relatively small, the line style which should be a catenary is considered as parabola. Then the length of cable can be approximated by

$$S = l + \frac{8}{3} \cdot \frac{f_m^2}{l} \tag{11}$$

According to Eq. (11) and Eq. (10), the difference between S and l can be calculated by

$$\Delta l = S - l = \frac{8}{3} \cdot \frac{f_m^{\ 2}}{l} = \frac{q^2 l^3}{24T^2}\cos^2\alpha \tag{12}$$

Then

$$\frac{d\Delta l}{dT} = -\frac{q^2 l^3}{12T^3}\cos^2\alpha \tag{13}$$

when equivalent elastic modulus is calculated by Ernst Formular, the elastic modulus is the tangent one. Then

$$E_{f1} = \frac{d\sigma}{d\varepsilon_f} \tag{14}$$

According to $\sigma = \frac{T}{A}$, $\varepsilon_f = \frac{\Delta l}{l}$, the tangent modulus of elasticity can be transformed by

$$E_{f_1} = \frac{d\sigma}{d\varepsilon_f} = \frac{d\frac{T}{A}}{d\frac{\Delta l}{l}} = \frac{dT}{d\Delta l} \cdot \frac{l}{A} \tag{15}$$

Where E_{f1} denotes tangent modulus of elastic which is calculated by the effect of sag. σ denotes tensile stress of cable. ε_f denotes tensile strain caused by the effect of sag.

Plug Eq. (13) into Eq. (15)

$$E_{f_1} = \frac{12T^3}{q^2 l^3 \cdot \cos^2\alpha} \cdot \frac{l}{A} = \frac{12T^3}{q^2 l^2 A \cos^2\alpha} \tag{16}$$

According to $q = \gamma \cdot A$, $L = l \cdot \cos\alpha$, $\sigma = \frac{T}{A}$. Eq. (18) can be transformed as Eq. (19)

$$E_{f_1} = \frac{12T^3}{(\gamma A)^2 L^2 A} = \frac{12\sigma^3}{\gamma^2 L^2} \tag{17}$$

where L denotes the length of horizontal projection of cable. Then the equivalent elastic modulus E_{eq1} can be described by

$$E_{eq1} = \frac{\sigma}{\varepsilon_e + \varepsilon_{f_1}} = \frac{\sigma}{\frac{\sigma}{E_e} + \frac{\sigma}{E_{f_1}}} = \frac{E_e}{1 + \frac{E_e}{E_{f_1}}} \tag{18}$$

Plugging Eq. (17) to Eq. (18), Eq. (18) can further be normalized by

$$E_{eq_1} = \frac{E_e}{1 + \frac{q^2 L^2 E_e}{A^2 12\sigma^3}} \tag{19}$$

Where E_{eq1} denotes the equivalent elastic modulus which is calculated by Ernst formular. E_e denote the elastic modulus of cable. L denotes the length of horizontal projection of cable. σ denotes the stress of cable. q denotes the uniform load intensity under self-weight of cable. A denotes cross sectional area.

3.3 INFLUENCE CAUSED BY BOUNDARY CONDITIONS

The boundary condition of the cable is between hinged and clamped because of anchor devices at the ends of the cable. Considering the actual situation, it is more closed to the clamped support. Without considering sag-extensibility, the results of the cable force which is calculated under each boundary condition are same when the bending stiffness is neglected. The Eq. (2) shows that the flexural rigidity is negligible when the cable is long. The value of cable force which is calculated without considering flexural rigidity is larger, but it generally dose not exceed 5%. However, for the short cable, the differece will be more than 5%. The cable force should be modified by choosing a reasonable effective length of cable for reducing the error. Because the stiffness of the anchor head at both ends of the cable and its corresponding connection parts is larger than the other parts, taking the difference between the distance between each anchor point at the ends of the cable and the length of connecting cylinder as the effective length of the cable can meet the requirement of the accuracy of estimating cable force on construction when the cable force is calculated by Eq. (5).

4. THE ANALYSIS EXAMPLE

Xinzao Pearl River Bridge is a prestressed concrete cable-stayed bridge with double pylons and single cable plane, whose tower, girder and pier are consolidated together. Spans are attributed as (64+140+350+140+64)m, each plane has twenty-six couples of stay cables which use semi parallel wire strands, and each of the cables is composed of 187 to 283 pieces of steel wire. At each side span, auxiliary piers, which are conductive to enhancing wind resistance of construction and strengthening the rigidity of structure in operation stage, are set up at 140 meters away from the center line of main tower. The elevation of Xinzao Pearl River Bridge is shown in Fig. 3).

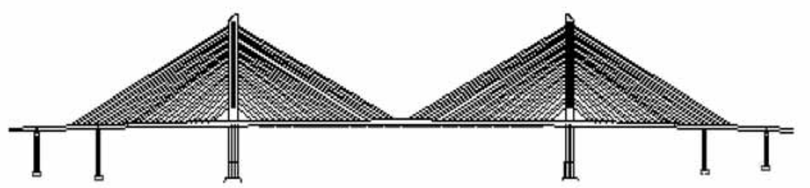


Fig.3. Elevation of Xinzao Pearl River Grand Bridge

The spacial finite element model of Xinzao Pearl River Bridge is built by using finite element software MIDAS. The full bridge is divided into 689 nodes and 574 elements, which includes 462 beam elements and 112 truss elements. The computation model of the structure is shown in Fig. 4).

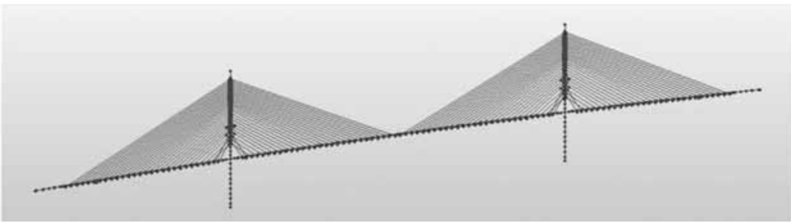


Fig. 4. The model of Xinzao Pearl River Grand Bridge

Table 1 The comparison between measured cable tension and theoretical cable tension

Serial number of cable	Location of cable	Measured fundamental frequency (Hz) Measured value	Measured fundamental frequency (Hz) Average value	Measured cable force (KN)	Theoretical cable force (KN)	Absolute error	Relative error
26	upstream	4.970 4.962 4.958	4.963	3848	3843	5	0.13%
26	downstream	4.989 4.971 4.990	4.983	3879	3843	36	0.94%
27	upstream	4.977 4.960 4.989	4.975	3755	3746	9	0.24%
27	downstream	4.966 4.971 4.967	4.968	3745	3746	-1	-0.03%

The comparison of cable forces of full-bridge is shown as Fig. 5)

The comparison between the measured cable forces and the theoretical cable forces in cable 26 and 27 after the third tension is shown in Table 1

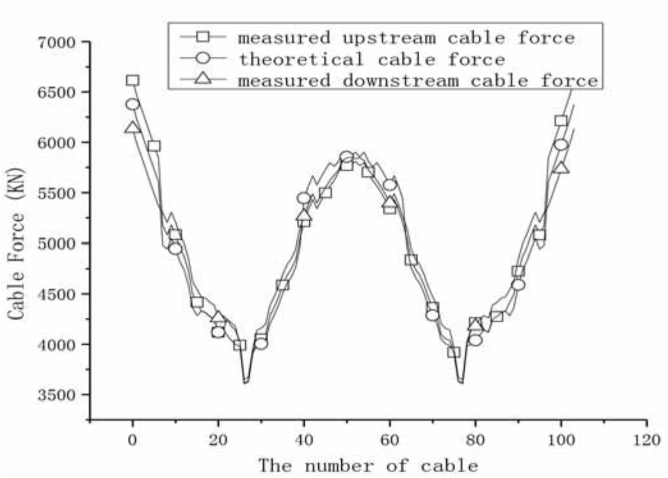


Fig. 5. The comparison of cable forces of full-bridge

5. CONCLUSIONS

The objective of this work is to introduce factors influencing estimating cable forces by adopting frequency method. Main conclusions are as follows: Frequency method is nearly only one way for measuring the cable which have been installed on construction. If the cable is relatively long, the effect of flexural rigidity on fundamental frequency can be neglected. Otherwise, in order to reduce the error, cable force should be calculated by low-order frequency. The deduction of the relationship between cable force and fundamental frequency in Eq. (7) is under the assumption that the sag of cable is neglected. Taking the difference between the distance between each anchor point at the ends of the cable and the length of connecting cylinder as the effective length of the cable can meet the requirement of the accuracy of estimating cable force on construction when the cable force is calculated by Eq. (5). The acquired cable forces based on frequency method are relatively precise, and the accuracy requirements are satisfied.

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CONSTRUCTION BRAND ON THE POLISH MARKET

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Keywords

research, marketing, construction brand

ABSTRACT

The most commonly used marketing tools are various kinds of rankings, and competitions, which prove company's position or promote its products if the company manages to achieve high position. The primary goal is to build or confirm the so-called brand. Construction industry is not different in this regard. In Poland, prizes won in the construction brands ranking carried out since 2005 by ASM Research Institute - Centre for Market Research and Analysis Sp. z o.o. receive broad recognition[1].

THEORETICALLY ABOUT THE BRAND

A brand is a name, symbol, term, design, symbol, or a combination graphic created to mark and distinguish goods or services from other competing products. It may consist of two parts: verbal (name) and nonverbal (symbol, logo). Composing verbal part of the brand you use words that are aimed at the association, the names of cities, countries and regions, names of animals, symbolizing nature. Names can come up with history, with literature and musical works. Brand may consist of a combination of letters or alphanumerical characters. Brand or part of the brand under legal protection becomes a trademark[2]. A brand is well kneaded, good opinion about the company or product.

Features of the brand:
- identification – which means distinguishing the product from competing products,
- guarantee - guarantees a certain level of quality,
- promotional - when attracting the attention of buyers and encourages them to buy[3].

Most durable distinguishers of brands are:
- the value (refers to the values offered by the manufacturer).
- culture (representing a certain culture)
- personality (may suggest some personality).

How to choose a brand?

Brand, as the word selected by managers of the company to promote their products:
- should suggest the benefits of efficiency, quality of the product,
- should be easy to remember, pronounce, recognize,
- should be differentiated from competitors' brands,
- should not mean anything negative in other languages.

Advantages and disadvantages of having a strong brand:
- lower marketing costs due to increased customer confidence and higher brand loyalty,
- maintaining a higher price level, because its quality is seen as more durable,
- easy expansion of product lines,
- protection in price competition.
- the high cost of promotion, advertising, commercial service,
- the need of continuous testing and development,
- the need to continuously look for differences between the products[4].

PRESENTATION OF THE ASM RESEARCH INSTITUTE

ASM - Centre for Market Research and Analysis Sp. z o.o has been operating since 1996 with the status of the Research Institute and the Center for Research and Development. From its establishment the company its main activities included market research and analysis of investment and construction industry, as well as the b2b market. As the company expanded, the offer has broadened and now includes also the study of other markets as well as social and economic research. As the only research agency in Poland ASM has won numerous awards in the field of innovation and is the winner of the innovation rankings carried out by scientific institutions.
The company operates throughout the country and cooperates with foreign partners in the implementation of international research projects co-financed with the 5, 6 and 7 Framework Programme[5] , Intelligent Energy Europe[6] , Leonardo da Vinci[7] and the European Fund for the Integration of Third-Country Nationals [8].
Several years of research experience in the construction market meant that ASM is one of the best specialists in the market. ASM also run a number of initiatives aimed at supporting and uniting the entire construction industry. Such activities, among others, include:

- Coordination of Polish Construction Technology Platform [9],
- Organization of Conference Construction Market Monitoring,
- Co-realization of Industrial Program of Promotion of Window and Door woodwork and Sectoral Program of Promotion of Construction [10],
- Creating a Ranking of Construction and Building Materials Distributors Brands, which is a basis for awarding of prizes of the Construction Brand of the Year and Distributor of the Year.

CONSTRUCTION BRAND

Research Ranking Construction Brand of the Year is an annual event organized by ASM - Centre for Market Research and Analysis Sp. z o.o since 2005. The idea of creating the ranking, arose from a joint initiative of ASM and the International Poznan Fair, the organizer of the BUDMA construction fairs. The common aim was to encourage distributors to participate in the Fairs, and creating opportunities in a special way to honor their achievements. Today, Construction Brand of the Year Ranking is one of the largest and most important of this type of research conducted in Poland. The award is all the more valuable that is given on the basis of nationwide research undertaken in the various groups of recipients of construction products. Therefore, each awarded company can be sure that her choice had been made by a representative group of respondents (usually about 2000), and that the results of this study has the most objective character. The classification is created based on the analysis of the results of the survey, with the help of CATI technique (Computer Assisted Telephone Interviewing). The ranking includes the usual array of assortment categories, and the best brands chosen within each category. In addition, the Construction Brand of the Year is chosen - the only one which stands out against the all other, regardless of category.

THE WINNERS FOR 2014

The winners of Golden Champion of the Year 2014 in the categories of building materials are: Garage doors WIŚNIOWSKI, company brand "WIŚNIOWSKI" Sp. z o.o S.K.A.[11] , Sealants - Silicones SOUDAL, Brand of company SOUDAL Sp. z o.o., Mounting foams SOUDAL, Company brand SOUDAL Sp. z o.o.[12] , Construction fixings WKRĘT-MET, Company brand "KLIMAS WKRĘT-MET" Sp. z o.o.[13] , Windows FAKRO, Brand FAKRO Sp. z o.o.[14] .

THE COMPANY FAKRO FROM NOWY SACZ

The FAKRO Company was founded in 1991 as a private company based in one hundred percent on the Polish capital. In the 20 years from a small, family company has grown into an international corporation, which today occupies the position of vice-leader of the global market for roof windows. Its co-founder and current president Ryszard Florek - the main initiator and executor of launching production of roof windows in Poland. Today, FAKRO is one of the most innovative and fastest growing companies in Poland.
The Fakro Group, which employs more than 3,300 people, consists of 12 production companies and 16 distributors, located in Europe, Asia and America. Fakro company's products can be found in more than 50 countries around the world - wherever there is a demand for such products. Export sales accounts for 70% of total sales.

MARKETING OF VICE-LEADER OF THE GLOBAL MARKET FOR ROOF WINDOWS

As part of the work on this material I have collected information directly at the source, i.e. in the company Fakro from Sławomir Gawlik (Group Marketing Director) and Anna Korczyk (Specialist on Public Relations). Below are the answers to asked questions:
1) How the company marketing communication looks like. Is there anything distinguishable in this area?
Our marketing communication is addressed to both business partners and individual clients. We are trying to extensively use available channels to reach our target customers but with very precise targeting. The key customers of our marketing communication are private customers, distributors, roofers and architects. We communicate with them through content transmitted both by traditional methods (press advertising, trade shows, sales, conferences, etc.) as well as using new access channels such as the internet web 2.0.
The most important and most effective marketing tools are training organized for our business partners both in the field and in our headquarters. Annually we invite approximately 4 000 people from the country and abroad. Such meetings are a great opportunity to present the company's technology park and its extensive Research and Development department. In addition, it is an opportunity to exchange experience, comments and observations of people cooperating with our company.
2) What kind of marketing you prefer and why?
Our actions are based on the broader understood marketing mix. In analyzing our marketing activities it is difficult to say clearly which action is most effective. The main reason for this is the nature of markets and hence the need to adjust our actions. We use marketing strategies appropriate to the specifics of the market and its needs, their range is very wide and thanks to the synergies we get results. In our work we use, inter alia, sales promotion, advertising, press, radio, television and the Internet, fairs, merchandising, sponsorship, PR, CSR ...
3) How do you assess and based on what data the effectiveness of your marketing?
One of the best indicators supporting the effectiveness of marketing activities is the position of vice-leader with about 15% share of the global market. Other elements are the numerous awards and rankings of brand awareness. Based on independent studies, the effectiveness of our marketing is very high. For example, we were awarded the title Construction Brand of the Year 2014 as the most recognizable brand on the roof window market among professionals (by ASM - Centre for Market Research and Analysis).
4) What is the most costly element of marketing?
The vast majority of marketing activities requires considerable funding. As part of our budget, we try to divide them to effective measures adjusted accordingly. Our philosophy is flexible approach to marketing. Depending on the requirements, the funds may have different shape depending on the situation on individual markets.
5) Please list 5, 10 sources of your success.

1) DEVELOPMENT (a strong and sustainable position among the world leaders in the construction industry)

FAKRO is one of the most dynamic and fastest growing companies in the roof windows industry in the world. Durable, functional, safe and energy efficient FAKRO products have won great popularity and have become an integral part of the newly built buildings and allow to build a modern interior filled with sunshine. FAKRO products are a new quality of life.

2) INNOVATION (products that are safe, energy efficient and environmentally friendly)

FAKRO Company has always put on innovation. FAKRO is proud to own modern research and development center. Product development is done by over a hundred engineers, and the company has won more than a hundred patent applications. FAKRO is a company that exports to many countries not only roof windows, but also the creative ideas of Polish engineers. In this way, the company sets new trends for the roof windows industry in the world, and Poland has become a world leader in their production.

3) RESPONSIBILITY (corporate social responsibility for the sake of customer, business partner, employee and environment)

FAKRO strategy for further development primarily determines the concept of ecological, energy-efficient and intelligent home. In order to warm homes the company has successively introduced to the market many innovations, such as automatic ventilator, solar collectors, or super energy-efficient roof window FTT U8 Thermo with improved thermal insulation performance. It's the warmest window on the market with a single glazing unit designed for passive buildings. What is more the company constantly expands range of products also equipped with a wireless communication system between electrical devices Z-Wave.

4) ENTHUSIASM - TEAM (creativity, effectiveness, job satisfaction)

Our staff consists of people with passion. Years of experience enabled FAKRO to achieve a stable position in the global market, providing customers a sense of security and satisfaction with purchase. Competence and highly qualified employees are the strength of our company.

5) CARE FOR THE CONSTRUCTION OF ECONOMIC COMMUNITY

FAKRO, in addition to efforts to ensure high quality production and development of markets, attaches great importance to the economic development of Poland. Thinking about this goal, the President of FAKRO Ryszard Florek has established Think of the Future Foundation, propagating knowledge about the economy and free market mechanisms.

Further positions of sources of success include: knowledge, hard work, luck, courage and charismatic leader - co-founder of FAKRO - Ryszard Florek[15].

Polish construction companies are paying more attention to marketing, including building their brand on the market. This is particularly important for companies such as Fakro, whose expansion is already global in nature. Other companies also attach importance to this elements, and achieve successes in export. Polish exports is the flywheel of the Polish economy.

NOTES

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[14]http://www.fakro.pl/

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PARAMETER SENSITIVITY INVESTIGATION OF THE LARGE-SPAN MAIN BEAM SECTION

POSTER

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Keywords

continuous rigid frame bridge, cantilever, parameter sensitivity

ABSTRACT

In order to ensure the completion can meet the requirements of design and use, it is necessary to consider the various factors affecting the bridge construction, so that it can feedback to the construction. This paper takes the Dongtou cross-sea bridge as the basis, using software simulation, exploring the long span continuous rigid frame bridge deflection and stress in various stages of construction, analyzing the parameter sensitivity. Respectively the paper analyzes changing trend and the influence degree of deflection and stress under the biggest cantilever stage and service stage with the change of density of concrete, elastic modulus of concrete, prestressing and temperature. The conclusion show that the actors above all make deflection changing a lot, and density of concrete has influence on max stress in some extent. This paper provides reference for the design and construction of continuous rigid frame bridge in the future.

1. THE PROJECT'S ENGINEERING SITUATION

The Dongtou Cross-sea Bridge is located in xiaopu village, Wenzhou City, Zhejiang Province. The main bridge layout is 75+125+125+75 (m), choosing concrete continuous rigid frame bridge four holes of a joint. Main beam use C50 concrete material and section is single box of straight web section. Parts of concrete girder longitudinal section are designed in accordance with full prestressed concrete structure and adopts variable sorghum. The main bridge arrange by single. The width of section is 12m. Deck transverse slope is 2%. Radius of vertical curve is 8000m. Curve of beam under the edge change as 1.8 times in parabola. This project use the basket cantilever to construct.

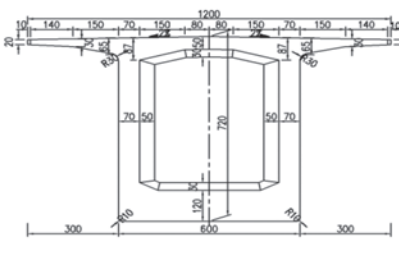

Fig.1 pivot section

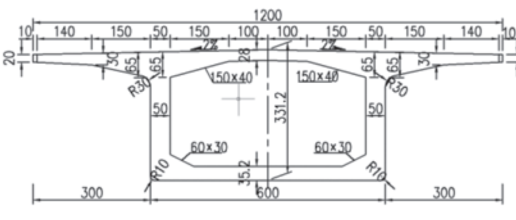

Fig.2 midspan section

2. THE FINITE - ELEMENT MODEL

This paper uses the large comprehensive analysis program with finite element MIDAS/CIVIL to make model. According to the actual situation of engineering construction stage , the bridge model is defined into 52 construction stages, which each block is subdivided into three construction stages, the block construction, the prestressed tension and the basket walking. The model is as follows.

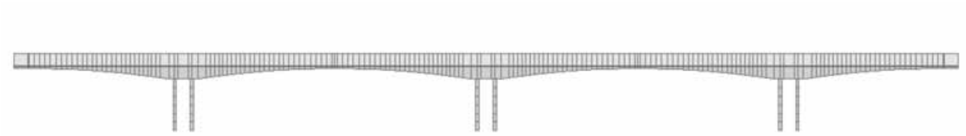

Fig.3 model

3 SENSITIVITY ANALYSIS OF MAJOR PARAMETER

The main design parameters of continuous rigid frame bridge are the deae load of the structure, the elastic modulus, the prestressed parameters and temperature change. This paper differentiates Dongtou Cross-sea Bridge in max cantilever stage and the completed bridge stage, taking the deflection and stress as the analysis object, regarding the scope of change as the standard of parameter sensitivity.

3.1 Sensitivity analysis of concrete density

In the practical engineering, concrete real measure density higher than ratio design one occasionally because some of details. This paper consider the main beam density increase and decrease 10% differently as changing situation, and respectively, comparing with its original density status. The result of deflection and stress curve diagram are followed.

3.1.1 The effect on deflection and stress with concrete density changing based on the completed bridge stage

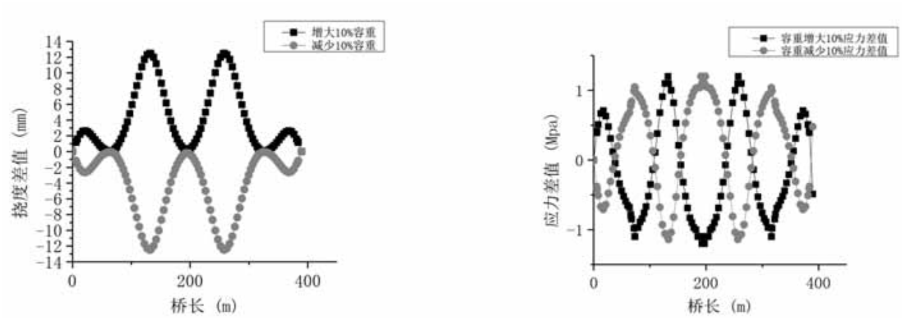

Fig.4 Deflection and Stress difference of the completed bridge stage

From this curve programs above we can know that, when the concrete density changes, the largest change of deflection is generated in the middle of each span, which highest up to 14mm. When the density increases, the deflection of bridge is on the rise also; when the density decreases, and deflection is also decreased compared to the original situation. In the comparison parts of largest stress, either density increases or decreases, the stress change scope is from 0Mpa to 1.5Mpa. This phenomenon shows that density has large effect on deflection of the completed bridge stage, and smaller effect on bridge stress.

3.1.2 The effect on deflection and stress with concrete density changing based on the max cantilever stage

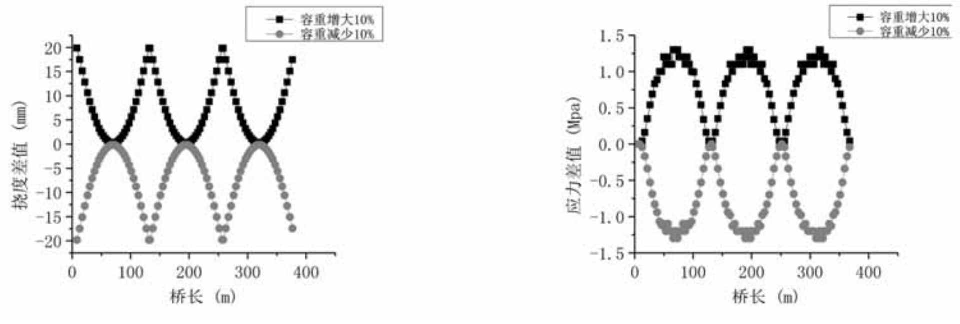

Fig.5 Deflection and Stress difference of max cantilever stage

According to the pictures above, when density changes, the end of cantilever deflection changes largest in the max cantilever stage, which the highest value coule up to 20mm. The deflection trend of increase and decrease is same with completed bridge stage, which concrete density increases the deflection increased accordingly, the deflection is reduced when the concrete density decrease. In the parts of largest stress, which is same as the completed bridge state, either the density increases or decreases, the stress changes from 0Mpa to 1.5Mpa. It is obviously that deflection of the max cantilever bridge stage is influenced largely by the density, and the stress of this stage is effected smaller.

3.2 Sensitivity analysis of elastic modulus

As a kind of nonlinear materials, with the pass of time, the cement hydration reaction of concrete is more complete, the internal structure of concrete more dense, the overall strength and the modulus of elasticity greater,. In this model, the elastic modulus increases and decreases 10% compared with original one respectively and then consider the effect of elastic modulus on the stress and the deflection of main girder.

3.2.1 The effect on deflection and stress with elastic modulus changing based on the completed bridge stage

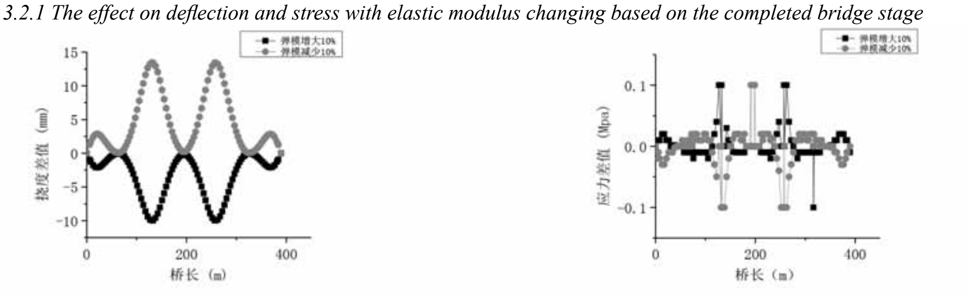

Fig.6 Deflection and Stress difference of the completed bridge stage

Seen from the diagram, it is obviously that on the completed bridge stage the elastic modulus of concrete increases 10%, deflection increase nearly 18mm correspondingly. While on the completed bridge stage the elastic modulus of concrete reduce 10%, the middle span deflection reduced almost 10mm. From the figure it can be concluded that small change of the elastic modulus of concrete will cause large changes in the vertical deflection. In the parts of max stress difference, the change of elastic modulus does not cause the value of the max stress has a floating range, the difference only varies 0.1Mpa.

3.2.2 The effect on deflection and stress with elastic modulus changing based on the max cantilever stage

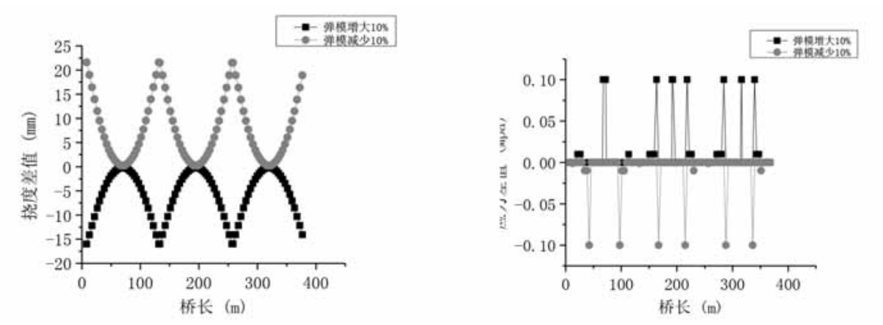

Fig.7 Deflection and Stress difference of max cantilever stage

On the analysis of above charts, an obvious phenomenon can be got that the concrete elastic modulus of max cantilever stage increase in 10%, both the large cantilever deflection of end sides increase near 23mm correspondingly. When the reduction of elastic modulus value low to 10%, comparing to the max cantilever deflection caused by the original elastic modulus, the deflection of end sides reduce 15mm. Figure 12 also shows that the deflection changing effect the elastic modulus of the max cantilever stage cause is asymmetric. The effect of elastic modulus increasing cause on deflection changing of end sides of max cantilever bridges is larger than the elastic modulus decreasing effect on deflection changing of end sides of max cantilever bridges. But the elastic modulus has little effect on the max stress value of max cantilever stage, which is similar with completed bridge stage, between 0.1Mpa. Therefore, the influence of elastic modulus error must be fully considered.

3.3 Sensitivity analysis of pre-stressed parameter

According to the literature [1] and [2], in the analysis of sensitivity parameters, the parameter sensitivity analysis of prestressed could be developed from three aspects, which is the value of prestressed tension, channel friction coefficient μ and the channel deviation coefficient of per meter K. This paper just analyzes the prestressed tension and investigates the influence of prestressed caused on concrete continuous rigid frame bridge's deflection and stress.

In the practical engineering of this paper, prestressed project is post tensioning method, stretching at both ends, which prestressed value is 1395Mpa. In the model calculation, prestressed tension is up and down 10% respectively, then calculate the deflection and max stress of beam in the effect of prestressing force. The comparison results are as follows.

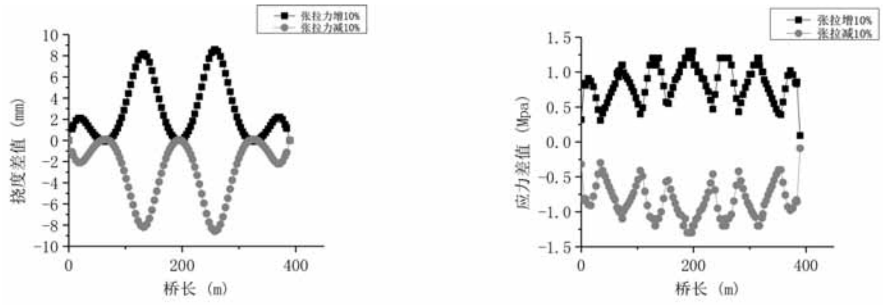

Fig.8 Deflection and Stress difference of the completed bridge stage

Through the analysis above the conclusion is easy to summary. Prestressed tension has largely influence on deflection of the continuous rigid frame bridge beam. On completed bridge stage middle span, deflection could change up to 8mm with influence of prestressed tension, and the changing the prestressed tension increased and decreased cause is symmetrical on the graph. The change of prestressed tension have influence on the maximum stress in some extent. The peak value could reach up to 1.5Mpa. Thus, prestressed tension changing should not be underestimated in actual engineering. In practice projects, we should control the tensioning degree strictly, and cut down prestressing force error to a minimum.

3.4 Sensitivity analysis of temperature

In the process of the main beam's construction, the outside temperature is changing. The change of temperature will alter the main beam's deflection and stress. There are two kinds temperature in engineering which should be considered, the annual temperature variation and local temperature variation. Generally, the local temperature refers to temperature variation which the sunshine generate. Due to the thermal conductivity of concrete is small, the internal structure change caused by temperature will lag, so it will produce a certain temperature variation on different levels of structure, this is the local temperature which in bridge structure. Solar radiation and cold cooling suddenly belongs to the effect of local temperature [3]. The annual temperature variation generally refers to the seasonal temperature change, its influence on the bridge is holistic, which means each part of the whole bridge temperature is heating up or the cooling. I unify the Wenzhou local temperature and define heating and cooling in system, heating and cooling in roof as follows.

Table 1 The definition of temperature Unit: ℃

Initial temperature	24
upper limit temperature in system	34
lower limit temperature in system	8

3.4.1 The effect on deflection and stress with heating and cooling in system based on the completed bridge stage

The actual project construction period shows that, compared with the max cantilever stage, the impact which the annual temperature variation cause on completed bridge stage is more significance. Therefore, this part mainly analyzes the influence which heating and cooling in system cause on the deflection and stress on completed bridge stage, and put the deflection and stress of constant temperature stage as reference. The comparison results are as follows.

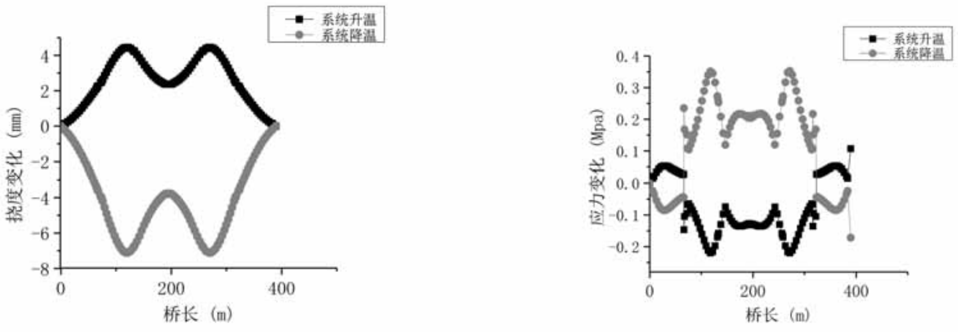

Fig.9 Deflection and Stress difference of the completed bridge stage

The image above shows that, the annual temperature difference make an obvious effect on the alignment of main beam. The annual range of temperature increase 10 degrees, which cause the biggest deflection changing of main beam up to 4mm. When temperature reduce 16 degree, this results to max deflection value decreases 7.5mm of middle span. In contrast, the influence of the annual temperature difference on the main beam max stress is not significant, the max stress variation is only 0.4Mpa. So, the impact of heating and cooling in system causing on deflection of main beam of continuous rigid frame bridge is large, the effect on stress can be neglected.

4. CONCLUSIONS

In order to solve the question of design parameters influence degree of continuous rigid frame bridge and main parameter identification, this paper establish the corresponding model using the professional computing software which base on engineering the Dongtou Cross-sea bridge, analyze the parameters sensitivity. Considering the influencing factors of various aspects, main conclusions are got as follow.

(1) Whether the completed bridge stage or the max cantilever stage, influence of density on the deflection of both sides is obvious, on the max stress is general. The suggestion in the construction is that we should strictly control the weight error.

(2) The effect of elastic modulus on bridge deflection is also significant, and the variation of the elastic modulus have small effect on the structure stress .

(3) The prestressed tension have large influence on the deflection of bridge, deflection could change up to 8mm with influence of prestressed tension increase 10%. Tension have some effect on the maxi stress of main beam. In the process of construction, we should strictly control the tension size.

(4)The annual temperature has influence on the deflection of two stages of the continuous rigid frame bridge. It is recommended that when in measuring and closuring time in the construction, we should try to choose the early morning. And it is best to avoid measurement or construction in the time when temperature change intense.

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THE APPLICATION OF CIRCULAR ARC FAILURE NOMOGRAM IN THE ROCK SLOPE STABILITY ANALYSIS

POSTER

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Keywords

geotechnical engineering, rock slope stability, Flac3D, safety factor

ABSTRACT

This paper first introduces the different analysis methods of rock slope stability, and then expounds the basic principle of Hoek - Bray method and calculation method. Then combined with the actual situation of a certain open-pit mines, respectively using circular arc failure nomogram based on Hoek-Bray method to calculate the safety factor of the slope, and the finite difference software Flac3D to establish three-dimensional model of slope to calculate the safety factor. While comparing the safety factors, we have concluded that the safety factor obtained from the circular arc failure nomogram close to the analog value, high reference value, it can get better application in the actual slope stability analysis.

1. INTRODUCTION

At present, with the development of mountainous area construction, railway, highway construction, there are more and more slope engineerings, and the slope stability analysis is an important subject in slope engineering, it is also provides an important scientific basis for the design of open-pit mine slope and slope, thus, governance. Open-pit mine in our country is numerous, it provides a good material for the research of slope stability.

The rock slope stability analysis method basically has two kinds of methods. The first kind of method is established in the sliding surface of slope cases, according to the critical slip surface is uncertain, according to the sliding resistance of critical slip surface and slip force calculation of slope safety factor directly. Force of the critical slip surface can be caused by the static equilibrium conditions of the solution, these methods mainly include the limit equilibrium method, balance block theory, etc. The second method, first using the numerical analysis methods (such as finite element method, discrete element, such as block and DDA) determine the displacement field and stress field of slope, then use the overload method, strength reserve act to slope limit state, thus indirectly get the safety factor. This not only considering slip of the balance of physical, but also considers the displacement coordination condition and constitutive relation of rock mass.

With the progress of technology, more and more engineering using numerical simulation methods for slope stability analysis, the combination of the three gorges ship lock engineering such as Xiao-dong Kou's Flac3D is adopted to improve the stress, deformation and stability analysis of high slope excavation of simulating value with the measured values close to, change trend. This shows that the Flac3D in rock slope stability analysis has higher credibility. But as a result,the Flac3D modeling process is relatively complex, three-dimensional model calculation cycle is long, difficult, to a certain extent, restricts its further application, the circular arc failure nomogram has certain advantage in these aspects, you can get a good application in engineering practice.

This article, which is based on a certain open-pit mine, uses the circular arc failure nomogram based on limit equilibrium method, application in accord with certain conditions will determine the various parameters to the formula, calculate the safety factor of slope.Finally make a comparison between the safety factor of slope calculated by Flac3D numerical simulation method and the former one, judge the reliability of the safety factor calculated by the circular arc failure nomogram, and then to achieve the purpose of judging rock slope stability.

2. HOEK AND BRAY METHOD IN THE APPLICATION OF THE ROCK SLOPE STABILITY ANALYSIS

2.1 Hoek Bray damage calculation principle of rock slope

When Hoek and Bray discusses basic mechanics mechanism of slope failure, use a single along the inclined plane of rock slide in the model. This is the most simple model, rock slope failure in most practical cases, the need to discuss the failure process is more complicated. In this paper, using the limit equilibrium method to analyze a project the possibility of arc. When rock and soil is very weak, such as in soil slope or abnormal development or already broken rock joints (e.g., in the waste dump), damage will be determined by a single discontinuity, but it is a circular failure surface. In the soft fractured rock mass slope, the damage way is often controlled by multiple discontinuity. The failure surface is along the direction of least resistance across the slope, this way of damage is usually takes the form of circular arc.

The happening of the damage condition of circular arc form is usually interpreted as: when the individual particles compared to the size of slope rock mass is extremely small, cut the particles due to the shape of their relationship is not mutual occlusion. Therefore, the slope will be activities like “soil”, in a circular pattern. Highly alteration and weathering of the rock are also prone to damage in this way, therefore, according to the circular failure assumption to design the slope in opencast stope surrounding cover is appropriate.

2.2 Derive the circular arc failure nomogram

When deriving the stability nomogram in the Hoek-Bray method, they made the following assumptions:

A: assuming that the material of the slope is homogeneous, that is to say, the mechanical properties of the material does not change according to the loading direction;

B: the shearing strength of the material is expressed as bond strength and friction angle ϕ equation $\tau = c + \tan\phi$ to express its characteristic;

C: assuming that damage is happened along through the failure surface of slope toe circular;

D: assuming a vertical cracks on the top surface or in the slope surface;

E: tensile crack and failure surface is under the condition of considering slope geometry and groundwater, the safety factor of slope for the location of the minimum value when;

F: considered in the analysis of several kinds of conditions of groundwater, from dry slope to have a strong supply of fully saturated water slope. These conditions later in this chapter to give rules.

Definition of slope safety factor is:

$$F = \frac{\text{Available slip strength and shear strength}}{\text{Shear stress along the failure surface to mobilize}} \tag{1}$$

Rearrange the equation, too:

$$\tau_{mb} = \frac{c}{F} + \frac{\sigma \tan\phi}{F} \tag{2}$$

In equation τ_{mb} is the shear stress along the damaged surface.

In combination with a project, can refer to the corresponding circular damage diagram as shown in figure 1

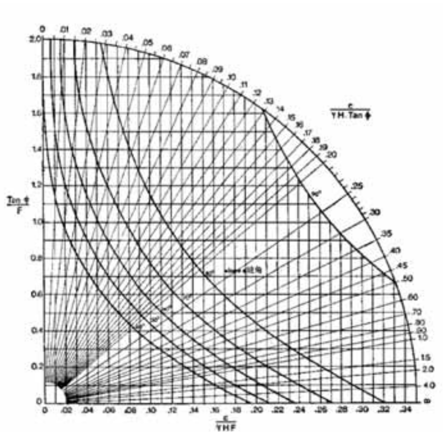

Fig. 1 The circular arc failure nomogram

2.3 The use of the circular arc failure nomogram

In order to use this figure to determine a specific slope safety factor, should according to the following steps:
Step 1: decide is believed in the existence of similar conditions of groundwater, to choose the most close to calculate the figure of these conditions;
Step 2: calculating the dimensionless ratio:

$$\frac{c}{\gamma H \tan\phi} \tag{3}$$

On a scale in abac cylindrical check to the value;
Step 3: in the second step to check the value as a starting point, find it along the radial lines and corresponding to consider slope Angle curve intersection;
Step 4: which one is more convenient, find out $\tan\phi / F$ or $c / \gamma HF$ corresponding value, and calculate the safety factor.

3. ROCK SLOPE MODEL AND CALCULATED

3.1 The establishment of calculation model

(1) the calculation parameter selection. Because of the slope rock mass is relatively single, we can roughly calculated as a kind of lithology. Model of the equivalent parameters of rock mass is: bulk modulus: 200 MPa; Shear modulus: 100 MPa; Internal friction Angle: 45 degrees; Cohesion: 100 kpa; Tensile strength: 100 kpa. Material density is above the underground water level: $2500 \mathrm{kg/m^3}$; The material density of under water: $2600 \mathrm{kg/m^3}$.
(2) the composition of calculation model and boundary conditions. In simulation of rock slope is divided into 4510 units and 5394 nodes. Through two columns around the body and three brick body model is shown in figure 2. Model selection is a deep pit, about a quarter of the 25 m is the height of slope, slope is 2:1, axisymmetric vertical plane is in y = - 30 xz plane and x = 0, z plane. In order to guarantee the mechanical system of the whole system, at the bottom of the model boundary on the vertical displacement constraints, constitute the displacement boundary conditions, the upper model as free boundary condition. Model considering the influence of groundwater, the free surface until the top of the model, from behind the slope Angle and slope Angle of the lower part has leakage, free surface of ground water level through written FISH function. Slope calculation model of grid as shown in figure 2.

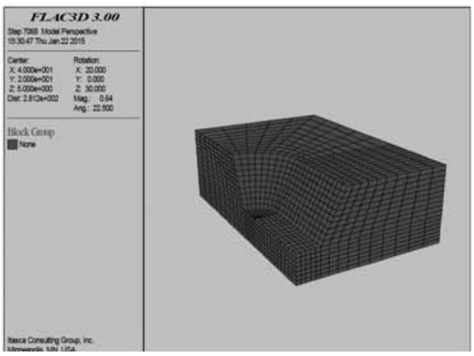

Fig. 2 Meshing diagram

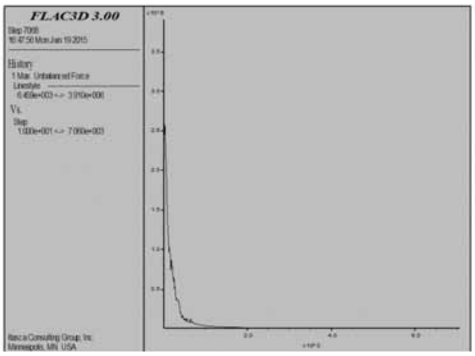

Fig. 3 Maximal unbalanced force

4. CALCULATION RESULTS AND CONCLUSIONS

Inputting the data of the grid division and the boundary conditions into Flac3D, after a 7068-cycle calculation, we can get the following result shown here.
From figure 3, the maximum unbalanced force under the influence of the structure, there was a big step in about 300-300 jump, after steady decline gradually, after a 3000 - cycle close to zero, after the simulation shows that the model has rendered balance, no plastic flow, meet the needs of actual calculation.

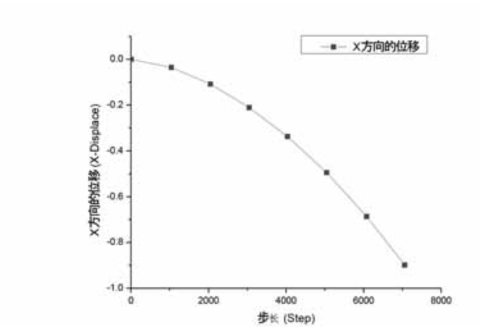

Fig. 4 Displacement change in the X direction

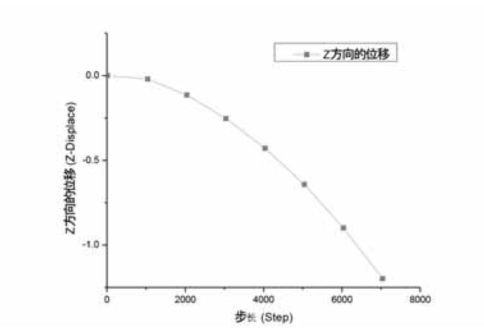

Fig. 5 Displacement change in the Z direction

Figure 4 and figure 5 respectively recorded a slope failure plane displacement in the X direction and Z direction, combined with the two direction of displacement, displacement on the surface of the unknown damage increases with gradually over time.

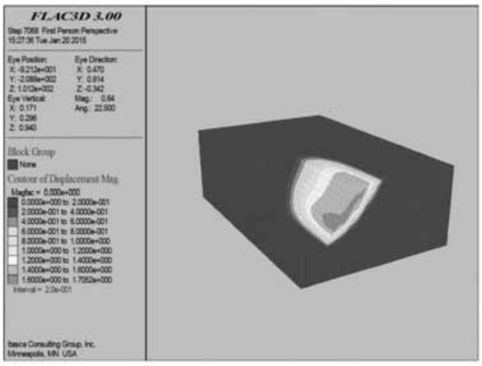

Fig. 6. Displacement contour map

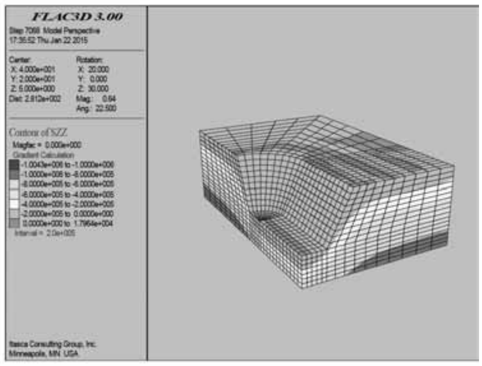

Fig. 7. Stress contour map shows the Z direction

By the displacement contour map shown in figure 6 it can determine the area of slope failure occurred, combining of the destruction of shown in figure 7 stress contour map shows the Z direction of the slope instability, angled damage distribution of circular arc form, slip along the arc.

The safety factor calculated by Flac3D is 1.7, the safety factor calculated by circular damage abac is 1.61, the error is 5.3%, combination. By comparing the knowable by damage figure calculated safety factor of circular arc failure nomogram close to the analog value, high reliability, and the calculation method in the practical engineering practice is simple and quick, and the characteristics of calculation data seems to be high sensitivity, the real and reliable.

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CIVIL AND STRUCTURAL ENGINEERING IN ADVERSE CLIMATIC CONDITIONS USING THE EXAMPLE OF PROJECTS FOR ASTANA AND ATYRAU

POSTER

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Keywords

architecture, the climate, soils

ABSTRACT

Kazakhstan is characterised by a wide variety of climatic conditions. In this regard, clear zoning of the territory of the Republic of Kazakhstan is provided that is delineation of areas with similar climatic and anthropogenic (man-made) conditions that affect the parameters of technical regulation, standardization and design in urban planning.

Climatic zoning of the territory of the Republic of Kazakhstan shall be provided in accordance with comprehensive analysis of general climatic structure, landscape and climatic, construction and climatic, and physiological and climatic and agroclimatic characteristics of the territories. When assessment of construction and climatic conditions they should be guided by SNiP RK 2.04-01-2010 "Building climatology", according to which the territory of the Republic of Kazakhstan is divided into 4 climatic regions and 16 subdistricts, reflected in the reconnaissance-type climatic map for construction. Seismic zoning of the territory of the Republic of Kazakhstan is provided in accordance with the special research, seismic analysis, data of engineering-geological surveys and establishes the territorial areas of current and potential seismic activity. To estimate seismic favourableness of certain territories and functional territorial zones of seismic materials of seismic microzoning are used. Astana refers to the IB, and the city of Atyrau to the IVG climatic subdistrict. In Astana there are harsh, long winters with low temperatures, strong winds and marsh land. In Atyrau the surface is flat, climate is continental, very arid, with hot summers and moderately cold winters. There are different hydrogeological and geological structures in these two cities.

In the paper by example of the objects differences in all aspects can be traced, also you can consider solutions on natural-technogenic processes, availability of the soils which are specific by composition and condition, climatic factors, affecting general landscape of the city and planning solutions covering the issue of improvement of living conditions of the population. When development of the cities of Atyrau and Astana along with urban planning and architectural and planning methods of arrangement of space-spatial structures, one of the key points is the right approach in selection of design concepts and filler materials.

These two climatic regions, reviewed in the paper can be found in other countries, such as: Russia, North of Mongolia, Georgia, Armenia, Azerbaijan, Eastern Turkey, North America (Canada) and Northern Europe (Norway, Sweden, Ireland, Portugal). Contemporary design solutions of buildings and structures provided in difficult climatic conditions by example of projects for Astana and Atyrau will be interesting for all in the industry of construction and design in similar climatic conditions.

1. INTRODUCTION

Natural conditions of Kazahstan are quite various. Significant factors of zoning of the territory of the Republic of Kazakhstan are climate, relief, seismic, sanitary-epidemiological and ecological condition of the territory, high level of development of communications, transport, engineering and other infrastructure, availability of natural resources, and a variety of territorial production complexes.

2. BACKGROUND

In connection with building climatology, the territory of the Republic of Kazakhstan is divided into 4 climatic regions and 16 subdistricts with special characteristics. (Fig. 1). In addition, there are a number of other zonings, including seismic. (Fig. 2).

According to SNiP RK 2.03-30-2006 “Construction in seismic areas” regions of the cities of Atyrau and Astana do not apply to seismic zones, but under SNiP RK 2.04-01-2010 “Building climatology” they have different, and at that, adverse conditions in their own way. Astana refers to IV subregion, and the city of Atyrau to IVG.

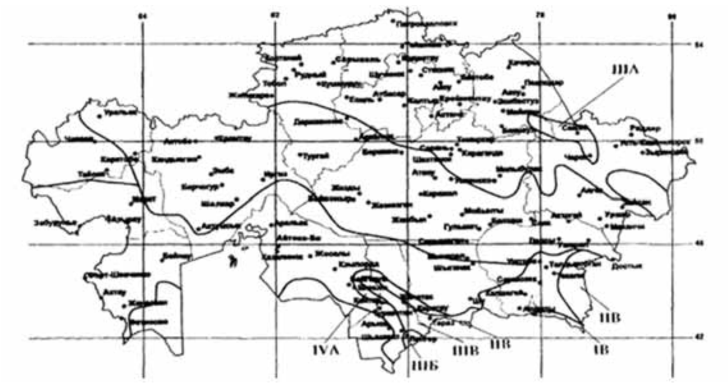

Fig. 1 Climatic zoning map of the Republic of Kazakhstan.

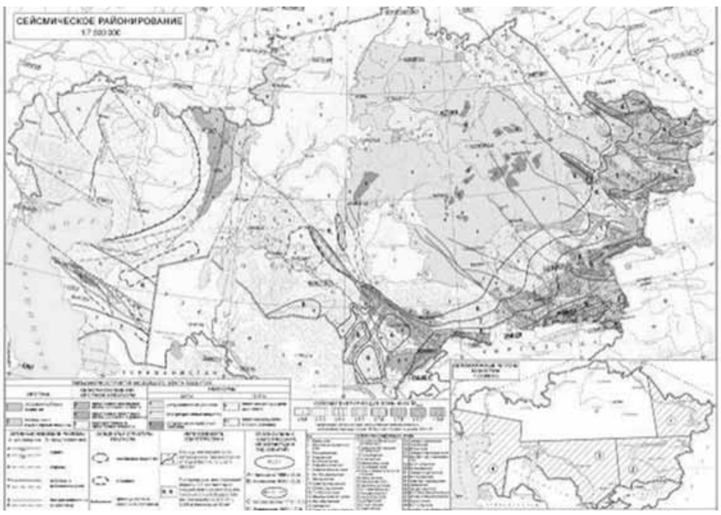

Fig. 2. Seismic zoning map of the Republic of Kazakhstan.

3. CASE HISTORY

Cold long winters and hot, dry summers, as well as the high activity of wind regime with sandstorms during great part of the year and solar radiation during summer are unique features of Atyrau. The average duration of the cold period is 210 days, that makes 60% of the year. This, in turn, causes the uncomfortable conditions for human body during the period of 94 days and 153 nights. Average wind speed with prevailing direction to East and South-East is 6.5 m/s, which significantly exceeds the limit of comfort of sanitary-and-hygienic criteria. On average, during 2-3 days, and in some years for 5-9 days every month, there are very strong winds, 15 m/s. Despite the high activity of wind regime, frequency of snowstorms is not large value due to the dry winter. On the average 6 days with snowstorms are marked. In the warm season of the year, overheating is registered within 70 days at the mean. The average temperature of July 26,3° C, the average maximum is 32,6 ° C, the absolute maximum is 46° C. At this time of year rationally-thermal factor plays the primary role in the formation of the uncomfortable conditions. Exceptional aridity of warm period makes high frequency of dust storms. Average number of days with sandstorms is 54 days per year.

Fig. 3. Sports complex in the city of Atyrau.

Fig. 4. Hazrat Sultan Mosque in Astana.

Thus, leading climatic factors, count of which is necessary to create optimal microclimate both in construction as a whole and in premises are excess of solar radiation, overheating in summer, as well as active wind regime in winter and periods of transition of the year. Therefore, to ensure optimal conditions for visitors, for example, the sports complex in Atyrau (fig. 3) activities aimed on maximum reduction of wind speed, solar radiation and dust level by construction of grates along the facade of building, maximum widening of the bulk and a high level of landscaping and planting.

In geomorphological view the site is located within the Pre-Caspian lowland. Groundwater depth (perched water) -1.5 ... 2.1 m from the ground level. Feed source is the artificial flooding. Groundwater belong to the group of brackish water.

Taking into account the topography and soil properties with closely spaced to ground level aggressive groundwater, no provision has been made in regards to basements. Also, taking into account features of the region with its wind regime and sharply continental climate in an accomplishment of territory and its landscaping, recommendations including these factors have been adopted. So, the main pedestrian areas are protected from solar radiation and winds by semi-enclosed galleries, walls with a height of 1.6 m. Paving and planting of the site shall include protection of ground surface from blowing out. In particular, it is alternation of coatings made of concrete, shell limestone, concrete and sand slabs with planting, raised to 0.4 -0.5 m from the surface of paving at its maximum areas. In view of climatic conditions of the area, volumetric-spatial construction of the sports complex has a compact solution that greatly ensures the possibility of creating a favorable microclimate inside the building. In connection with the fact that depth of ground water level is 0.8-2.2 m they are heavily aggressive to concretes of normal density and metal, actions to reduce their impact on structures and utilities below shall be provided. Filling takes place within 1.5 -2.5 m and lines of heating system are laid at a minimum possible depth of their protection.

In comparison with the city of Atyrau, the capital of Kazakhstan, Astana, referring to IB climatic subregion, is characterized by a sharply continental and arid climate. Winters are cold and long, with stable snow cover. Summers are relatively short, but hot. The area refers to the zone of insufficient and unsustainable moistening. The annual course of air temperatures is characterized by persistent severe frosts in winter, intense build-up of heat in a short spring season and heat during the short summer. Estimated duration of heating period is 215 days. Average number of atmospheric precipitation for the year equal to 326 mm, maximum rainfall amounted to 480 mm. Astana is characterized by frequent winds blowing predominantly to the Southwest (in the winter) and northeast (summer). The strongest winds occur in winter months and summer months winds are dry. Number of days per year with wind is 280-300. Average depth level of foundation soils is 234 cm. The maximum penetration of zero into the soil can reach 350 cm if dry harsh winter,

Geological structure of construction sites, by example of the project of the Hazrat Sultan mosque (fig. 4) composed mainly of loams and clays and loam soils, with a total capacity of 2.8-5.2 m, as well as loams and clays of 1.0 - 5.5 m in thickness, medium gravel soils of 2.5-10.7 m in thickness, rubbly-block area of 1.0-16.0 m in thickness. This formations are underlaid by rock strata represented by alternation of siltstones and sandstones with penetrated thickness of 1.0 -18.5 m. On top of these deposits are covered with earth soils of 0.4 -2.8 m in thickness, and in some areas with vegetation layer of 0.2 m in thickness.

On site of surveys according to data of drilling underground water are exposed to a depth of 1.0-3.5 m (absolute marks of steady level amounted to 349.00-350, 87 m).

Under conditions of natural regime groundwater level is subject to seasonal fluctuations: minimum water stand is noted in March, the maximum level is achieved at the beginning of May. The amplitude of the fluctuations in the well-studied area is 1.0 m -1.5 in spring time you should expect rising groundwater at 1 m above the specified level. Filtering coefficients of soils composing the plot survey by the results of express-pumping are in the interval of 1.08-1.20 m/day.

In turn, this is very important for adopting space-planning decision of facilities erected in this region. In particular,

accesses and entrances to the mosque should be located on the Leeward side of buildings. The main directions of streets should not match the directions of prevailing winds; take into account the traditional the Mecca orientation of the mosque. Therefore the main entrance to the mosque was settled on two broad ramps from the northern side, above which the entry portal, flanked from two sides by minarets is located. Ramps lead to the spacious square framed on three sides by the gallery with a colonnade and forming a traditional courtyard with coating for protection from inclement weather and strong, dominant in winter, south-westerly winds and blizzards. The entire building is based on stylobate in connection with aggressiveness of soils.
A similar effect of climatic condition occurs also when residential development of the city of Astana. This is in particular the application of half-planning that includes extensive wind-proof screen houses (not less than 60 m) and development, located in the zone of influence of windshield. Use of these screens provides protection from wind for other residential buildings and structures to be included in the building. Protected houses give savings in heat losses compared with objects directly exposed to the wind. The proposed type of planning excludes formation of zones with high wind velocities on the territory of housing group. It is established that urban planning solution in forming urban residential areas eliminates the possibility of excessive snow-deposits inside the building. This significantly reduces the cost of snow removal inside the yard, transport and pedestrian communications.

4. RESULTS

Thus, in development of the cities of Astana and Atyrau you should avoid basements, and open territory under abeyance in Atyrau, which is unacceptable for this climatic region. Given the direction of prevailing winds in Eastern and South-eastern areas, which are characterized by sandstorms, layout must be provided for in such a way as to driveways and pedestrian paths constantly cross creating winds knock down. In the buildings of latitudinal orientation to reduce unfavorable factor of excessive insolation it is recommended sun protection and compulsory air conditioning of the premises used. Difficult natural conditions require strict observance of agro-technical measures for growing trees and shrubs. In Astana with the harsh winter, low air temperatures and strong winds they focus on thermal properties of external enclosures, airtightness of walls, windows and doors, thermal insulation of ledges, glazing is taken as triple. You should avoid roofing of complex profile, contributing to the formation of large snow deposits. On the facades of the buildings it is not recommended to use niche, belts and other scarcements or sinking down items. Entrance in residential and public buildings shall be designed with double entrance lobbies with direction of movement through the lobbies, possibly with turning. Loggias and balconies as a rule shall be allowed in areas with the most severe climate. In accordance with aggressivity of soils in structural concepts generally pile foundations shall be provided in the building.

5. CONCLUSIONS

Thus in development of these cities the following concepts shall be used:
- windshield and sun protection
- activities on soil conservation and protection from dust storms
- protection from snowstorms in winter
- corrosion protection for underground structures and utilities
- lowering of the groundwater level during construction.

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SYSTEM OF TENEMENT BUILDINGS IN THE ARCHITECTURE OF EUROPEAN AND FAR EAST RUSSIA CITIES OF THE EARLY TWENTIETH CENTURY

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Keywords

tenement buildings, large-scale and artistic level of redevelopment, formation principles, architectural and artistic image, landmarks

ABSTRACT

The research work is devoted to tenement buildings in Russia. It's includes the comparison of distinguishing marks of tenement buildings European and Far eastern Russian architecture. Tenement buildings are the main types of existing pre-revolutionary buildings, which shaped and influenced the architectural and artistic image of the cities.
One discovered general principles and regional features of tenement buildings and their influence on the architectural and artistic landscapes. Tenement houses present different stylistic directions in the architecture of the Russian cities.
The social significance of the streets is to preserve and revive local traditions with unique Russian trends. Tenement buildings are one of the most significant buildings in the historic center of the most cities in Russia today. The research of the early twentieth century tenement can be used in the design of this kind of buildings today.

1. INTRODUCTION

Tenement buildings as a new type of multi-purpose kind of building of European cities were built in the second half of the XIX century. The social and economic structures of society were changed during the industrial revolution. Commercial and urban centers appeared influx of population. There was a need in the premises for commercial and financial activities (offices, studio, workshop), as well as in residential areas with different degrees of comfort for small families of middle class citizens (officials, lawyers, businessmen, representatives of creative professions). Historically, a tenement was a kind of a building that was built for making profit from renting out the spaces for various purposes. Tenement building is a building that consisted of several floors. The first floor was for the purpose of public spaces such as shops and offices. These public spaces formed the appearance of buildings. The upper floors were for the apartments for rent. Also there were domestic premises in these buildings. Tenement buildings that were 3 - 5 floor high became the main type of buildings in the downtown area. They formed the ensemble of the streets and squares. Tenement buildings are the dominant accents in urban development of the Russian cities.
The author of this article aims to explore the tenement buildings of the Far Eastern and European cities. Identify their typological, volumetric and compositional characteristics and their role in shaping the architectural environment of the city.
The biggest cities of the t were built at the beginning of the second half of the XIX century, during the re-development of the Russian Primorsky region. Their primary buildings (60-70 years of the nineteenth century) were the Farmstead buildings (wooden houses). They were replaced by the row houses, which were located along the red lines of the streets. As a rule, the streets, consisted of 2 or 3 story buildings constructed of bricks. Besides, the reason of building row houses along the red lanes streets was connected to the lack of free lands and their high prices too. Consequently, tenement buildings solved the problem of affordable residential space for different strata of the population. The character of buildings had changed. Moreover, rugged relief of the Far East cities that were constricted with military districts also influenced the character of housing development. As wooden buildings

were becoming old, they were being gradually replaced with new tenement buildings. In the premises, one may notice that the urban system of Far East cities were formed on step-by step basis. And one can see that the urban system of Far East cities were formed with stage design. Tenements played the main role in this process. These buildings formed a new image of the cities and they acquired an urban look. Layering new regular urban system in the historically existing structure led to the formation of the new architectural landmarks. Tenement buildings harmonized the architectural ensembles in terms of symmetry and order. Ensembles and individual buildings built in 1890-1916 created originality and uniqueness of the architectural appearance of the city nowadays. It makes them significantly relevant from the architectural and artistic side.

2. TOWN PLANNING FEATURES OF TENEMENT HOUSE LOCATION

Streets connect all processes of the city. In other words, they dictate the location of the building blocks and the land property and define the composition.
As a rule, tenements were placed along the streets and in the intersections of the main roads according to the urban planning structure of Far East cities. In this regard, there are two main types of tenement buildings from the town planning point of view: corner buildings and row houses (Fig. 1).

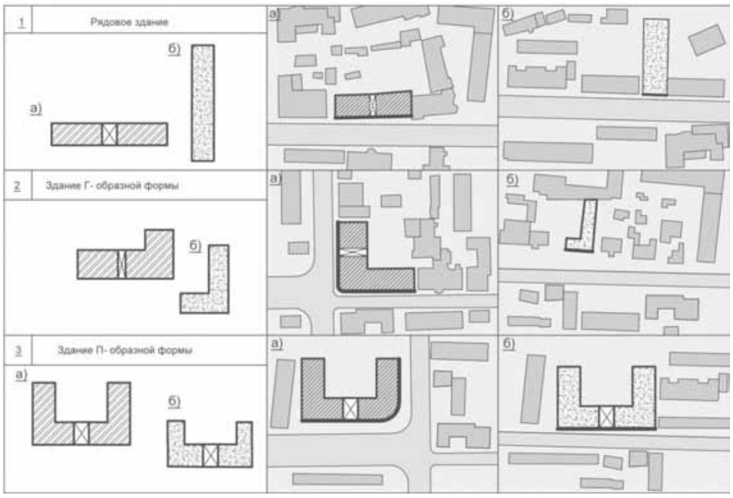


Fig. 1. Tenement buildings classification scheme based on the general principles of space planning structure building.

Angle type' tenement buildings which were located at the corner of the streets intersections became the landmarks of urban ensembles. These buildings are one of the most important urban accents in the central part of the city. That is to say, they determine the major
Artistic level of streets building at present. These kinds of tenement buildings are also considered to be dominants and accents in the structure of neighborhood. The Corners of the buildings facing the intersections and crowning the front facade were emphasized with particular architectural and artistic techniques. The examples of such tenements are: tenement building V.P. Babintseva (20 Svetlanskaya Str), tenement building M.P. Pyankova (1a Fokina Str.) and others.
Buildings that had an ordinary location were built close up along the street red lines. These tenement buildings had one front façade. They were ordinary houses with flat facades. The Examples of tenement houses of this type are E.F. Medvedev (5 Svetlanskaya Str) building, A.B. Fillipchenko (111 Svetlanskaya Str) , I.S. Baginova (16 Svetlanskaya Str) and others.

3. REGIONAL FEATURES

One of the Vladivostok regional distinctive features is complicated in terms of building urban landscape. Tenement buildings influenced the large-scale and artistic level of building development. Sometimes this level was formed taking into account the specialties of the complex landscape of urban environment. Tenements located in the complex areas with a steep relief are the masterful examples of usage of the unsuitable for construction places. Consequently, original space-planning decisions are appearing. Interesting examples of complex mountainous terrain usage in urban planning are tenement building L.S. Berkowitz, L. Sh. Skidelsky (Fig. 2), the ensemble of business and residential buildings of Sinkevich brothers and Fikhman (Fig. 3), tenement building D.A. Amorandosa and others. These building are "cut into the steep relief without disrupting its structure and volume-planning solution. They are designed in a way to make the entrance on the 1st floor at lower elevations and also at higher elevations - on the 2nd and even the 3rd floors.

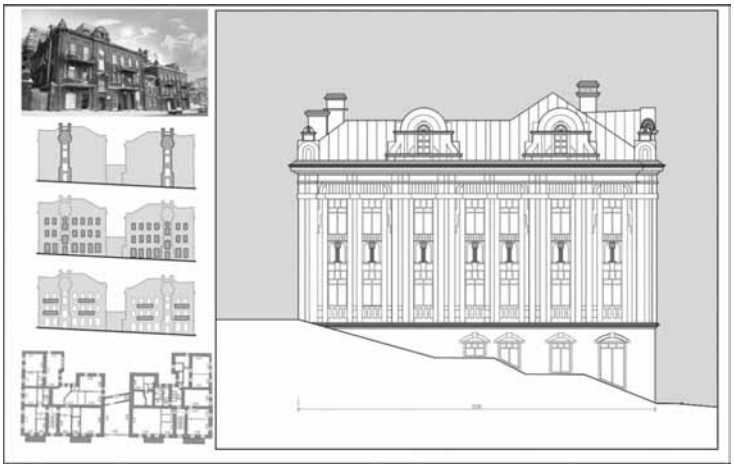
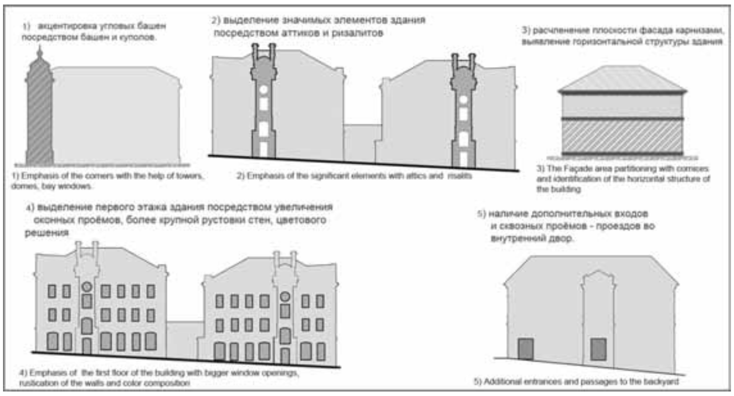


Fig. 2. The tenement building of L.Sh. Skidelsky (30A Ocean Avenue Str).

Fig. 3. The ensemble of business and residential buildings of Sinkevich brothers and Fikhman.

4. ARCHITECTURAL AND ARTISTIC FEATURES

The Features of the architectural and artistic composition of tenement houses are closely related to the urban building location in the city structure. For example, if a tenement building occupied angular position, the angle of the building was emphasized with a dome or cut at an angle of 45 °. Domes had different shapes, some of them were more elongated other had a spherical form. The Examples are tenement building of Demby (25 Fokina Str) and tenement building of Zimmermann (24 Ocean Avenue), which is located at the corner of Okeanskii prospect and Fontannaya Str. The Accents of the buildings are two large balconies located in the area metered at a 45 degrees angle and there is an octagonal dome at the top of the roof. Also there is an example of an apartment building of MP Pyankova rectangle (1A Fokina Str.) where the dome has a shape of a rectangle. The Examples of this type of



buildings are F.A. Koltsov (st. Abrekskaya 6) tenement building, F.A. Beliatski (10 Karla Libnehta Str) tenement building and O.I. Terletskiy (10 Krasnogo znameni Str), as well as the other tenement buildings.

Sometimes attic had an offset eliminating "the arch-pass" in the backyard. The example is E.F. Medvedev (5 Svetlanskaya Str) tenement buildings.

Thus, it may be noted that the apartment buildings influenced and formed the overall architectural and artistic composition of neighborhoods and streets. Typical techniques of the architectural design of facades of tenement houses in Russia are:

1. Emphasis of the corners with the help of towers, domes, bay windows (Pic. 5).
2. Emphasis of the significant elements with attics and risalits (Pic. 6).
3. The Façade area partitioning with cornices and identification of the horizontal structure of the building (Pic. 7).
4. Emphasis of the first floor of the building with bigger window openings, rustication of the walls and color composition (Pic. 8).
5. Additional entrances and passages to the backyard (Pic. 9).
6. Allocation of significant elements of the building attics and risalits.

Furthermore, artistic styles are considered to be other evaluation criteria of architectural and artistic features. These styles influenced the formation and composition of tenement houses. At that time, Russian Far East didn't have any local architectural traditions. Thus international entrepreneurs and architects contributed to the emergence of variance of styles and 'medley' buildings. Tenement houses present different stylistic directions in the architecture of the city. Facades of the buildings were performed in the following styles: the so-called 'brick style, classicism, late classicism, modernism and eclecticism combined with Baroque and Empire motifs and local colors.

Those days, most of the firm contractors originated from China. It explains the variety of Chinese motifs in Russian Far East architecture.

5. CONCLUSIONS

The social significance of the streets is to preserve and revive local traditions with unique Russian trends. Nowadays, people are concerned about saving the national spirit of the local architecture. The development and reconstruction depend on the research of the historic city of Russia. And even now, tenement buildings affect the scale and artistic level of the Vladivostok city development. Besides, the tenements formed the features of the city landscape. For the success of modern architects. restorers must carefully study the architectural techniques that formed the Russian architecture performed by the talented architects from the previous era. The feature of the Far Eastern architecture is a complex of Russian, European and Oriental architecture. This complex has unique features as the cities of the Primorskiy region have an interesting architecture of pre-revolutionary period.

Tenement buildings influenced the scale and level of the city artistic development. They formed the features of the urban environment landscape.

Tenement buildings are one of the most significant buildings in the historic center of city today. The research of the early twentieth century tenement can be used in the design of this kind of buildings today.

STUDY ON TESTING INDEXES OF CONCRETE DURABILITY

POSTER

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Keywords

high strength concrete, fatigue, damage, mechanical properties

ABSTRACT

Research on fatigue performance of concrete structure has a long history, from the beginning of the last century appear reinforced concrete railroad bridge, people began research on fatigue performance of concrete, but mainly in view of the normal strength concrete. In the past ten years, the gradual development and use of high-strength concrete, high strength concrete performance studies has the corresponding research. Domestic and international issues of common fatigue concrete structure has been a lot of research, and major research of high-strength concrete is the material selection, preparation methods, mechanical properties, structural design and construction, the research on fatigue performance of high strength concrete is very little. And concrete structures subjected to fire or sometimes through the course of other causes of high temperature, low temperature and length of time of their experiences are different, some of the works of high-strength concrete structures integrated operating condition may experience high temperatures, fatigue, etc. These will give concrete damage, causing a series of changes within the concrete material, affects the mechanical properties and durability of concrete structures, so the solutions to these problems demands increasingly urgent and unavoidable.
Fatigue status quo of high strength concrete after high temperature comprehensive overview of this article were reviewed research profiles after high-temperature mechanical properties of high strength concrete and fatigue testing, the progress of the main conclusions and theoretical research, and further studies need to be conducted discussed prospects of the main research directions concrete fatigue problems.

1. INTRODUCTION

In our daily life, there are a lot of concrete engineering such as crane beam, the highway pavement, airport runway, except under static load, but also by the role of repeated loading vehicles, aircraft, and wind, waves, currents, and even sometimes suffer from fire or other causes through the course of a high temperature process. Structural materials under repeated loads of action, will take place the below static load strength of brittle fracture, namely the fatigue damage. From the aspects of load, fatigue load in civil engineering generally can be divided into high-cycle and low-amplitude, low-cycle and high-amplitude, and super high- cycle three types. Generally considered to be low-cycle fatigue cycle times of less than 1000 times; high-cycle fatigue cycles between 103 and 107 times, higher fatigue cycle named super high-cycle fatigue. Therefore, when in the structure design, not only to consider the issue of fatigue strength of structural components, but which may be subjected to high temperatures also consider its comprehensive conditions. Many scholars at home and abroad on the fatigue test properties of concrete carried out more in-depth study and achieved certain results. However, the fatigue damage of concrete after high temperature research reported is not much, just ordinary concrete after high temperature of axial compression fatigue test research [1], the fatigue properties of high strength concrete after high temperature research reports have not been seen. This paper summarizes the recent years on the properties of all kinds of structure concrete after high temperature fatigue research situation, and discusses the current problems existing in the study of high strength concrete after high temperature fatigue properties.

2. EXPERIMENTAL MATERIAL

Table 1 Mix Proportion Design Parameters

number	serial number	water-binder ratio	coal ash dosage/ %	mineral powder dosage /%	ganister sand dosage /%	steel form	wooden form	formwork	mix time/s
1	3F40	0.3	40	0	0	Yes	No	No	—
2	4F40	0.4	40	0	0	Yes	No	No	—
3	5F40	0.5	40	0	0	Yes	No	No	—
4	3F20	0.3	20	0	0	Yes	No	No	—
5	3F30	0.3	30	0	0	Yes	No	No	—
6	3F40	0.3	40	0	0	Yes	No	No	—
7	3K20	0.3	0	20	0	Yes	No	No	—
8	3K30	0.3	0	30	0	Yes	No	No	—
9	3K40	0.3	0	40	0	Yes	No	No	—
10	3F35S5	0.3	35	0	5	Yes	No	No	—
11	3F40t30	0.3	40	0	0	Yes	No	No	30
12	3F40t60	0.3	40	0	0	Yes	No	No	60
13	3F40t90	0.3	40	0	0	Yes	No	No	90
14	3F40b	0.3	40	0	0	Yes	No	Yes	—
15	3F40	0.3	40	0	0	Yes	No	No	—
16	3F40mb	0.3	40	0	0	No	Yes	Yes	—
17	MarineC35	0.355	35	25	0	Yes	No	No	—
18	MarineC40	0.332	35	25	0	Yes	No	No	—
19	MarineC50	0.304	20	20	0	Yes	No	No	—

(a) cylinder specimens (b) plate specimens

Fig. 1. Test specimens

Aement: choose P.II 52.5 Portland cement produced by Anhui conch cement co.
Aggregate: choose Fujian medium sand as fine aggregate whose fineness modulus is 2.7; choose Wenzhou macadam as coarse aggregate which is 5~25mm continuous grading.
Admixture: choose class I fly ash of Wenzhou power plant; choose mineral powder of Hengchang ,Zhangjiagang.
Water reducer: choose PC high performance water-reducing admixture of Kaidi, Nanjing.

3. TEST SPECIMENS

Water-binder ratio, dosage and types of admixture, mixing time of concrete and template types were taken into account in the analysis of impacts on concrete durability [8-12] according to Ordinary Concrete Long-term Per-

Fig. 2. RCM method testing apparatus

Table 2The relationship of initial current with testing time

initial current I_{30}(mA)	applied voltage after adjustment U (V)	new range of initial currentI_0(mA)	testing duration(h)
I_{30}<5	60	I_0<10	96
5≤I_{30}<10	60	10≤I_0<20	48
10≤I_{30}<15	60	20≤I_0<30	24
15≤I_{30}<20	50	25≤I_0<35	24
20≤I_{30}<30	40	25≤I_0<40	4
30≤I_{30}<40	35	35≤I_0<50	24
40≤I_{30}<60	30	40≤I_0<60	24
60≤I_{30}<90	25	50≤I_0<75	24
90≤I_{30}<120	20	60≤I_0<80	24
120≤I_{30}<180	15	60≤I_0<90	24
180≤I_{30}<360	10	60≤I_0<120	24
I_{30}≥360	10	I_0≥120	6

formance and Durability Test Method Standard.19 groups of test specimens were designed whose mix proportion design parameters have been given below in Table 1.

There are two kinds of dimensions. One is φ100mm×100mm cylinder test specimen used for RCM method. Another is 900mm×400mm×100mm concrete plate specimen used for PERMIT method.

4. TEST CHLORIDE ION DIFFUSION COEFFICIENT OF CONCRETE WITH RCM METHOD

Test age of concrete is 40±5d , the main steps are as follows:

(1)Vacuum processing;

(2)Inject300mLNaOHsolution with 0.3mol/L concentration to positive pole and 12LNaCLsolution with 10%mass concentration to negative pole.

(3)Keep testing room temperature (20~25)°C. Regulate the voltage to (30±0.2) vunder unloaded condition and record initial current get through every specimen. Follow-up applied voltage (the second column in table 2) was decided by the range of initial current corresponding to 30V voltage(the first column in table 2).Record new initial current according to practical applied voltage ,then determine testing duration (the forth column in table 2)by the new range of initial current(the third column in table 2).

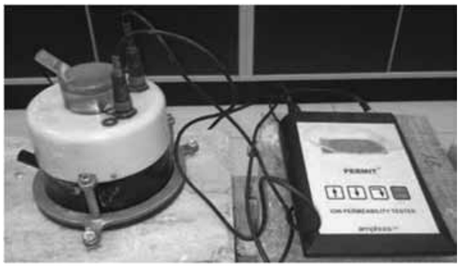


Fig. 3. Permit method testing apparatus

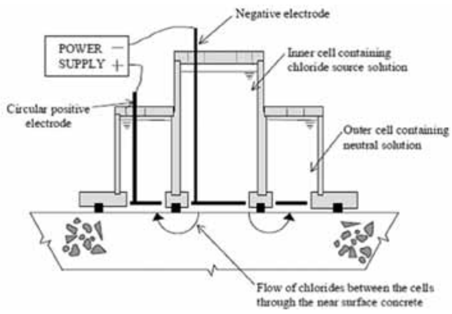


Fig. 4. Permit method schematic plot

(4)Split the specimen and spray AgNO3 solution indicator with 0.1mol/L concentration on cleavage plane to measure the distance color line from the bottom of the specimens.

(5)Calculate the chloride ion diffusion coefficient of concrete by equation (1) according to the test results.

$$D_{\mathrm{RCM}}=\frac{0.0239\times(273+T)L}{(U-2)t}\left(X_{\mathrm{d}}-0.0238\sqrt{\frac{(273+T)LX_{\mathrm{d}}}{U-2}}\right) \tag{1}$$

In which, DRCM is chloride ion diffusion coefficient obtained by RCM method, accurate to0.1×10−12m2/s; U is the absolute value of voltage(V); T is the average value of initial temperature and final temperature of electrolyte of the positive pole (°C); L is the thickness of the specimen (mm), accurate to 0.1mm; Xd is the average chloride ion penetration depth (mm), accurate to 0.1mm; t is testing duration (h).

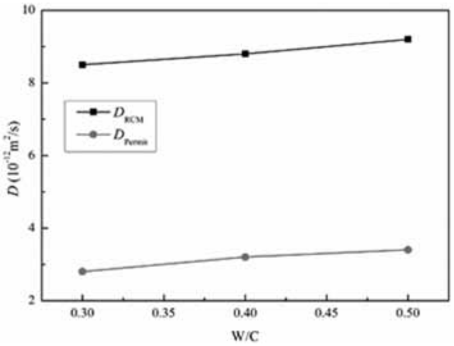
5. TEST CHLORIDE ION DIFFUSION COEFFICIENT OF CONCRETE WITH PERMIT METHOD

PERMIT ion mobility spectrometer concludes tester and digital controller, testing apparatus is as shown in Figure 3

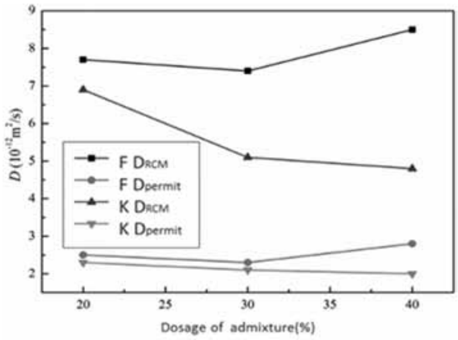
Table3 Experimental result

number	Serial number	D_{RCM} ($\times 10^{-12} m^2/s$)	D_{Permit} ($\times 10^{-12} m^2/s$)
1	3F40	8.5	2.8
2	4F40	8.8	3.2
3	5F40	9.2	3.4
4	3F20	7.7	2.5
5	3F30	7.4	2.3
6	3F40	8.5	2.8
7	3K20	6.9	2.3
8	3K30	5.1	2.1
9	3K40	4.8	2
10	3F35S5	2.6	0.7
11	3F40t30	9.6	3.5
12	3F40t60	8.4	2.3
13	3F40t90	8.7	2.2
14	3F40b	8.6	0.5
15	3F40	8.5	2.8
16	3F40mb	8.2	0.6
17	MarineC35	3.2	1.5
18	MarineC40	3	1.3
19	MarineC50	2.7	0.8

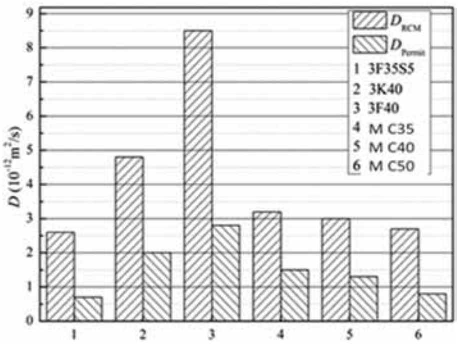
Apply 6V direct current to electrodes inside and outside the container. The inside container containing 425mLNa-Clsolution with 0.55mol/L concentration is negative pole. The outside container containing650mLdeionized water is positive pole. The testing process is shown in figure 4.



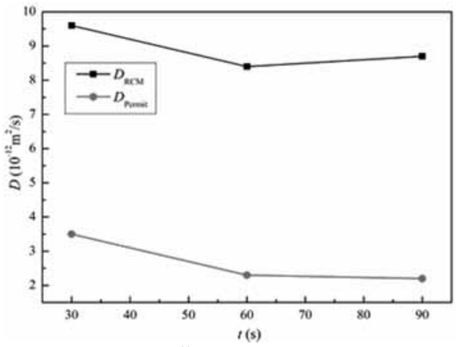
(a)di fferentw ater/cement ratio



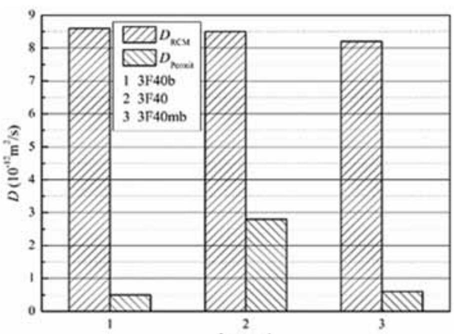
(b) different dosage of fly ash and mineral powder



(c) different dosage of admixture



(d) different mixing time



(e) different types of formwork

Fig. 5. Influence of different factors on the chloride ion diffusion coefficient

Theoretical formula of chloride diffusion coefficient:

$$D_{\mathrm{Permit}} = -(\frac{\mathrm{d}c}{\mathrm{d}t}T)(\frac{R}{zCFE})(V\frac{L}{A}) \quad (2)$$

In which, DPermit is chloride ion diffusion coefficient obtained by PERMIT method,m2/s; dc/dt is chloride ion concentration gradient of anolyte , mol/m3•s;T is average absolute temperature of steady state phase ,K; R is universal gas constant, 8.31J/K•mol ; Z is the ion valence(chloride ion valence is -1);C is intensity of the ion source solution ,550mol/m3; F is faraday constant,96500c/mol; E is potential difference of positive and negative poles,60V; V is the volume of solution in outside container(anolyte),0.00065m3; L/A is ratio of flow length and external area,3.74m-1.

6. EXPERIMENT RESULT ANALYSIS OF CHLORIDE ION PENETRATION PERFORMANCE

The relationship between chloride ion diffusion coefficients tested with RCM and PERMIT method and all the factors are as follows in Figure 5.
Testing results show that DRCM>DPermit for the same concrete which is led to by various reasons [13-16]. Firstly, experiment processes of these two methods are different. RCM method is chloride ion unsteady migration inside the specimen, while PERMIT method is steady-state migration test. In the second place, the difference of saturated state will also affect testing results. RCM method adopts vacuum saturation mechanism which could achieve better saturated state. While PERMIT method can only realize local natural saturation limited by test conditions and specimens, which can’t form good ion channels.

Figure 5(a) shows that the chloride ion diffusion coefficients of concrete tested by RCM and PERMIT method gradually increase with the increase of water cement ratio, indicating that the ability to resist chloride ion penetration of concrete declines with the increase of water cement ratio. Analysis suggests that capillary porosity of hardened cement paste and interconnected pores increase with the increase of water cement ratio, thus lead to the increase of the permeability of concrete.

Figure 5(b) shows that the chloride ion diffusion coefficients of concrete decrease and then increase with the increase of content of fly ash. The activity of fly ash is low. The cement content which is the main cementing material of early hydration decreases when dosage of fly ash is large. Thus makes the concrete unconsolidated for the reason of insufficient hydration in the test age.

Figure 5(b) also shows that the chloride ion diffusion coefficients of concrete decrease with the increase of content of mineral powder. Adding mineral powder makes transition zone of surface and internal concrete denser, significantly increasing the ability to resist chloride ion permeability of concrete. Reducing rate of the chloride ion diffusion coefficient of concrete slows down with the increase of content of mineral powder when mineral powder dosage is large.

Figure 5(c) indicates that double mixing admixture has significant effect in improving the resistance to chloride ion permeability of concrete [17]. The reason is that the average particle sizes of cement, fly ash, mineral powder and silicon powder are different which could guarantee proper continuous gradation to reduce the total porosity of concrete. Furthermore, calcium in mineral powder react with water creating Ca(OH)2.Ca(OH)2reacts with silicon phase and aluminum phase in coal ash ,accelerating the hydration rate of mineral powder.
Figure 5(d) shows that concrete chloride ion diffusion coefficient is higher when mixing time is 30s and significantly reduces when mixing time is 60s.Concrete chloride ion diffusion coefficient of 60s and 90s is equivalent .So concrete mixture could be stirred evenly when mixing time of forced concrete mixer is more than 60s.
Formworks of 3F40b, 3F40 and 3F40mb specimens in Figure 5(e) are steel form and formwork, steel form and wood form+ formwork .Three chloride ion diffusion coefficients obtained by RCM method are basically equal. Chloride ion diffusion coefficients of specimens using formwork are obviously lower than without formwork. Analysis suggests that using formwork could only improve the compactness of surface concrete which has no obvious effect on inside concrete. Testing time of RCM method is long and chloride ion infiltrates deep inside of

the concrete specimens, thus the surface compactness of concrete has no big influence on chloride ion diffusion coefficient. While testing time of RCM method is short which test the chloride ion diffusion coefficient of surface concrete .Compactness of surface concrete is improved after using template resulting chloride ion diffusion coefficient's significant decrease.

7. CONCLUSIONS

In conclusion, change rules of test outcome of RCM and PERMIT method are basically similar. The resistance to chloride ion permeability of concrete is improved after lowering water/cement ratio or adding admixtures, especially when appropriate admixtures are mixed.

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REVIEW OF RESEARCH ON THE FATIGUE OF HIGH STRENGHT CONCRETE AFTER HIGH TEMPERATURE

POSTER

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Keywords

concrete, durability, chloride ion

ABSTRACT

Chloride diffusivity is an important indicator of the concrete durability in marine environment. The RCM method and the PERMIT method were selected to test diffusion coefficient of chloride ion, considering accuracy, operability and other factors .Water-binder ratio, dosage and types of admixture, concrete mixing time and template types were taken into account in the process of researching. Experimental results show that the ability to resist chloride ion penetration of concrete reduces when the water - binder ratio decreases or admixtures are added, especially when moderate admixtures are added. Concrete mixture is mixed uniformly when the mixing time of 60L forced mixer is more than 60 seconds. Using formwork can only improve the compactness of concrete specimen surface, which has no obvious effect on the inside of concrete specimen. The results obtained will contribute to construction and further research of the concrete durability.

1. INTRODUCTION

In our daily life, there are a lot of concrete engineering such as crane beam, the highway pavement, airport runway, except under static load, but also by the role of repeated loading vehicles, aircraft, and wind, waves, currents, and even sometimes suffer from fire or other causes through the course of a high temperature process. Structural materials under repeated loads of action, will take place the below static load strength of brittle fracture, namely the fatigue damage. From the aspects of load, fatigue load in civil engineering generally can be divided into high-cycle and low-amplitude, low-cycle and high-amplitude, and super high- cycle three types. Generally considered to be low-cycle fatigue cycle times of less than 1000 times; high-cycle fatigue cycles between 103 and 107 times, higher fatigue cycle named super high-cycle fatigue. Therefore, when in the structure design, not only to consider the issue of fatigue strength of structural components, but which may be subjected to high temperatures also consider its comprehensive conditions. Many scholars at home and abroad on the fatigue test properties of concrete carried out more in-depth study and achieved certain results. However, the fatigue damage of concrete after high temperature research reported is not much, just ordinary concrete after high temperature of axial compression fatigue test research [1], the fatigue properties of high strength concrete after high temperature research reports have not been seen. This paper summarizes the recent years on the properties of all kinds of structure concrete after high temperature fatigue research situation, and discusses the current problems existing in the study of high strength concrete after high temperature fatigue properties.

2. RESEARCH STATUS FATIGUE PROPERTIES OF HIGH STRENGHT CONCRETE

Fatigue problems of ordinary concrete structures at home and abroad have a number of studies [2-5], there is a clear specification of the design provisions interpretation [6, 7], but less research on the fatigue of high strength concrete structure. Compared with ordinary concrete, high strength concrete with high density, high strength and brittleness, etc., under fatigue load are more likely to occur brittle fracture, so we need to further discuss its fatigue properties. Experimental studies mainly include uniaxial and multiaxial, constant amplitude and variable amplitude, and other combinations of conditions.

Theoretical studies of ordinary S-N equations, and boundary surface theoretical model [8,9], plasticity constitutive model [10], and the thermodynamic compatibility damage model [11], micro-plane model [12], and the fatigue strength and stiffness degradation model [13], the fatigue life of the statistical distribution model [14-16], and so on.
Compared with ordinary concrete, high strength concrete with high density, high strength and brittleness, under fatigue load are more likely to occur brittle fracture, so we need to further discuss its fatigue properties. Ming Zhong[17,18], etc. Beijing Jiaotong University , the tensile reinforcement ratio and cyclic properties of parameters analyzed by the deformation properties of high strength concrete bending members repeated loads under high cycle. They also studied the changes between the law of development of cracks and fatigue stiffness high-strength concrete beam under fatigue load, analyzed that high strength concrete beam under fatigue load stiffness is reduced, the crack width increases.
Compared with ordinary concrete beams, the development of high strength concrete beams in the initial growth rate significantly higher than ordinary concrete beams, circulating at high stress levels, $2 \times 10^4 \sim 5 \times 10^4$ times enters the stage of stable development. But after the cracks into the stable development stage, its crack development rate is less than ordinary concrete beams.
The characteristics of high strength concrete beam as follows: the cracks once appear, the width is larger, general crack when the crack width up to 0.04 ~ 0.08 mm, and soon on the beam lateral extension, the greater the reinforcement ratio and the lower crack width. This reflects the high strength concrete material brittleness and ductility. With the increase of fatigue loading cycles in $1 \times 10^4 \sim 10 \times 10^4$ times the $\omega_{\max}$ crack width changes rapidly, then basically stabilized. Peigang Wu [19] etc.
Tsinghua university, had been studied the fatigue behavior of high strength concrete in uniaxial compression under constant and variable amplitude cyclic loading was investigated and compared with those of normal strength concrete. Based on the test results, the fatigue strength and fatigue strain of high strength concrete under constant amplitude cyclic loading in compression were studied. The empirical expressions about fatigue strength, total longitudinal strain and residual strain were derived, and a proposed expression using residual strain to predict damage was put forward.
According to the test results of high strength concrete under variable umplitude cyclic loading, a revised expression for P-M hypothesis was suggested as well.

3. RESEARCH STATUS AFTER HIGH TEMPERATURE FATIGUE PROPERTIES OF CONCRETE

At home and abroad on the study of concrete after high temperature were more, not only focused on the mechanical properties of lower level, more attention to its root causes. Georgali, B. and Tsakiridis, PE [20] proposed by observation of microscopic method, a reasonable assessment of concrete temperature experienced by the lower limit and the damage depth of concrete. Fares, Hanaa [21] also studied the self-healing concrete compressive strength of the microstructure and physical properties as well as high temperature after using microscopic methods. Lima, R.C.A. [22] thought of concrete after fire would change its macroscopic mechanical properties such as compressive strength. Research on high strength concrete after high temperature fatigue damage rare reported. And related experimental study on fatigue of ordinary concrete like Xingang Zhou [1] the high temperature of ordinary concrete axial compression fatigue test research, after he put specimen heating chamber, set the heating temperature, constant temperature for 3 h, and make specimen in the natural cooling to room temperature in the cabinet.
The heating temperature points in two groups, one group of 200 ˚C, another group of 300 ˚C. After heating, all showed clearly uneven distribution of surface cracks. Cracks in concrete and surface after subjected to cyclic loading, will gradually accumulate with increasing the number of loading cycles repeatedly extension. Moreover, the greater of the difference above and below the stress level, the faster the crack extension of, achieve fatigue damage of circulating load time (cyclic times). During the test, the crack can be clearly observed with the extension with cyclic loading conditions, generally 3~5 visible cracks developed into the up and down through the cracks. The width and length of these cracks continue to increase, which leads to the coagulation on the completely destroyed. When they eventually destroyed, the damage form of concrete basic remain the same as the static effect damage state, namely the middle convex outside concrete crush, concrete at the ends of the approximate cone.
It is particularly noted that static axial compression damage and some coarse aggregate can be destroyed. The axis of concrete after high pressure fatigue tests showed that when the destruction of the state, without any damage to

the coarse aggregate, which further illustrated that micro-cracks after extended high temperature under the action of repeated cyclic loading fatigue is the main factor in properties degradation. Fine cracks will arise and develop among the surface of concrete aggregates if concrete exposed to high temperature 100°C~300°C.
Compared with concrete at normal temperature, the uniaxial compressive strength of concrete exposed to high temperature below 300°C almost remain constant. But, under constant amplitude cyclic loading, fine cracks will develop further, so the fatigue behavior of concrete will reduce remarkably. Peiyin Lv, Yupu Song [23], etc. were studied tensile fatigue properties under repeated load amplitude at different temperatures and the design of the concrete strength for C30, axial tensile and splitting tensile test was carried out on the block. Analysis of the concrete tensile fatigue strength, stiffness, deformation of different temperatures, establish the corresponding fatigue equation and considering the effects of temperature and unified fatigue equation, and the fatigue properties of concrete under normal test results are compared with the results of other researchers given the total longitudinal strain, secant modulus of the empirical formula, and the second phase of the total strain rate of growth, decay rate secant modulus and fatigue life of the relationship.

4. CONCLUSIONS

This paper summarizes the fatigue properties of concrete at home and abroad in recent years with a view future scientists to examine the effect of concrete fatigue properties sprang out. On the status of the fatigue properties of concrete after high temperature analysis, we found only at home and abroad to study on fatigue properties of high strength concrete, research plain concrete after high temperature fatigue properties more, and the study of high strength concrete after high temperature fatigue properties is almost blank.

At the same time, the domestic and foreign researchers tend to a variety of factors to fatigue and complex environment separately from a separate study, while such studies do not conform to the objective practical application, it is difficult to judge the damage process and degree of structural concrete. Visible, due to the different purpose and different angles, fatigue study said about the concrete after high temperature, failure to temperature history of concrete, macroscopic mechanical properties well linked, failed to reveal the combined effects of heat and force of the concrete internal structure evolution mechanism ,between various research methods and results to confirm each other enough.

Therefore, the experiences have not been set up concrete temperature height and the length of time , the relationship between the macroscopic mechanical properties more perfect model: the model can qualitatively describe science materials at high temperatures and mechanical damage to a combination of the structure characteristics and relationship. System needs to be further in-depth research, which will be the future of concrete fatigue performance further main direction of research is also the author of ongoing research.
For these studies, the current group of Southeast University academician Sun Wei is also studied fatigue properties of structural concrete in multi-factor coupling, and achieved certain results.

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REVIEW OF RESEARCH ON PREFABRICATED STEEL STRUCTURE RESIDENTIAL BUILDING INDUSTRIALIZATION

POSTER

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Keywords

prefabricated steel structure, industrialization, lattice column, the earthquake force

ABSTRACT

Prefabricated steel structure residential building industrialization in foreign countries has developed for several decades and the increasing maturity of the technology is fast. But in domestic, the research is less. In recent years, countries are vigorously promoting green building, energy saving, low carbon environmental protection structure system, and the steel structure housing industrialization is in accordance with these requirements. For prefabricated steel structure housing industrialization, the main problem now is that how to solve in the structure of the building structure on the horizontal seismic force resistance. In this article, first synoptically introduced the developing course of prefabricated steel structure housing industrialization, and introduces the structure that is joined in the structure between the column support, through between pillars support the role of the new type of lattice column. This structure resist force of passed from the horizontal seismic. What is mentioned in this article is through the column support which can solve the prefabricated steel structure residential building horizontal seismic force resistance and good to enhance the integrity of the structure system .In addition ,this is very helpful for the development of prefabricated steel structure residence system.

FOREWORD

Building industrialization is a way of housing production change, the by the building original manual and mechanical mode of production into a modern approach to building production mode. This is a big chang for the residential mode of production. In June this year, relevant departments held a building industry modernization of national building standard design training, from the national the relevant provincial urban construction departments attended the meeting. At the conference, the relevant department leaders, comprehensively promoting the modernization of Chinese construction industry sustainable development important speech. Because of modern construction industry in China in recent years vigorous development trend is good, this has become an emerging strategic areas and construction transformation and upgrading of the window, and the attention of the country will have the very big. Therefore, the modernization of construction industry research has application value. In addition, in recent years, countries are vigorously promoting green building, energy saving, low carbon environmental protection structure system, and the prefabricated steel structure residential building industrialization not only accord with the requirement of green building, more in line with the trend of construction industry modernization.

1. THE DEVELOPMENT OF INDUSTRIALIZATION OF PREFABRICATED STEEL STRUCTURE RESIDENTIAL BUILDING IN OUR COUNTRY

Building in the early stage of industrialization, from the founding to the 1980 s, the industrialization thought came up with. On May 8, 1956, the state council issued decision on strengthening and development of construction industry. This is China's earliest industrialization road which is put forward. During this period, the domestic demand for building is very tense. During this period, with the developing of socialist industrialization, residential industrialization also started the research. But at this point, the domestic introduction of the ideas of the Soviet union, “a fast way to solve housing shortage” of building industrialization idea introduces some of the ideas from the Soviet union at the time. This theory derivatives the idea of “developing standardized production, mechanical construction and standardization design”. The mechanical construction is the core of housing industrialization, and the mechanical construction of the main way is fabricated structure. Over this period, the development of steel structure in our country is still in a period of relatively slow, so in this period of prefabricated steel structure building industrialization development in our country is more slowly.

From the ninety s and 1980 s, construction of industrialization development is an exploration of housing industrialization. During this period, the precast concrete production has experienced an unprecedented big development period of prosperity. In this period our country appeared a lot of precast concrete manufacturers, annual production of precast concrete number of 25 million m2. At the same time, construction industry in our country has great changes, and many buildings were made by the precast concrete components which greatly shorten the production cycle of the building. But related prefabricated building design, construction standards, the relevant construction technology, construction methods and safety procedures has not been established. Even in some aspects and the current domestic construction technical standards and norms in many places still not compatible, which makes the top design, the examination and approval and acceptance can not depend on. At the same time these aspects have certain influence to the industrialization of residential large-scale promotion. Over this period, the national steel production maintained a high growth, and the number of steel, varieties, specifications of steel structure has been achieved even more than the international standard. This for our country's steel structure residence has laid a solid foundation.

The height of building industrialization. Since the 1990 s, with the development of other countries in the world prefabricated construction industrialization, with the policy of our country, the development of Chinese industrialization of prefabricated construction in our country has entered a period of rapid development. In 2006, the ministry of construction issued the trial measures on settling national housing industrialization base file, national building industrialization base began formal implementation, through construction of residential industrialization base is driving the development of building industrialization. Under the state council on forwarding the national development and reform commission and ministry of building and urban-rural development "green action plan" hair [2013] no. 1 files, these will push forward construction as an important content of industrialization.

The new path of industrialization with Chinese characteristics and promoting the development of construction industrialization are the party central committee and the state council determine a major strategy. A major measure is to build a well-off society in an all-round way and also related to the housing urban and rural construction global urgent and significant strategic task. So, prefabricated steel structure residence has became the development trend now. Some well-known domestic construction companies also began to the implementation of the steel structure building industrialization, such as yuanda, hangxiao, etc.

After 60 years of development, in domestic the development of residential industrialization has experienced twists and turns, and now is entering the development period. Although this is still in the stage of groping forward, prefabricated steel structure building conforms to the slogan of the current green building with the low carbon, low noise, low pollution. And in terms of construction, not only greatly reduce the construction period, and in the construction site most of them are dry construction, which will be the lowest noise and pollution.

2. FOREIGN PREFABRICATED STEEL STRUCTURE BUILDING INDUSTRIALIZATION DEVELOPMENT

After the second world war, due to the severe trauma of the war, people's demand for housing is very large. In order to solve the problem of the shortage of the house, some European countries adopt industrial prefabricated and built a large number of residential and a series of standard and the building system, and continue to many countries by the rapid development of economy, such as the United States, Canada, Japan, etc. After decades of development, the development of building industrialization of developed countries has reached a mature stage. In the 1960 s, the United Nations on the basis of summarizing the experience of countries put forward the Suggestions for building modular coordination and pointed out that " generally adopting the modular coordination is to promote building the whole process of the most effective way to realize industrialization, and is now generally accepted for the people the most effective way to solve the housing problem". Up to now, the United States, Europe, Japan has formed a complete set of residential industrialization system. In the mid - 1980 - s Japan began to carry out integrated housing. Japan's steel structure residential also started to realize industrialization of residential and formed a complete building industrialization. In recent years, some of Japan's enterprises according to different demand of resident, and through own adjustment, the housing industrialization constantly got improved. Summarizing foreign prefabricated steel structure housing industrialization development, despite the different social background, economic condition, policies and measures, but countries are all highly advocates residential industrialization. Especially in the advocacy of sustainable economic development of contemporary, prefabricated steel structure residential industrialization has become the trend of the world.

3. THE DEVELOPMENT SITUATION OF PREFABRICATED STEEL STRUCTURE HOUSING INDUSTRIALIZATION

Steel structure housing development in our country has experienced 60 years of development, which a form to meet the requirements of building. Combined with the status quo of China's steel production and steel market, the ministry of construction and the original country construction steel technical coordination group for the national construction steel structure industry fifteen plan and development plan for 2015, and strive to construction steel structure in our country during the 15 steel quantity achieved 3% of the total steel production, to reach 6% in 2015. Promoting the development of the steel structure housing, for domestic development of new materials and new system has a big role. At the same time, due to recent years, countries are actively promoting green building action, so the prefabricated steel structure housing is a big trend of promotion. Now, also some large companies in the country of prefabricated steel structure residential industrialization made some exploration, such as, in 1999 in the zhengda, they built first prefabricated steel structure system, the eight level residential buildings. By the end of 2010 prefabricated residential area has more than 1 million m2 . Hangxiao in 2003 for $1 billion dollars in xiaoshan built residential steel structure component production base, and in the tonglu built residential steel structure supporting system of three board production base.the introduction of the world's leading steel structure component, internal and external wall and board production equipment and process, complete sets of production of steel structure housing products.

But as a result of domestic prefabricated steel structure housing industrialization development time is shorter, the frame structure of research needs to be improved. With the universality of steel structure housing, not only to meet the requirements of building design, but also satisfy the economical aspects. Especially under the axial force, horizontal seismic force of superior mechanical properties, so add column in steel structure support, through between pillars support the role of the new type of lattice column, this structure to resist from the horizontal seismic force of passed. From the component not only resist the horizontal seismic force, from the aspects of overall structure, improving the integrity of the structure. The artifacts for prefabricated steel structure residential system has played a supplementary role.

4. THE PROBLEMS AND THE PROSPECTS

Prefabricated steel structure building industrialization regarded as the trend of contemporary development. Although this can meet the national policy for the many, and is a low carbon, low pollution, low noise, structural system. But the system still has some problems, the following problems and its prospect of this system:

(1) The corresponding research facilities also need further research. Because of the system development time is shorter, supporting facilities to study also need further research, such as the column support between research, now a lot of scholars to support between pillars have part of the study. I believe in the near future this problem will be solved.

(2) Prefabricated steel structure housing industrialization needs corresponding to the specifications and standards. With the development of prefabricated steel structure housing industrialization, although there has been a lot of enterprises to carry out the part of the project, the lacking of specification for prefabricated steel structure housing industrialization and standard makes the system have a benchmark for the construction industry. As the structure of the system is complete, the corresponding norms and standards will be improved.

Above all, prefabricated steel structure building industrialization not only showing its green, no pollution, low noise characteristics, but also reflects the economic, fast, and the characteristics of industrialization. To promote the development of large steel structure in China has very important meaning, can be predicted, prefabricated steel structure building industrialization in our country in the future decades of development will be more promising.

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SESSION 2

ARCHITECTURE AND DESIGN,
URBAN PLANNING,
URBANISM

THEORETICAL ASPECTS OF THE FORMATION AND DEVELOPMENT OF THE IDENTITY OF URBAN PUBLIC SPACES. BY THE EXAMPLE OF THE LARGEST CITIES IN FRANCE

POSTER

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Keywords

identity of the city, public space, identity factors

ABSTRACT

City is the place of human interaction, city is a whole of people. Public spaces form the face of the city, they are possible only when there are people in them. Public spaces are a key element in determining the identity of the city. In today's global world the importance of identity increases. There is a need for identifying, forming and development of the city's identity, finding the means of its expression especially in urban public spaces. For this purpose it is necessary to determine the factors that shape identity. After analyzing these factors it will be possible to work out a strategy of the city's identity development, which will be unique to each city. The author allocates three groups of urban public spaces identity factors: environmental factors, architectural and spatial factors and social factors. The group of environmental factors is divided into landscape (geographic features of the area: relief, water area, visual communication, etc.) and climate (climatic features of the area). The group of architectural and spatial factors is presented by physical (material) objects of the urban environment (architecture, forming a public space, its character, scale and aesthetic characteristics), open urban spaces (typology and configuration of open spaces, the scale, the principle of its organization), and virtual space (positioning system, the introduction of modern technologies). The group of social factors includes: society (urban society, local communities, their traditions, mentality), models of behavior (events, traditions, lifestyle, etc.), and history (events, historical facts, etc.). Urban open spaces factor is considered separately using specific examples on different scale levels, and is divided into two types: zonal (spaces having areal character) and linear (having a linear character). Zonal open spaces are considered on the following scales: the scale of the large fragment of the city (for example, the historic center of Strasbourg), the scale of square (for example, the central square of the Vieux Port in Marseille), the scale of the park (for example, Parc de Bercy in Paris); linear open spaces: the scale of the street (for example, Viaduc des Arts in Paris), the scale of the waterfront (for example, Riverfront of The Confluence in Lyon). At the intersection of presented three groups of factors "cultural layers" of the city are formed, which the author believes are crucial to the concept of identity. Lewis Mumford believes that the main mission of the city is broadcasting the cultural heritage of human civilization. In the given direction the article describes cultural layers, their temporal and qualitative features on the example of regional identity. Also the article highlights the function of public spaces in the city, which is the cultural education of the human mind. Features of man's perception of identity of public space are marked, both positive and negative perceptions. The notion of the identity of the city is introduced. It is a combination of old, traditional and new elements of the city's identity. This area can be variable in its parameters and represents the quintessence of the city's identity. The author of the article relies on the scientific works in adjacent fields of science, philosophy, sociology, cultural studies and political science. Authors observations taken in the largest cities of France (Paris, Lyon, Marseilles, Strasbourg) were used. As a result of the research we propose the following scheme of action for the formation and development of the identity of the city public spaces: analyze the complex of factors that determine the identity, form a strategy of identity and form a region of the city's identity. The combination of these measures can make the city unique, attractive and competitive.

1. INTRODUCTION

According to most of the general urbanistic concepts, city is the place of human interaction, city is a whole of people. Public spaces form the face of the city. They are a key element in determining the identity of the city [Barbara

Engel]. From the point of view of political scientists, culturologists, sociologists and architects social or public spaces are first of all defined and characterized by the society, in other words, public. Considering features of the interaction of urban space, society and psychological characteristics of human space perception in more detail, there is an opportunity to talk about the identity. It should be mentioned that the identity may be different: urban identity, the identity of the city and the identity with the city, regional or territorial identity. In this paper aspects of the city's identity are mainly discussed, taking into account the person as a viewer and the features of his space perception.
The identity issues are affected in different areas of city life, and become the key in determining the strategy of urban development more and more each year. It is substantiated by the fact that in the modern world person is a defining resource, which cities are fighting for. As a potential resident, a businessman or a tourist he is attracted by the exceptional manifestation of the city, which are determined by the identity. Therefore active interaction between the city authorities, its communities, the scientific community, professionals in the field of urban environment and also which is very important, artists accumulates. They are the bearers of the identity. One of the positive examples of such cooperation could be Lyon, which was able to significantly improve the quality of its public spaces in a short time.

2. BACKGROUND

The city faces the following main challenges: determine the identity, form or develop it, find the ways of its expression in urban public spaces. To do this, the factors that determine the identity of the city in urban public spaces must be found. Various factors classifications are considered in different scientific works. For example a sociologist Diaghileva distinguishes stable factors (location, climate, history), variable factors (the size and population of the city, the appearance, the welfare of life, cultural traditions, local communities) and symbolic factors (urban symbols, the political climate, cultural codes of behavior of the inhabitants, significant events, personalities, fashion, etc.) (Dyagileva N. 2013). It is also permissible to classify them on the physical (material) and intangible ones. The author proposes the following classification. There are three groups of factors of identity: a group of natural factors, a group of architectural and spatial factors and a group of social factors.

3. METHODS

In order to form the proposed classification of the determining the city public spaces identity expression factors, theoretical writings on urban studies of Russian and foreign authors were investigated. Also during the study realized and unrealized architectural and urban projects such methods as critical analysis of the positive and negative qualities, method of comparative analysis, for comparing similar projects and graph-analytical method to assess the quality of the solutions proposed were used. The author also uses an on location study of public spaces of major French cities. For this purpose such on location research methods as observation, photographic fixation, etc. were used. In the final stage, such methods as compilation and typologization for composition of typology for classifying the identified factors were used. The research results were analyzed, and on their basis the proposed factors classification was developed and a new concept was formed.

4. CASE HISTORY

The Group of natural factors includes the landscape, which is largely crucial for the city as a whole, and for the open spaces of the city particularly. This concept includes all the geographic features of the area (topography, water areas, etc.), visual links formed due to the relief, landscapes, panoramic views, and more. Gustafson Poster writes about the importance of the landscape as follows: “Landscape focuses and intensifies the experience of time and space. It is both a necessary feature of our artificial habitat and the act of social and cultural expression” (Betsky A. 2008).
The second natural factor is climate, which is one of the most important humans expectations in choosing the city for living. Climate largely determines the identity of the city. Striking examples are London and St. Petersburg, in the mind of every person they are identified by changeable and rainy climate. It is interesting that Amsterdam with the same climate does not have such reputation. Together the landscape and climate determine the specificity of the flora and fauna of each city, which also affect the open public spaces. “Every detail, every object of nature becomes important as a symbol. Nature haunts us like the childhood and spontaneity, through the filter of memory” (Lefebvre H. 2000).
The group of architectural and spatial factors is represented by physical (material) objects of the urban environment. Such as architecture, that essentially forms the “border” between public space and private space. The character of architecture, its scale, aesthetic characteristics, its historical value, building density and so on affects

the identity. Architecture is the most expressive translator of the identity of urban space. In the cities with the rich architectural heritage the variegated ensemble is formed, in case the objects refer to different historical periods and styles. Symbolic or recognizable architectural objects significantly affect the external image of the city's identity focused mainly on the "guest". They also influence the internal image, representing for example a coordinate system, or being the center of attraction of a particular social group. The second factor of this group is urban open space. Fragments of urban space as well as architecture can form the identity through the features of their configuration, size, principles of organization, etc. A striking examples are historically formed trabulis in Lyon. These are pedestrian streets-tunnels crossing the main, extending along the river Saône, streets of the historical center, which was saturated with housing for weaving mill's workers in XIX century. This factor of expression of the identity of the city in public spaces is the most interesting within this study. So the more detailed consideration should be given to it. The author divides the factor of open spaces of the city into two types: zonal (spaces having a real character) and linear (having a linear character). Zonal open spaces are divided into the following scale levels: the scale of the large fragment of the city, the scale of square, the scale of the park. For example, the historical center of Strasbourg is perceived as a unique single complex of open public spaces, because half of its streets were closed to vehicle and turned to pedestrian as they were centuries ago. As a result, a person experiences sensations that occur in the space of the medieval city. The scale of the square is invited to review on an example of the central square of the Vieux Port Marseille, that was reconstructed in 2013 by the project of Sir Norman Foster. According to the project a significant part of the square became pedestrian, the roadway for cars was reduced and in the center of the square the construction of laconic form was erected. This construction thanks to the mirror coating reflects what is happening on the square and the surrounding historical buildings as well. This method draws the viewer's attention on the surrounding architecture and underlines the specificity of the space. The scale of the park can be represented on the example of Bercy Park in Paris. This park was renovated in the late 90s of the last century, until 1970 the territory was used as a major wine warehouse where the wine was delivered from the provinces. Despite the fact that the place has lost its previous function, every visitor has the opportunity to "get in touch" with the history. The history of the park can be recognized in such details as saved railway tracks, which were used for driving up the wine barrels. The authors of the reconstruction project preserved the structure of the internal streets of the territory. And the key object of the territory has become the saved fragment of two-story buildings area – the Bercy village. Now it is a commercial street with restaurants and cafes.

Next, consider the linear open space. In this section the scale of the street is invited to consider, a striking example can be the Viaduct of Arts in Paris. The facility was built in the mid-19th century – it was the railroad "Paris-Strasbourg", which led to the Place de la Bastille. However, in the middle of the last century, this railroad has lost its relevance, and in 1994 the facility was renovated and the Viaduct of Arts was opened. The first level was set aside for artists' studios, on the second outdoor level a garden-promenade that caught the fancy of the citizens was laid out. The most interesting method was the change of the viewer's perception angle of the city. A similar project of the reorganization of the transport infrastructure element into the promenade was implemented in 2009 in New York (The High Line Park). The scale of the waterfront is presented by the example of Konflyuens district promenade in Lyon, the reconstruction of which is conducted on the Herzog and de Meuron architects' master plan. On the waterfront – the former port area – overhead cranes were kept and a number of storage facilities were reconstructed, having received new functions (Fig.1).

The main task of expressing the identity in urban open spaces is to build a "connection" between the man in this space and the history of this place, thereby enriching him spiritually and intellectually, provoking him to new communications, bringing up and developing a sense of responsibility and belonging to this place. Thus a person (citizen) identifies himself with this place and the city as a whole.

The third factor of this group, it is the virtual space. At the moment, it is impossible to completely isolate the real space from the virtual space. The digital space is able to complement the identity of the city, to saturate the real space with information through the introduction of new technologies, and make it more accessible to the viewer. However, there are concerns over the active introduction of digital technologies. The first concern is that according to the concept of Louis Mumford, it contributes to the destruction of the social texture of the city. He also speaks to the fact that the city becomes invisible, and that now people do not need to meet for action, resulting in the formation of man increasingly shifted to the sphere of symbolic communication rather than material urban forms.

The third group is a group of social factors: the society (urban society, local communities, their traditions, mentality), models of behavior (activities, traditions, lifestyles, etc.), and history (events, historical facts, etc.). The society is a carrier of identity, its translator, spectator and participant. The most eloquent expression that proves this idea can be the quote of Manuel Castells: "The space is not a reflection of the society but its expression (Castells M. 2000). The space cannot be separated from the society – it is the society". The society transfers the knowledge, experience and tradition from generation to generation. Communities, if any, perform a crucial role in the development of identity. On this occasion, Glazychev V.L. expresses the right opinion: “Empty public spaces or the lack of them say about the absence of the urban community” (Glazychev V. 2009). In such case the words of Bernard Tchumi should be mentioned: “the architectural space is determined by the actions that occur in it, as well as the walls that form it”. At the moment, this has resulted in such a direction in architecture as a behaviorologiy. The following opinion of Pellegringo P. is also interesting: “The identity of urban space lies not only in the traditional architectural forms, but also in the geometric configurations and human-scale space configurations, and in the aspects of the interaction of citizens with this space” (Pellegrino P. 1998). And “If the energy is the ability to perform the work, then the identity is the ability to socio-cultural, civil or economic activity” (Krylov M. 2005).

To determine this identity the professionals appeal to the history, the cultural layers, which are formed in course of time and can be expressed in architecture and urban space. Cultural layers should be considered on the example of regional or territorial identity, which is the correlation of the individual to a specific geographically limited community (Krylov M. 2005). This raises two issues: time and quality. Issue of time deals largely with the identity of the city, and quality issue – with urban identity. Time issue refers to the history, the traditions, reveals a unique and unrepeatable aspect (trait) of a given city or territory. To date, in Russia regional identity is widely used in branding, in order to attract the tourist flow. However, there are some differences between Russian and European experience in the process of defining a regional identity. In the old European cities usually the identity (attracting tourist flow both internal and external) organically grows out of the gradually developed complex combination of many cultural layers, which are expressed in the static elements of the urban environment and in the behavior patterns of the society, its everyday life as well. In Russia this gradual, phased development has been dramatically interrupted for a long period of the Soviet era. Over time, this period has also become a part of history, one of the cultural layers that enriches our heritage, however, it also partially broke the cultural traditions and connection with the pre-revolutionary period of Russian history. This phenomenon broke the organic links with the history, so the modern authorities often have to “think up” the grounds for the city’s identity, there is a “myth-making” practice, which is not consistent with the feelings and the identity of the local community, it is imposed to people. It attracts tourists, but an educated person can always differ authentic things from the “the fictional”. As a result, there is a substitution and distortion of local culture. The question arises what cultural layer should we refer to and develop it. The author believes that it is necessary to choose the one which is most pronounced at the moment, and which the locals in its most diverse identify themselves with.

The second issue is quality. It is proposed to reflect on multicultural nature of modern cities. Cities, especially large metropolises have plenty of “faces”, it is expressed in the form of national or religious communities, different social strata of the population by status, income, etc. The question arises: what should be the fundamental identity for the city, which is true. Each fragment of the urban environment has its own identity, expressed by different means, whether we have to preserve and develop it or not. The modern city has to bear rather the identity of multicultural city. As a result, public spaces of multicultural city will be able to cultivate tolerance in men. This in particular says Hajer Maarten based on specific examples (Hajer M., Reijndorp A. 2001).

The arguments about architecture, identity is only possible in human consciousness, and is largely determined by the peculiarities of his perception of reality. One of the basic concepts of Hannah Arendt is that reality exists only through the publicity. Therefore it is necessary to take into account the peculiarities of perception of the space and its identity. Turning to the issues of perception of the space we should appeal to the works of Kevin Lynch, both founder and researcher of the city image, which is formed in human consciousness. Among the architecture theoreticians and planners, he was the first to theorize a matter of perception of the city by the resident. Currently the scientific community has accumulated a large number of papers on this topic in architecture, sociology and psychology area. The perception of the city is unique for every person; it forms a single image of the city in terms of ones relation to it, personal experience, the level of cultural development and education. The image of the city may also be collective, according to which mental maps of the city are usually made. It is important to note the words of Hannah Arendt: the unity of the public space, is not so much the unity of views, as the unity of the relationship, the possibility of which just also defined by the difference of views (Arendt H. 2000). This raises another feature of space perception differences: there are places the identity of which corresponds to the views of everyone. However, the more traditional elements of the city identity are closer and clearer to one age group, the younger generation will identify the city by other, newer places. Also, the city is imposed by a virtual image of open spaces formed by the network and supplementing the real objects. As a result of the overlay of old and new elements and components of the city’s identity, including virtual space, what was called by the author the city identity area is forming. This is a variable in its physical characteristics and parameters public space, that represents the quintessence of the city’s identity. In the changed socio-economic environment it is becoming increasingly apparent. For example, as the architect Wolf D.Prix thinks we should not mourn the loss of public space, but reinterpret it as a free-floating, network and medial event, which is more like a semiconductor than a sequence of spaces (Betsky A. 2008). This area is part of an equally changeable connection framework of the city. It is confirmed by Doreen Mesen words: spaces-transformers may not have their own stable identity of "places", they become "places processes" (Massey D. 1994).

5. RESULTS

As a result of the research author has identified three groups of factors affecting the formation and expression of identity in the city. In more detail the factor of open public spaces in the city was analyzed. Also, the term "area of identity" reasonably substantiated and introduced by the author. This new term brings the knowledge of the identity on a new level, in compliance with the current reality. The obtained results can be used in the research field and in practice as well. Architects, urbanists and landscape architects can use the research results in the design of public spaces in the city, which will contribute to the development of interesting solutions that emphasize the uniqueness of place and community.

6. CONCLUSIONS

Summarizing the arguments on the subject of identity of urban public spaces, it must be said, first, that they are a determining factor in the city's identity, and secondly, that identity is a system of relations that forms the city identity area. This is where the formation and development of the city's identity can be made. On this basis, a strategy for the unique and unrepeatable identity of public spaces of the city can be developed.

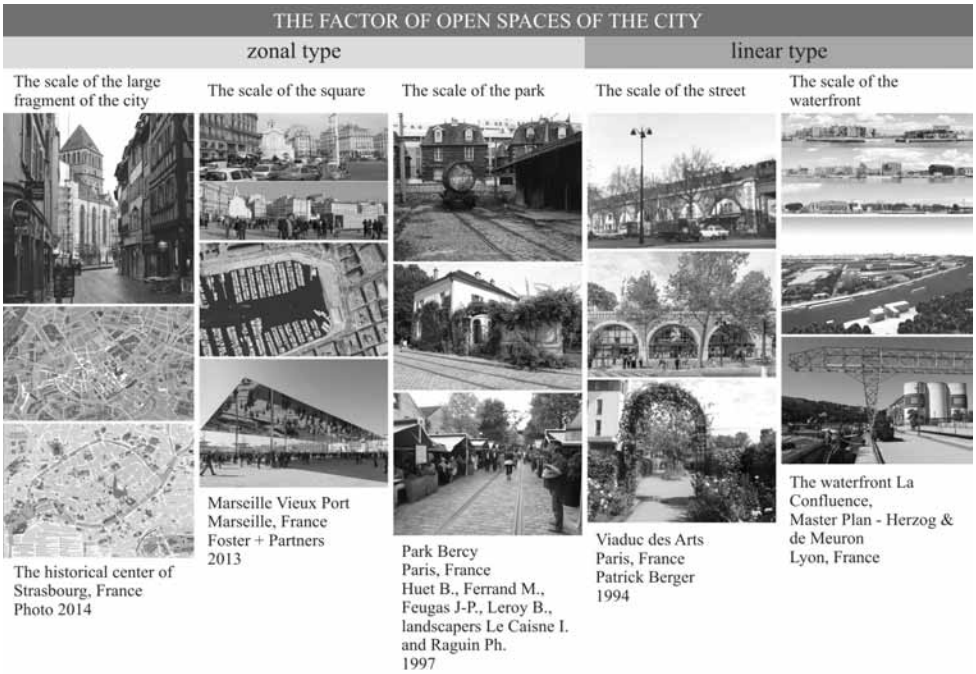

Fig 1. The factors of open spaces of the city.

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PRECONDITIONS FOR LARGE CITY PLANNING STRUCTURE DEVELOPMENT PROCESS MANAGEMENT TODAY

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Keywords

planning structure, communication structure, urban planning systems

ABSTRACT

The increasing complexity of the largest city planning structure necessitates the revaluation of the traditional architectural and spatial conception of certain planning elements and their connecting structure. It requires a more rigorous coordination of the placement of objects within the integrated solution for a uniform planning and communication structure of the city center. The analysis shows that the current stage of implementation of comprehensive activities for the development of architectural and spatial environment and modernization of all urban planning systems of large cities involves the rejection of uncontrolled suburbanization and the transition to a polycentric development. The adoption of a unified system of directional network planning structure of the city in the formation of spatial polycentrism of urban areas today is a prerequisite for sustainable urban development.

1. INTRODUCTION

The structure of the large city, as a place of the highest concentration of activity in recent years is undergoing a significant evolution due to outstripping growth of urban planning activities and increasing communicative activity. One of the key architectural principles - the principle of unity and hierarchy becomes especially important at the present stage of the city and its center development, and in many ways is associated with the evolution of the concept of planning structure of the city as a stable combination of structural planning elements and connections between them (Bocharov, Yu.P., Kudryavcev, O. K. 1972). Planning structure is a fundamental urban category. It is a capacious concept and can refer to a specific urban planning unit (town center, residential area and others.), having a territory, configuration, borders and structural subdivisions. The currently practiced usage of the city separate areas for public transport or facilities does not take into account the whole system of planning and spatial relationships. This, eventually increases the gaps between various public activity concentration nodes that function intensively and form communication flows. In the new circumstances the necessary conditions for the further sustainable development are the reassessment of the traditional ideas about the wide scope of architectural and spatial relationships of the planning structure elements and the requirement of more rigorous coordination of objects placed in the framework of a comprehensive consideration of the planning - communication structure of the city (Aloyan, A. 1985). The planning - communication structure is becoming an integral part of the modern city, ensuring the unity of public facilities and transportation systems and hierarchy of their functional and spatial interaction. Strengthening the role of communication systems in the organization of cultural and socio-economic processes across the city and its settlement system due to the increase of volume and intensity of traffic flow and increased importance of certain areas and the concentration of the active nodes of activity, requires special consideration as the planning - communication structure in all stages of urban planning.

2. THE MAIN CONCEPT

Urban development as a major component of the territorial strategy in Armenia, as well as all over the world has undergone major changes recently, primarily related to the revision of urban policy and forms of financing, taking into account new forms of property ownership and the transition from a state monopoly to a variety of investment activities. Already in May 1998 National Assembly of Armenia passed the new law “On Urban Development”. The Zoning project, a completely new type of project documentation was adopted in 2001. Another milestone was the creation of the urban cadaster, functions and necessary principles of which are fixed by law and special standards in 2003 (Ministry of Urban Development of the Republic of Armenia, 2003). The implications of the zoning completely replaced the previously practiced project of detailed planning, which have recently been completely excluded from the package of mandatory project documentation. The principles of planning structure formation as an interconnected system of planning elements and connections in general are given in the recently approved Urban development construction norms (Ministry of Urban Development RA. 2014).

All this was accompanied by the development of great volume of new urban development projects and other types of documentation for cities and their separate parts. In the same time in connection with the intensification of cultural and social-economic processes in the city and its metropolitan area, and the active implementation of transport and information means redefinition, reinterpretation and improvement of the concept of the architectural planning structure has become one of the most urgent problems of modern urban development. Fundamental changes in urban development strategies and design methods need on the one hand comprehension of previous experience on the other hand revision and re-evaluation of existing concepts.

3. METHODS

The study is based on the historical approach, which assumes a means of learning about something by considering its origins and development, and comprehensive evaluation, comparative analysis of urban systems of Yerevan, Minsk, Riga, Kharkov and other large cities which have in a relatively short period of time become major centers of large administrative agglomerations with a population of one million or more. The planning structure of those cities transforming at different stages of rapid development is facing a new and more profound transformation.

More detailed evolution of planning formation is considered by the example of Yerevan, taking into account study of past and current urban development documents and many years of direct involvement of the author in the work on the master plan of Yerevan[i]. There is a review of the peculiarities of formation and development of Yerevan's planning structure and planning ideas and concepts at different stages of the master plan and other projects. The issues of its existent spatial organization are revealed. Comparative analysis of the preceding development is given. The modern city main regulation elements of spatial and planning organization and territorial subdivisions depending on its urban enviroment values are singled out. The proposals on further spatial-planning development strategy of the large cities are formulated.

3. CASE HISTORY

In the process of social historical development the city has always been a place of political, social and cultural community of people, to a certain extent being the personification of political and religious authority.

The level of development of social life in different historical periods largely determines the nature of the construction of the public spaces and the degree of activity of the urban population. A certain correlation between public spaces and communication channels has always formed the basis of the planning of city development, creating such classic circuits like radial, gridiron plan, radial-ring, and others.

Each specific city developed in specific historical, economic and geographical conditions, and this despite a number of general trends imposed its imprint on the subsequent development.

Along with the global trends, the development of every large city is predetermined by specific conditions, its position in the settlement system and its effect - the interaction with other systems.

The process of forming the planning structure of Yerevan as the above mentioned group of cities can be divided mainly into two periods (Safaryan Yu.A., Gasparyan M.A., Aloyan A.A. 2011). The first period covers until approximately 1960 and was characterized by the actual concentration. This refers to both the planning and the spatial organization of urban areas and to the nature of the all kinds of relationships. The second period is characterized by the rapid development of the surrounding settlements (metropolitan area, the zone of influence), the intensification of socio-cultural and economic relations and as a consequence is the development of spatial structure of the city and its center.

The planning - communication structure of a large city is determined by the interaction of sustained concentration of citywide functions units of the center and the periphery of the city, increasing links with the unique historical, cultural, natural and recreation centers located in the area of influence of the city. The main factors determining balanced development of the the planning- communication structure of a large city at various levels of the organization should be, respectively: compositional axis, causing a continuous directional pedestrian link between the most developed individual nodes center: planning- communicational axis, organizing centrifugal and centripetal traffic flows of the city and agglomeration and ensuring polycentrism of planning elements: the planning -communicational direction, providing targeted and balanced development of the central functions in the direction of the zone of influence of the main city.

Historically formed concentration of contacts on axes preserved, but methods of travel have changed and evolved (intensification of contacts, high-speed off-street transport). The presence at this level of a large number of centripetal and centrifugal flows leads to the transformation of structural integrity and violation of the nodes from the inside . The interaction of the different directions of external and intra-urban transport and their interconnection with citywide objects in the structure of the city requires on the one hand more open planning decisions that enhance polycentrism in general, and on the other hand improving communication skills in the hubs.

4. RESULTS

As the analysis shows, we can single out the following stages of large city planning structure development:

1. fortified settlements or systems of such with their inherent elements,
2. compact, self-contained,
3. concentric-concentrated,
4. polycentric- dispersed,
5. directional-balanced,
6. balanced and evenly developed.

The growing level of communication activity is becoming the most important factor regulating the functional and spatial parameters of the modern city. The multiplicity of its planning structure necessitates the revaluation of the traditional conception of the spatial relations between certain architectural and planning elements and their communicative structure. It requires a more careful coordination of the placement of objects within the integrated solution for a uniform planning - communication structure of the city center.

As the experience of the present-day planning shows, the contemporary large city is currently divided into the following basic planning units or parts:

• Planning areas, uniting the separate planning districts;
• Planning districts, which form the neighborhoods and quarters;
• The central planning area (district) covering the designed borders of the city center;
• De facto center or most interconnected in space part of the city in respect of composition relations and planning;
• Core of the center - place of the highest concentration of social activity;
• Historic center or the historic core of the city covering the most valuable and the functioning part of the old historical buildings of the city;
• Separate public complexes - large planning nodes, the district centers, neighborhoods, blocks of houses.

The spatial relationship of these territorial divisions depends on factors such as the drawing of the plan, the nature of the distribution of the most important public facilities, and directly relates to the specific historical and urban planning conditions of the formation.

Both the center and other planning areas of the city must be treated as balanced and self-sufficient systems with circular metabolism organized according to sustainable development principles. These planning zones have to promote the city polycentric even development at the same time providing dynamic and directional development of the whole complex system of agglomeration.

All the planning areas\zones are grouped around the major planning - communication lines and highways connecting cities and agglomerations. In specially organized structural-planning nodes and by means of tangential highways touching the center of the city planning zones are connected to each other, the residential areas of the agglomeration and the recreational zones.

The balanced and even development of planning zones allow removing transit movement from the center and redistributing functions across the urban area, which will stimulate a more orderly spatial development of the city and its center.

5. CONCLUSIONS

The analysis shows that the current stage of implementation of the full series of measures for the development of architectural and spatial environments of urban development and modernization of systems of large cities involves the rejection of uncontrolled suburbanization, and the transition to a polycentric development. The implementation of an integrated system of directed network planning structure of the city in the formation of spatial polycentric urban areas lead to the simultaneous and balanced development of a consolidated self-sufficient planning units/ planning zones and formed a single structure-plannig framework that will help with:

• more balanced redistribution of the social functions of the city importance throughout the city;
• continuity of planning elements in the formation and development of structural models taking into account the current level of communication and communications;
• Putting out of transit traffic from the center and development of the tangential directions of traffic that in the new conditions will make for its discharge and orderly, well-organized volumetric-spatial development of the city architectural complexes.

Along with taking into consideration the factor of continuity, the imperative of modernity is the widespread formation of new common cultural values, aimed at finding efficient ways that enable the formation of a comfortable and accessible urban environment (Puchkov, M.V. 2009). The concept of global planning development should base itself on the varying degrees of area urban values. It presupposes the use and the creative development of the architectural principles of "global city." (Dobricyna, I.A. 2010). Stabilization and adjustment of the prior period achievements and formulation and development of program-based directives of planning development in modern times by way of formation of spatial polycentrism of urban areas with adoption of a unified system of directional network planning structure of the city today is a prerequisite for sustainable urban development. The general thrust of the work on the creation of high-quality habitat, supplemented with a number of attractive facilities, high level of culture, information availability and comfort must base itself on the growing interest of national and foreign investors in the urban development. The latter favors the sustainable growth of urban general culture categories, the comprehensive reorganization of existing structural and planning constructions, sustainable development of all urban systems, including a sharp increase in volumes of public structures, citywide recreation areas and the rehabilitation and preservation of historical, cultural and natural heritage.

NOTE

[i] Yerevan project, (2005). Project of Master plan of Yerevan.

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THE RUINS OF THE CANONICA DEI DECIMARI AT MAGLIANO IN TOSCANA

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Keywords

rilievo, medioevo, maremma

ABSTRACT

The remains of the Canonica dei Decimari or the church of San Bruzio are located in the Tuscan countryside among the olive groves that surround Maliano castle, on the southern edge of the Maremma. The extraordinary formal and technical constructional quality of the building, which can be appreciated in the surviving structures of the transept and the apse, illustrates a topic which is one of the most enigmatic and intriguing within the framework of the medieval religious architecture of the area of the ancient republic of Siena. Recognising the importance of the ruins is the first step in obtaining knowledge in order to protect and conserve the rich heritage of medieval architectures of the Tuscan countryside.

1. SAN BRUZIO: A ROMANESQUE CHURCH IN THE HEART OF PRODUCTIVE TERRITORY*

The remains of the architectural complex are located in the Tuscan countryside near the area of Roman and Etruscan tombs among the hills rich in olive groves surrounding Magliano castle, in the province of Grosseto, on the southern edge of the Maremma (1). The church of San Tiburzio[1], commonly called San Bruzio, was also remembered as the Canonica dei Decimari[2] in the XIII-XIV centuries because it depended on the monastery of S. Antimo. It is one of the most refined Romanesque architectures of the Maremma and its monumental size contrasts with the position outside the medieval castle of Magliano.
In order to analyse the reasons behind this ancient structure we must understand the area in which the ruins are found, from the morphological, but also the social-cultural, point of view.
Archaeological studies would have us believe that life in this area was concentrated in small villages located on the hillsides, as, moreover, is confirmed by history, where the population used to seek shelter in the hills following the attacks of their enemies, in particular the Saracens who landed on the near-by coast. On the other hand, the hills were not only easier to defend but they also contained streams providing drinking water. The area, bordered from north to south, by the via Aurelia and by the extension of the Clodia during Medieval times, was located at the centre of an important road junction for trading traffic[3] descending from the slopes of Mount Amiata towards the port of Talamone. One of the detours of the via Clodia extended along the right of the Albegna from Saturnia to Heba towards Colle di Lupo, S.Tiburzio, Banditella Colonna towards the sea[4]. In an east-west direction, the area is crossed by two rivers, the Ombrone to the north and the Albenga to the south, which surround it like a natural moat and the tributaries of which arrive almost as far as the Rocca Albenga, a well-fortified site which in ancient times must have been the main entrance for controlling the whole area coming from the hinterland. The road system, not very invasive, stretching along the ridge until the III century B.C. and limited to linking the two villages, with the advent of the Romans was enriched by infrastructures cutting across the countryside, creating links with distant regions, and in this way fostering the building of villas and farms along its routes. On a Roman lay-out, modified over the centuries and developed according to needs and available resources, the medieval network of roads was created, on which the presence of religious buildings made a significant mark. In this area the phenomenon of castle building was above all the work of the family of the Counts Aldobrandeschi[5], feudal lords of the *curtis*[6], but also of the Bishops who managed the local dioceses[7]. These also exercised military functions and needed to possess many fortresses both as defence structures from Saracen attacks, and as cornerstones of power[8].
The strong presence of such a family, already from the middle of the XI until the end of the XIII century, characterised the vast area which stretched from Sovana to Roselle, including Talamone, Magliano[9], Scansano and Grosseto. A county formed by about eighty castles, which, thanks to exploitation of natural resources, such as the extraction of precious metals, the production and sale of sea salt and the systematic use of pastures and uncultivated areas in

the raising of flocks of sheep, saw the Aldobrandeschi become absolute lords.
The production structures referred to two abbeys, the Abbazia di San Rabano located in the saddle between the poggio dell'Uccellina and the poggio Lecci and the Monastero di San Bruzio. The first site was particularly important since it offered hospitality to the workers of the saltpans when they travelled to the customs post over the ridge. It was therefore a local reference point along the coast and a link between the coastal area and the hinterland. On the other hand the monastery of San Bruzio was the sorting centre for iron coming from the Isle of Elba, which arrived at Talamone and was then transported to the Poggio dell'Ospedaletto or, alternatively, towards Pereta[10] a centre for the processing of metals. However, the castle building process was not homogeneous, as confirmed by archaeological research: initially, the castles co-existed with independent open sites, rural homes spread over the area. Among these, some villages were discovered which, following the discovering of ceramics relating to the VII and IX century, could be identified as Roman villas of the Republican period which, after the fall of the Empire, were occupied by shepherds and peasants giving way to the formation of villages. These were spread over the countryside, also in poorly defendable positions, in order to exploit the available lands; and to the north-west of the Roman town of Heba one of these is the site where the canonica di San Bruzio was later built. The place is three kilometres from Magliano castle, located on the sloping summit of a hill, described as a populated and hard-working village whose prosperity is proved by the surviving monuments spread across its area, the most of important of which is San Bruzio which Repetti defines as *'a temple whose architecture can be argued to date back to before the invasion of the Barbarians from the north and the south of the Tuscan Maremmas".* Essentially, starting from this hypothesis, its origin can be placed at around the VIII or IX century, but other studies believe that it dates from after the first half of the XII century. Although some believe that the building was built on the ruins of an ancient pagan temple, it seems that it can be identified by a Romanesque church[11], therefore it can be dated back to around the beginning of the XIII century, a circumstance which would demonstrate, that, via the Cistercians, in that period new artistic forms had already spread throughout the Maremma and upper Lazio. The lands of 'Pereto' and 'Oliveto', the 'Chiesa di San Tiburzio of Malliano' and a farmhouse on the ''Osa' appear in the bull of Pope Onorio III of 20 December 1216 in which the legacies on such lands were confirmed to the abbey of S.Antimo, at Montalcino, already granted with imperial diploma of 29 December 813 by Ludovico Pio, third son of Charlemagne. At the beginning the church was called San Tiburcio as can be seen in the Statutes of Magliano in 1356, where it was established that an annual tax of 25 liras would be charged for repairing the roof. It is mentioned in the Tithes of 1276 and until 1321-24 as 'canonica' exempt from the diocesan ordinary, perhaps because it belonged to the monastery of Sant'Antimo. In the XVIII century it became part of the Alberese estate.
The construction of S. Tiburzio was attributed to the Benedictine Order which prospered in the convent on the hills of S. Maria in Borraccia, in a location known as 'Convento diruto'; confirmation of this hypothesis comes from the ruins, in fact it was the Benedictines who introduced the stylistic characteristics recognisable in the ruins of the building. The monument, which has fallen to bits over the centuries following natural disasters or human destruction, shows, in the remains of finely decorated capitals and the fragments of the cupola base (2) the importance which it had in the lands of the Maremma. The ruins have been the object of digs, which have brought to light its original lay-out of a Romanesque church, and of consolidation works in the Nineties, but to date, its deterioration is increasing.

2. THE RUINS OF THE ARCHITECTURAL STRUCTURE**

The architectural analysis of the ruins of the church of San Bruzio became a geometric and measurement instrument for understanding its form up to the original late-medieval[12] layout, today reduced only to the end part: the transept with the connection of the nave, the perimeter walls of which also leave some traces in the ground, dominated by an octagonal cupola base one which the roof cupola was once installed. This structure, rising more than fifteen meters above ground level and built mainly in even blocks of fine-grained limestone[13], cladding the walls in a double layer, is perfectly positioned with the central apsidal zone on the eastern side. These are elements which, if they already allow us to recognise in the ruins of the architectural structure of the church particular proof within the Romanesque context under the government of the Republic of Siena between the XI and the XII century, offer the opportunity of investigating the emerging characteristics of such architecture. On the other hand, once we reach the site of the ruins, we immediately notice the elegant value given by the central square area of the transept bordered by four large round arches which rest on pillars supporting semi-columns with rich capitals modelled by symbolic figures (3). The depth of the composition is increased by the outward-pointing central apse, semi-cylindrical and supported by a semi-spherical basin made in even blocks of travertine and covered by a conical roof with three small single holes, one small central hole and two side ones with axis sloping respectively 360° with respect to

the diameter of the semi-circular horizontal section. The rhythm of the four pilasters on the outer cladding of the apse, crowned by harmonious hanging arches, together with the plastic relief of human and animal figures, with acrobats, bovine protomes and leaves decorating the capitals, illustrates how the refined decoration, recalling other well-known regional Romanesque testimonies of monastic architecture[14], immediately declares influences from Como-Lombardy. Regarding this, the geometrical rigour with which the travertine ashlars squared off and smooth on the surface, are laid along regular horizontal rows on thin beds of mortar, not only describe the considerable stereotomy with which the church is still presented today, in spite of its state of neglect, but also confirms the intervention in the form of the works of expert craftsmen, such as the master-builders from the Como area[15].
The above-mentioned remarks are confirmed in the type of structural connecting element which, through the pointed supports linked by arches in the presbytery area, supports the base of the cupola. In fact, resting on 45° curved sections closing the corners and also pointing outwards, the latter16 takes on a rigid eight-faced geometrical shape which provides the same number of edges as points of origin for the sections of the vaults of the pavilion vault. The cupola, in this way resting on an octagonal almost regular polygon, deriving from the rotation of a reference square, spreads out according to the layout through square stone ashlars and rows installed at precise distances[16]. If, on one hand the four pendentives assume an apparently aesthetic function of making the architectural structure slimmer, on the other hand, they legitimise its staticity by connecting the square perimeter to the octagon.
In this context, the data obtained from the integrated survey (4) have allowed us to establish, in a precise way, from the section between a vertical perpendicular plane to the walls of the presbytery and the portions of vaults still standing, the curvature of the cupola, belonging to an ellipse arch. This, together with the dimensional ratio that can be assumed from the design of the roof, identifies in the octagonal form of the base of the cupola, the most practical geometrical solution for solving the construction of the elliptic curvature using eight simple circumference arches. The iconographic structure of San Bruzio with its cross-shaped layout, originally with one single nave[17], pointing in an exact east-west direction and with the base of the cupola located at the centre of the cross, not only follows the typical layout of Tuscan Benedictine organisations, but also confirms above all that of architectural development recorded in the cupolas of Latin cross Sienese churches of the XII century until it was perfected[18]. In fact in the church of San Bruzio the 'Lombard echoes of the particular technique typical of the Como style[19], are illustrated through a blend of simple geometries and the dimensional relationship with which the arches, pendentives and vaults compose the cupola. Even though the upward movement and the appreciable decorative taste seen in the presbytery area, also demonstrate obvious stylistic influences in the ruins of northern European Romanesque style[20], from the cross-shaped layout with outward-pointing apse and with emerging arms covered by vaults, similar to a cross and without ribs which used to extend to the main nave[21], some characteristics emerge which also hint at Armenian-Byzantine architectural forms. Without a doubt, from this point of view, the church of San Bruzio could in this way represent the moment of transposition of an exceptional morphology, expressed by a language of the oriental tradition, towards the Christian and Latin sphere of the Benedictine order.

3. CONCLUSIONS

The objective of the research carried out on the ruins of San Bruzio is that of contributing to the recovery and conservation of one of the most important architectural emergencies in the historical-artistic heritage of the Tuscan Maremma, on which it is still, today, necessary to investigate further in order to understand its authentic cultural, environment and architectural values. In fact, the ruins of the structure correspond today only to the transept, the apse, the cupola base and to a portion of the pavilion cupola with octagonal base, declaring an exception formal and technical constructional quality such as to bear witness to the importance it possessed over the centuries. Also, through the comparison made with other Maremma churches of the same period, net of the sum of the various architectural influences, the cupola of San Bruzio seems to be not only the most original in morphological terms, due to the compactness of the wall cladding, but it also expresses an absolutely coherent precise geometric-static correctness, offering an architectural *unicum* of the Romanesque period in central Italy. The exact chronological location of the building of the church, although it is linked to limited historical data and has been placed within a span of around two hundred years, between the XI and the XII century, can be confirmed only through the comparison and stylistic analysis of the characteristic architectural elements that come into play in the local context where it is located, translating them into the objective understanding of this original architecture. Notwithstanding the debate of scholars on the historical circumstances and stylistic trends that have respectively conditioned and characterised such architecture, attributing it to a date of origin, the existence of a suggestive upward movement and a composition vocabulary of Como-Lombardo derivation, together with the stylistic features of Armenian-Byzantine architecture, give the church of San Bruzio an exclusive and intrinsic appearance in its current formal essentiality.

NOTES

[1] Saint Tiburzio lived in Rome in the III century and was martyrized together with his brother Valeriano, the husband of Saint Cecilia.

[2] The canonica was mentioned in the 'Rationes Decimarum' at the end of the thirteenth century (Citter C., a c. 2002. Guida agli edifici sacri della Maremma, Nuova Immagine, Siena, p. 39).

[3] Minerals, timber, stones for construction

[4] (Gianni G. 1970. Il Baluardo di Magliano, Pro Loco Magliano in Tuscany, p.22)

[5] The Aldobrandeschi family originated from the aristocracy of Lucca with Longobard roots. Its first important seat was in Sovana and then Pitigliano.

[6] The curtis was a medieval production structure: a series of plots and buildings subject to the power of a single lord.

[7] The seats of the bishops of the area were Populonia, Sovana and Roselle.

[8] (Aterini B., Nocentini A. 2014. L'abbazia di San Rabano esperienza architettonica e sintesi socio-politica della Maremma Toscana medioevale, in La Maremma al tempo di Arrigo. Società e paesaggio nel Trecento: continuità e trasformazioni, Collana Città e Territorio, Debatte, Livorno).

[9] The curtis of Magliano appeared in 1108 as the first castle documented in the area. The area of Magliano, of Etruscan origin, was part of the estate of the Counts Aldobrandeschi from the XI century until 1358, when the Republic of Siena obtained it on a perpetual leasing basis from the counts of Santa Fiora and ceded it to the government of the Tolomei family. (Aterini B., Nocentini A. 2014. L'abbazia di San Rabano esperienza architettonica e sintesi socio-politica della Maremma Toscana medioevale, in La Maremma al tempo di Arrigo. Società e paesaggio nel Trecento: continuità e trasformazioni, Collana Città e Territorio, Debatte, Livorno).

[10] Where deposits of antimonium and sulphur were also found.

[11] (Vitiello A., a c. 2000. San Bruzio mito e realtà, Edarc, Bagno a Ripoli, p. 9).

[12] Examination of the global dimensional data (form, its representation and evaluation) and specific data (dimensions of the ashlars, machining, integrations, etc.) was carried out through the use of three-dimensional measuring devices and instruments (total station and 3D laser scanner), during the master's degree thesis in Architecture of A. Nocentini San Bruzio e la sua cupola a padiglione, Florence University, 2011.

[13] It was the custom to also use local materials for the construction of important prestigious buildings. It does not seem inappropriate to assume that the travertine of San Bruzio came from the near-by hills of the banditaccia, where quarrying was frequent (Gianni G. 1970. Il Baluardo, op. cit., p. 22).

[14] Starting from the monastery of San Rabano on the Uccellina mountains, as far as the abbey of Sant'Antimo at Castelnuovo dell'Abate, Montalcino (Monaci Scaramucci F. 1975. Influenza della tecnica comasco-lombarda nella regione maremmano-senese con riferimento alla abbaziale dell'Alberese nell'antica Diocesi rosellana, in Il Romanico Atti del Seminario di studi diretto da Piero Sanpaolesi, I.S.A.L., Milano, p. 325).

[15] The presence of the master builders from Lombardy in central Italy is not only declared by many architecture critics and historians (Gianni G., Il Baluardo, op. cit, p. 8) but was also confirmed latter by provisions in the municipal statutes of Magliano (Belcari R. 2012, Il castello di Magliano: istituzioni, economia e società di una comunità rurale nella Maremma tardomedioevale e moderna, Polistampa, Firenze, pp. 32-33).

[16] Term with which the pendentive was defined when it presents a conical section. Use of such a connection element, typical of the Lombardy Romanesque period, is necessary in the case of square or octagonal based cupolas, composed of pointed supports linked by adjacent arches. These in fact are small niches that have the task of connecting different surfaces.

[16] The perfect alignment of the single holes splayed onto opposite sides of the octagonal base demonstrated accuracy.

[17] The most recent digs bring to light some brick portions of the walls of the nave, even if less thick and in poorer material compared with the structures of the transept and therefore attributable to updates carried out after the original project, prove the Latin cross layout of the church. (Vitiello A., a c. 2000, San Bruzio, op. cit., p. 15). According to some scholars, originally this layout had the following dimensions: length 32 meters, width 12 and 20 at the transept (Citter C. a c. 2002, Guida agli ed., op. cit., p. 39).

[18] (Monaci Scaramucci F. 1975, Influenza della tecnica, op. cit., p. 307).

[19] (Ivi, p. 325).

[20] At least to the French one, similar to the capitals of the monastery of San Rabano (Citter C., a c. 2002. Guida agli ed., op. cit. p. 40).

[21] As proved by the remaining masonry connections that cover the side arms of the transept with simple roofs. The conjugation of the typical Lombard layout with cross or barrel vaults in the transept extended also to the nave, here differ due to the absence of the ribs, for example, from the Duomo dei SS. Pietro e Paolo in Sovana.

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Fig. 1 The church of San Bruzio at Magliano in Toscana. View of the south side with the outward-pointing apse, oriented to the east.

Fig. 2 Bottom view which shows the connection between the presbytery and the base of the cupola. On the left we see the semi-spherical basin of the apse with stereotomic value.

Fig. 3 Picture of some capitals with Romanesque refined decoration depicting animal figures and foliage. One can note the different coloring of the stone material. Featured remnants of the cladding wall on the south side where we can see the typical wall.

Fig. 4 Image of the points cloud obtained by the three-dimensional survey made with 3D laser scanner, in 2011.

TRANSFORMATION OF HIGH VALUED URBAN TERRITORIES IN THE YEREVAN DEVELOPMENT PROCESS

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Keywords

Yerevan, high valued urban territories, historic analysis

ABSTRACT

The formation, transformation and development tendencies of high valued urban territories of Yerevan, conditioned by the socioeconomic phenomena of the period, have been studied. The purpose of the study is the definition of methods for preservation and increase of territories urban value, during further city development process.
The evaluation of the territories has been performed on the base of the factors defined by the "Urban Development. Urban and Rural Planning and Development Construction norms". In the evaluation process, the architectural and historic values of the territory have also been considered.
The study shows that the major part of high valued urban territories of modern Yerevan has been formed after the establishment of the Yerevan master plan of 1924 year. From the high valued urban territories of pre-1924 period, only individual buildings and unique lots are preserved which today lost their significance and risk to disappear.

1. INTRODUCTION

The usually spontaneous character of modern Yerevan urban development process causes not only the loss of buildings presenting cultural value but also to qualitative and compositional transformation of high valued urban territories. Probably the main reasons for the stated issue are the lack of evaluation methods of the historic environment, frequent noncompliance of the priorities of the urban development strategy of Yerevan, as well as the absence of state-investor relations regulation methods.

2. BACKGROUND

Adoption of The Law Concept of Yerevan Downtown Construction at 07.03.2013 highlights the importance of the stated issue (Prime Minister's Office. 2013). Through the establishment of a legislative foundation, the law concept indicates perspectives of preservation and improvement of high valued architectural image of Yerevan downtown in the city development process. Though it neither indicates the factors that form the urban value of the territory nor determines approaches for the development of such territories.
The issue of preservation and development of high valued urban territories is of high importance in a number of countries, and their development is ensured by the application of additional regulation methods. The examples of such regulation methods are "Spaces and Projects of National Importance – SAPONI" of Switzerland, "The Spatial Development Strategy" of Slovenia, "Secteur Sauvegardé" of France. In the case of "Secteur Sauvegardé" these are city territories the development of which is conducted with the application of additional legislative restrictions. The aim of the policy is to keep the connection between the new and old parts of the city in its development process, at the same time keeping the city dynamics in the historic part of the city (Studio Mutterer et Associés. 2013). However to ensure the preservation and increase of the territory urban value the definition of factors influencing the formation of the territory urban value and their evaluation methods are needed. The urban value of the territory is the measure of the territory ability to satisfy certain public needs (Ministry of Urban Development. 2003). The evaluation of the territories has been performed on the base of the factors defined by the "Urban Development. Urban and Rural Planning and Development Construction norms" according to which the urban value of the territory is formed on the base of the land value, engineering and transport infrastructure equipment, territory equipment with public facilities and investment attractiveness (Ministry of Urban Development. 2014). The current study also

considers the architectural and historic values of the territory as factors defining the urban value of the territory.

3. METHODS

Study of Yerevan archive urban development documents, master plans and current regulation methods. Analysis of criterias defining the urban value of the territory. Study of past and current urban development tendencies.

4. CASE HISTORY

The chronological boundaries of the study are set between 1856-2015 years. The study is performed by the periods of approval of city master plans: 1. From the approval of the first master plan of Yerevan to the Tamanyan period 1856-1923, 2. Tamanyan period 1924-1972. 3. Until the approval of the master plan of 2005 1973-2004 4. From the approval of 2005 master plan hereto 2005-2015.

First period 1856-1923. Despite the fact, that the first master plan of Yerevan was approved at 1856, the reconstruction works of Yerevan has been started earlier at the beginning of the 19th century. The old trade center of the city kept its location and developed into the system of squares and parks. It got equipped with municipal institutions, trade and public facilities and became the central business district of the city. Later for the unloading purpose of this zone three streets were laid from the city center in the north-south direction Astaphyan , Ter-Ghukasyan and Gubernskaya (Gasparyan, M.A. 1998). Abovyan distinguished due to its placement and functional equipment. Abovyan is located according to the master plan of 1856. It was a place of concentration of the major part of monumental, religious, cultural and educational establishments. The next street was Nalbandyan. Due to its equipment with public and municipal buildings the street obtained architectural unity and official image. Apart from the three major streets adjacent territories of Pushkin, Byuzand and Teryan streets were also of high architectural value conditioned by the presence of vernacular architecture of Yerevan.

Summarizing the study of the period and considering the criteria of urban value as mentioned above the high valued urban territories of the period were the trade market Ghantar, English park, Abovyan, Nalbandyan, Pushkin, Byuzand and Teryan streets (1).

Second period 1924-1972. At 1924, the master plan of Yerevan by A.Tamanyan has been approved, which served as a base for the design of all future master plans of the city. By the new master plan, a number of citywide facilities have been built, which later contributed to the equipment of this territories with public facilities and the stimulation of pedestrian movement. Republic Square, student block, Opera House, Nairi and Moscow cinemas became citywide urban hubs. Apart from the citywide facilities a number of public and residential buildings and complexes were built which due to their architectural qualities formed territories of high urban value.

The three main periods of Armenian repatriation also marked the period. It contributed to the creation of new settlements and the further expansion of the city (Harowt'yownyan, E'. 2012). The newly formed settlements later developed into blocks and now are municipal regions of the city. Local centers were organized at the new settlements, and they were equipped with public facilities.

At that period with the reversal of trade market, Ghantar lost its urban value. The construction of citywide facilities, residential and public buildings of high architectural value and the functional equipment of city increased the urban value of the Yerevan territory. Yerevan inherited the architectural heritage of the past period and managed to enrich it. Despite that, at the end of the period after the 1950 the model construction of USSR was gradually starting to distort the architectural image of Yerevan.

Third period - 1973-2004. By the master plan of 1972 the city continued to expand. Avan, Avan-Arinj, the 7th, 8th, and 9th quarters of Masiv, Malatia and Erebouni blocks were built. The number of citywide facilities increased with the construction of Northern Cascade, Music and Sports Complex and The Youth Palace.

If to date the city development was held mainly at the expanse of new territories then by the new master plan some part of the residential construction was conducted at the city center. Also considering the tendency of construction density increase high-rise buildings were constructed in the city center. The construction of model high-rise buildings in the historically formed environment of low and medium rise construction changed the city scale and led to the distortion of the city environment. The model residential buildings constructed at the Amiryan-Mashtots crossroad, Tumanyan and Sayat-Nova streets prove the above statement.

Another problem of the period was the lack of architectural monuments preservation methods and mechanisms of valorization of the historic environment. It caused the demolition of the significant part of houses and low-rise public buildings of pre Tamanyan period. Neither the urban role of architectural monuments was considered in the city development process.

In the early 90s the transition from socialist economy to free market had some negative impact on the urban development of Yerevan (Aloyan, A.A., Safaryan, A.Y. 2014). Urban development documents being processed during socialist orders wouldn't function properly in the new conditions. As a result, the construction of the city was often led at the discretion of individual proprietors, without considering the urban value of the territory or the urban strategy of the city. At the same time, the high urban status of the city center made it more attractive for the investments and led to its overdevelopment compared to other municipal regions. It caused the decrease in the urban value of local centers and sometimes even led to their disappearance.
During 90s in the absence of strict urban development control policy the percent of illegal construction increased. In the suburbs as well as in the city center without any urban documentation residential building yards and street sidewalks have been constructed with little public facilities. The construction at the lawn of the Abovyan street sidewalk with shops and booths was a clear example of it . The reconstruction of buildings of high architectural value without architectural projects got also widely spread.
The discussed events decreased the architectural and historic value of the city. Despite the construction of the new buildings and the increase of the level of functional equipment of city territories, the decrease in the urban value of city territory was registered in that period.
Fourth period – 2005-2015. In 2005 new urban development master plan for 20 years estimated period has been approved, according to which the city is being constructed to date (Safaryan, Yu. A., Gasparyan, M. A, .Aloyan, A.A. 2011). Probably the biggest project conducted by the current master plan is the Northern Avenue which has been previewed back by the 1924 master plan as a connection between the municipal and cultural squares of the city. Located in the city center it was endowed with high investment attractiveness that is the reason for the concentration of public facilities in here. Due to its location and functional equipment it became a peculiar hub of intense pedestrian movement. The development of the avenue is in process to date by the construction of an underground trade center in here.
After the approval of the new master plan the functional equipment of the city grew with unprecedented pace. The placement of public facilities at the ground floors of residential buildings got a common nature at that time which resulted in the functional equipment of the territory. In parallel with it the devaluation tendency of historic environment is noticed during the period. Inheriting the negative construction tendencies of USSR period the construction of high-rise buildings in the city center, ineffectual reconstruction attempts of historic complexes and demolition of architectural monuments is performed hereto. With of reconstruction of the Covered Market, Dvin hotel, the demolition of The Youth Palace, Afrikyan family house, and a number of other architectural monuments, the historic value of the city is in the danger of disappearance.

5. RESULTS

The study shows that the major part of high valued urban territories of modern Yerevan has been formed after the establishment of the Yerevan master plan of 1924 year. From the high valued urban territories of the pre-1924 period, only individual buildings and unique lots are preserved the significant part of which today lost their significance and risk to disappear. Due to its high urban status after the adoption of the new ownership type the city center functional equipment is in a pace of intense growth conditioned by its investment attractiveness. Though the investment attractiveness level is not low in municipal regions either, due to neglect of Yerevan urban strategy, the construction of these territories solves only local problems and doesn't ensure the increase of the territory urban value.

6. CONCLUSIONS

To ensure the preservation and growth of the urban value of city territories, urban development policies must be processed considering the urban value of the territory. For that purpose the evaluation of city territories and definition of urban value zones is needed, as an additional city development regulation method.
The urban development of Yerevan should be conducted by absolute compliance with the urban development strategy of Yerevan. The urban development strategy should be thoroughly processed and include a project of detailed planning for the suburbs of Yerevan.

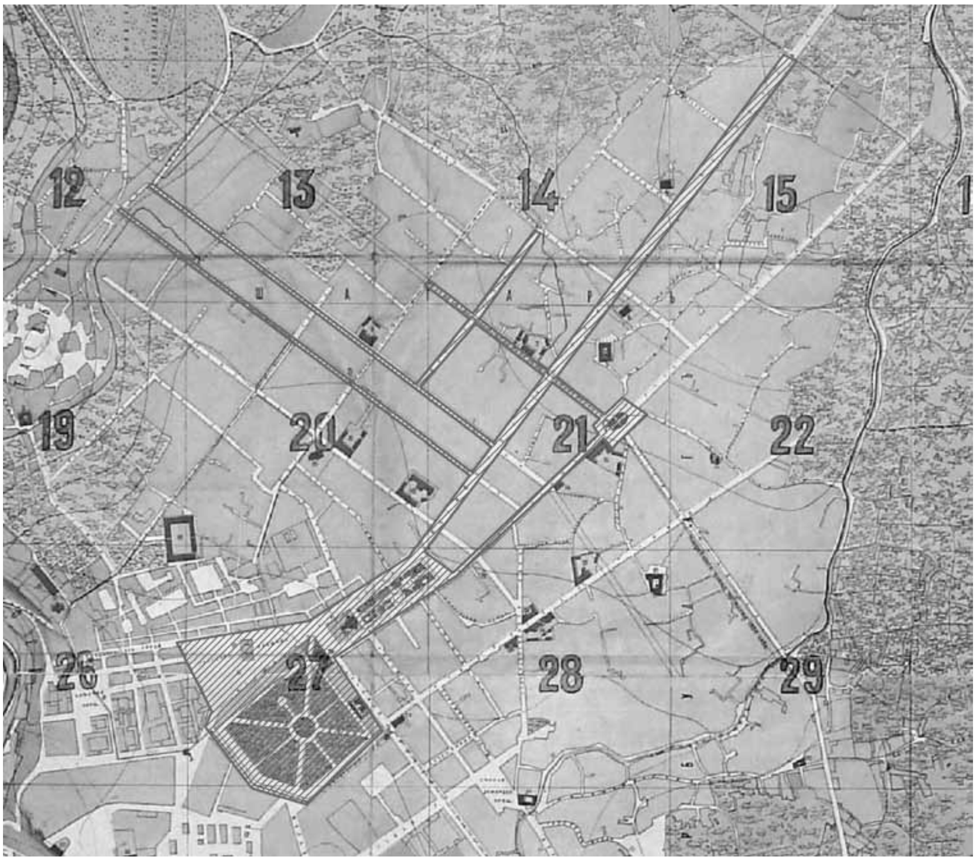

Fig. 1 Several high valued urban territories of pre Tamanyan period.

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THE ROLE AND PECULIARITIES OF COMPOSITION IN THE FORMATION OF WAYSIDE SERVICE OBJECTS AND COMPLEXES

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Keywords

wayside service, objects and complexes, building, dimensional composition

ABSTRACT

In the article principally preferable planning and compositional schemes of roadside service facilities are presented, dictated by the landscape, climate, functional, building development, and scale peculiarities. On the basis of the architectural planning there exists a spatial composition due to its defined regularities by architectural idea, effective natural sights, architectural elements and various environmental interrelations. The three most common of major development schemes are worked out, due to planning situation and climate features of the area. They are as follows: closed space, system of interconnected areas and buildings as well as the location of the main structure in the building development. As a mandatory requirement a special attention is paid to the separation of dominant building in all compositional schemes, subjecting it to other components of building composition. Small architectural elements and the role of the environment improvement are of importance in the formation of the most comprehensive and complete group formation.

1. INTRODUCTION

With all the variety of dimensional and architectural-artistic solutions of wayside service complexes, they are predestined to guarantee the comfort of the services through architectural means. The formation of wayside service objects and complexes greatly contributes to the creation of more favourable and attractive environment.

First and foremost architectural composition depends on the situational urban conditions which are the environment scale, the nature of existing buildings, the connection with transport means. The architectural-layout structure of wayside service objects and complexes is the basis of the dimensional solution. The expressiveness of the architectural image is conditioned by the conservation of the regularities defining its structure, which are the presence of the architectural idea, the correspondence of the spatial solution with the environment, the building integrity, the correspondence with the layout structure of the composition scheme chosen for the buildings and constructions, their zoning according to importance.

2. BACKGROUND

Creation of any layout composition depends from the relationship of architectural elements and the environment. The necessary condition of perceiving any architectural space is the indication of its form. It is either closed space encircled by perimetral building, or isolated placement of the principal building with creation of compositional gravitation zone or with free placement of single architectural volumes. In any case for creating architecturally organized space it is necessary to have compositional interaction of various elements it is composed of, depending on their size, form, scale as well as placement maneuvers.

The layout and dimensional idea of building can be decided by highlighting the natural sightseeing places, by unifying all the institutions in one common volume or by their decentralization and connection with the picturesque structure through covered passages.

3. METHODS

Comparative analysis of international and national scientific and project experience and development of suggestions and consultation on that basis.

4. CASE HISTORY

The network distribution of wayside service objects in the Republic of Armenia, as well as their formation and compositional solutions in a specific environment are regularly chosen without a complex assessment of urban situation, landscape and climatic peculiarities and other factors, which leads to architectural image and compositional solutions not suitable to the environment and the traditions of the country, thus discouraging the development of tourism.

5. RESULTS

In case of spatial structure solution the following four schemes are more commonly met: 1. interconnected spaces and buildings system, 2. enclosed space, 3. freely placed volumes in limited space, 4. linear development of space (fig, 1)[1].

Let's discuss the peculiarities deriving from the four principal compositional maneuvers in different situational conditions from the point of view of their preferred application.

Each one of the compositional maneuvers has its peculiarities. The compositional scheme of interrelated spaces and buildings is characterized by gradual opening of deep prospects and allows to use widely the expressiveness of single landscape elements. It is mostly used in big complexes as in plain spaces where a complex multiplan space is created, as in spaces with deviated relief, where spatial connections are enhanced through transit prospects and the whole composition is viewed from different points. The heterogeneity of this maneuver – stepped or dimensional type anfield composition – is applied in the conditions of sharp relief.

Enclosed spaces perceive not the volumes, but space of the buildings in formation and the flat spaces limiting it. The integrity of the composition is guaranteed by the enclosure of the building, small ruptures between the volumes, the symmetry of free space with the height of the surrounding buildings. This maneuver is common in all the climatic zones with the exception of hot and humid areas, where it is necessary to create an artificial bio environment with special microclima (Barseghyan T.S. (ed). 2011).

Freely placed scheme in limited space is characteristic of cooperated building. This kind of building is similar to a big sculptural form, where free space seems to pass by the surroundings. Isolated composition is suitable to use in case of presence of good inspection conditions of the principal volume from different parts of the surroundings (in a free area, where the green trees, lakes, rivers, hills, etc. become elements of composition).

The linear development form is made through perimetral or point building with juxtaposition of certain green areas. This compositional maneuver gives an opportunity of sequential expansion and at the same time grows the loss of time necessary for movement, the comfort of complex service is reduced, the organization of approach ways for service and the common economic zone.

Besides the indicated compositional schemes there can be also an open volume composition, which is applied in case of presence of landscape elements able to actively take part in the creation of the architecture of the complex. It is usually constructed according to the principle of panoramical perception of building. This maneuver is especially suitable in favourable climatic conditions, in mountainous area with water surfaces (basins, lakes, rivers). It is applied with multi-stage building harmonically fused with the nature and characterized with high density and layout agility. For the first time the principal approaches of layout and dimensional compositions of wayside service objects and complexes are examined, suggestions for their preferred versions of applications are given with complex assessment of urban, landscape, climatic peculiarities. The factors influencing the compositional solutions of the latter are revealed. Scientifically reasoned principal suggestions on compositional structure are being developed (Barhin M.G. 1980).

6. CONCLUSION

The application of this or that compositional maneuver is conditioned by the created layout situation and the climatic peculiarities of the terrain.

In extremely cold conditions closed composition is more suitable. The aspiration to reduce the extensiveness of pedestrian connections between the service institutions leads to enclosure.

The buildings near forests, rivers and lakes should be done taking into account the maximum openness towards the nature. Here isolated composition can be applied as the principal maneuver of spatial solution (it is enforced also by building small, cooperated type constructions).

In hot, dry climatic conditions building enclosure is necessary, which is the reason enclosed composition is more logical (in case of guaranteeing ventilation) and the composition based on space and building interpenetration on the account of the usage of closed passages and summer spaces[2].

Compositional integrity is connected to the nature of architecture and layout structure of the constructions that are included in its building. Each composition should correspond to buildings with a certain layout scheme. For instance in case of closed composition dimensional volumes of buildings with simple layout are suitable, facade and not deep schemes, equal height of building is preferred

In case of compositional solution built by interpenetration of spaces and buildings it is more suitable to apply different storied objects with enclosed layout structure, as the perception of such building is based on the changes of prospects and alternation of buildings, covers, improvement elements, open squares, etc.

In case of isolated composition the form of the layout is very important, in particular from the point of view of expressive solution of facades. Here are suitable complex stepped structures, the variability of building width, the inclusion of internal yards, entrance accentuations, height declines; the construction acquires agile, sculptural character.

In panoramical as well as in closed composition it is preferable to use buildings with great expensiveness, alternating them with the facade placement of the principal object.

In case of all the compositional schemes it is necessary to single out a dominant building, subjecting all the other parts to it. The dominant role is accentuated near the end of the entrance or in the prospect of the principal accentuations by placement of a dominant in high terrain and creation of open space (park grass, forest, water area) in front of it. The principal object occupies a corresponding dominant position (Kirilov, L.I. 1973).

In case of formation the asymmetry of architectural composition is used, which allows to include the building in the surrounding landscape more easily, or the symmetry which guarantees the balance, vividness of the solution, included the contrast between horizontal and vertical volumes, the rhythm, the important mean of dimensional connection on the account of regular alternation, accentuation, repetition, enlargement of elements, expressiveness of outline, inclusion of active vertical or spatial covers, small shapes in the building, etc.

There are many asymmetrical compositions conditioned by natural factors: beautiful landscape expressed by vivid relief, natural green areas and water surfaces. In these conditions the asymmetry maneuver corresponding to the dynamic characteristics of the environment multiplies the opportunities of a closer approach to the landscape by the building.An interesting compositional maneuver is the creation of a vertical dominating in the surrounding landscape and able to organize the environment, which enriches the image and outline of the composition.

The creation of the vertical accentuating the outline, depending on certain conditions, can be separate or be included in the composition of the construction.The issues of the suggested versions of the composition, of their phase realization possibilities, their suitability and exploitation should be solved on the basis of specific situation and conditions.

The listed composition forms are wildly applied in many wayside objects and complexes. It is necessary to mention that each composition form has both positive and negative sides, which for instance in case of limited space – enclosed structure – gives an opportunity to organize the best connection between the common area and the constructions of all the institutions of the complex. The advantage of the form volume in space is the absence of secondary facade and the multi-plan architectural environment. The disadvantages might be the splitting of the common area and insufficient orientation of visitors during the provision of services. The linear development of the complex area has prevalence of the continuity of incessant axes. Simultaneously the time spent on movement increases, somehow decreases the efficiency of complex service. At the same time the complexes have the possibility to form closer operative connections with the environment and its visible perception, which in this case is considered one of the most important advantages. During the usage of each form the specific compositions can be limitlessly different; their selection is characterized by the conditions of the area and the approach of the architect.

An essential place in the creation of a completed complex is occupied by small architectural forms, elements of monumental-decorative art and external improvement – pergolas, trellis, fountains, pools, bookstalls, decorative and advertisement placements (banners, showcases), flower-gardens, retaining walls, sculptures, staircases and ramps, pavement elements of squares and paths, illumination, etc.

The application of different small elements is important for the individualization of the image of wayside service subjects and complexes. Besides, by the means of placement of banners, pergolas, retaining walls, staircases a close connection with the surrounding landscape can be achieved. In this case the small architectural elements serve as intermediate rings. The opening maneuver of the spaces (vestibule, hall, rest area) towards artificial lakes, rivers, parks, gardens or other picturesque neighbourhood is limited, through which the internal space of the building visually communicates with the surrounding natural environment. All of this extends the artistic and operative borders of wayside service objects and complexes.

The placement of small architectural elements depends on the dimensional solution. Thus in the centre of the closed composition are placed often vertical elements accentuating and organizing the space – monument, fountain. In case of a composition based on juxtaposition of spaces and volumes the role of connecting elements, sheds, passages, pergolas, decorative or retaining walls, increases. In case of an isolated composition the small architectural elements often accentuate the approaching ways and the entrances (Reshotnikov N.V. 1977).

The small architectural elements complete and develop the total dimensional composition of wayside service objects as well as of the complexes they form. For the first time in the Republic of Armenia on the basis of scientific and project comparative analysis consultations on the application of preferred layout and dimensional schemes for wayside service objects and complexes are given, taking into account the complex assessment of urban situation, the landscape and climatic peculiarities as well as the environment.

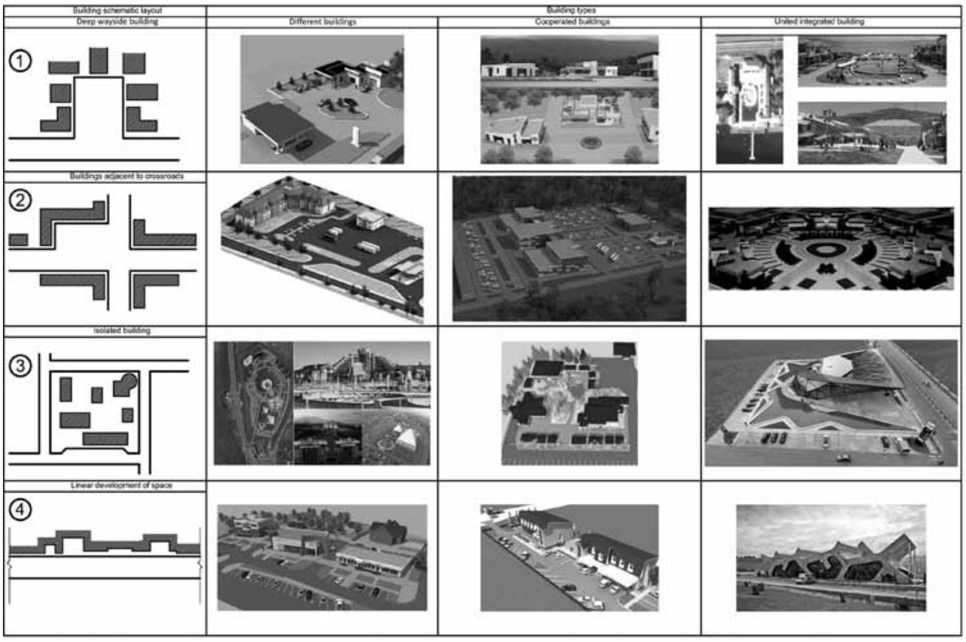

Fig. 1 Schemes of spatial building for wayside service complexes.

NOTES

[1] Pictures in the table are loaded from the Internet

[2] Building codes (RACN II-7.01-2011). Construction climatology

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ARCHITECTURE PROGRAMMES, THE ISSUES OF WOMEN AND WATER AS HAZARD AND WATER AS HERITAGE IN THE FIRST HALF OF THE 20TH CENTURY

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Keywords

woman architects, water, pioneers

ABSTRACT
This paper will look into gender aspects in building with water. Two pillars will be looked for: water as a hazard and how gender issues are considered in climate change adaptation (i.e. reconstruction of sites) and water as heritage, namely the planning of resort architecture on the seaside or in architectural objects of thermal bathes. From the historic evolution, be it historic development of sites and buildings or historic roles of women in the profession, conclusions for design today will be drawn.

1. INTRODUCTION

Several initiatives are dealing with the gender dimension of research or/and of architecture. This contribution aims to combine both. Research on the architecture of women from pioneering times to today are enjoying a spread today. Several years ago there were just some sessions at the European Architecture History Network congresses (ex. Guimaraes, 2010). More recently the COST action genderSTE was established (2012), and, along with two working groups on contemporary structural change in research, which is in line with initiatives such as WIRES (women initiative in research and engineering summit) in the USA, the European Centre for Women and Technology, the gender summit series which spread from Europe to North America, Africa and Asia, it has a working group on cities, including transport and climate change. As such, genderSTE introduces the dimension of pioneers in architecture, as it was seen at the EAHN. The genderSTE action organized in Rome in 2014 the engendering cities conference, and in 2015 is organizing in Istanbul a training school on the topic. 2016 will be the final conference including this and the other dimensions. Recently European programmes started funding Women's creativity since the Modern Movement (MoMoWo) in frame of the Culture programme. A map of women architects from pioneering time to present will be created, thus extending what the IAWA database from Virginia University was doing since a while. Also, a series of conferences started specifically on this topic, under the title Matrix, in Portugal. Literature has been issued, such as DonnArchitettura (Eccheli and Tamborrino, 2014), which brings together women architects from today and the pioneers, the first in their own declaration and the later in analysis. Another recent comprehensive publication (Dümpelmann and Beardsley, 2015) is bringing together summaries of previously disparate research on pioneers of landscape woman architects. Aim of the research presented in this paper is to look at how architecture programmes relate to women when building with water in different roles, such as investor/mecene, planner and user. This builds on previous research of the author on decision systems (Bostenaru, 2004). Preliminary research on the role of women as mecene included also some on women in fairy tales (Bostenaru and Kauffmann, 2011). That was a comparative cross-country study, as the study here. The research is most close to DonnArchitettura, as it tries to "build the future on lessons from the past", as in the reintegration grant of the author, and develop forms on the pioneers and forms on contemporary mobile architects and their structural change dimension. As mentioned, the roles women can take are more diverse, looking not only at architecture by women, but also at architecture for women, meaning for women communities, women investors, or for accounting for women users in gender diverse settings. Women are seen as both subject and object.

2. BACKGROUND

The author is member of the COST action genderSTE Working Group 3 II (Climate change and energy), and Management Committee observer from the Marie Curie Fellows Association. The Marie Curie Fellows Association is investigating the situation of contemporary women scientists, while in her quality as an architect the author extended the scope of the research to some aspects related to the genderSTE focus in WG3 (both cities and climate change). Pioneer women architects can serve as a role model just as now it is searched for in the association. The Marie Curie Fellows Association issued a booklet on Role Models of women scientists (http://mcfa.eu/site3/?-q=women-science-working-group-mwiset). More recently, in frame of the Marie Curie Alumni Association, the working group Gender Equality for Mobile Researchers in Science was created, and this one also published a booklet on role models (currently available internally at the association). The building dimension becomes more visible in frame of the MCAA booklet, which includes also other role models dealing with buildings. In frame of the current project of the author, in addition to the historic role models of pioneer women architects, role models of mobile architects will be included. As such, the author got in contact with former Marie Curie fellows dealing with buildings, for the research side, and with former fellows at the Romanian School in Rome, which hosts her, for both research and practice side. Since nowadays the number of women practicing architecture grew, this seemed to be a selection criterion. Mobility influenced also pioneer women architects, which led from that time to a global style. To name just a few examples, Virginia Andreescu-Haret, the first Romanian woman architect, was mobile between Romania and Italy. Maria Theresa Parpagliolo Shephard, the first Italian woman landscape architect, between Italy and England. Lina Bo Bardi between Italy and Brasil. Wivi Lönn between Finnland and Estonia. Erika Paulas, an early Hungarian woman architect at the time of Art Nouveau, such as Wivi Lönn, between Switzerland and Hungary/Transylvania. Fig. 1 depicts some works of these pioneer women architects. Queen Mary was also a woman who counted in Art Nouvau, as she introduced in the castle of Pelişor Darmstadt style Jugendstil, another example of mobility, from Germany and England to Romania. The coup de fouet congress in Barcelona in 2015 was dedicated to women who counted in Art Nouveau architecture.

3. METHODS

The research employed the following work plan:

1. Gender aspects in reconstruction of sites after natural disasters

a. Doing excerpts from Bostenaru (2007) regarding gender aspects – family housing in Vienna and „planning, constructing, living for women“ in the Emscher zone – investigation of the particular gender aspects in participative planning

b. Consulting literature /discussing results of the project „Gender Impact Assessment in the Context of Climate Change Adaptation and Natural Hazards” (GIAClim)

c. Comparison between own results and GIAClim results – leading to conclusions regarding participative planning for women

d. Supplementary analysis of participative planning aspects for women in case of Corbeni (Romania), Kos Karoly Association projects (participative planning in general already analysed in the doctorate, regarding tradition – a gender specific question might also be if innovation in this field is needed) and similar cases in Italy

e. Analysis how far these aspects are covered by the Horizon 2020 programme

f. Work on a decision tree in which one of the actors is „women“

2. Gender aspects in planning of tourism resorts in connections to water

a. Description of resort architecture of pioneering women architects and women involved in architecture (as mecene) in thermal resorts and on the seaside in Romania (the discussion on mecenate shall be put in connection with the decision tree worked on before, as investment is a constant problem in arts such as architecture, and this will build a connection to IS1104 COST action on economic aspects)

b. Analysis of the historic evolution of gender specific planning of thermal bathes and free bathes (lake, seaside) including the villa resorts – changes in the floor plan from Roman and Turkish times over Art Nouveau till contemporary planning of architects and of students. Methods: archive research, space syntax computer analysis.

3. Gender aspects in historical architecture

a. Comparison of the history of the profession in Italy and in Eastern European countries in architecture – to be put in the context of the decision tree (if the women were experts or inhabitants or investors – which actor they were and how this was recognised).

4. Conclusions regarding blue-green infrastructure: water and landscape, and gender issues. Work on the publications (several presentations to emerge, as well as at least one publication from the report).

4. CASE HISTORY

Some previous research has been conducted to look at the user issue, along the dimension of user participation in architecture planning. The doctorate of the author () looked at reconstructions after flood, earthquake and red mud from the point of view of participative planning, while another work, a book on participative planning (Bostenaru, 2007), also included an analysis of involvment of women in such processes (in the Emscher area in Germany). Two of the named case studied, are located in Romania and Italy. The Romanian reconstruction after flood is from the 1940s, by architect Richard Bordenache, trained at the Romanian School in Rome, for the village of Corbeni in Argeş county, and extensive archive research was done. Participation in rural world, such as networking between villagers, has been investigated (Bostenaru, 2015). The third case study investigated a similar approach today (reconstructions have been done also after flood in Hungary, throught the Association Károly Kós), of traditional building, and it is investigated how far the methodology in the German space, presented in the participation book, has been applied here, as participation is not a characteristic in Eastern Europe. The landscape dimension, already investigated for climate change and gender issues, also plays a role in the planning and in the mecene dimension of women. Such, Marthe Bibesco was active in the restoration of the Mogoşoaia castle and garden near Bucharest, a complex along the "Emerald necklace" of the Colentina river lakes as the Le Notre forum called it, which also represents Romania at the Minieurope exhibition in Brussels. Queen Mary commissioned the building of a castle with an impressive garden in the seaside resort of Balchik (today Bulgaria), where also a pioneer woman architect was active building characteristic villas: Henriette Delavrancea-Gibory. Luiza Blaha, the Hungarian actress, let a villa be built in the Lake Balaton resort in Hungary. Elena Luzzatto, the first Italian woman architect, collaborated with Maria Theresa Parpagliolo Shephard, the first Italian woman architect, in building a war cemetery in Rome, after Maria Theresa Parpagliolo Shephard planned also the green spaces for the Espozione Universale Roma (EUR 42). Virginia Andreescu-Haret, the first Romanian woman architect, built a casino in the Govora thermal bath resort, middle in the cure park. This approach is very similar to what we find in Italy. Elena Luzzatto built a villa in Ostia, the seaside resort of Rome. Le Notre investigation of landscape architecture build the basis for comparison between Romania and Italy, since a previous Le Notre forum was held in Rome and featured the landscape of EUR we mentioned. Not only along with Le Notre investigation, this dimension of water is a line of tourism research connected to the heritage of water. Water as hazard, such as of flood, is one aspect in this research. Another aspect is water as heritage. Building on the diploma work of the author, which looked at water as vulnerable habitat instead of water as source for vulnerability, as hazard, this includes the communication between architecture and the landscape of water. In Rome an aquarium will be opened soon below the EUR park lake, as initially planned. This was put in the context of other aquaria visited by the author, such as Monte Carlo, Barcelona, Lisbon etc. This maybe be expressed in the architecture of bathes, which in Italy has tradition since Roman times, but included some new inputs to Turkish time, Art Nouveau, Modernism and today (Meder, 2011). For Italy remarkable Art Nouveau spa-s are those in Salsomaggiore şi San Pellegrino terme, the later being subject of the excursion of Resseau Art Nouveau. For interwar time subject of investigation in Italy are the bathes in the region of Cesena, such as Castrocaro şi Fratta , but also in Genova region. Planning, for example a spa, is a gender sensitive issue, which evolved in history. The author advised such projects of students and interviewed contemporary architects (Bouratoglou et al, 2015). The architect who designed the reconstruction in Hungary (Imre Makovecz) also designed two some modern bathes, which are to be compared with the historical ones – if the floor plan changed since women and men do not bath separately, for example. The Szechenyi bath in Hungary is another water related site at Minieurope, where the connection between water and heritage buildings is highlighted in a landscape park. This part of the research included archive research to have access at the floor plans. During the reintegration grant of the author methods to analyse floor plans based on function have been developed, following the decision tree methodology and more recently Space Syntax. For such public spaces Space Syntax proved particularly suitable. Apart of the architecture of bathes, an architecture having to do with water as mean of purification is that of spiritual places. Some of the pioneer women architects designed churches and memorials, but again some monasteries are places for women communities. Examples for such are the beguinages at water in Belgium and in the Netherlands. So far this kinds of architecture programmes for women as users were not investigated, research focusing on the change of the architecture programme of housing to the modern type of woman in the 20th century (Pollak, 2005, Cosseta, 2000).

5. RESULTS

Research of the author focused on Art Nouveau and interwar architecture in Europe, with a focus on Eastern Europe. A focus has been protection against disasters, first earthquakes, now also flood. The gender dimension is new in this research. Pioneer women architects in Romania (partially today Bulgaria territory), Hungary (partially today Romania territory), Estonia, Poland from Eastern Europe, and Italy have been looked for. Apart of mobility between countries we see that the frontiers were also mobile at this time in history. The society models for woman architects were different in these countries, in some of them women architects being married with other architects or civil engineerings and cooperating also in the profession, sometimes signing independently the works, sometimes together. This is worth to be compared with the practice today, when, for example Daniel Libeskind cooperates with his wife but is the main signatory. Another example are the partners of Enrico Miralles. The inclusion of cooperation with the Marie Curie Fellows Association led to investigating situation today and to pioneering times in these Easter European Countries. The Role Models booklet has been presented at the EuroScience Open Forum in Dublin (2012) and Copenhagen (2014) and at the eurodoc conferences in Budapest (2014) and Cluj-Napoca (2015). genderSTE connections have been drawn at the eurodoc conferences, and the stay in Hungary enabled links to Zsolt Mészáros, for turn of the century architecture, and Pál Ritook, for interwar architecture. From the turn of century architects we highlight Erika Paulas, who built in today's Transylvania (Bistrita, Cluj-Napoca and Medias). The author hosted a Short Term Scientific Mission on the role of landscape architecture for the COST action "Climate change and migration" (articol arhitext). In frame of genderSTE colleagues in the WG from Vienna have a project on „Gender Impact Assessment in the Context of Climate Change Adaptation and Natural Hazards" (floods and mud slides, participative planning https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&menue_id_in=300&id_in=9726). Also the Marie Curie Alumni Association has a working group on Climate Change, preparing a project proposal, just like the gender related working groups. In frame of the genderSTE WG research included working at improving the waste and water part for gender issues for the Horizon 2020 draft programme, the part on water. The gender dimension is building an important part of the Horizon 2020 programme. Women and water is part of other research programmes as well, such as a 5 years programme in Japan (http://wings.synfoster.hokudai.ac.jp/). Water is an interdisciplinary matter, as the a junior summit on water in Stresa, organised by the ESF, where the author participated and was in charge for video (Bridle et al, 2013). Some of the architecture of this women is endangered. It used to be so at the time of planning (Erika Paulas won the competition for the Bistrița it was not built after her plans) and testimonies of women architecture continue to be erased (modifications at the Govora casino by Virginia Andreescu-Haret, demolition of the Prager villa by Henrietta Delavrancea-Gibory, the only one in Bucharest in Balchik style, and of some of those in Balchik).

6. CONCLUSIONS

Approaches and evolution of pioneer women architects were compared with the situation of today drawing conclusions for design and planning, and testing applicability in teaching assignments. A methodology (the decision tree and the roles of women in it) was developed and methodologies already developped by colleagues for particular cases in other countries were tesed. Research on pioneer women architects exists in a number of countries, including those investigated, but not always the specific gender dimension is being seen. Given the focus of the applicant this research investigated to which extent mobility was possible and helpful in this context. Going into depth of research is subject of continuation. The needs of women are included in the definition of the architecture programme, especially in the functional connections. For this the study of the space and of the plan is important, not only of facade and style, and such research is rather rare. From the architecture programme of the single building this can extend to the planning of city or resort settlement quarters: housing quarter and loisir quarter. There is a need of increased awarness of the architecture of pioneer women and the role it played for structural change. The architecture of the begin of the 20th century, particularly interwar architecture, is many times not considered old enough to be preserved and architecture of women even more so. The global dimension of mobility can lead to drafting women networks in this time. A first exhibition at the 2014 architecture Biennale (Meder et al, 2015) showed such networks for Eastern and Central Europe, including a woman architect, Margarete Schütte-Lihotzky, but more can be done for those investigated in this research.

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THE TRANSFORMATION OF KINDERGARTENS

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ABSTRACT

Kindergarten is a current architectural topic, which is with us since the 19th century. The development of kindergarten recorded quick rise after World War II, when changing the traditional scheme of family because of enormously increase women's employment.. Since the 70s of the 20th century changed the social conditions define the different goals of education, reflecting new societal demands and specific wishes of parents and the extended range of educational methods, including alternative pedagogical practices. Article aims to provide arguments for the courage to implement such a nursery, but even to a change of legislation and building standards. New information about the positives and negatives of the practices implemented nurseries would shift expert views on architecture nurseries. Active involvement interdisciplinary approach (child psychologist, teacher, and architect, representative of the child) would lead to effective development architecture kindergarten.

1. INTRODUCTION

First institute for preschool children were, in Czech countries, build during 19th century. Their rise was forced by changes in the company and in home economics. Maria Theresa's reforms (Freis, J. 2005) were gradually education transferred from the Church to the State and new laws were passed, which supported education of wide layers of the population. With sharp increase of the industry and with follow–up moving of the people from countryside into the towns, as so as due to gradually increasing employment of women, it was necessary to improve the care about preschool children by institute.

Traditional multigenerational family is falling apart and more and more responsibility about members of family gradually passes to state. Equality of men and women

In the 50s of last century this trend was strengthened and firmly anchored in a Czechoslovak society.

Theoreticians of architecture, for example Karel Teige (Teige, K. 2012), they brought the idea of new structure of society to the extreme. They thought about family as a relic and traditional cohabitation in living kitchen as step back in evolution of society. The women go to work as the man. The flat lost economic function and is used only for oversleeping. Eating is shared and children are educated in children´s home by skilled labour force. Kindergartens are part of experimental construction of collective houses.

2. ROLE OF KINDERGARTENS IN SOCIETY

As quickly as it developed a new typological kind – kindergartens, equally was changed their role in the society. While the former nursing homes, incurred during 19th century, provide children by physical case and social case, in new incurred kindergartens was added the function mental and moral education. The primary role, to provide to children one worm food a day and appropriate hygiene, was moved through the need to care about children of working mothers to educational activity and resulted in active care *"to prepare children for entrance to basic school."* (Gillová, P. 2008)

Access to preschool education takes place in periods, when is again restored the principle in opposite to the previous. While during an educational reform movement in interwar Czechoslovakia (1918-1938) it is the personality oriented aim of preschool education, socialistic concept restored after the political putsch 1948 is oriented to collective, socialization, bigger group of children and deepens the constitutionality of preschool education.

Another change occurs in 70s in the last century, in Czech countries after 1990. Rediscovered humanizing tendencies have a direct impact on access to preschool education.

A gradual move away from constitutional education and preschool education is more interested in single. There is allowed integration of children with specific needs. Leads to rediscovery of alternative education, incurred on the beginning of 20th century.

3. TYPOLOGY IN HISTORY

Originally closer undifferentiated spaces, usually in existing building other use, where specified during interwar Czechoslovakia by teacher Anna Süss (Svatoš, T. 2002). She divided kindergarten to space for playing, learning and garden. This concept is used till today. She was interested in equipment space for children. Anna Süss highlights the needs adapt furniture size of the needs of children, not only to cope with self-care, but also to be variable. Kindergartens are built, during first half of 20th century, as small buildings on free site. During the second half of the last century they are mostly become part of a comprehensive housing and become part of areal of basic schools. (Stýblo, Z. 2010)
First schools were constructed as brick structural system. There are dominate less differentiated spaces and facilities of school and departments seem to be inadequate. In the present day are these layouts modified according to current hygienic and operational needs, mostly according to the standardized typology kindergartens from later years. Standardized kindergartens from 70-80th of last century in Czech Republic have all of them almost same layout and they are use till today. They are mostly build with 3 or 4 departments (classes), with space for director and with the own facility for providing meals. Two storey houses are consisting from departments based on age of children. Each department has own entrance from exterior. Own entrance has also staircase, which leads to two departments on the second floor. Throw very small vestibule goes men to children cloakroom. The entry to class is made possible through the washroom situated near cloakroom. Behind the washroom is room with toilets for children. Class has usually L shape... The dining room adjoins the preparation of meals, which is distribute from the kitchen situated always in the first floor of the building (with own entrance and supply court). From classes in the first floor is possible to come out to patio and through patio to the garden. This way is not usually used; children always go through cloakroom, when they go to the garden. These buildings were built as reinforced concrete prefabricated structures including reinforced concrete prefabricated ceiling and woods called panel.

4. TRANSFORMATION OF CONCEPT

How is changing the education of the preschool children in 21st century, so this change, on several levels – typology, function and aesthetic, follow by the very architecture.
The examples below represented kindergartens of 21st century, which respond to current needs of preschool education and the same time focus on needs of child. Where choose realizations in Austria and China, as representative nurseries built abroad and one school in Czech Republic. Each of them exceeds the traditional production and quality of kindergartens.
While the example from Austria seems to be most innovative and progressive due to current trends in conception and education principles, Czech school is avant-garde by its facade, without bigger ambitions in design solution of interior. China school presented itself by polyhedral footprint, which from exterior created cute mass corresponding to the children’s imagination.
Selected examples represent a closer shift in mentality in the design and implementation of kindergartens from the very widespread standardized kindergartens of former regime, i.e. kindergartens institutional type, to the schools of 21st century, which represent current knowledge about education of children. It means developing not only the entire team globally, but targeting on the individual, small groups and until then, the whole team. Supported is at the same time relationship between children, also the relationship to space, which they use, relationship to surroundings, which is close to kindergarten or they can meat on way home or during the walks with teachers.
Using of space by children is not dictated, but a variety of space invites the child to its own proposals and thoughts about its use. Relationship of inter layout to surroundings teach the child perceive the world in a broader perspective. It therefore rejects the isolation of architecture from the actual utilized landscape. The child learns to understand the context.
Elimination of long corridors, closed staircases and streamlining of whole layout, allows good orientation, but also bigger parents cooperation. Opening to the public (requires the creation of multifunctional spaces) then help participation kindergarten on live in the town or village.
Kindergarten in Lichtenegg in Austria is one-storey building with added loft, which expand classes. Scale is of adequate size users. Each class uses its terrace, which inhabits. Spaces are multifunctional and flexible use (vestibule as art workshops, gym widespread in the lobby as a social space, etc.). Within classes are created shelters for smaller groups or individuals.

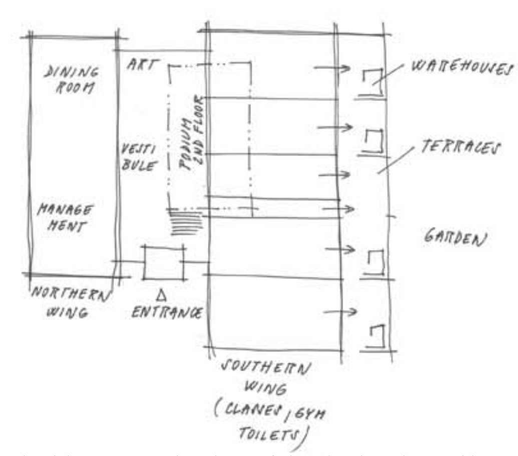

Fig. 1 Kindergarten in Lichtenegg, Austria, schema of plan (drawing Klára Frolíková Palánová, 2015).

Preschool in China is ten classes. Departments are situated around green atria and ground classes are extended to the garden they use. Folding weight classes created playful concept.

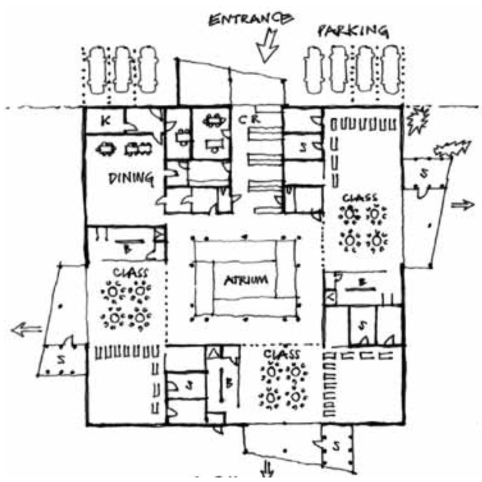

Fig. 2 Kindergarten in Krásné Pole, Czech Republic, plan of ground floor (drawing Vendula Šafářová, 2015).

5. CONTEMPORARY ARCHITECTURAL TENDENCIES OF KINDERGARTENS

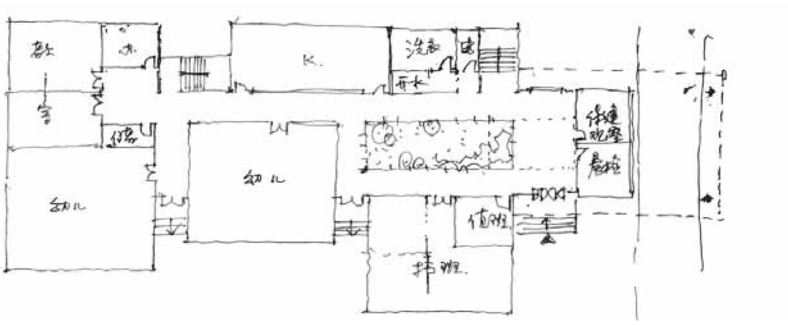

Fig. 3 Kindergarten in Suzhou, China, sketch of the ground floor (drawing by Richard Cai, AAI, Shanghai, 2010)

Of the examples is evident effort to bring a scale of the building to size of children, as the main user. Transparency objects allow parental involvement and municipalities into the live of the kindergarten and vice versa. Child is not isolated in educative institution but it is part of the municipality story. Child is not just postponed in the system of the education, but actively participates on live, same as parents can influence and monitor the activities of their children and they are not just passive spectator. All chosen examples trying children close world throw haptic perception and promote their imagination stimulating design. Stability tribal classes gives to child a sense of security, same as (on Austria example) shelters in the class. School thus grants that each child has own nature, from which follow its own needs.

On example of Czech kindergarten is evident shift of perception of intimacy children by sliding washrooms from entrance to classes. But transparency of classes from atrium and exterior also, without shelter or other possibilities individual or small group activities, limits using of space for clear collective. Likewise remains strict differentiation spaces, excluding the atrium, however, also supported by dividing a separate dining area.

Maximum linking the interior and exterior kindergarten in Suzhou eliminated the impact of large-scale kindergarten, as well as the location of different classes into separate volumes.

It is evident that the typology kindergarten to individualize from general architecture, receives its own typology, which is transformed from separate space towards freedom space. This means, that individual spaces (class, game room, sleeping room) blend together and overlap or they change their function during a day. The building has educative concept. Teach the child and initiates the action. It gives stimulus to interaction, when the child is not only limited user of the building, but active player, personality, which transforms the building and settles suit your needs and mood. Child needs a chance experience mystery and emotion, alone without adult openly manifested his creativity. Therefore the building has to be safe, but inspirational also. It has to promote children's potential.

The aim of new conception of kindergarten is to develop and support children´s mind and soul, not raise a child to "herd" behaviour, which is introduced into the system. Ask for feedback realized schools, what works and what to avoid. Directive teaching should be the concept of the past. According to Ismail Said concept buildings for children needs interdisciplinary approach, using child psychologists and architect, who knows the environment, where children play and grow. The inherent is the knowledge of cognitive child development.

6. CONCLUSION

Since the 70s of the 20th century, the changing social conditions define other targets education, reflecting both new societal demands and the specific wishes of the parents. Expanded the range of educational methods, including alternative pedagogical practices. The transformation of the education of children followed architectural form kindergartens. The article provides arguments stimulating the courage to implement such kindergartens or even change legislation and building standards, if not allow for example the concept of rotating classes or do not respect the scale of children. Obtaining new information about the positives and negatives of practice realized nurseries, qualitative shifts expert views on architecture kindergartens. Active involvement interdisciplinary approach (child psychologist, teacher, and architect, representative of the child) leads to the efficient development of architecture kindergarten.

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VULNERABLE HOUSES IN THE SOUTHEAST OF MEXICO

POSTER

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ABSTRACT

In Mexico, many people build their houses with masonry walls, these are typical and traditional for rural buildings. Furthermore, are relatively inexpensive. Masonry walls present advantages as structural, insulating and dividing elements. Nevertheless, it also presents low resistance to tension and insufficient capacity to support deformations in its plane, and, in order to reduce the possibility of brittle failure, it requires some reinforcement.
In this paper, the non-linear behavior of masonry structures, that constitute the houses located in the Southeast of Mexico, is studied. In particular, their response to ground vibrations due to seismic prospection studies. Of particular interest is the situation in this region of Mexico, where a series of static and dynamic load conditions for housing arise. The results presented in this study can be useful as an analysis tool for correct intervention in order to reduce similar risk conditions.

1. INTRODUCTION

In this paper, a study to understand the current situation of masonry houses located in the Southeast of Mexico is presented. It is expected that the results of this analysis will be helpful for the development of this region, which is of particular relevance because the structures located in this region are subjected to the effects of studies of seismic deep reflection1 made by private companies to locate hydrocarbon deposits. The effect of these studies on households depends on intrinsic factors such as soil type, the foundation of the buildings and construction criteria. In México, the seismic behavior of buildings using masonry walls has been extensively studied (Meli, 1975; Alcocer, 1997). This traditional building system has great diversity in their practices and it is usually associated with craft methods.
There have been numerous investigations to understand the behavior of masonry housing. These structures are made in accordance with the particular needs of each region and the records obtained from seismic events. The use of systems-based masonry shows great advantages as structural and dividing element. However, it has low resistance to tension and insufficient capacity to support deformations in its plane, and, in order to reduce the possibility of brittle failure, it requires some reinforcement. Therefore, from a structural point of view, analytical non-linear models have been developed to study the response of masonry walls subjected to lateral or horizontal loads such as earthquakes. Unfortunately, there is insufficient information to build correct masonry analytical models, this occurs despite being elements that resist both, vertical and horizontal loads. Based on the aforementioned argument, in this work, a new mathematical model to represent the behavior of confined masonry structures subjected to static vertical and dynamic horizontal loads, is evaluated. Moreover, in order to study the behavior of housing located in the Southeast of Mexico, an analytical model is proposed. Additionally, through inelastic models its nonlinear response is analyzed.

2. CHARACTERISTICS OF MASONRY WALLS

2.1. Structural and seismic response of masonry walls

When masonry walls are subjected to lateral loads (as the forces induced by the action of an earthquake), the structural response variables needed to characterize its behavior are essentially the lateral displacements, rotations of the wall and the angular displacements (Cecilio, 2011). Their interaction can be represented by equation 1), in which the contributions of shear, bending and total displacements are shown:

$$\Delta_T = \frac{Vh^3}{3EI} + \frac{Vh}{GA} \qquad \text{Equation 1)}$$

Here, *V* and *h*, are the shear and height of the wall; *A* and *I*, are the area and moment of inertia of the equivalent section. *E* and *G*, corresponds to elasticity and shear modulus.

Furthermore, requirements for seismic design of masonry structures that have been established after the 1985 Mexico City earthquake, have led to significant changes in the design of buildings. Such requirements have been based on lessons learned (Alcocer et al., 1999), observation of the damage from past earthquakes and on understanding the behavior of isolated or coupled walls subjected to cyclic lateral loads in laboratory tests. Therefore, in order to have a thorough understanding of the seismic behavior of masonry structures, it is necessary to experimentally analyze the interaction between their different elements such as the quality of the wall elements, their resistance, and the size and the amount of reinforced elements for confinement. That is, the interaction to be achieved between the wall and the elements of confinement. In figure 1), the behavior of a masonry structure subjected to the action of seismic forces is shown.

The design of a confined masonry building with horizontal and vertical reinforced concrete elements, have demonstrated an acceptable seismic performance. However, it has been observed that the strength of the walls decreases quickly, while the concrete element that confines the walls is damaged (Cecilio 2011).

3. STUDY OF THE MASONRY HOUSING

A representative masonry house is studied. The aim is to understand the behavior of this kind of structures located in the Southeast region of Tabasco in Mexico. The model is analyzed under different cases of excitation produced by underground explosions with explosives. The model is subjected to accelerations of soil resulting from nearby underground explosions. The house is located at a distance of 240m with respect to the underground detonations.

3.1. Computer tool for the study

The numerical analysis was performed with the CANNY-2010 program (Kan-Ning, 2009), which was developed to solve structural engineering problems. The program CANNY has also been developed for general purposes and is able to simulate nonlinear structural problems of three-dimensional frame structures and frame-shear wall structures under dynamic and static loads. It includes beam, column, wall, shear element, truss element, cable, spring, isolator, damper, beam-column joint element for modeling most building structures (Kan-Ning, 2009).

3.2. Description of the model studied

A typical house of the Southeast region of Mexico was analyzed. It was built 25 years ago. The model consists of masonry bearing walls (hollow concrete block). The roof was constructed with a reinforced concrete slab and it is supported by concrete reinforced horizontal elements. As it can be seen in Figure 2) both slab and concrete

Fig. 1 Behavior of masonry housing under the effect of an earthquake (CENAPRED, 2009).

Fig. 2 Masonry house studied.

reinforced horizontal elements have damage, also the floors show cracks.

3.3. Behavior of housing

The behavior of a house subjected to environmental vibration was studied by using triaxial accelerometers (in the

Model	Frequencies (Hz)	
	Transverse	Longitudinal
01	6.006 to 6.152	4.272 to 4.395

longitudinal “L”, transverse “T” and vertical “V” directions). In Table 1), the vibration frequencies obtained from the analyses of these records, are presented.

Table 1) Fundamental vibration frequencies (measured from ambient vibration tests).

The analytical model of the masonry structure (representative housing), was performed by using the aforementioned CANNY-2010 program; in the following, the results of the calibration are presented. The model was built considering all elements that provide structural stiffness. In Figure 3) the three-dimensional model of the studied house is presented.

The calibration of the mathematical model was carried out by using the results of the environmental vibration test.

Model	Frequencies (Hz)	
	Transverse	Longitudinal
01	5.618	4.824

The results are shown in Table 2). Subsequently, the model was subjected to history accelerations (representing repeated underground explosions). Figure 4) shows the recorded history accelerations applied.

Table 2) Calculated vibrational frequencies.

The acceleration history included several detonations. This was done in order to study the effect of repeated underground explosions on the masonry house. Its structural response was analyzed by using, as a parameter, the relative

Model	Longitudinal		Transverse	
	maximum	minimum	maximum	minimum
01	-2.20E-05	2.10E-05	-5.60E-06	5.20E-06

displacement of the storey (distortion). As it is well known, this parameter shows how the structure responses as a result of soil movement. In Table 3) the maximum calculated distortions for the studied house, are presented.

Table 3) Maximum calculated distortions.

The values obtained are below the maximum allowable values presented in the literature (Reyes, 1999). Additionally, the history of distortions of the storey of the house was obtained. Also, it was observed that the values of the distortions of the studied house were below the maximum allowable values.

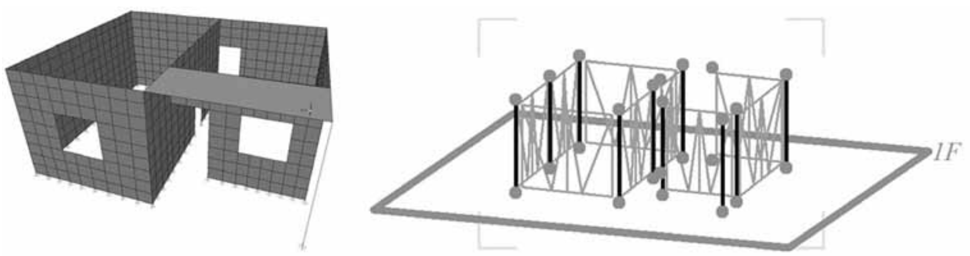

Fig. 3 Mathematical model of the studied structure.

4. COMMENTS

For the model studied, the present analysis showed that the storey distortions, due to environmental vibration tests, did not exceeded the allowed values according to the current standards. The representative model, calibrated by using characteristics of real tests, did not show any damage as long as it is placed beyond 240 m from the point

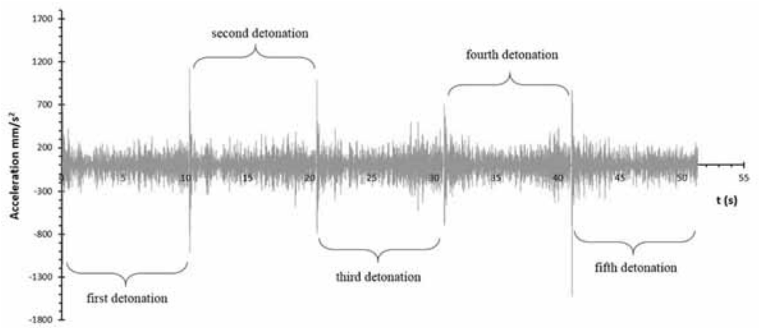

Fig. 4 History of ground accelerations.

where the seismic deep reflection tests were carried out. For shorter distances possible damage from underground explosions could be envisaged. This, however, is matter of further studies.

5. CONCLUSIONS

In this study, the effects of underground vibrations on masonry houses were numerically explored. A model of the proposed vibration was developed in CANNY-2010 (Kan-Ning, 2009) and the inelastic behavior of confined masonry was examined.

From the data obtained from an environmental vibrational test, a hysteresis model was calibrated to represent the inelastic behavior of confined masonry. It was found from the analysis that the bilinear/trilinear hysteresis sophisticated model of the Canny-2010 program, was able to represent within a good approximation, the inelastic behavior of masonry structures subjected to lateral loads.

That is, the Canny-2010 program allows proper modeling of the nonlinear behavior of masonry structures. The hysteresis model reproduced the inelastic behavior of masonry walls studied in the laboratory. Also, the employed hysteresis model was able to represent, with a good approximation, inelastic behavior of masonry structures subjected to lateral loads due to ground vibrations.

With the hysteretic model used, it is possible to represent and study masonry structures with inelastic behavior under repeated underground explosions.

NOTES

[1]"It is a method of exploration that geophysicists use based on the principles of seismology to estimate the properties of the Earth's subsurface from reflected seismic waves. The method requires a controlled seismic source of energy, such as dynamite, a specialized air gun or a seismic vibrator" (Definition of seismic deep reflection, 2015).

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ANALYSIS OF URBAN RESIDENTIAL ENVIRONMENT OF THE FAR NORTH OF RUSSIA AND METHODS OF ITS DEVELOPMENT ON THE EXAMPLE OF THE CITY OF UKHTA

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Keywords

Residential environment, reconstruction, sustainable development.

ABSTRACT

The aim of this work is to find the ways of developing a residential environment of modern cities in the Far North of Russia. The key problem of these cities is their single-industry. The new economic reality has caused many problems for these cities.
The author also pays attention to the quality of the residential environment of the cities, considering it an important factor. The Residential environment of the cities is connected with the social and demographic population composition of the city. These connections have a two-way nature of interaction. That is, solving the problems of residential environments, it is possible to achieve positive changes in the social and demographic spheres.
The author analyzes the problems of the residential environment of the city Ukhta and suggests the ways of transforming it. In his proposals the author relies on the existing social and urban context of the city, uses the principles of a comfortable, affordable and diverse housing, adapting them to the features of the existing buildings.

1. INTRODUCTION

The region with the conventional name “Far North” includes a vast territory of Russia, including areas of the Arctic polar zone, tundra, forest tundra and taiga part. That’s about 60% of the country - an area virtually untouched by human activities. It is home to about 8% of the population of Russia. Most of the population, production capacity and the most productive agricultural areas are mainly concentrated in areas with the “softest” climate - in the west and south - south-east of the country. However, economic and political expediency tells us that despite the “severity” of the territories of the “Far North” for human habitation their development is necessary (Garshtya, 2015). This thesis is also supported by some government programs such as the program “Socio-economic development of the Arctic zone of the Russian Federation until 2020”, the program “Socio-economic development of the Far East and the Baikal region.” Of course, the further economic development of these regions will affect the field of housing construction.

2. BACKGROUND

The Analysis of the cities in the “Far North” in the example of the city of Ukhta is possible thanks to a number of common factors. The vast majority of the cities in the “Far North” were built in the times of Soviet Union. The settlement system developed in the USSR was based on the idea of economic orientation of the individual regions of the country depending on the climate and the resources present, transport and energy. This approach predetermined the appearance of monotowns by industrial and mining enterprises. The construction complex of the Soviet Union was forced to solve the problem with the formation of new settlements emerging in the north industrial complexes in in a very short time (Zaydfudim, 1998). Therefore, at the design stage the social environment of the city was formed, as a rule, in the following way: in the framework of existing rules a “normatively sufficient” city was created . It was expected that with the time, this city would “transform” and a stable social and residential environment will be formed inside it.
The Implementation of the “normative” approach in the construction of new monotowns in the North and the Far

East is clearly seen in the growth of the urban population - it is growing abruptly - with the development of the city-forming enterprise. The “Normative approach” involved the use of standard solutions in organizing residential environments and public spaces, and the use of standard projects of residential and public buildings (Nazarova, Polouektov and Sorokin, 1984). All these factors have led to the similarity of problems and imbalances arising in the cities of the “Far North.” Accordingly, for their solutions similar techniques may be used. After the collapse of the Soviet Union the monotowns of the Russian «Far North» faced serious economic, social and demographic problems. One of these problems was the problem of the poor quality of the residential environment. Ukhta City Master Plans of 2008 and 2013 suggested developing the residential environment of the city through the construction of new residential areas, while completely ignoring the problem of the reconstruction of the existing ones. This approach leaves out the existing problems of the city and does not use available resources - communication, public space, engineering networks and housing fund.

3. METHODS

The development of the methods of the residential environment should be based on the concept of sustainable development, including social, economic and ecological components. Thus, the analysis of the residential environment in the city of Ukhta includes the study of its social context (the social component) and the urban context (economic and ecological components). The Analysis of the social context includes collecting and processing statistical data of the population of the city. The Analysis of the urban context includes collecting and processing - statistical data on the quality and structure of the housing fund of the city. Based on the results of the analysis a number of conclusions were made. Based on these conclusions a number of development methods of the residential environment of the city of Ukhta were formed. The Testing of these methods is modeled in the form of projects for the reconstruction of several residential complexes in the city of Ukhta.

4. CASE HISTORY

Analysis of the social context (Fig. 1).

The population of the city of Ukhta within the study area is 99.6 thousand people. Most of the population are working people, the second largest group is represented by retired people. It should also be noted that the total number of full-time students in the institutions and universities is quite large for such a small town. Women and men in the population of the city are of almost equal amount. The largest age group is represented by males (16 - 59 years) and women (16 - 54 years). Groups of the population older than working age and younger than working age are almost equal. Thus, we can say that the population of the city of Ukhta balanced in its composition, mortality and birth rates is almost equal, which means zero natural growth.

Analysis of the urban context (Fig. 2).

The total area of the urban settlement is 615 hectares. The average population density is 157 people per hectare. The Housing Fund of Ukhta is about 2.2 million. m^2 of total area, with an average of 21.3 m^2 per resident. The ownership structure is as follows: private households - 81%, municipal household - 19%. The area of dilapidated residential houses takes 1.8% of the existing housing fund. The level of providing multifamily housing with the engineering equipment is quite high (93%). The most common house by the number of storeys is a five-storey one (41.1%), followed by a two-storey building (23.3%). In general, the city is dominated by low and mid-storeys (up to 5 storeys, inclusively) - 85%, which is a very good indicator of the level of a comfortable environment (a high level of visual ecology, optimal modes of insolation are achieved). The following construction materials are widely used in the housing fund of the city: brick (63%), reinforced concrete panels (28%), wooden houses (9%). What’s interesting is that panel buildings are mainly located in residential groups, but in some places form the building front of the street. In the construction of the city a specific set of typical houses is used. Residential buildings are represented by fifteen massive typical series and their modifications, a little-used series of buildings is also present. Among the used series the two prevail - brick houses of series 447 (1-447) and panel houses of series 467 (1-467). Both series are implemented in five-storey buildings. They form the core of the residential area of the city of Ukhta. Most of the housing fund is represented by two-room apartments (54.4%), followed by the three-room (23.5%), and one-room apartments (19.9%). Low rise buildings, low relative density of the population, a large number of green spaces (about 28% of the city area) are valuable resources for the further development of the residential environment of the city of Ukhta. However, there are problems in organizing residential environment: lack of playgrounds; trampling playgrounds and other areas, turning them into transit zones; inefficient use of territories near houses; lack of protective plantations; lack of communication areas; degradation of vegetative cover due to unauthorized traffic or parking of motor transport; spontaneous car parks, lack of parking spaces in the yard.

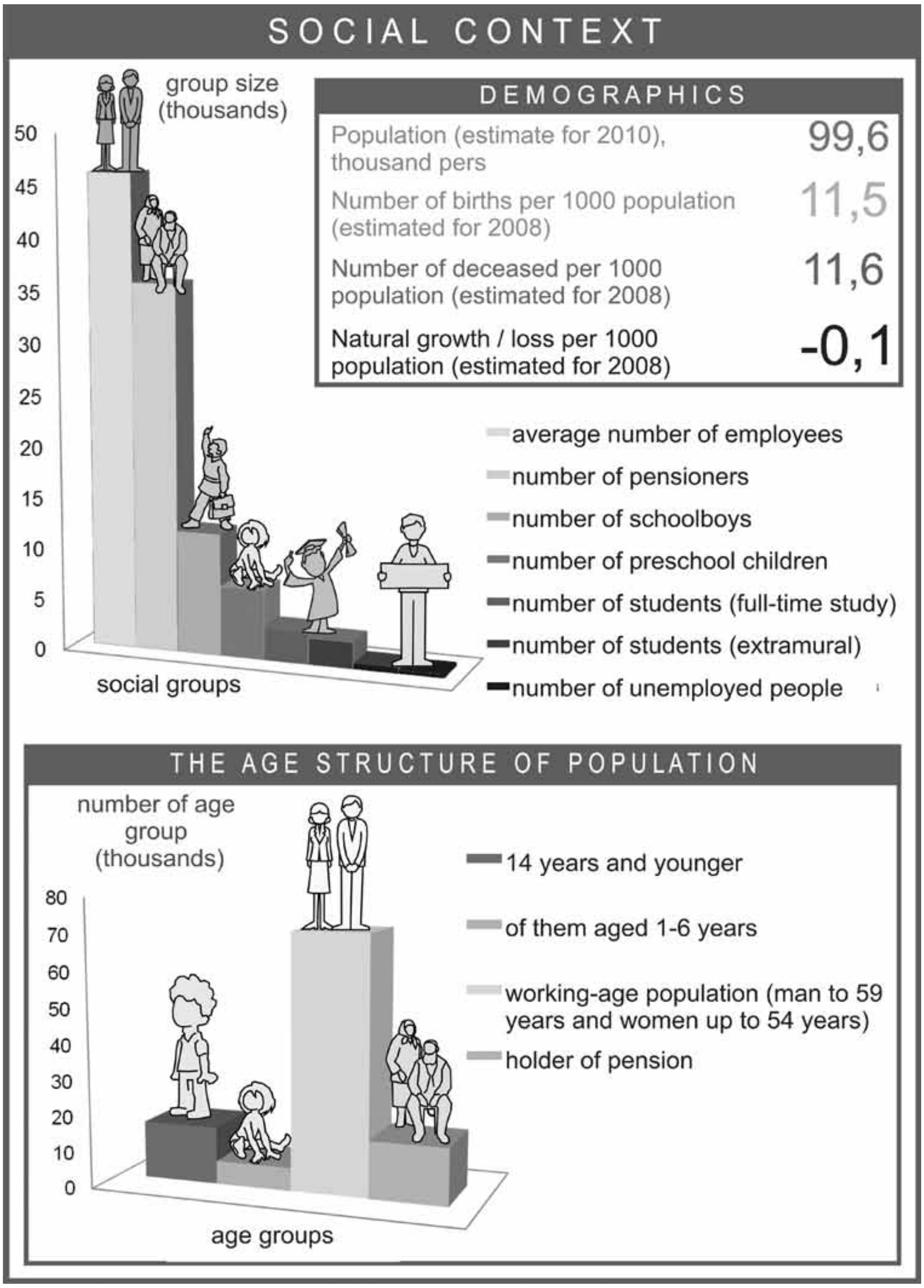

Fig. 1 Results of the analysis of the social context of the city of Ukhta

A comparison of the social and urban context (Fig. 3).

The average family structure in Russia and the population of the city are well known. An approximate distribution of the housing fund by apartments among the population, depending on the number of people in a family gives the following result. The Housing Fund of one-room housing almost completely covers the needs of childless families in terms of provifing every family with its own apartment. The same is true of the childless families, consisting of two people (a couple). The number of one-room apartments covers the needs of these families as well. Two and three-rooms apartments, in the ratio of 65 to 35 respectively, might be provided to families consisting of three members (parents and one child). A family of four members may be settled in individual three and four-room apartments. The Housing Fund of the city of Ukhta has sufficient reserves to ensure affordable and comfortable

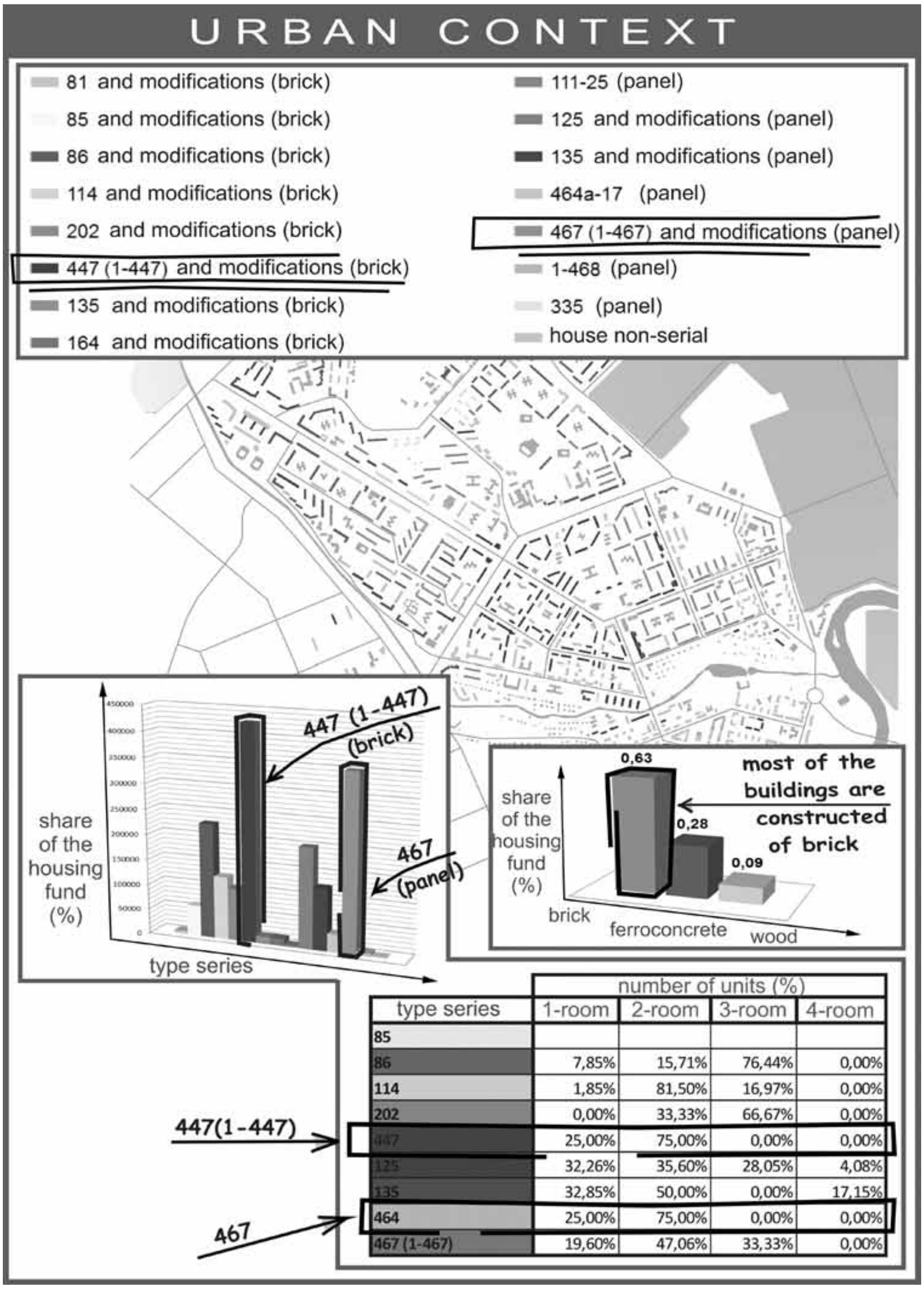

Fig. 2 Results of the analysis of urban context of the city of Ukhta.

housing for all citizens. The shortage of housing is not identified. That's the problem of the quality of the housing that comes to the forefront (Garshtya, 2012).

5. RESULTS

For working out the principles of developing residential environment in the city of Ukhta it has been decided to develop three variants of housing reconstruction in three different areas of the city (Fig. 3). These territories have a different character, a different landscape and a different functional and social importance for the city (Garshtya, 2011). This suggests a different approach in shaping the architectural appearance and social programs of new public and residential complexes. The proposed three variants of local reconstruction have the programmatic character. Their task is to create a " center" of reconstruction and development of residential structures. Reconstruction of these residential groups will not solve all the housing problems of the city of Ukhta, but will create a precedent

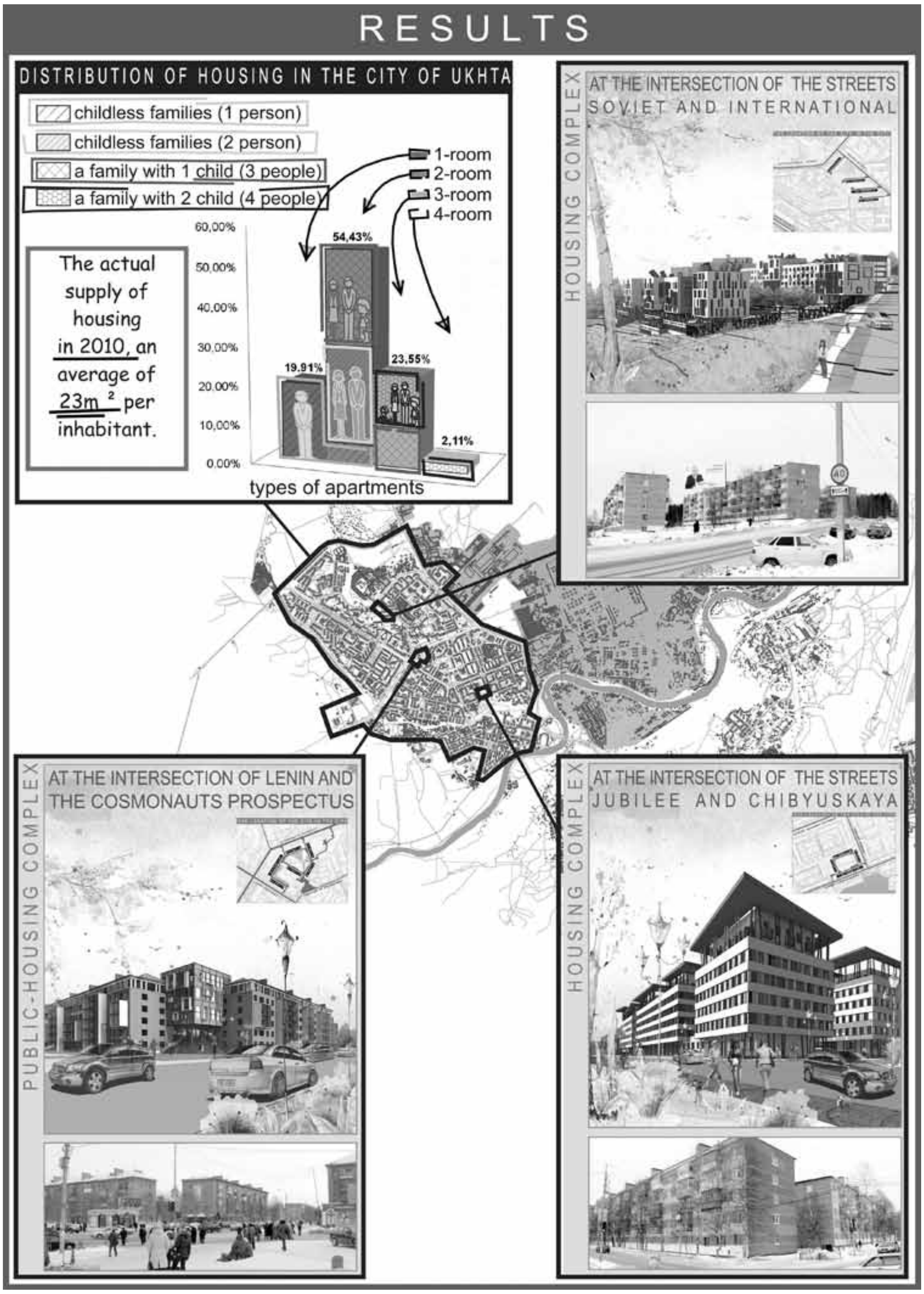

Fig. 3 The distribution of housing fund of the city of Ukhta. Examples of reconstruction of residential environment of the city.

of a new approach to housing construction - “address design”.

6. CONCLUSIONS

The development of the residential environment in the cities of the “Far North” should be based on three principles.
- Attention to a person and to his needs. This will neutralize the distortions in the development of the city, caused by the use of “normative approach” during the construction of the city;
- Active reconstruction of the existing types of buildings. Improving its quality. Formation of a diverse housing. Housing should accommodate living units available to different social groups. A great number of different elements in the system (in this case - in the social system of neighborhood) gives greater stability;
- Attention to the context of the urban environment. Analysis and utilization of specific territories for further development and creation of the “original” environment.

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SMART DESIGN FOR SMART CITY
Link as a plan strategy from architecture to landscape

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Keywords

structure, identity, movement

ABSTRACT

Contemporary architecture builds dynamic relational spaces, not single objects perceived as static. From this point of view, through the concept of connection intended as a project mode to connect separate spaces, we have the possibility to build an overall project strategy that makes the space convertible to different scales, to different dimensions and in an interconnected way, it follows that architecture, city and landscape are not separate project parts but are conceived through the same primary and physic action constituted by movement and journey, this last being intended as an instrument of practice knowledge, dynamic orientation and physical and perceptive identification. The project aims at penetrating the physical reality of the territory through a critical approach in order to be able to design it in accordance with a specific identification of man with its living place and thus to be able to reconstruct and broaden the idea of city and citizenship.

1. INTRODUCTION

Today architecture is, more then ever, an architecture of relationships instead of being an architecture of objects, of dynamic relational spaces instead of static scenes. The environmental emergencies of our times and the vanishing of the traditional urban forms in Europe as much as in other continents, make the meaning of this assumption wider and more true in regard to both the ‘natural’ territory and the anthropized territory.
Architecture of relationships means the need to design the spatial and physical-perceptive connections between land and building, inside and outside, public and private uses, open and covered, natural and artificial, in an organic way and to give to these connections the value of primary meaning of the project itself.
Art and contemporary architecture turn themselves towards the landscape: a living and experienced landscape, not only contemplated or viewed; a landscape to be interpreted in order to reveal its points of strength *‘through a discovery movement, through the section design and the perspective view, through the modelling, the engraving the definition of scenes, through the assembling, through the positioning of elements according to topological instances, trough the dynamic relationship between cartesian geometry and geometry of the informal’* [1].

2. BACKGROUND - Architecture as landscape

Such considerations open the doors to a more active cooperation between architectonic and urban design and the modern architecture of landscape where this last one investigates, phenomenologically, the generating and evolutive processes of the forms. The extreme modernity of making landscapes stays, at the end, in this planning generative processes of evolving forms more then of defined forms. The modernity of creating landscapes connects to the never-ending movement of our time looking for evolution and change, looking for spaces of relationship and relationships among spaces more then looking for crystalized and defined spaces. Modernity, it is known, prefers the rites of passage, the running in space and time. From here comes the space to the process, to the never-ending change.
‘But the process does not imply to give up the form, better it means to investigate the dynamic form, the growth, the development, the maturing, the germinating, the dieing, the flowerishing again. To plan living forms and their development is clearly something within the mind of the landscape designer. The attention to how things signify, to

the unavoidable issues of the ecosystem in a prolific immersion into the landscape is part of his approach and sensibility. These skills are increasingly more required to the architect that works on the city and on the landscape' [2]
At the same time the landscape, considered organically as natural and/or anthropized territory, is a limited resource already massively exploited and transformed by mankind without being planned correctly. The challenge is then to trace forms of thought that allow a city-territory connection, giving the possibility to reach the maximum density and flexibility of uses and the minimum consumption of territory. The settling guideline should then be 'less is more' [3] also for the urban and landscape planning. The less we bind the use of territory today, the greater the possibility of using it correctly in the future will be. This does not mean to retreat from planning, it means to use a critical approach in the planning activity. What the goal should be is to keep the possibility to modify the territory in the future, being able to re-plan it as many times as needed, exactly as it happens in nature. *'Nothing is created and nothing is destroyed in nature, everything changes'* [4]. According to this theory the territory-landscape is then intended as material to plan and preserve following the idea of flexible interface, a multidimensional, multi-scale and equipotential scheme able to develop itself gradually through traces that are not fully binding but that host within themselves a possible change.

3.METHODS – Connection as strategy

Connection intended as an architectural, urban and landscaping planning strategy imply the possibility of creating a flexible plan of natural and artificial spaces in order to guarantee that 'permeability of uses' to the territory that leaves it full of possible variations within the same strong idea.
Sustainability, conceived as relationship between means and purposes, as a limited use of the natural resources and as meaning reached with a few signs is the strong idea today behind architectural, urban and landscape planning. The creation of a network of meaning, an invisible net of connections based on the territory characteristics and then always different but able to give answers to the needs of economic, productive, social, cultural and environmental development that will raise in the future is necessary to plan the sustainability within natural or urban territories. Such connections are infrastructural-artificial, environmental-natural, urban-settling, functional-perceptive, architectural-localizing and temporal-experiencial. They determine the possibility to create a net-structured territory, a territory aimed at orienteering and hosting visitors and citizens and suitable for a flexible use of the open and built spaces interconnected through the concept of multiple speed routes and multiple levels. The concept of connection must be declined in different but contemporary levels of knowledge and planning if it has to be applied also to the landscape intended as natural and artificial territory; the level structure may be defined as follows:

1_site.	structure:	morphological systems
2_mark.	identity:	urban marks
3_scape.	movement:	fluxus systems
4_link.	connection:	concealed fields and poles
5_network.	net:	landscape and routes
6_texture.	system:	new urban and natural landmarks

The first three levels (layers) are at a greater analytic gradient and progressively turn themselves into the three final levels (layouts) at a greater synthetic gradient. The layers do highlight a net of meaning of the places, while the layouts are the plan synthesizing of a new meaning already concealed in the places but to be taken out and that has the aim to create urban or landscaping identity through the real crossing in movement of the places.

4. CASE HISTORY – Sport City Masterplan. Reggio Emilia Italy

Commissioned by Reggio Emilia city council the Sport City feasability study and masterplan tries to use the different gradient layers and layouts to design and approach the city and lanscape as a unique material.
The high speed train station defines a new infrastructure of the territory, intended as a fast transport system, but introduces a new pole of excellence within the territory of Reggio Emilia and creates the possibility to give a new set of meanings to the whole urban system. The interpolation and connection between the historical centre and the high speed train station allows to define a new urban "texture" conceived as a "sport and free time city" northbound and southbound, but also a new artificial landscape, that goes from the Santa Croce neighborhood to San Prospero Strinati eastbound and westbound.

1 Site. **structure**

The deep and exact analysis of the natural context, both urban and architectural, reveals morphological and systemic traces that identify diversified meshes and spaces crossed by flows at different gradient of speed and density. Every single part of the territory has specific values and characteristics that have to be explained and interrelated to the possible economical, cultural and social developments. The plan must trace the structure of the places in order to transform them accordingly. The urban and geographical morphology, where clearly identified, has got into itself the warning signs of the possible sceneries of future development.

2. Mark. **identity**

The natural and urban morphological systems within the topological and topographic analysis of the place determine the structure of the city and of the landscape, but the urban marks are the verification sphere of the presence of a system identity. The natural and/or urban marks are considered as buildings or open spaces able to give shape and order to the systems; they are 'orienteering points' not only in the historical and/or architectural meaning of the word, they are public spaces in a wider sense, places of sociality, attractive poles and social condensers, able to attract crowds of people and then to generate movement, able to become milestone of identification for the citizens. [5]

The possibility to trace them in the city or in the natural landscape identify the existence of possible identity elements; this does not mean that they are perceived as representative of the urban identity by the citizens themselves but for sure the are potential knots of physical-perceptive net to be revealed, a hidden hardware to be given meaning again.

3 Scape. **movement**

The context, intended as the place of the plan, has got in itself all the urban flow systems, considerin with urban all the structural flows alternative to the infrastructural one, namely motor-veicular: they are represented by
ciclying systems, walking systems, water flow systems, green areas, urban woods and country. Such routes and places define an 'alternative city', the ecological one of the free time, of sociality, of soft urbanity that aims at connecting with the landscape considered as overall territorial field and that includes the city and the natural or re-created green spaces. The routes and the green places of the open spaces represent a structure that is often weak and poorly attended, but they are the aggregation and attraction poles of the citizens as much as the open/closed built spaces both public and commercial are. They are by definition open and are becoming increasingly fundamental spaces for the organization of the citizens' time and for the enjoyment of the city thus strongly creating the feeling of a high or low standard of quality life.

Fig. 1.1 Site. Structure -2.Mark. Identity – 3. Scape. Movement - Sport City Masterplan. Reggio Emilia

4 Link. **connection**

The vision and the assembling of the different layers (1,2,3) found on the territory, allow the definition of concealed spheres and poles that can build, as limited, punctual, possible and realistic urban or landscape plans, centrality and polarity. These, placed into the net of both infrastructural dynamics (transport systems) and structural dynamics (morphological systems), change and transform the whole territory, thus granting the presence of signs, attractive poles and concealed condensers that structure whatever is already existing and the new key points of the project. According to this view we can trace connection spaces and elements able to interpolate and re-define the city. They are recognizable and definable according to a dimensional scale (territorial, urban, of neighbourhood) and according to the position related to the urban texture in which they are placed: they become concealed spheres and poles.

5 Network. **net**

The plan does not only define the concealed poles and spheres of connection; it also re-define the net through landscaping elements such as the green and route systems. The net, then, rearranges and gives a hierarchy to the open and built spaces by spinning on the punctual elements of the systems, being them concealed or not, thus creating selected continuities and discontinuities according to an idea of landscape, to a urban idea of the city and of the suburbs as a whole of different and definable polarities able to project a clear image of themselves through the poles of the net and able to connect territory spaces with different values. Connections and systems are always recorded according to an idea of territory that is crossable and usable by the citizens: this imply the possibility to identify in it and to build 'landscape' intended as a system of perception of the territory in its values. The net is planned according to the vehicular, cycling, pedestrian, natural and port connections; these are open spaces and landscapes that always interface with the scale of the territory, of the city and of the neighbourhood.

6 Texture. **system**

The aim of the plan is to define exactly, through the concept of connection, territorial, urban and neighbourhood polarities that, declined into the net and in coincidence with the positions defined by the concealed spheres and poles, re-structure the territory turning it into a experienceable landscape (crossable and perceptible) with architectural urban and natural emergencies, that give meaning and depth to the existing urban systems thus allowing the creation of 'texture'.

The texture, in this case, is not intended as a clean and definable system but rather as a net shaped territorial mesh, that builds a layer of meaning on the existing and concealed urban polarities through the dynamics of routing. The texture is such only in function of urban landmarks that establish centres of attraction or extension of the public space.

Fig.2. 4. Link. Connection - 5.Network. Net - 6. Texture. System - Sport City Masterplan. Reggio Emilia

These urban landmarks (point of reference) are definable as topologic and typological figures that establish a priority use and character according to their scale (territorial, urban, neighbourhood) but at the same time, being connected in a net, change the overall perception of the urban system.

5. RESULTS

The connection, intended as a planning mode that defines landscape and not only architecture, creates the possibility to reconfigure the existing beginning from new assumptions. On the other side the very same concept of connection and relationship space is the backbone of a progressive thought on the tectonics and on the due capacity of the plan itself to create new fluxus and routes, new relationship through the spaces.

The identity of a place is not made of the formal and architectural codes only, but is made of the quality and intensity of the connections (link) and of other experiences taken from other disciplines, with other thinking strategies and other identities. The art of connecting is nothing more than the strategy through which two or more elements placed in different spots are linked.

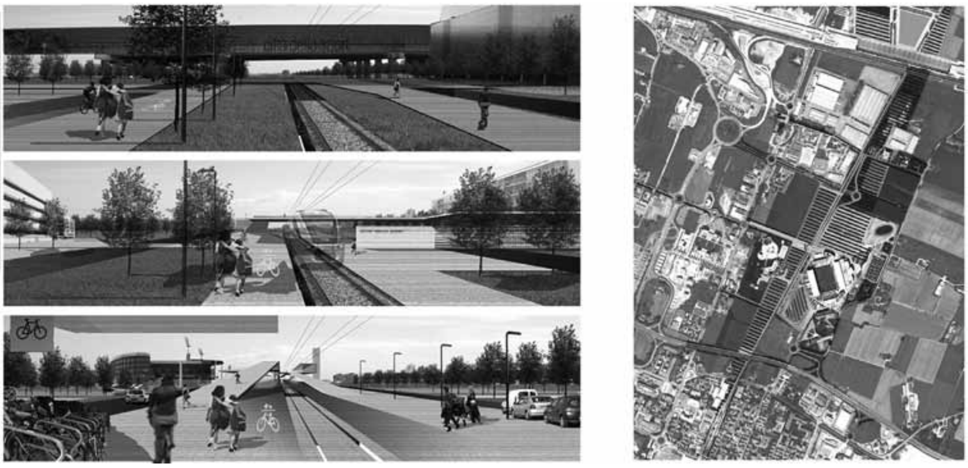

Fig.3 Masterplan. Link as a plan strategy from architecture to landscape

Merleau-Ponty, criticizing the gestalt couple of figure-background introduces the theme of the horizon and the theme of movement in the definition of a space increasingly less euclidean-cartesian and increasingly more topologic. 'For what concerns spatiality the body is the third term, always implied, of the background-figure structure, and each figure is outlined on the double horizon of outern and of body space. Whatever analysis of the body space that imply only figures and points has to be rejected as abstract since figures and points cannot be conceived nor can they exist without horizons…'[6]

Richard Serra adfirms that the use of landscape has to be experienced by walking through the work-site:

'the site is redefined, not at all represented… the allocation of all the structural elements in the open field brings the observer attention to the topography of the landscape through the route within the landscape itself… the dialectic of walking and or watching at the landscape determine the experience of sculpture.' [7]

This assumption of Serra send us back to a notion of the landscape geometries built on topological and phenomenological concepts (genius loci, space of experience), of movement, of body space that send back to the phenomenology of perception. But this attention to the topologic space and to the body space is present in some fundamental experiences of the modern architecture too: let's consider for example Le Corbusier or Mies van der Rohe.

6. CONCLUSIONS

Quoting Christian Norberg-Shulz [8] we might refer to 'centres of mass' internal to the space that builds proximity relationships, to 'routes, axes, directions' that cross the space, that build continuity relationships or spatial sequences and to 'domains, fences' that delimitate the space.

The spatial centre of the landscape, as much as the once of the architectural work, is not a geometrical centre anymore but the place most visited by citizens, the place were passage is higer. The architectural work is then built up through assembling and through sequence and lived in movement. The American architect Steven Holl is a key author in the outline of contemporary architecture in reason of his attention to an architecture of relationships.[9]

It is not by chance that his work continuously refers to the Theory of the phenomenology of perception by Maurice Merleau-Ponty and to the effort to realize them in the architectural work, thus placing himself in that research line that aims at unveil contents of spatial dynamics and of perception in movement in architecture, in close synthesis between the space and time categories. [10]

Both city and landscape increasingly develop themselves as architectural/urban events that have their principle in the route conceived as a real mode of appropriation of territory endured by man. The spatial-temporal concept that nurish the figure of route is the one of the fourth dimension, of routing time and then of sequence.

The sequence connects, inside the experience of places, their characters and their differences, as much as a camera produces a space based on multiple fragments, the photograms, that constitutes a unity but live as well alone. The sequence of images produced by the route, as physical and mental experience, transforms the reinassance prospective fixity into a representation of the contemporary movement, whose single instants are the fragments of a united story that develops itself on a series of traces actually recoverable in the site and change them so to make them part of a urban or landscaping system that only a whole perception of the place might notice.

The sequence is also to enjoy a dynamic unity that twists, transforms and defines itself in each single moment. The

urban architecture, as much as the landscape, is conceived as a perceptive and full sensorial experience, as physic dynamic of movement and route.
This concept and thinking modality enables to build an overall planning strategy that embraces landscape and city, linking them together through a physical-perceptive experience and not only through an aesthetic-imaginative one and that transforms the contemporary architecture self-reference of the 'griffe' in a real interpretation of the places, able to create an identification mechanism between citizens, nature and city space.

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'Architecture - Holl writes in Anchoring – *is subjected to circumstances. Contrary to the other arts, a building lying on the ground is also the result of the experience of a place. The site of a building is not only a component of its plan; it is a physic and metaphysic foundation… Architecture is not an insertion in the landscape but it is more the instrument to explain it.'* (Holl 1991) .

THE FEATURES OF FORMING ECO DISTRICTS' LARGE-PANEL BUILDINGS IN YEREVAN

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Keywords

eco, district, large-panel

ABSTRACT

The urbanistical structure of Yerevan has developed on the basis of construction traditions that have formed during the centuries in the consideration of the existing climatic conditions and landscape. One of the most important trends of contemporary world architecture is eco architecture, which integral component is new technology usage, that has not fully used in Armenia.
Based on regional conditions and done building projects researches, it was analyzed large-panel building renovation opportunities in Yerevan city's Charbakh district also with the use of new construction technology and eco building materials.

1. INTRODUCTION

One of main branches of suistainable architecture is eco architecture. The main idea involved is to minimize the negative environmental impact of buildings by efficiency and moderation in the use of materials, energy and development space. Eco architecture uses a conscious approach to energy and ecological conservation in the design of the built environment. According to this statement the main two part of research must be ecological issues and energoefficiency of buildings. Taking view to Yerevan's urban development one of main issues are reconstruction of old residential building due to new standards. There are numbering about 2500 large panel buildings in Armenia. Large -panel residential buildings dating from 2nd half of 20 century are to be found in almost every settlement across former USSR territories. Go to the statistical numberings in the territory of the former USSR more than 170 million settled in large panel building that were built between 1950s and 1980s. The settlement fond that was formed from 5 level large- panel buildings allowed to solve the problem from cheap and easy view. Although the situation of settlement crysis, lack of 1st serie experience of planning and building large panel buildings, the deficit of qualified work of manpower bring to massive building creation with low consumer qualifications, uncomfortable flats, the creation of microdistricts with monochrome and monotone build-up. Less significance was given to durability , energoefficienty of building and ecological clearness of environment (L. V. Khalturian 2006).
The physical and moral decay of the buildings and infrastructure , due to lack of maintenance and inadequate management structures after privatization are listed as problems which could lead to serious endangerment of the housing stock. Proposed coordinated activities for social, economic, environmental revitalization of those buildings included intensive coorperation and knowledge transfer involvement of financial international support.
Eco districts are the right scale to accelerate sustainability — small enough to innovate quickly and big enough to have a meaningful impact. Eco districts are a comprehensive strategy to accelerate sustainable development at the neighborhood scale by integrating building and infrastructure projects with community and individual action. Fundamentally, Eco districts are an effort to deploy high-impact, district-scale sustainable projects that drive experimentation and innovation.
Eco districts include the following phases:
- District Formation
- District Assessment
- Project Feasibility + Development
- District Management

Districts like Western Harbor in Malmö, Sweden; Southeast False Creek in Vancouver, Canada; and Dockside Green in Victoria, Canada, are creating a new generation of integrated district-scale community investment strategies at a scale large enough to create significant social and environmental benefits, but small enough to support quick innovation cycles in public policy, governance, technology development and consumer behavior. Each of these districts is measuring a set of important sustainability indicators — local greenhouse gas emissions, vehicle miles traveled, transportation mode splits, stormwater quality, access to healthy local food, utility savings, job creation and access to services, among others(2).
The most important partin forming of eco districts is creating energoeffiecent, clean environment. In all counted eco districts the same factors of suistainable future architecture were situated.
The main points of structure are:
- Green roofs,
- Energoeffienc technologies
- Secondary use of rain water
- Eco clean building materials.

2. BACKGROUND

The article research was done on abroad experience especially including the done research results from the large-panel buildings renovation in countries of former USSR and also by taking into account the results of large-panel renovation experience done by UNDP in Yerevan Avan district.

3. METHODS

The research include the structural method. This method includes : baseline data collection, multifactorial , stimulating and limiting factors analysis.

4. CASE HISTORY

During the Soviet period and 1990s energy effiency and green environment were not main priority in construction of multi-appartments. For the reconstruction was chosen A1-450 Pk building as from energo efficiency it has very low results. This project was proceed to show the energy efficiency potential of existing buildings and economic justification of measures. The high seismic resistance and the actuality of construction has been taken into account. A complex of technically and economically justified measures has been selected according to the net present value, investment size and result, payback period and interred rate of return, local production capacity, protection from pests, compliance with sanitary standards, market price have been taken into account.
The external walls of the building are 300mm-thickreinforced panels, and no thermal insulation has been foreseen for those walls originally. This external walls have been insulated with 60mm-thick extruded polystylene slabs.

Sequence of layers of the insulated wall are these[fig.1].

1. Wall surface (Brick + Plaster)
2. Special adhesive Concrete Mix
3. Insulation
4. Cement Screed
5. Pvc Wire Mesh
6. Special Cement Plaster
7. Aestethic layer

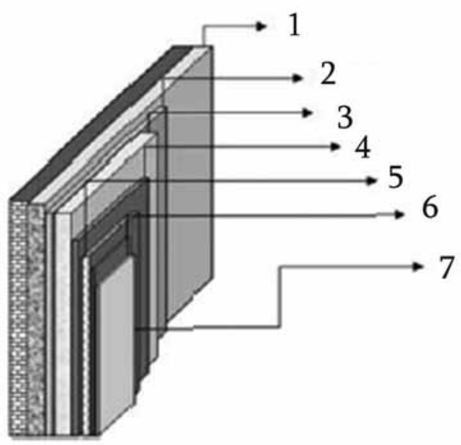

Fig. 1 Layers of the insulation.

To evaluate the buildings' thermal modernization results continuous monitoring and measurement based energy audit have been implemented during 2013-2014 heating period. Data about energy carrier's consumption from the last 3 years have been collected. The data façade have been compared with the same kind of building data(without enveloping).

As result of enveloping of the building the energy performance was improved about 2.5 times (reduced from 178 kWh/m2 year to 74 KWh/m2 year)[fig.2].
As a result it has been possible to ensure quite affordable heating for residents (under 100% thermal comport level heating costs are around 0.7 USD for m2/month. Annual savings are around USD 15.000(according to current gas and electricity tariffs).

The energy efficiency potential is panelbuilding of Armenia is about 1.260 mln KWh/year. The GHG reduction potential following energy efficiency upgrading will be around 250 thousand for CO_2 / year. The annual savings will be around USD 64.5 mln (based on 2014 gas and electricity tariffs(3).
Eco districts' large-panel buildings forming in Yerevan Charbakh district.
Charbakh is situataed in the south-east part of Yerevan. It has outside borders with districts Erebouni, Kentron, Malatia-Sebastia and Nubarashen. It has external borders with Ararat.From the North it touched to city's center.
During the period of USSR this district was also known as factory block. The Experimental factory of pure metal is situated here.This all have its influence on air pollution.
As the district is situated in the south east part of country it come out with more hot summers compare with the other district. The green spaces get less in this district.The first step of renovation is the deep analyze of building and environment around of them.

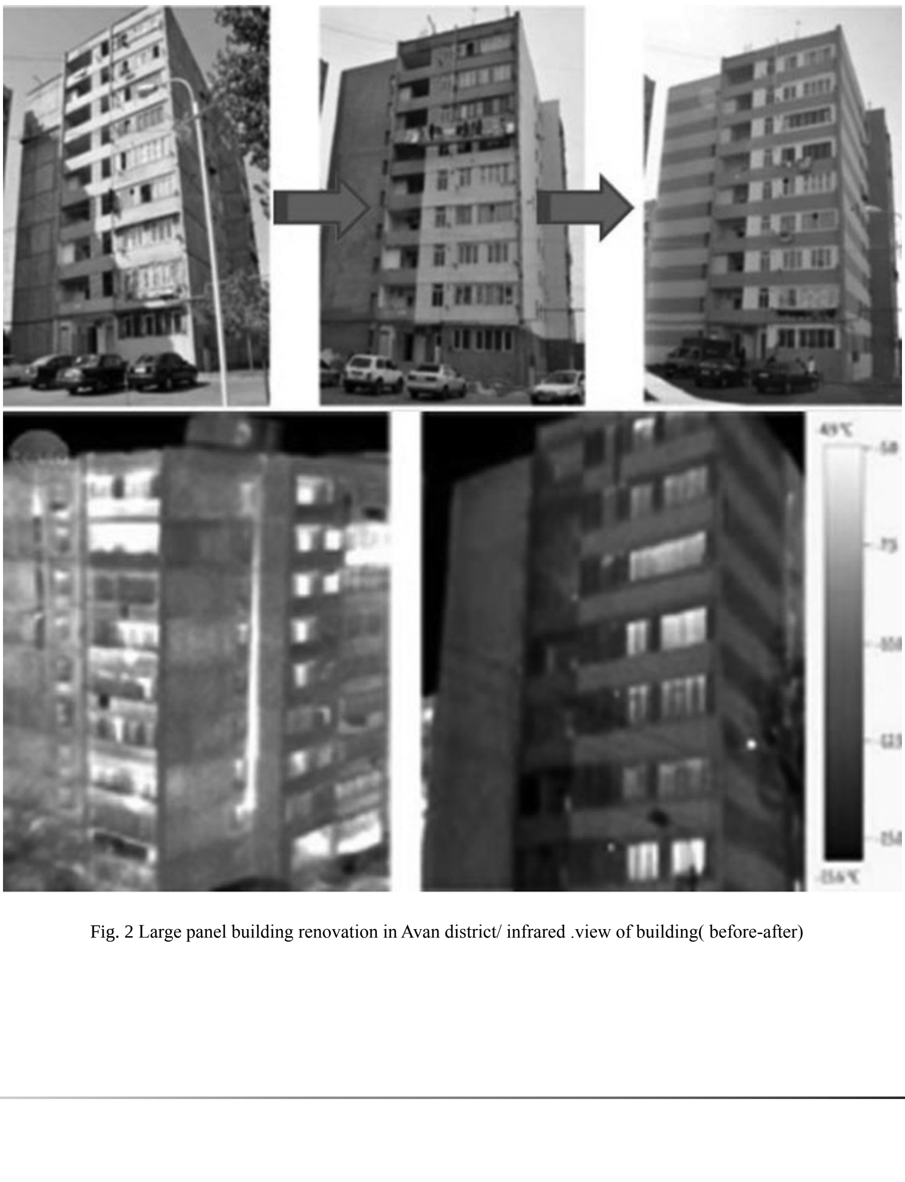

Fig. 2 Large panel building renovation in Avan district/ infrared .view of building(before-after)

The settlement was built between 1964-1966 on a block of land of 200 sqm and consists of 9 buildings . Each four storey residential building consists of one bedroom flat , two bedroom flats. They are composed on orthogonal composition with enough open areas and landscaping and other urban facilities.

Predominent building type is concrete panel building with 3 and 4 stories. The complex is typical for Yerevan mass residential buildings. It is constructed with prefabricated walls, floors and roofs. Non bearing internal walls reconstructed of prefabricated concrete panels which thickness is 10 cm .The slabs are 14 cm thick prefabricated concrete elements. The clean structural height of all wall panels is 270 cm. The roof contains of two 100 mm thick concrete panels with 100 cm in accessible space between . Horizontal and vertical perimeter wall panel joints are usually visible. The thermal insulation is bad .

There are roads , yard between the buildings. The structure is made from view of good access of mind . But the researches shows that there is not enough parking spaces for the certain number of private cars.
There is fullifilled purpose for renovation of district. The main structure point is renovation of external and internal walls from the view of thermal insulation. Coming from the done experience in Avan district the same idea can be used. The most important thing is the renovation of façade by adding new thermostat material and changing windows. As the new material can be used Rc panel 5cm thickness,internal pre-cast RC panel 14 cm thicknessabd storyfoam or fiberglass thermal insulation 6 cm inserted in between the panels. The horizontal and vertical perimeter walls panels joints are usually visible and sealed with special sponge hose from inside and elastic sealant from outside. The other important thing is to fix flexibility of the flats with the view of reducing the possibility to move internal not structured walls.

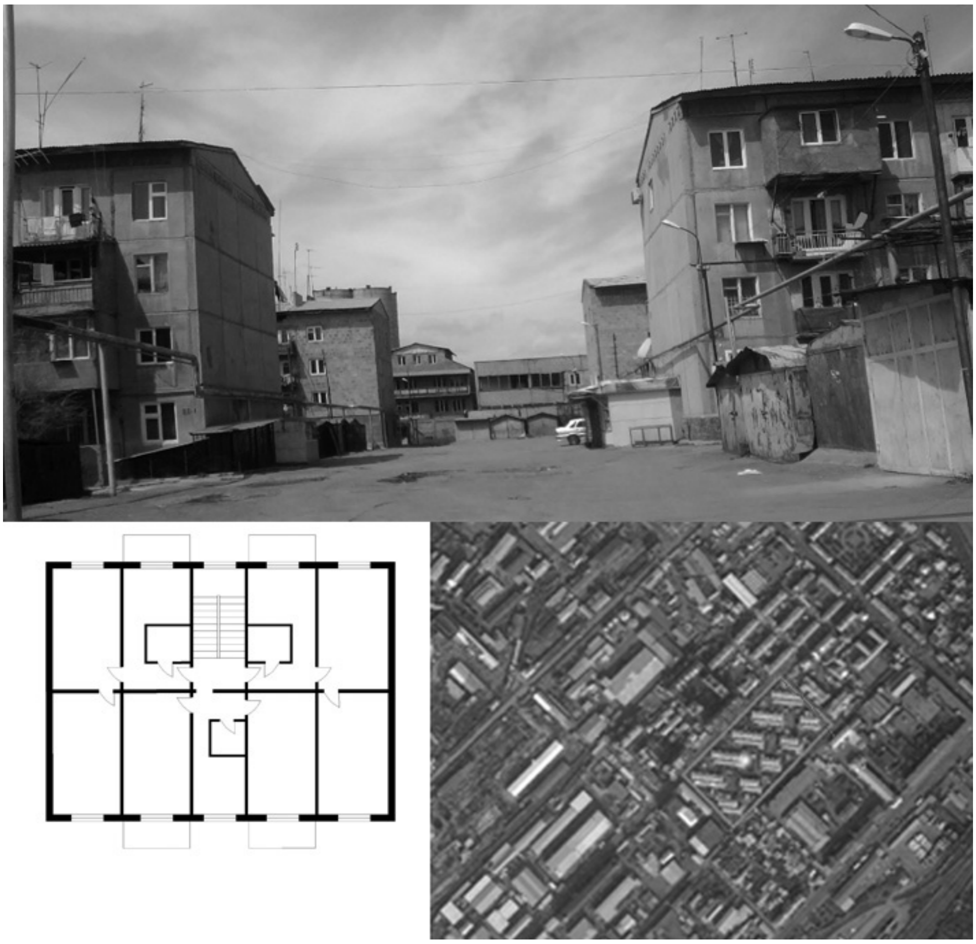

Fig. 3 Large panel buildings of Charbakh

The façade must be painted with more warm color . In the south east point of building the water collectors can be installed.

The proposed solution is the most adequate and possible for the certain case. The guaranties based on type of usage of materials and 20 years of gained experience of the same usage in abroad.

The propose can be also done on renovation of roofs. As the buildings are not high the roofs can be used as green spaces.

Between front neighbour buildings there is suggested to be done secondary one level up connections where rent flats for young families will be situated. This prupose will help to create new eco, cheap clean environment in Yerevan city as suggested module will be used in other districts renovation work [fig.4].

5. RESULTS

The results of article of the forming of eco districts large panel buildings will :

• Have influence on city's new development view forming.

• Increase new green spaces for residential districts and make new clear and welthty environment for its habitants.

• Will create new buildings with new modern and energoefficience technology usage

6. CONCLUSIONS

• The Yerevan have good climatic conditions for developing eco districts

• Using eco district stragedy in Yerevan will help to incraese the ulility savings

• The new concept will help to create new green, healthy environment.

Fig. 4 Large - panel building renovation prupose

NOTES

In research history were used the published results of "The potential of improving energy efficiency of panel buildings in Yerevan Republic Armenia" UNDP programm www.beeca.net, http://ecodistricts.org/target-cities/projects/

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TECHNIQUES OF MODERN INTERPRETATION OF ETHNO-CULTURAL MOTIVES IN ENVIRONMENTAL DESIGN

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Keywords

ethnic motifs in modern design, design education, architectural environment design

ABSTRACT

Design, created on the basis of ethno-cultural motives, is a global trend. Apart from fashion tendencies, there are objective reasons why ethno-cultural motives are relevant for modern design. This is the presence of a specific ethnic marker bearing the sign of national originality while decorating national cultural events. Technique of creating new objects by means of modern interpretation of historical, cultural, ethnic and other associative images is quite relevant and prospective. As the examples show, it is an inexhaustible reservoir of inspiration; using this technique it's possible to create new architectural and designer objects which will give national originality and coloring, and will also enrich modern architecture and design.

1. INTRODUCTION

As the saying goes: "The history repeats itself". Throughout the history of architecture and design every master contributed something new and all of their creations got new interpretations. Thus, the style took another twist, producing a new style or a direction in architecture, art and design.

Analysis of a modern world design experience shows that historical themes, when harmonically combined with modern materials, allow to create new trendy designs.

Design, created on the base of ethno-cultural motives, is a global trend. Today historically important patterns and ornaments decorate costumes by famous fashion designers, interior objects and furniture in many countries. Apart from fashion tendencies, there are impartial reasons why ethno-cultural motives are important for modern design. It is a presence of a peculiar ethnic marker, bearing the impress of national originality. It is especially important for the decoration of national cultural events: making a national pavilion at international exhibition, decoration of urban environment and interior during the international competitions, environmental design of national holidays. Designer doesn't have to replicate all the details literally. It is much more important to fit the distinctive image into real modern conditions harmoniously (pic. 1).

The most vivid examples are the buildings which are built for international exhibitions, for example Expo Milano 2015. Promotion of ethnic elements in a modern architecture and design bears educational functions, expands the cultural knowledge, allows people to understand the foreign culture, to find in it some traces close to their own culture, forms and raises tolerant attitudes. All of this contributes to intercultural relations and communication development.

Creating such elements is relevant not only when creating thematic international exhibitions, but also in multinational cities, states and countries in order to demonstrate different nations' peculiarities, commonness of interests, problems and their decisions. Thus, in Copenhagenian municipal park Superkilen, situated in a multinational district, a multinational park was created for the citizen's faster integration. There small architectural forms of different countries were placed. Swings from Baghdad and benches from Switzerland, rubbish bin from London and signboard «Москвич» from Russia neighbor there.

Ethno-cultural elements can be also used in a city design to increase the tourism appeal. Such design objects in countries with rich history and culture strengthen the impression and the level of immersion into the national atmosphere. Among other points, special thematic parks are created which function as museums with reconstructed ethno-cultural environment and with the atmosphere of a specific historical period.

To increase the tourism appeal one more technique is used: filling of a home cultural environment with the objects of a different culture. As a rule, such technique aims at attracting the definite sociocultural group of tourists. For example, if a large number of tourists from the same country is observed, people create the elements, which will be appreciated by this sociocultural group. This is the popular technique of creating ethno-cultural city environment attractive from the tourism viewpoint. Even a new sight can be created themed on the already existing sight. Thus, for example, mini Big Ben, the small-scale Eiffel Tower and even the miniature Venice with gondolas and many other things appear.

But one of the most difficult tasks, which architects and designers face, is creating the unique image on the basis of historical images. It's impossible without the scientific approach and studies of historic-cultural heritage on the one hand and modern equivalents on the other hand. At the same time the author must be competent in modern tendencies concerning design, materials and technologies. Apart from this, the following social and psychological questions must be studied: are the citizens ready to accept the modern alternative and won't the designed object raise rejection and anger as something strange and alien?

Relevance of the issue of modern interpretation of ethno-cultural motives is also proved by the fact that a large number of contests takes place which aim at creating exhibition pavilions introducing countries on world exhibits. Apart from this, there is a contest in Russia called the Architectural Russian image. Its creators stimulate young architects and designers to search for new modern decisions while designing buildings and objects of design of architectural environment. Objects created on the basis of modern interpretation of cultural images become more comprehensible and closer to a modern person as they meet his functional and esthetic demands.

Such a search is really important, because design decision reflects the level of cultural evolution. Architects and designers serve the retransmitting function. It means retransmission of ideas, experience, sense, information, a new twist of technologies development. But the primary and generalizing factor is cultural values.

The most popular technique, using for creation of modern objects, is the replication of ethnic ornaments on a design element by means of dyeing, perforation or patterning. There are examples of using these techniques in elevation design, stained-glass windows, perforated sun protection building elements, wall surfaces, partition walls, fences, stairs, floor or ceiling patterns, pieces of furniture and equipment, lamps (pic.2).

Another one impressive way to create a new design is using of small but representative ethnic image or form in out of proportion scale. This technique was initially provocative, but today it is a kind of a clever game, which easy fits urbanistic scenery and interior. This method is realizing in the form of a representative symbol, e.g. hieroglyph, which is made in a scale of a building as well as in a scale of furniture elements or street-art objects.

The method of creation of new objects by means of modern interpretation historical, cultural and ethnic associative images is vividly embodied in design. Ideas, evolved from the same form or symbol, can be performed in many different ways depending on used material, light or colour score.

Thus, matryoshka-armchair by Olga Kryukova and Matrshyoka Light chair with the in-built lightning, the colors of which are manageable, are based on the same form and are made in the same scale, bear the same meaning. But at the same time different materials and perforation technique made the characters of these armchairs absolutely different (pic.3).

A task to create a modern interpretation of ethno-cultural motives in objects of the urban environment was given to students of "Architectural Environmental Design" department in the context of coursework. In the first stage students, according to world experience, carry out analysis of objects, determining by which means designer reaches modern reconsideration and interpretation of ethno-cultural motives. In the second stage students gather textures, colour scores, peculiar to the chosen ethnic style; study thoroughly and sketch representative elements. In the third stage students create a modern object of a distinctive ethnic image.

Making of this task refines taste, lets to study thoroughly the historic style, prospects of modern material, to comprehend and analyze world design experience and to create on this basis a new relevant design decision of city environment objects. Choosing themes and styles for this course project teachers pay special attention to the Russian south region theme rich in archeological sites, to the interpretation of the cultural heritage of the region in a modern way. It will help to preserve traditions and to create a modern interior and object environment.

As an object for designing a student can choose a piece of furniture and interior or street facilities. Thus, for example, the student Yulia Ushakova has worked out design elements of children's playground: a bench, a bicycle parking, a slide. As main forms associated with Russia she took matryoshka, balalaika, a knitted glove and a typical pattern used for embroidery. The project was humorously called: Russian bear, matryoshka, balalaika. The shapes of these associative forms were used in the project. The bench was created out of three shapes of matryoshkas. The balalaika's shape became an element of the byke-parking. The image of bear was not used directly, but only a bear's footprint was used to create a sand-pit. It gives an impression that the bear was here, but has just left. The typical colors were used in the project: red, blue and white. Apart from this, the embroidery pattern was widely used as an ornament, it was reproduced on the designed surface by coloring it (pic.4).

Another task for students was to work out the sketches of fireplaces, the images of which would be inspired by Scythian and Sarmatian cultures. Here the technique of creating of new spectacular designer decisions by means of using small and typical ethnic image or form in a different scale was used. Thus, the elements of zoomorphic ornament were used during the decoration of the fireplace: these are the typical image of a deer, hunting scenes, and also patterns used on the coins (pic.5).

Application interior ethno-cultural forms of student work clearly shows N. Zhuchenko. This is the interior of the hotel in the city of Sergiev Posad. Here we use the typical elements of Russian wooden architecture. Elements of the decoration of the facade have been applied in the interior of this hotel (pic.6).

On finishing the task the students arrange an exhibition, voting and discussion of works in order to recognize the interest to the accomplished project and to get comments on the work. It lets to identify the demand for the created project, consistence of the decision, its compliance with the modern requirements to design.

Creation of new objects by means of modern interpretation historical, cultural and ethnic associative images is very actual and promising. Ethno-cultural motives performed by means of modern design will provide finding common cultural features and rapprochement. As examples confirm, it is an extraordinary fund of inspiration. This method allows us to create a wide variety of new architectural and design objects, giving us originality and colouring, enriching modern architecture and design. Elements of equipment made in one city style will visually identify a city and thus provide strengthening its tourism appeal.

Fig. 1 The interpreted national motives on the building elevations of Namaste hotel in India and Russian pavilion on the World Exhibition in Shanghai.

Fig. 2 A table, two benches and a table football. The interpreted national motives completed with DuPont™ Corian® material, design by Yaroslav Galant, processing by Artishock.

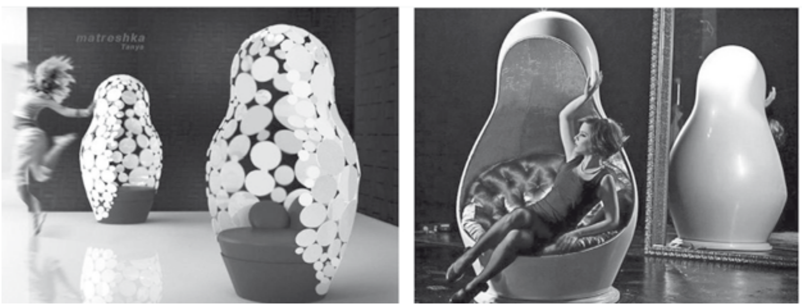

Fig. 3 Matryoshka-armchair by Olga Kryukova and Matryoshka Light Chair Georgi, Petar Slokoski.

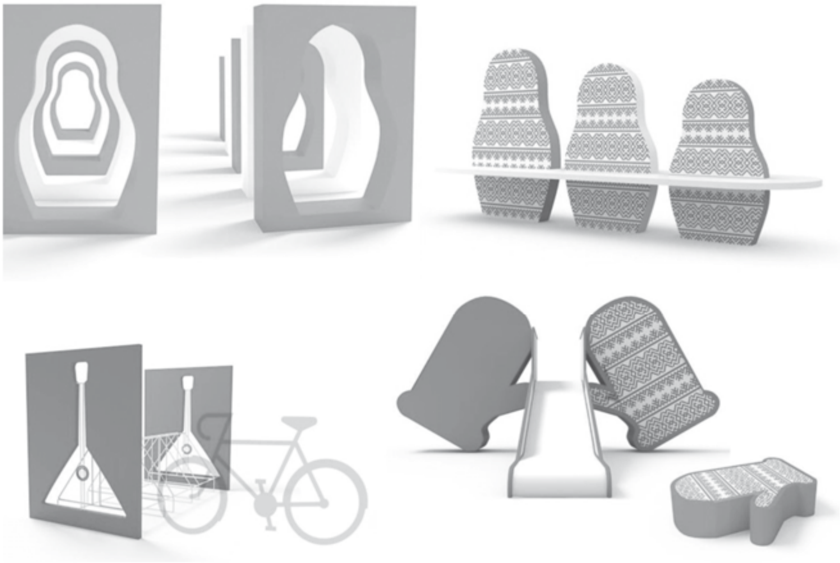

Fig. 4 Design elements of children's playground: a bench, a bicycle parking, a slide. The work of a student Yulia Ushakova. The supervisor: Gorgorova Yu. V.

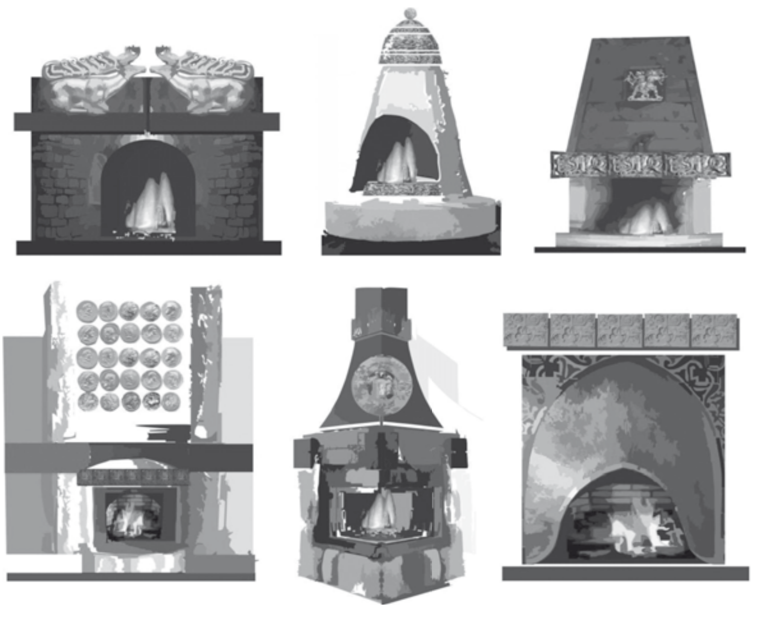

Fig. 5 Students' works. Sketches of fireplaces, the images of which were inspired by Scythian and Sarmatian cultures. The supervisors: Kozlov V.P., Gorgorova Yu.V.

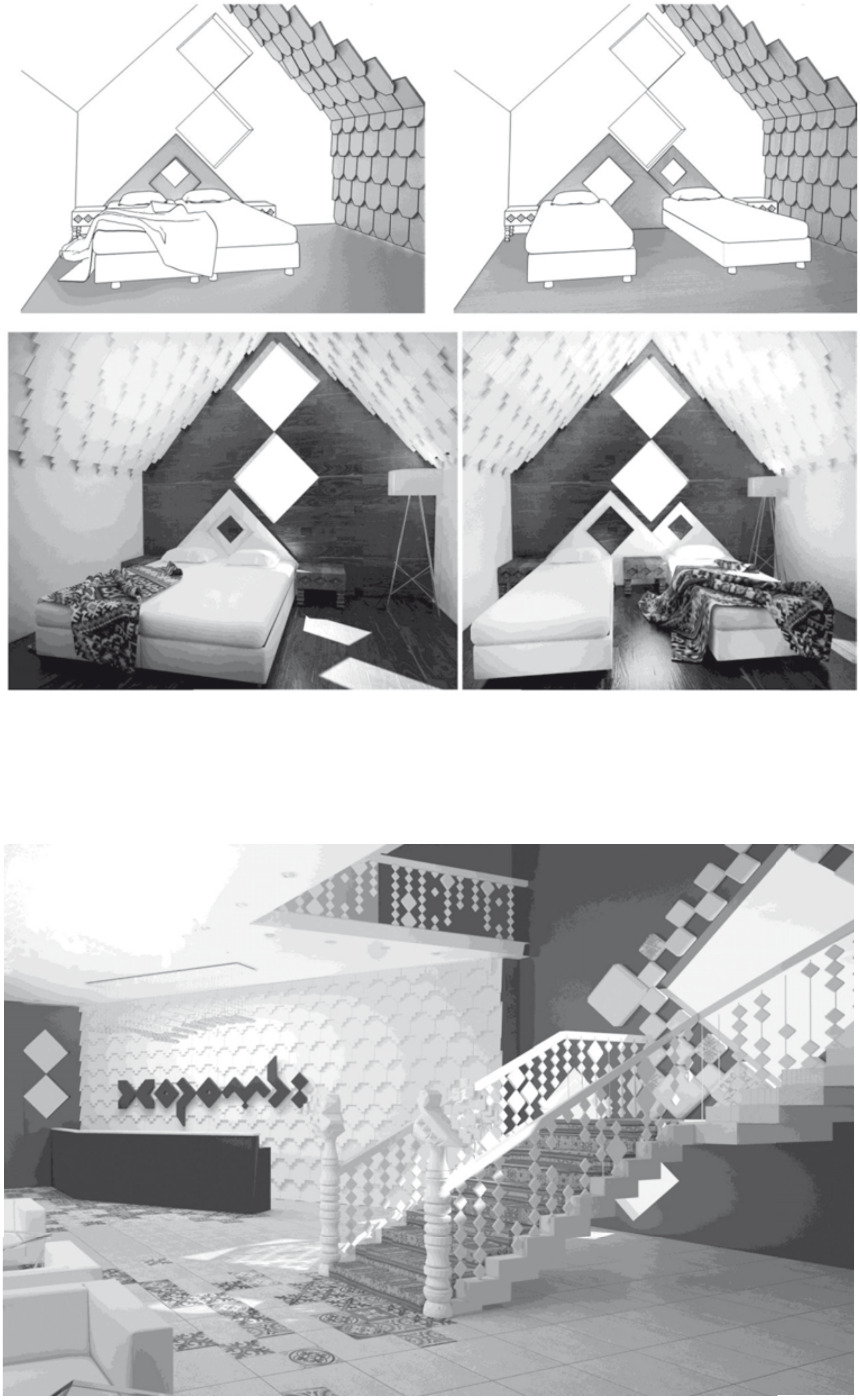

Fig. 6 Interior of the hotel in the city of Sergiev Posad. The work of a student N. Zhuchenko. The supervisors: Kozlov V.P.

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ARCHITECT DAVID CHISLYAN'S CONTRIBUTION IN THE REDEVELOPMENT OF ARMENIA

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Keywords

artik tuff, architect David Chislyan, new masonry

ABSTRACT

Armenia has had a rich history of natural stones from which cities were built. There are several types of stones, including secluded pink and lilac Artik tuff. Artik tuff, with its numerous positive properties, has been used in the construction of building in almost all cities of Armenia, including the ''pink'' capital Yerevan. D. Chislyan (1879-1970) had an important contribution in the history of this stone. His unprecedented role is in the 20th century's Artik tuff's lode discovery, quarrying and founding of mechanized enterprise establishments, which at the end of the century were considered to be the major amalgamation of tuff quarrying. One of Chislyan's innovations was the development of the method for the stone masonry. Chislyan was the first who built Artik tuff buildings applying layered masonry blocks. Furthermore, the buildings that were built based on his projects during that period are still standing. They have even resisted the destructive earthquake of 1988. His innovation has entered into the real world and is one of the most important components of the Armenian architecture. The research is based on D. Chislyan's private archive's materials and literature research.

1. INTRODUCTION

Tuff stone is an integral part of the Armenian architecture's concept. It has been used to build different kind of edifices for centuries. The oldest tuff building was built in 301-303 after adopting Christianity as the state religion. The building was Etchmiadzin Cathedral, the first cathedral built in Armenia, and is one of the diamonds of Armenian architecture. Of course, nowadays tuff of ''pink'' Yerevan is world famous, with its numerous positive properties, which have been utilized used for decades in Armenia and abroad. However, few know how and by who in the 20th century Artikyan type of tuff stone of medieval churches was regenerated and began its rapid use and distribution worldwide.

The main objective of this paper is to identify and highlight architect D. Chislyan's innovations, forasmuch that made a revolution and it had a profound effect on architecture and urban planning. Furthermore, Chislyan's work highlights that being architect does not solely mean designing or planning, as it is perceived by the society nowadays.

2. BACKGROUND

Almost a century has passed, but a lot of archive materials on this topic have not been explained and looked at thoroughly. Chislyan's overall activities in the field of architecture was published by an honored architect of the Republic of Aremnia, professor E. Tigranyan in "Contributions of Armenian architects in the Transcaucasus near the end of the XIX 19th century and at the beginning of XX 20th century" book. An article was written in the Soviet era named " The founder of stone industry", as well as in Melkumyan's "Stone is our heritage" book, but no mention about stone masonry constructive change and its solutions were reported. Also, there isn't any significanct constructive review and analysis, which leaves a gap in the history of Armenian architecture. In addition to the provision of material data, this study will help to clarify that era's structural new (for that period) wall stone masonry solutions that were implemented many times after that.

3. METHODS

The study is based on:
• D. Chislyan’s private archive materials research
• Collection of data, documentary materials and drawings
• Literature study
• Analysis and processing (working out).

4. CASE HISTORY

There are 5 types of Armenian tuff stone: aniakan, artikyan, yerevanyan, byurakanyan, felzitayin.

Artikyan or Artik tuff was not a commonly used stone before architect Chislyan’s innovation in the beginning of the 20th century. Artik tuff attracts attention with its numerous positive properties , which are valued by architects and builders alike (ex. Tsentrosoyuz Building constructed in 1933 by Le Corbusier) . Professor S.Melkumyan’s book published in the end of 20th century titled “Stone is our wealth” abundantly evidences the positive properties of Artik tuff.
“*The major firm for tuff quarrying in the USSR and in the whole world is the Amalgamation of “Artiktuff” which was founded as long ago as 1928*” (Melkumian, S. 1989).

David Chislyan was born in Don’s Nakhichevan region populated by Armenians. In 1901 he began his higher education at the St. Petersburg’s Imperial Institute of Civil Engineers and graduated from the Riga Polytechnic Institute (1905-1909) as an engineer-architect. Since 1910 until 1926-1927 Chislyan works in Tbilisi, occupying high positions. In 1926 Chislyan arrived in Leninakan (now Gyumri) to do reconstruction work after the devastating earthquake, as the chief architect and head of works of project studio. The architect, since 1914, paid attention to the unique qualities of Artik tuff and started his private study of the physical and mechanical properties, and already from 1926, for proving the value and properties of tuff, he built experimental house in Leninakan, which showed positive data and from 1927 research work began in Moscow[1]. That was the start of the opening of a quarry, exploiting, mining and processing mechanized enterprise of stone. Hence, Artik tuff started to be widely used in Armenia and abroad (Moscow, Sochi, Sinop and other places).
The medieval structures as churches from Artik tuff were built by “Midis” type of masonry. Piece-stones placed in the outer layers, between which were filled with rubbles and linked with mortar. The thickness of that kind of wall is not less than 50 cm (Soviet Armenian Encyclopedia). Probably Chislyan was the first who replaced “Midis” type by single layer blocks masonry (35 cm) and provided constructive methods to use. Blocks and tiles are rectangular in shape parallelepiped with equal sides and smooth surfaces.

There are 4 types of supporting walls [2]

1. Supporting walls of massive blocks in the entire thickness.
For this masonry the thickness of stone may be 25, 30, 35 cm, the height of 80 or 40 cm. Independently of the degree of processing, tuff stone masonry is being carried out in horizontal rows in bandaging. 1)
2. Supporting walls of massive blocks of alternating rows, with half of the blocks consisting of two stones with an axial seam.
These walls through a row have massive block of the standard height of 40 cm, followed by a row composed of two semi-blocks 80 cm in height, with a single unprocessed surface facing to the inner surface of the wall.
The construction of this masonry is much more complicated than the massive blocks in the entire thickness of the wall.
3. Supporting walls, with alternating rows consisting of massive blocks and slabs with backfilling the voids between the slabs. 2) 3)
This method permits economical use of stone blocks and general use of blocks’ waste, but there are problems with the implementation of masonry, because it requires precise execution.
4. Supporting walls of usual masonry from nonstandard stones more or less regular shape.
In this case the stone’s thickness: 25, 30, 35 cm, the length and height range from 30 to 70 cm. Thickness of 35 cm tuff stone is completely enough for a wall to ensure building’s heat insulation. In this type of masonry, it is possible

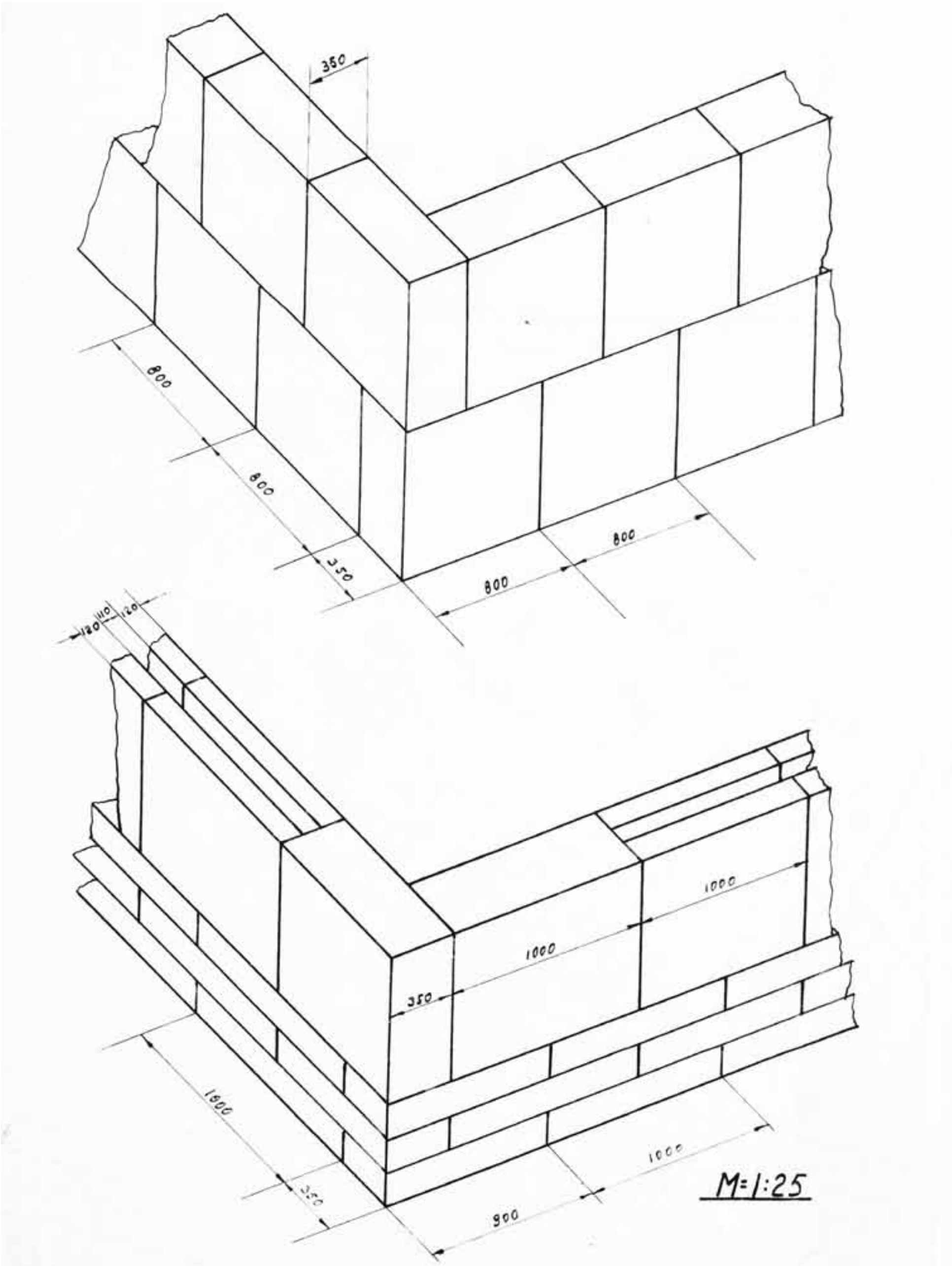

Fig. 1 Supporting walls with backfilling the voids between the slabs

to make rows equal or of different heights.
Tuff is also widely used in dividing walls, interfloor coverings, roofs and etc.

5. RESULTS

Examining D. Chislyan's interference, we can evaluate that he undoubtedly had an important impact on the architecture of Armenia. Many cities were built after the beginning of the 20th century which could not be imagined without buildings made by Artik tuff. Within a century the stone became one of the most frequently used and proved its good sides. Due to the present day it has wide application. Also the direct result is that the best suppor-

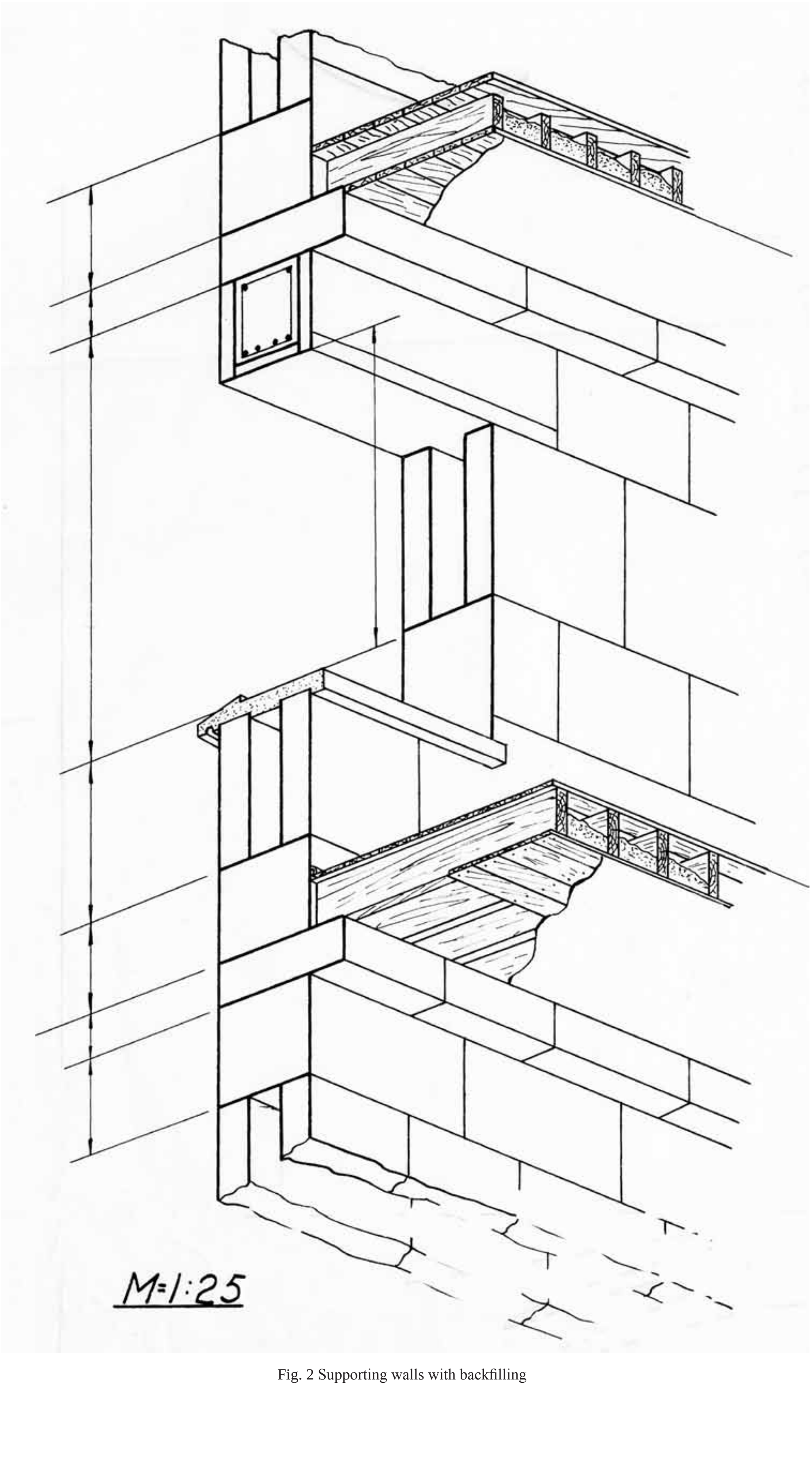

Fig. 2 Supporting walls with backfilling

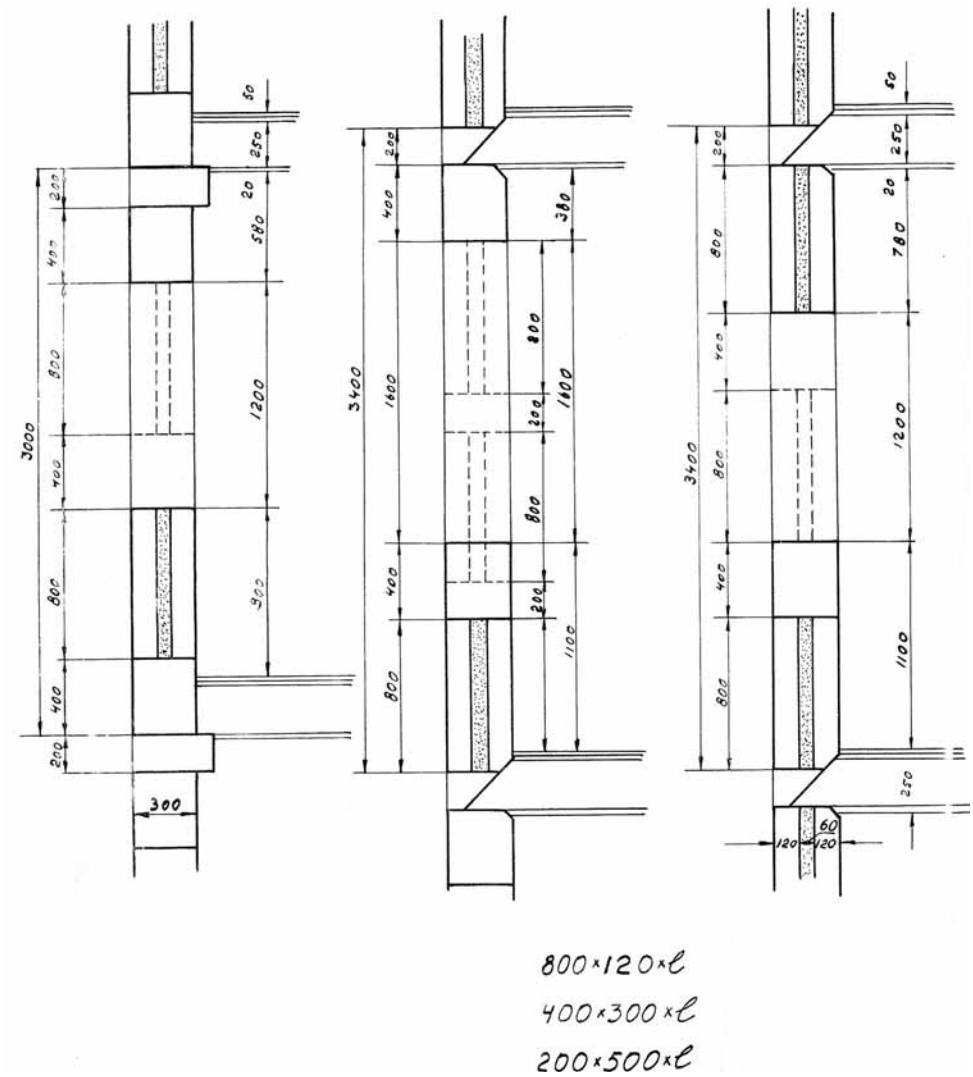

Fig. 3 Supporting walls with backfilling the voids between the slabs

ting walls' construction methods are supporting walls of massive blocks in the entire thickness and the supporting walls of usual masonry from nonstandard stones more or less of regular shape, because of being less complicated.

6. CONCLUSIONS

Architect David Chislyan's contribution in the redevelopment of Armenia is significant. He not only helped regenerate construction by Artik's tuff, mechanized quarrying and processing (as in the past all of that had been done manually), but also invented a new construction use of tuff stone. Based on these the large-scale spread of tuff became possible, which is important for aesthetic, architectural-constructive and economical aspects.

NOTES

The data [1,2] and images are taken from David Chislyan's private archive's from National Archives of Armenia, stock 996, list 1.

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ISSUES OF MODERNIZATION OF SCHOOL BUILDINGS OF THE REPUBLIC OF ARMENIA

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Keywords

school, typology, modernization

ABSTRACT

The shift to 12-year education system, changes in the program and content of the general education sector as well as the organization of teaching process with the employment of new technologies have created the need to modernize the buildings of schools.
The article reflects on the current state of the issue. It reveals the main issues related to urban planning, architecture and layout. The typological classification of buildings of general education complexes and separate school buildings is carried out. Relevant recommendations for the reconstruction and modernization of the structures of each group are elaborated.

1. INTRODUCTION

After the independence of Armenia and with all the social and political changes, the education system has been also affected with certain modifications. New types of educational institutions have been created; schools, collages, educational complexes, private schools, primary schools specialized in some specific subjects. These processes lead to the transformation of the educational system, there are massive school reorganizational issues.
The 12-year general education system was introduced in the 2006/07 academic year and new methods of education were launched, school programs were adjusted by adding new elements, new academic subjects like “Chess,” “National Song and Dance”, “Music” and so on.
But these innovative learning processes are taking place mainly in Typical buildings inherited from the previous social system. Gradually the discrepancy between the education process and its material environment is increasing.
The most recent problem of school buildings probably date back to the 1988 Spitak earthquake, which resulted in radical changes of the seismic resistant construction requirements in the Republic of Armenia (Ministry of Urban Development of the Republic of Armenia 2014).
Today, related to the social changes ongoing in the country, the reformation of the education sector is being handled not only by architects, but also by sociologists, psychologists, doctors and other professionals.
After a long break the themes of schools and school buildings has re-emerged in the modern scientific topics and research activities.
Some countries apply a productive methodology of school building design. It seeks to involve, the teachers, parents, pupils and students, and let them participate in the discussion of the new school buildings as well as the renovation projects, because without the input of the participants of the learning process in the educational project proposals, the school would not function properly.
The architects and the other specialists have the task of complying school buildings and complexes not only in terms of today’s requirements, but also in terms of opportunities for their further development.

2. BACKGROUND

To fully understand the architectural problems of the educational buildings, we need to analyze the content of these functions. According to the RA Law on Education (Ministry of Justice of the Republic of Armenia 1999), there are three types of schools:

1. Public education school, one or more of the total, including an educational institution type that implements primary education plans in specific subjects.
2. Specialized public education school, in military, sports, crafts, art or an educational institution type that implements primary education plans in any field of science.
3. Special general education school, with special educational needs, as well as an educational institution type that implements primary education plans for students with anti-social behaviors.

The main programs implemented in public education schools are generally set at 12 years, including elementary (Grades 1-4), secondary (Grades 5-9) high school (Grades 10-12) (Ministry of Justice of the Republic of Armenia, 2009).

The Republican state agencies conducted some studies to assess the problems of the public education structures and evaluate the necessary resources to execute their solutions. Studies show that the majority of the schools are in dire need of either repairs, or strengthening works, or even reconstructions. 11 percent are in structurally extreme poor conditions, while almost 5 percent are in need of new subsidiary buildings. 209 schools have no sport facilities and 254 schools don't have multi-purpose halls (Statistical Yearbooks of Armenia, 2012, 2013, 2014).

For more than ten years, the government as well as individual organizations, are allocating funds to schools for repairs, reconstructions and seismic upgrading issues. Many schools have been reconstructed and new ones have been built, but structural as well as substantive requirements of these schools have not yet been met. The school buildings are incompatible with the contents of the educational process. Often reconstructed school projects or even newly constructed ones are not considered effective, because they are being built in accordance to the requirements of the former social system.

3. METHODS

To fully imagine the problem and with the intent of finding solutions, first we have to study the historical development of different schools in Armenia, with their architectural and functional features. Current school building types are classified as separate groups. This allows doing a comparative analysis of different types of schools and distinguishing between their issues.

The research methodology is represented with a consistent transition in the educational process and architectural development of the school building.

And according to these, the architectural organization of theoretical analysis to study the nature of the school and its definition based on the current stage of its organization.

The research methodology also includes a survey of the social system. It includes all stakeholders. The competent authority in education in RA, government and community agencies, non-governmental organizations operating in the field of education, teachers, students, parents and others.

Because, there are also examples of new, non-traditional schools, then comparing the characteristics of the regular school activities to the innovative ones, will make it possible to identify patterns, which a new school must comply with.

4. CASE HISTORY

The construction of school buildings in Armenia had several stages. At each phase the public, social and aesthetic needs were different, and those needs have found their direct expression on the structures' functional organization and architectural composition.

Thus, in the 1920-30s the issue of eradicating illiteracy of the population and implementing compulsory primary education had been established. There were still no clear understanding of the structure of school buildings and their architectural demands. With a special decree the church got segregated from the school, and a two-level education system was set, elementary and a seven-year education.

Common requirements of the educational process were established in the mid-1930, which served as a basis for typical later designs of 280, 400 and 800 students' school buildings.

In the 1950-60-ies, when the construction of new residential neighborhoods was widespread (mainly with medium story height), the need arose for typical school buildings that complied with the new requirements (Tigranyan

E., 1973). Meanwhile, in the 70s, the story height in the neighborhoods got increased and with it, the capacity of accepted schoolchildren in a given school also got changed, but the contents, the class room compositions and especially the architectural changes were not undertaken.
In the light of the new social and economic situation, and in order to determine the architectural problems of the public education school buildings, any given school must be registered in the public school development system, disclosed with it the impact of the changes of the development ,and also specifications and dimensional requirements. The characteristics of the modern public education are considered as an integral part of the social system.
Another important direction is associated with the introduction of all inclusive education. It is known that only just a few years ago; the country has officially adopted the legal acts concerning the education of children with disabilities and special needs in mainstream schools. However, the school buildings are not yet ready for this kind of reforms.

5. RESULTS

Studies show that nowadays there are a few key factors which are considered the basis for the architectural formation of the educational buildings.

1. The participants in the educational process (teachers, pupils and their parents) and the nature of their activity in presenting the basic requirements of the contemporary school building.
2. The development process of the educational activities and the dynamics of the architectural reformations of the school buildings.
3. The informational public demands regarding the contemporary school structures.

The above factors, as well as visions of the (ideal school) from various interest groups, are creating the conditions to reorganize the existing school buildings and transform their generally typical architectural character.
Since there are examples in Armenia of innovative schools (fig.1.) , from an educational as well as architectural point of view, they can be considered the basis for the design or redesign of future projects (fig.2.) .

6. CONCLUSIONS

At the moment, the current public school network of Armenia represents generally a system of typical buildings. Its compliment with the modern architectural and urban requirements is considered a priority task. Moreover, it should be based on a reformed educational system, not only on today’s needs. The rapid transformation of the society, the information technology contributions and continuous developments, with consideration to the architectural problems of the educational buildings, are raising a more comprehensive platform.
In order to have school buildings ready to face further versatile requirements and transformations, we have to accept as a basis, flexible and free architectural planning schemes, when conducting reformations on existing school structures.

Fig. 1 Yerevan Ayb School in Armenia

Fig. 2 Dilijan International School in Armenia

NOTES

[1]Taken from the website http://aybschool.am
[2] Taken from the website http://mepcad.am

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PROJECT OF ENHANCEMENT OF NATURAL AND HISTORICAL-CULTURAL RESOURCES IN CHINANDEGA AND LÉON DEPARTMENTS (NICARAGUA), THROUGH A PROJECT OF COMMUNITY BASED TOURISM

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Keywords

Nicaragua, natural reserves, community based tourism

ABSTRACT

The paper discusses a research project that DASTU, Architecture and Urban Studies Department of Politecnico di Milano, and the NGO Africa'70 have in course to identify planning tools in order that transformations of territories and development actions of Sustainable Tourism may cooperate in the challenges for the conservation of natural and cultural Heritage and in the fight against poverty and social exclusion that the contemporary and globalized society is asked to deal with. The research of ecological and inclusive strategies, by which even remote areas can enjoy infrastructure, services and proximity necessary for economic and social development, can find answers in Sustainable Tourism. It can be an important element of social and economic growth of the marginal areas. The application of the research is the North-Western part of Nicaragua, in the departments of Chinandega and Leon, an area with several nature reserves and a fragile environmental ecosystem.

1. INTRODUCTION

Until the nineteenth century, mankind has lived basically dispersed in wide areas used to derive their proper livelihoods. Only a small percentage of the population lived in cities. Currently the world's population living in urban areas exceeded the rural one (54% versus 46%) and the tendency of the population is to be concentrated in urban centres seems to be an inescapable feature of the development of the next few years (66% by 2050) . In countries in which the modernization of agriculture began before, mass immigration to the city ceased and it is recording a gradual redistribution in urban neighbourhoods and rural towns to form new entities, made up of traditional cities and peri-urban elements that are called in various ways: the city-regions, meta-cities, metropolitan areas or post-metropolis. In less Developed Countries in the coming decades, there will be an increase in migration from the countryside to the cities of people driven by the search of urban benefits, such as job opportunities and basic services. The phenomenon has led to a gradual abandonment of rural areas and the formation of urban slums where migrants find themselves dwelling in worse in living conditions than those of their place of origin. The consequences of these uncontrolled changes are the progressive deterioration of the territories and the formation of inordinate, disorganized and inefficient conurbations. Perhaps it is possible to imagine a less unbalanced development of the territories and a relation between city and countryside of a less confrontational and more synergistic order. Therefore it is necessary to use planning tools that adopt ecological and inclusive strategies, which consider the territory as a whole and that foresee that the rural parts may, at least partially, enjoy the proximity of infrastructure and services necessary for economic and social development. One of the factors contributing to the development of the territories more environmentally and socially fairer is tourism, which, if properly planned, can become an instrument, not of consumption and deterioration of the territory but of nature conservation and socio-economic growth.

2. BACKGROUND

In developing countries tourism industry has become an important economic sector. Sustainable tourism is increasingly perceived by national governments and international organizations as an effective tool for poverty reduction and of the preservation of natural and cultural Heritage. The opportunities related to tourism were understood after testing negative experiences related to mass tourism and land consumption. Since the Seventies numerous initiatives have developed to seek alternatives to mass tourism (Turner & Ash, 1975; Smith, 1977; De Kadt, 1979) that over the years have taken different names and forms such as: sustainable tourism, responsible tourism, ecotourism, Community Based Tourism (CBT), Rural Community-based Tourism (RCT). On the boost of optimism on the contribution of tourism to conservation and community development, many forms of CBT have experienced to fight poverty through the direct participation of the local population in the dynamics related to tourism. There is also an extensive literature on the subject that interprets not uniquely the results of these experiences. If some continue to support what is considered a viable and effective alternative to consumption tourism others have also highlighted some critical aspects (Muckosy & Mitchell, 2008; Goodwin & Santilli, 2009), as they often constitute rather mythical forms of tourist rather than real, unable to bring real economic growth and social development. In particular the limits of such forms of tourism development can be traced to a low impact on poverty reduction and a dependence on external financing. Generally, the reports relating to projects of CBT conclude that actual results in terms of poverty alleviation and socio-economic development were below expectations and underline the difficulties in generating positive processes in marginal locations, far from the traditional tourist routes not served by adequate infrastructure. The main weaknesses of these interventions have been suggested as being identified by the offer, having no link with traditional tourism enterprises, being affected by a general lack of skills in business and tourism, or in being the application of top-down models that do not take into due account the needs and the dynamics of the local people.

Without going into ethical issues and going beyond ideological differences, it should be noted that the conservation of protected areas and historic cultural heritage cannot be achieved without the involvement and support of local communities. The identification of adequate and sustainable forms of CBT is conditio sine qua non to enhance and preserve territories and cultures. This is not to deny possibility of free initiative of the tourist industry, whose presence is always desirable, as it finds synergies within a shared objectives development project. On the considerations arising from the fact that the interventions of CBT are located in marginal areas of the territory, it should be noted that the competitive and structural limitations/ opportunities inherent in their location are obvious since the setting of the initiatives. The inaccessibility, lack of services or insufficient training of tourist operators, are characteristics of the marginal areas. To overcome such problems it is fundamental to set a land use planning that takes a logical system, and thus sets up strategies of management of tourism resources in it that can involve the different actors of the territory in an integrated way. Many of those, which have been identified as the limits of CBT initiatives, are due to the fact that they have not been supported and coordinated through appropriate instruments of spatial planning. In the transformation of the territories environmental, economic, cultural and social-impacts often overlap or merge: it is necessary to understand what planning tools should be put in place to manage them in the most appropriate way. For this purpose there is an ongoing theoretical and applied work research project in which the DASTU, Architecture and Urban Studies Department of the Politecnico di Milano, and Africa'70, NGO in cooperation and development, have involved several international organizations. The project aims to identify patterns of land development through the activation of processes of integrated enhancement of environmental and cultural heritage that allows making system of identities and peculiarities present in specific territories and the growth of forms of sustainable tourism. The application case of the research is the area of the north-western part of Nicaragua, in the departments of Chinandega and Leon, an area where with several nature reserves that protect a fragile environmental ecosystem characterized by the presence of volcanoes and lagoons.

3. METHODS

The research project being tested in Nicaragua has an interdisciplinary approach, since the complexity of the territories and their transformation processes are such that cannot be solved only within an exclusively disciplinary vision. The interdisciplinary approach is necessary when dealing with complex issues and when the processes of socio-economic and territorial transformations may have consequences at different levels. The evaluations of CBT projects, for example, often have to refer to the limit of a single point of view of a discipline, such as science of tourism, economics, sociology, anthropology, agrarian, or architectural design and planning. The research project also has a systemic approach because it is believed necessary to consider the territory as a whole, overall and in relation between its parts. Through a systemic view it is possible to frame the initiatives to promote tourism within the transformations of the territorial system. This is indispensable when working in marginal areas. A systemic view allows identifying possible strategies to activate processes of integrated enhancement of environmental and cultural heritage through the development system of identities and peculiarities of the different regional systems. Even marginal areas or parts of territories without strong attractions, with good landscape resources, if embedded in a broader territorial and well integrated context, can lead to synergistic phenomena of major scale and increase the attractiveness of the territory. Taken individually, however, such resources, just as marginal, such as rural areas with development problems, would not be able to generate tourist flow. Starting from a reading interdisciplinary and systemic of local resources we may identify strategies to develop tourism on the one hand enable the concentration of services in specific areas (to minimize potentially negative impacts on the natural and socio-cultural environment or to provide services in places that lack them) on the other they allow visitors to enjoy the entire territory, including marginal areas. In addition to distributing the benefits of a wider territory and otherwise difficult to access, the formation of a regional tourism can be an offer that adapts to changes in tourism demand, which has evolved from mass standardized tourism to more customizable models, that can offer the opportunity to circumvent the traditional circuits and give the opportunity to direct and real immersion in a different reality and culture.

4. CASE HISTORY

Also in Nicaragua recently the tourism sector has taken on a growing role in the economy of the country and great organizational efforts have made to promote the dissemination of sustainable tourism. In particular numerous experiences of CBT have been activated, experimented with various degrees of success, within projects Pro-poor Tourism independent among them (Zapata et al., 2011). These interventions rarely interacted with other actors and services of the tourist market. They are organized in networks of CBT (e.g. REDTURS or RENITURAL). Loans from international development organizations have made three thematic tourist routes: “the Ruta del Café Nicaragua”, “Ruta del Agua Nicaragua”, “the Colonial y Ruta de los Volcanes”. The application part of the ongoing research project is the development of experiences that have been gained within the socio-economic development actions related to the Colonial y Ruta de los Volcanes. It aims to maximize synergies between acts of exploitation of sustainable tourism and socio-economic and cultural development of the territory of the departments of Chinandega and Leon, in their complexity of natural areas, rural areas and urban areas. Chinandega and Leon are the urban areas of reference of a territorial system characterized by the presence of a large number of protected areas linked to the presence of the system of volcanoes as the Nature Reserves of Volcan Cosigüina, the Complejo Volcánico Casita-San Cristóbal, the Telica Volcano, the volcano Cerro Negro and Momotombo Complejo Volcánico, or to the need to protect coastal areas, such as nature reserves Padre Ramos, the Delta del Estero Real, Isla Juan Venado or the reserves established to protect the genetics of some species such as the nature reserve of Apacuna. It is an area that has many environmental resources and is subject to geological risks, volcanic eruptions, landslides and hurricanes. It is a fragile ecosystem in which tourism projects can actually become elements that support the environment and trigger new ways of land use, more friendly both environmentally and socially, or, if they are not properly supported, can easily lead to a further land consumption.

The research project was developed from both from lines of tourism development by the National Chamber of Tourism of Nicaragua, CANATUR, and from the experiences of Africa ‘70. The ONG has played a central role for the performance of two on-site activities of environmental protection and socio-economic development supported by international cooperation: the project development of sustainable rural tourism in the Volcanic Complex Natural Reserve San Cristobal-Casita and a training project on solid waste management and sustainable rural tourism in six departments of the Colonial y Ruta de los Volcanes. Several concrete results have been achieved such as the realization of works for the development of tourism services. The tourist development planned has to be integrated with the planning of the territorial transformations, in order to obtain success of sustained efforts and to encourage processes of social and economic development in the region as a whole. A sustainable management plan can enhance overall the region, find ways to introduce forms of protection of the environment and its biodiversity, reduce deforestation in place, often carried out with devastating fires, and allow local people a decent life in harmony with the natural environment. This is possible through the adoption of integrated models of development, which, starting from the different uses of the land and its resources (in this case, agricultural, forestry and touristic), also to draw up the draft of a plan for protecting the natural environment and sustainable and diversified agricultural development that may individuate techniques and innovative models of intensive agricultural production, based on organic practices that do not harm the ecosystem. The organization of a system for use in rural areas based on CBT offers the opportunity to people not only to draw any more income through their participation in the economic benefits that may result from the spread of tourism, but also provides an opportunity to socio-economic growth because, through it, they would have access to opportunities, services and infrastructure in their developed territory diversified. It is necessary that the CBT is not organized in isolated and independent areas but is active part of a territorial system that cooperates for the protection of natural and cultural heritage.

The research was organized interdisciplinary and is expected to carry out the following activities, which will always be shared with the local people and the institutions that represent it:

1. Collection of documents and updating of cartographic bases, at different scales of the territory and containing the data collected from the various disciplines involved;
2. Reworking the data acquired and systematization and comparison with maps and analysis of environmental risks;
3. Mapping of environmental, landscape and cultural and historical importance of the area and settlement systems and architectural artefacts with historical and cultural value;

4. Mapping agro-food systems;
5. Definition of scenarios of intervention and identification of strategies for the development of the area;
6. Identification of priorities for action at different spatial scales.

The goal of the research project is to frame in an interdisciplinary and systemic action to protect nature/historical/cultural and socioeconomic development within an overall plan to promote tourism in the territories of Chinandega and Leon. Within it, specific actions will be studied to make sure that nature reserves and rural areas are an integral part of the overall value of the territory. For example, that in order that the promotion of nature reserves may become effective, there must be a tourism development of the entire system as well as the entire local territorial system can benefit greatly from the tourism development of the natural reserves.

5. RESULTS

The main expected results of the research project are: updating the repertoire of knowledge on both methodological setting of the research and of the case-study; the improvement of survey methodologies, field survey, processing of data collected and shared development of the same through an interdisciplinary point of view; the joint establishment of strategies for upgrading of existing assets, both physical and social; the elaboration of strategies to promote the area; the development of a model of investigation and intervention applicable in other contexts of similar matrix.

6. CONCLUSIONS

Sustainable tourism, if planned along with the territorial transformation, can be an effective tool for environmental protection and socio-economic growth and may drive a more respectful development of the planet and more socially just. The departments of Chinandega and Leon, due to their economic, social and territorial offer a unique opportunity to experiment new synergies between sustainable use and tourism. Their environmental and cultural heritage has a significant and acknowledged tourism potential: it is necessary to identify planning tools that allow physical, economic and cultural accessibility, and favour interpretation systems. It is important to act so in order to try to overcome the challenges for the protection of natural and cultural heritage and the fight against poverty and social exclusion that the contemporary and globalized society asks to deal with. For this we need to find alternative strategies to the old logic that sees environmental protection and economic development as opposed and imagine instead a more balanced development of the territories and a relation between urban - rural less confrontational and more synergistic.

NOTES

[1] Font: United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).

[2]The CBT concept is used very broadly and flexibly. For the Mountain Institute uses it to "describe a variety of activities that encourage and support a wide range of objectives in economic and social development and conservation." (The Mountain Institute, p.1). WWF defined it as a form of tourism "where the local community has substantial control over, and involvement in, its development and management, and a major proportion of the benefits remain within the community." (WWF, p.2).

[3]See Mowforth & Munt, 2003, Mitchell & Muckosy, 2008, Goodwin H. & Santilli R., 2009.

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MOSAIC FROM THE PUBLIC BATH OF ARMENIAN ANCIENT CAPITAL ARTASHAT AND RESTORATION OF ITS ORIGINAL IMAGE

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Keywords

mosaic, public bath, antiochian school.

ABSTRACT

A public bath has been excavated on the territory of the ancient capital of Armenia, Artashat, (2nd c. BC – 4th c. AD). All the walls of rooms, as well as ceilings and floors, were covered with high quality waterproof plaster. During the excavations fragments of floors paved with mosaics have been found in some of the bathing rooms. Small cubes (tesserae) in great quantities points to the existence of mosaic covers of floors and door thresholds in all rooms. The central panel of the floor mosaic was made using the technique opus vermiculatum while decorative borders used the technique opus tesselatum. The preserved fragments of mosaics in the bathing rooms frigidarium, tepidarium, caldarium and laconica provide an opportunity to restore and recover their original image. When restoring the mosaic picture we discovered that the design of tepidarium mosaic looked like a rich carpet painting with geometric and ornamental motives. The floor mosaic of the caldarium depicts a scene image in central composition.

1. INTRODUCTION

The ancient capital of Armenia, Artashat, (2nd c. BC – 4th c. AD) is located on the left bank of the river Arax and occupied an area of approximately 450 hectares. Since 1970 systematic excavations of Artashat have been undertaken. In recent years a complex of public bath was discovered. The public bath was adjacent to the sacred temple podium (temenos); it consisted of nine bathing facilities, equipped with underground rooms- hypocaust. There are evidences of mosaics of floors and door thresholds in all the rooms of the bath complex. On the territory of Armenia, the mosaic of Artashat is the second excavated monument of its kind. The first one is the Garni mosaic, which dates to the end of 3rd c. AD. The present paper aims to study the mosaics of Artashat public bath complex and to restore their original images.

The public bath complex consisted of nine bathing facilities, corridors and boiler. Fragments of floor mosaics were discovered in several rooms. Unfortunately, in many rooms dampness and fire damaged hypocaust columns, resulting in the floor collapse and fragmanted mosaic. Besides moscaic fragments, great quantities of small cubes and tesserae were found in these rooms. This indicates that mosaics covered floors and door thresholds in all rooms. The mosaic consisted of small cubes of the local felsite, had different sizes and forms (from 1.5 to 0.3 cm). The mosaic was created by pressing the small cubes into the lime mortar. According to drawing, along with white undyed tesserae there were the felsite tesserae dyed in different colors with organic dyes. Major efforts have been made to restore the original drawing and compositions of mosaics.

2. METHODS

The study of preserved fragments of mosaics was carried out. Careful measurements of preserved pieces was conducted and plotted on a drawing. The method of construction and extension of lost symmetries was applied to recover the missing parts of the mosaic. The integral picture of the mosaic was restored. The comparative analysis of the pattern elements and the data from the scientific literature was carried out.

3. DOOR THRESHOLD

The mosaic of threshold, which leads to the first room, frigidarium, is preserved partially (width of 0.45cm, length of 0.50cm). A careful study of preserved fragments enabled us to complement and restore a geometric ornament of the threshold with white background and blue frame in which two blue rhombuses are inscribed. There are right triangles in four corners of the main rectangle, paved with dark blue tesserae on white background. Other preserved thresholds of rooms were covered by smooth white tesserae (1.5cm). The geometric pattern consisting of simplest elements resemble decorative art of Near East and Asia Minor. Rhombus-shaped mosaic images find analogues with mosaic of Anemurium, Asia Minor (Rassell, 1974), as well as with mosaic of Antioch on the Orontes (Elderkin, 1934) dating back to the end of the 2nd – beginning of the 3rd cc. AD.

4. TEPIDARIUM

The tepidarium floor had area of 24 m2 and was decorated with mosaic. A preserved section of the mosaic floor is about 5m2, there are flaws and lacunas which disturb the integrity of the composition. Piecewisely continuing and complementing the fragment pattern we were able to restore the overall composition of the picture. The restored picture reveals that a finely decorated multicolored mosaic looked like a rich carpet painting with geometric and ornamental motives. One can observe a principle of symmetric disposition of the elements with rich details and a large variety of colors, resulting into a profound and holistic picture. Mosaic is made of painted multicolored tesserae (about ten colors) on a white background. Alternation of contrasting colors– blue, yellow, terracotta, golden brown, grey-blue and red– created a splendid decorative effect. Sizes and shapes of mosaic cubes are related to the patterns.

During the reconstruction, we revealed the ability of ancient mosaicists to combine different ornamental elements into a single completed composition. In addition to the tesserae with square faces, there are also those of rectangular, triangular, and oblong forms according to the technique of opus vermiculatum, which provide for a more graceful and correct drawing in the middle of the field. Borders are made of larger square stones, according to the technique of opus tesselatum. The main background for the central medallion is a light golden field, in which we see a pattern of alternating, inscribed in each other, and equal-in-size rhombuses. Rhombuses are made of white and blue tesserae. In the center of smaller rhombuses there are small cruciform inserts from blue tesserae with a central white tessera. An analogous design with a similar golden field and a rhombus-shabed pattern in the central medallion is common for mosaics of the Roman period, for example, in Antioch (Morvillez, 2007), Madaba, Alexandria, and Dzalisi and etc.

The frame, bordering the central square, has the form of a fan-shaped gray-blue and white band, which in its turn is framed by a toothed belt of 0.02 m wide. A plain brown strip frames the tress. Antique mosaicists created a clear geometric construction with ornaments of multicolour (blue, white, gray) tesserae that form an interlaced fan-shaped patterns of a rich colorful ornament. The reconstruction demonstrated that the central medallion was filled with a rich and colorful complex pattern of geometric and ornamental motives, layered to create a three-dimension image that reminds the second decorative style. The square is saturated with complex colorful ornamental motives. We were able to restore the integrity of the image, by remaining part of the main disk, circles inscribed in it, as well as some small details of the mosaic. It turned out that a disk with diameter of 1.70 m was inscribed in a blue square. Six interlaced rings were inscribed in the disk, with centers located in the middle of the radius of the big disk. The diameter of each ring was 0.90 m. Every ring in its turn was framed with an edge of 0.03 m wide. The rings created three 8-shaped interlacing ornaments. Inside each ring, there were three main alternating elements (band, crest waves and bordered guilloche). The segments, formed as a result of three rings interlacing, were filled with ornaments "double axe"; they are of alternating colors (blue and terracotta). In the center, between the interlacing rings a vegetation pattern in the form of six-petalled rosettes is seen.

Ornamental mosaic motives like those of Artashat tepidarium, were common in the ancient world for a long time. Greek mosaics of 2nd c. BC discovered on the island of Delos have borders with crest waves in few curls. The mosaic in Artashat does not have a complex pattern which means that is of a later origin. Artashat's ornamental motif "crest wave" pattern resembles Zeugma mosaics in Roman times (Tyson, 2002), where one can see the similar border with a set off strip ornament. The bordered guilloche of Artashat mosaic consists of wavy interlaced blue, white, and golden brown curved lines with central white tesserae which are also often found in mosaics of Roman times, e.g. Tripoli, the 2nd c. and the beginning of the 3rd c. AD (Luquet, 1967), (Elderkin, 1934).

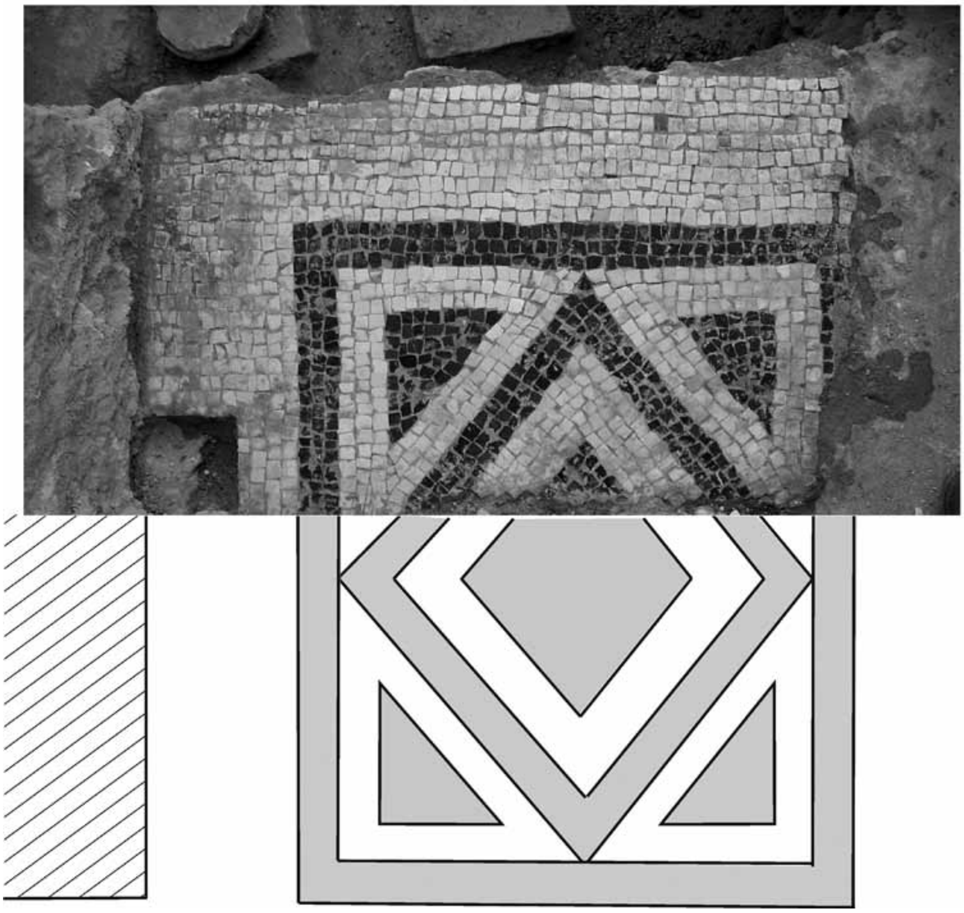

Fig. 1 Restoration of the integrity of the threshold mosaic.

Based on the symmetry, it can be assumed that the floor field picture consists of two identical closely adjacent decorative squares with a toothed border pattern. The reconstruction of this composition is based on the symmetry of compositional elements and parts as well as on the size of the entire area of the floor, where the recovered part occupies half of the total area of the room. Besides, great quantities of the same color tesserae were found in the destroyed part of the room. The mosaic picture amazes with its smoothness, clear construction, the richness of ornamentations, sharply accentuated lines of its contour.

5. CALDARIUM

The floor of the next bathroom, caldarium, was also decorated with mosaics. In spite of the fragmentary and poorly preserved mosaic, it is evident that the mosaic of this room had a very richly decorated compositional drawing. Unlike the tepidarium, the floor mosaic of the caldarium had a scene image in a central composition. Here green, pink, purple, yellow, blue, white and black colors were predominant. There was a border of relatively large white felsites tesserae under the walls of the room. Borders of meanders of various configurations and different colors followed the white boders. It is to be noted that a meander motif was widely used also in wall paintings of living premises of the ancient Artashat.

Discovered mosaic fragments evidence that the central part of the mosaic, apparently, had the medallion with a scene composition. A fragment with the image of a full human face was found in the central part of the mosaic of this room. The preserved fragments are: the right eye, nose, part of the mouth, parts of the forehead and hair. A tessera of dark color indicated that the pupil was placed in the corner of the eye. It softens the contrast with the white of the eye and gives the face a calm expression. This technique is a distinctive characteristic stylistic feature

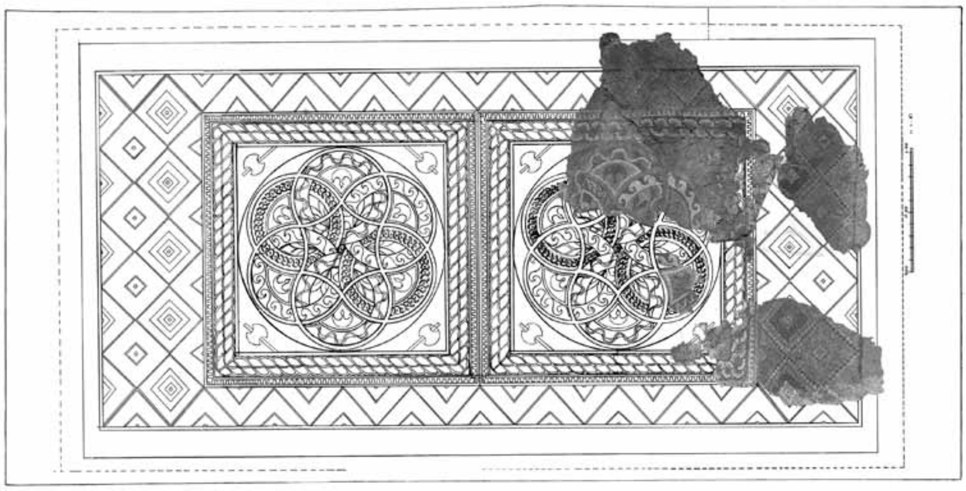

Fig. 2 Reconstruction drawing of the tepidarium mosaic.

of the 2nd c. AD mosaics (Dunbabin, 2003). Another fragment has a part of lapidary inscription in Latin; it is the word “VER” of black tesserae meaning “spring”. Fragments were also found with representation of flowers and other colorful ornaments, which possibly framed the central scene composition. Depending on the drawing, tesserae of various form and sizes were used. The tesserae used in the drawing are often so small that they could be put together only with the help of pincers.

Mosaics of Artashat public bath, covering premises of the tepidarium and caldarium are excellent examples of decorative art of antique Armenia, 2nd – 3rd cc. AD.

6. FRIGIDARIUM AND LACONICA

Floors of frigidariuma and laconica were also decorated with mosaics of the same patterns. In frigidarium the part of the mosaic floor is preserved with an area of two third of the room. The white background field was enlivened by a dark blue frame of 0.08 m wide, in 1 m from the western wall and 1.2 m from the eastern wall. In laconica mosaic is partially preserved near the walls. The floor of the laconic is practically destroyed in the middle part. Nevertheless, the discovered numerous dark blue tesserae indicate that the middle part of the room was also ornamented with dark blue pattern on the white background, which is common to antique art.

7. RESULTS

The mosaic of the threshold from apoditarium into frigidarium was complemented and restored, the integrity of the geometric patterns was obtained (Fig. 1).

The reconstruction drawing of the tepidarium mosaic was made using the preserved fragments, construction methods and based on symmetry concept. The restored picture looked like a rich complemented carpet picture with geometric and ornamental motives (Fig. 2).

An attempt is made to arrange the discovered small fragments of meanders bands, the central image of the human face, and lapidary inscriptions into a suggested composition of the caldarium mosaic (Fig. 3).

8. CONCLUSION

Based on the planning scheme, the Artashat’s public bath had all the characteristics of Roman public baths construction. Reconstruction and restoration of the Artashat’s public baths mosaics showed that all mosaics are similar to those in Western Asia and Asia Minor. The variety of decorative techniques, range of colors, perspective reflection law and colorful ornaments allow us to attribute the mosaics to the Antiochian school of the mosaic

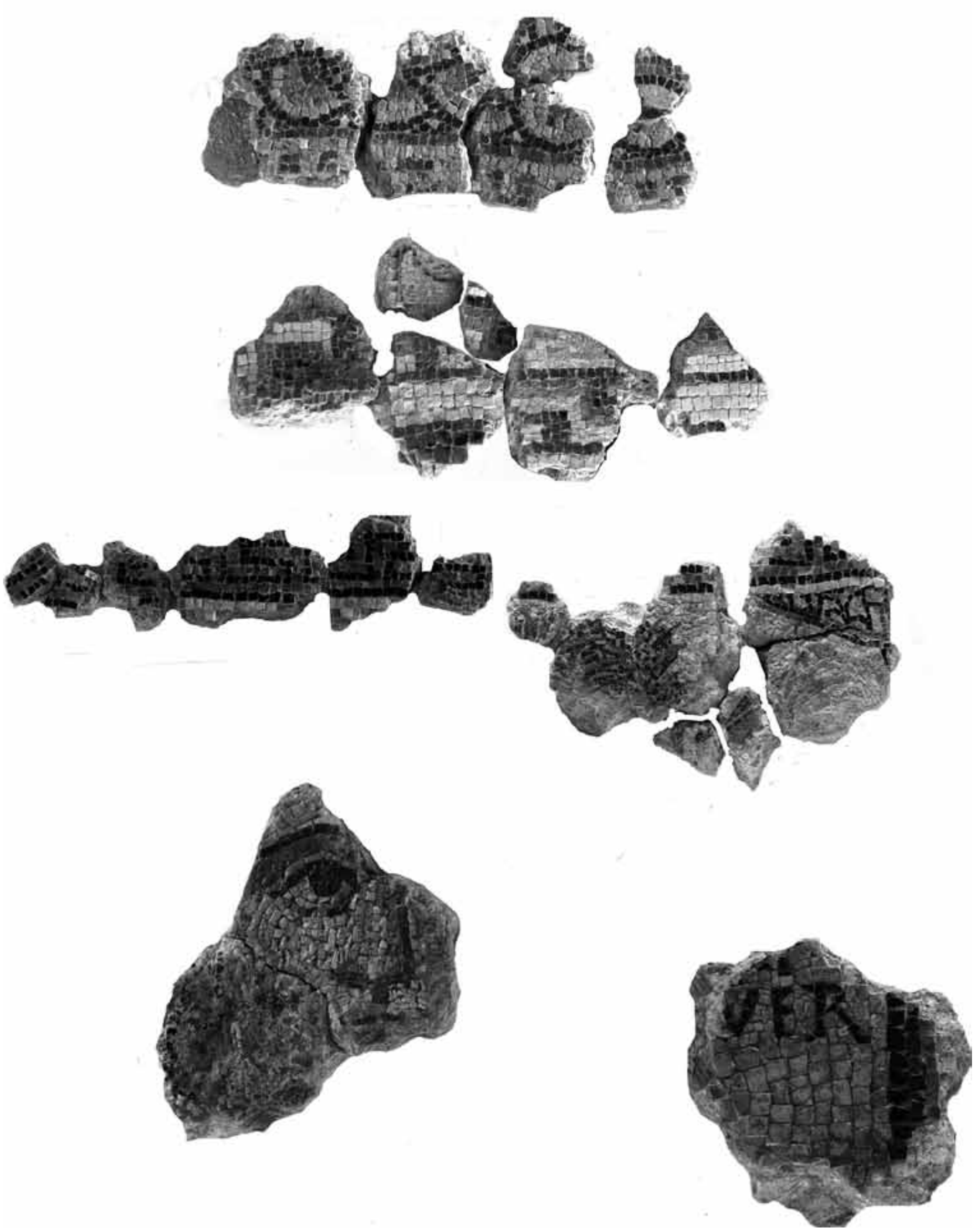

Fig. 3 Caldarium mosaic fragments arrangement.

decorative art representing the second decorative Pompeian style. The mentioned stylistic characteristics enable us to date it to the end of the 2nd and the beginning of the 3rd cc. AD. Artashat's public bath mosaic is a new contribution for the history and the study of the influence and spreading of ancient culture on the territory of ancient Armenia.

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THE SIGNIFICANCE AND THEORETICAL ASPECTS OF CLASSICAL MONUMENTS' 3D-RECONSTRUCTIONS FOR CONTEMPORARY CLASSICAL ARCHITECTURE

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Keywords

classic, 3d-reconstructions, antiquity

ABSTRACT

The aim of this paper is to show the significance and theoretical aspects of 3D-reconstructions of badly preserved ancient architectural masterpieces both for architectural theory and modern architectural practice. Contemporary interpretation of classical architecture is mainly based on foundation which was created by architectural and art historians in XVIII-XIX centuries. However contemporary architectural history rested on the newest progress of archaeology gives us a lot of new information about badly preserved antique architectural masterpieces. 3D-reconstructions of such monuments based on the modern computer technologies have to increase our conception of ancient architecture and discover the new stratum of Greek and Roman architectural monuments both for architects and for the wide public. In the Moscow Institute of Architecture the creation of such reconstructions is a part of educational process and scientific research. The paper is accompanied with author's reconstructions of two monuments: late Roman palace at Nag-el-Hagar and the temple of the Roman imperial cult at Luxor and also with several examples of 3D-reconstructions made by foreign scholars.

1. INTRODUCTION

The aim of this paper is to show the significance and theoretical aspects of 3D-reconstructions of ancient architectural masterpieces both for architectural theory and modern architectural practice (note 1). This direction of architectural history is very important because it gives a possibility to bring into widespread use unknown badly preserved ancient monuments. Such investigations demand both their comparison with similar monuments and their examination in wide cultural contexts, which allows the architectural theory to take part in multidisciplinary researches.

2. BACKGROUND

Contemporary interpretation of classical architecture is mainly based on foundation created by architectural and art historians from the Renaissance until XIX century. The theoretical ideas from the Renaissance treatises to Johann Winckelmann's study and the publications of many authors (such as members of the Society of Dilettanti) together with practical works of architects from Palladio to nowadays establish our conception of classical architecture. Today we perceive antique architecture in the light of this conception.

3. METHODS

However contemporary architectural theory has to be based on the newest progress of archaeology and accompanying sciences which give new information about badly preserved antique architectural masterpieces and their architectural and cultural context. For example nowadays due to many newly discovered Graeco-Roman and Hellenistic monuments architectural theory received more complete knowledge about buildings of Late Antiquity, architecture of Roman provinces and Eastern Hellenistic states. Previously the architecture of these periods and regions was unpopular among the architectural historians.

4. CASE HISTORY

3D-reconstructions of newly discovered monuments based on the modern computer technologies and more complex knowledge about ancient architecture, including periods and states which were unpopular before, have to increase our conception of ancient architecture and discover the new stratum of Greek and Roman architectural monuments both for architects and for the wide public. There are a lot of visualization projects which shed new light on the imagination of ancient architecture. For example there are the visualization of late stages of Forum Romanum made by CvrLab (CVRLAB archives) and other scholars (Packer, J.E. 2006; Gorski, J.G. and Packer, J.E. 2015), project Archeovision by Centre national de la recherche scientifique (Archeovision), the Museum of Reconstructions (Museum) and admirable project Byzantium1200 which contains Constantinople's architectural masterpieces visualization (Byzantium1200) made by Tayfun Öner with the help of many scholars.
In the Moscow Institute of Architecture the creation of such reconstructions is a part of educational process at architectural theory and scientific researches made by postgraduate students, lecturers and research fellows. It is necessary to note the studies by S. Klimenko and Yu. Klimenko (Klimenko, S.V. and Klimenko, Yu.G. 2011).
It is important that the reconstruction is not only a model of some unsurvived monument, it also could and should be the instrument of verification. Furthermore the process of reconstruction creation could provoke the discussion about the monument's architectural peculiarities and their interpretation. It should be noted that any reconstruction can't be considered as complete. Today the archeological evidence, which gives the data about features of the alike architectural objects, is much broader than decades ago, and different scientists would have the various opinions about the view of a monument and its architectural features.

5. RESULTS

The paper is accompanied with author's reconstructions of three monuments: late Roman palace at Nag-el-Hagar (Karelin, D.A. 2011), the temple of the Roman imperial cult at Luxor (Karelin, D.A. 2014) and the principia the of fortress at Dionysias (Karelin, D.A., Zhitpeleva, T.I., Karelina M.A. 2015).
Nag el-Hagar (note 2) fortress was situated to the south of Luxor (ancient Thebes), close to Kom Ombo (ancient Ombos). Probably this fortification was built during Diocletian's rule and possibly with his own participation during his stay in Egypt. Its architectural features correspond with other examples of Tetrarchic Roman military architecture in Egypt. I chose this fortress for the reconstruction because Nag el-Hagar, on the one hand, is a typical example of the Late Roman castrum which belongs to the period of Diocletian and has its main features. On the other hand, it has a lot of special and original architectural peculiarities which appeared because of special conditions of its building and usage. The remains of the palace of the Roman governor (or military commander) which was found inside the fortress are of a great interest to specialists in the late Roman palace architecture (Fig. 1). The newest archeological researches show that the fortress had an unusual principia (Franke, R. 2013, p. 461). The

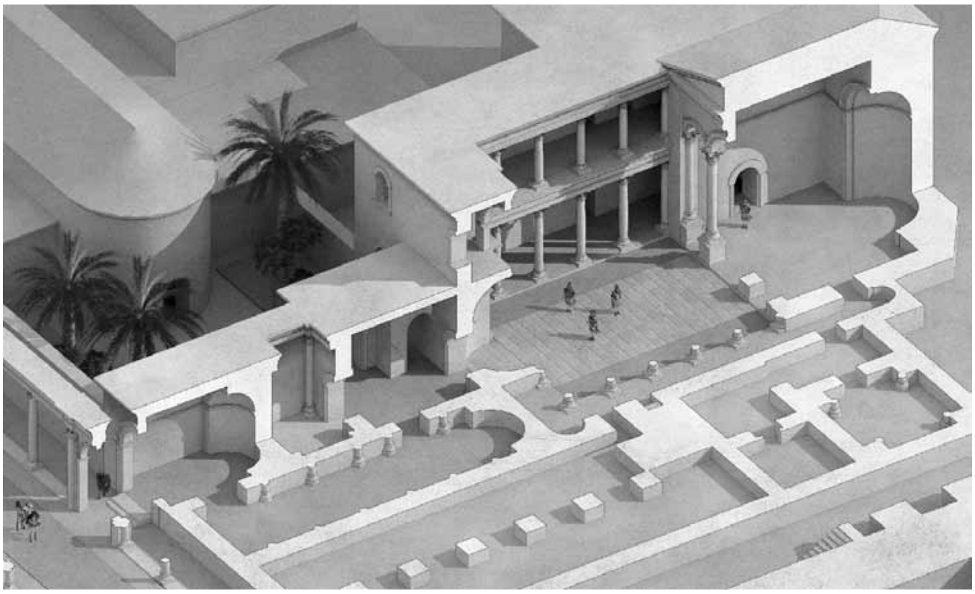

Fig. 1 Axonometric view of the late Roman palace at Nag el-Hagar (reconstruction by the author).

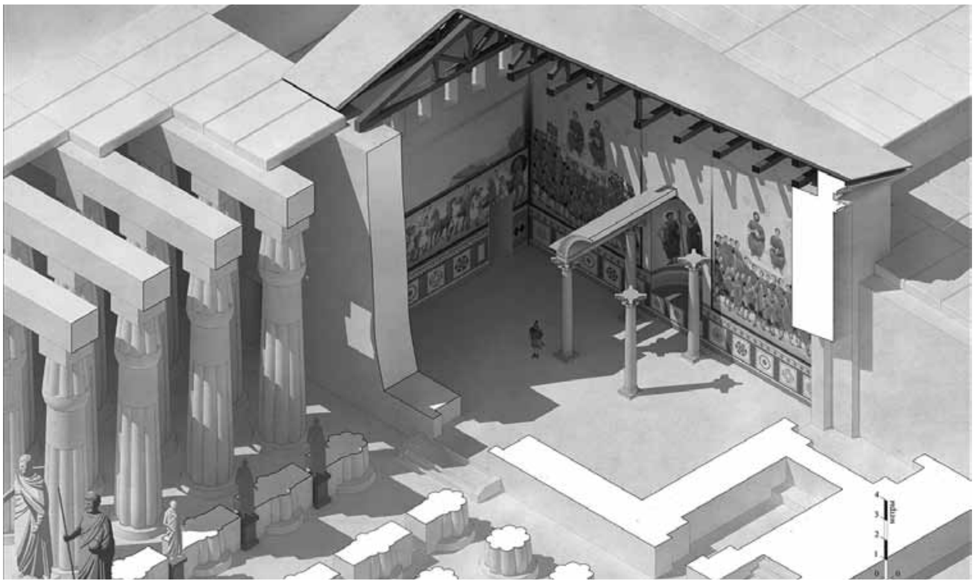

Fig. 2 Axonometric view of the late Roman temple of the imperial cult at Luxor (reconstruction by the author and Karelina M.)

computer reconstruction shows that Nag el-Hagar fortress was not only the military base but the majestic ensemble as the famous fortress at Luxor as well and its planning and architectural peculiarities were influenced not only by its military function, but also by the artistic concepts of the late Roman architecture.

The next architectural masterpiece is the Roman temple of the Imperial cult at Luxor (Fig. 2) which was founded inside the principia of the late Roman fortress (note 3). This military complex was built around the ancient Egyptian temple at Luxor during the reign of Diocletian. The Roman temple inside the principia is of particular interest. On the one hand, the common principles of the Tetrarchic art and architecture were used. On the other hand, their architects had to include the principia with Imperial cult temple into the ancient building. It is remarkable that they used its chambers with maximal efficiency and so inside the Egyptian temple typical Roman principia appeared. Furthermore it is possible that in the Roman temple the architects used some principles of the ancient Egyptian architecture. Despite hypothetical character of some suppositions of the reconstruction it seems that in whole it allows to imagine how the Roman Imperial cult temple could look like.

The third monument is the principia of the fortress at Dionysias (note 4). This masterpiece of late Roman military architecture is the rare example of rather small fortress dating from the end of III to the beginning of the IV which interior planning was untypical and simplified due to increase the architectural significance of the principia (Figs. 3-4).

6. CONCLUSIONS

The reconstruction as mentioned above have to expand the architects’ knowledge about the newly discovered badly preserved classical masterpieces of architecture. Furthermore they could be the new sources of inspiration and adoption of architectural elements, compositions and citation for neoclassical architects all over the world.

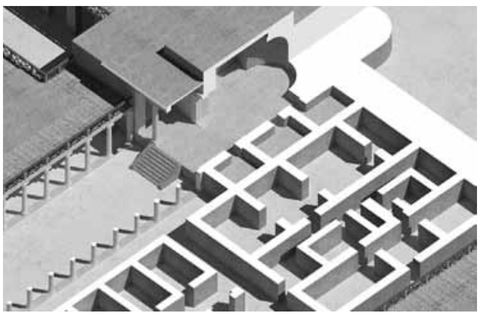

Fig. 3 Main street of the late Roman fortress at Dionysias (Egypt). Axonometric view (reconstruction by the author, Zhitpeleva T. and Karelina M.)

Fig. 4 Main street of the late Roman fortress at Dionysias (Egypt). Perspective view (reconstruction by the author, Zhitpeleva T. and Karelina M.)

NOTES

1. This work is a part of scientific project №14-18-01601 "*The Past and the Future of Classical Architecture"* supported by Russian Science Foundation performed in Moscow Institute of Architecture. (MARHI).
2. About the Nag el-Hagar fortress see (Wareth, U., Zignani, P. 1992; Mackensen, M. 2009; Franke, R. 2013).
3. About the temple of Roman imperial cult at Luxor see (Monneret de Villard, U. 1953; Kalavrezou-Maxeiner, I. 1975; Deckers, J.D. 1979).
4. About the fortress at Dionysias see (Schwartz, J. 1969).

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ARCHITECTURAL-PLANNING PARTICULARYTIES OF OPEN SPACES IN CONSIDERATION OF YEREVAN CITY HISTORICAL DEVELOPMENT

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Keywords

open spaces, monumental buildings, cultural identity

ABSTRACT

Recently do to science and technology development the significance and the role of historical environments dramatically increases in all over the world and in Armenia too. Humanity need some sort of return to their roots and identity, valuate their own history, culture and architecture, preserve and keep the important fragments of it and show in a good way to the world. From the urban, architectural and visual points of view the historical character of every city in the World, as well in Yerevan provides two aspects: urban open spaces, without fences walls and covers, which are mostly open to the natural and climate skim influences, such as streets, squares, residential courtiers, act, and close areas, such as monumental or valuable buildings and structures.
The research is mostly based on the comparison of nowadays "quality and quantity" of public open spaces and monumental buildings with historical situation. The value of open spaces occurring in an urban situation has many aspects like their form, use or location.

1. INTRODUCTION

Twentieth century urbanism has left the huge influence on the globe. It is impacts on social, economic, and environmental sustain¬ability as well as on our lives. Urbanization con¬tinues also today, more than half of the world's population lives in cities. Urban growth has effects in many ambits, mainly due to economic and political changes, concern the programme of densification. After this sort of realized programmers for future urban development the next step is going to be the questions connecting to the demystifying the open spaces, creating a denser but still spacious environment.The significance and the role of historical environments dramatically increases in all over the world and in Armenia too. Humanity need some sort of return to their roots and identity, valuate their own history, culture and architecture, preserve and keep the important fragments of it and show in a good way to the world. From the urban, architectural and visual points of view the historical character of every city in the World, as well in the capital city of Armenia, in Yerevan provides two aspects: urban open spaces, without fences walls and covers, which are mostly open to the natural and climate skim influences, such as streets, squares, residential courtiers, act, and close areas, such as monumental or valuable buildings and structures. Nowadays unfortunately the architectural-planning structure that was created in the previous period has partly changed, due to development of the city life. In these circumstances the modifications are also visible in organizations of public open spaces, which planning have to deal intensively with the question of how much of open space network has to be public and publicly available to allow for a sustainable and community oriented urban development. This introduction will focus on an analyse of that two aspects separately at the same time concentrate on their relationship and the significant role each one in sustainable development of urban environment.

2. BACKGROUND

So the urban open space is that main understanding which is going to be talked about during whole analysing process in this article. For that kind of understanding in landscape and natural engineering there is not the exact term, it's called "fragment of the urban environment", "Urban areas", "City landscape", "Urban interior", "Urban ensemble", act.. Each of this terms defines the phenomenon from their point of view, but three of them are most popular: "open space", "Urban environment", "Urban interior", because this ones most precisely define the "environmental" essence of the object. (http://mason-portal.ru/landshaftnyy-dizayn/iskystvennie-kamni-v-landshaftnom-dizaine.html) Architectural open space we are feeling in the cities, streets, alleys and parks, stadiums and squares, where human creativity set borders in the "emptiness", so anything that visually limits the viewer, whether it is walls of buildings or rows of trees. All this things allow us to understand the essence of the concept "Urban open Space" or "Urban interior". The difference urban interior from usual one is the combination of elements that creates by the architect such us fragments of the landscape, horizon, street prospects, panorama, and act. It is clean that the main task of architect is to isolate, to limit the certain part of the space by the material forms. The city's "Urban open spaces" in general is created by buildings and structures and especially when we are talking about the historical cities, these terms automatically becomes into if not monumental buildings, the valuable ones for the appropriate city environment. With this as a background, the main research questions of the thesis are outlined.

3. METHODS

On the one hand the research is based on the comparison of nowadays "quality and quantity" of public open spaces and monumental buildings with historical situation and in the other hand it is based on the analyses of open spaces and monumental buildings: organizations, relationship, the level of their physical preservation, the modern modifications act, in a sample of historical core of capital city of Armenia, Yerevan-the administrative, cultural and industrial center of Armenia. The value of open spaces occurring in an urban situation has many aspects like their form, use or location.

The method is based on the analytic comparison of historical center of Yerevan city and especially the new constructed parts of it Northern Avenue, with the historical situation. Northern Avenue is a pedestrian avenue in Yerevan, Armenia, which opened in 2007. It is located in the central Kentron district and links the Abovyan Street with the Freedom Square on Tumanyan street. Detailed research of the appropriate part of the city start from urban organisation finished with a separate monumental and valuable buildings and structures will show that the "quality" of open spaces depends not only the literate solutions from the point of urban organization, but also valuate the importance of preservation historical character of it. Firstly, a sustainable use of the spaces for the current generation is required and secondly, the responsibility towards future generations must be taken into account.

At the same time were done two types of analyses: direct analyses, organized in the appropriate Avenue and closed areas, and indirect analyses, such as comparison of archive documentations and schemes, belonging different times. Due to direct analyses it is visible that the historic core of our city is totally new constructed by high rise multifunctional buildings, so not only the visual scale of the environment is changed, but also the historical and architectural character are completely disturbed. This factor couldn't leave the role of spatial perception of the open space. Therewith the appropriate schemes and documentations shows that in general the shape and usurface of open spaces are accrue in expense of historical buildings and structures.

4. CASE HISTORY

Historic cultural landscapes, towns and cities are threatened all over the world and also in Armenia. They suffer from thoughtless replacements and renewals. The growing population density leads to an increasing use of land. That implicates negative effects on the preservation of historic ensembles, settlements and inner-city historic areas including open spaces. Only interlocking settlement area and open space secures the future urban livelihood as any city needs "free space" kept free for future generations. (Долуханян Л. К (1980)

The history of Yerevan city dates back to the 8th century BC, but the term of "historical city" of the Yerevan coming not only from the long term development in historic, but also from the urban and artistic aspects, such us valuable monument, ensembles, municipal complexes, urban and natural landscape, cultural areas that has also archeological values, act. (Harutyunyan, V, Nalbandyan, G., Grigorian, A., 2005)

Cities change constantly. Historic city centers thereby experienced change of meaning. Coping loss of historic urban planning patterns, replacement of buildings or open spaces and new dimensioning of surrounding without

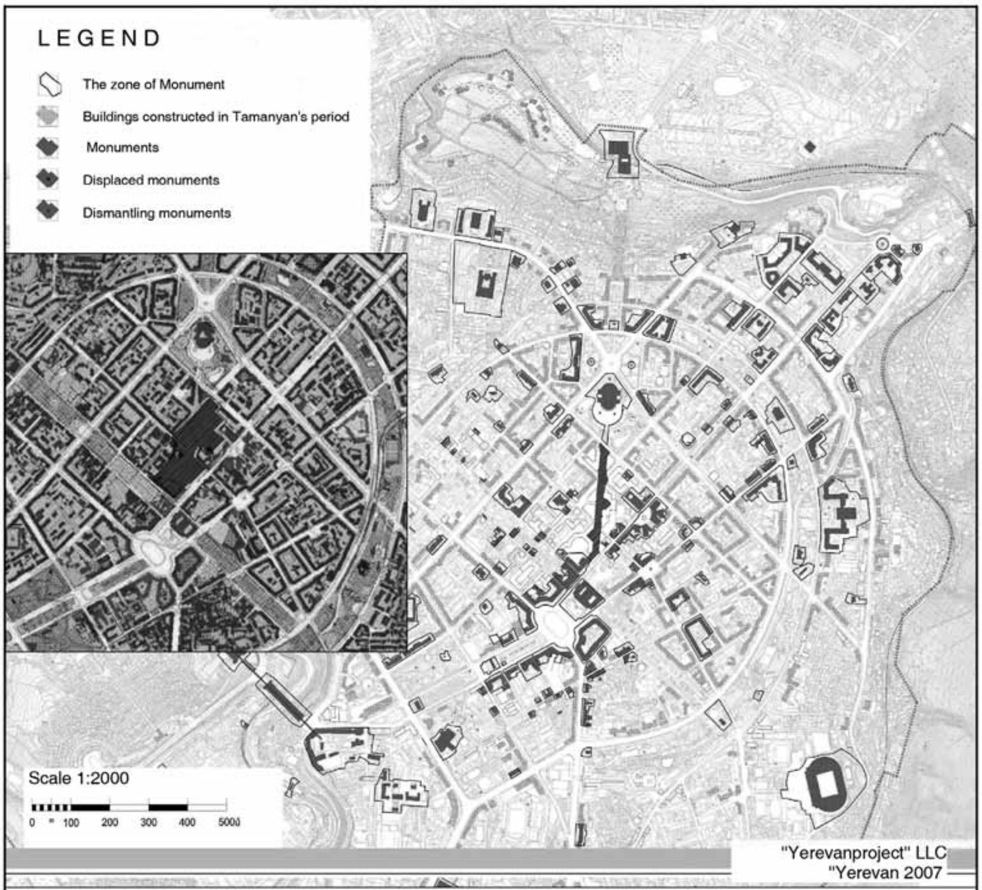
losing the urban identity is a challenge for urban planning. Process oriented and differentiated measures requiring comprehension of handling and use of traditional urban substance are needed. For many centuries adaptation of existing buildings and urban patterns to new needs of society and trade was an ongoing process that didn't affect urban substance seriously. This changed fundamentally within the past few decades. Historic elements like buildings, urban patterns or open spaces belong, like the ground, to resources that are nor duplicable and irretrievable. Cultural identity is a contribution to secure immaterial fundamentals of life according to human-environment interaction approach. (Alexander S.A.,(2008)
To keep urban heritage of Yerevan city alive an action strategy is needed. This strategy has to include a framework for joint action of all groups involved, including the local authorities. It also has to develop a strategy to preserve the urban context and sense of place while allowing a further development due to the legitimate expectations of the inhabitants.

5. RESULTS

As a result in the historical core of Yerevan city we have new constructed Northern Avenue, which architecture in the boundaries of this article is not going to be discussed. The point that is interesting is its influence from architectural and urban viewpoint. The literate organisation of urban open spaces in every city in the world and especially in historical ones, such as in Yerevan depends in a few aspects: valuation of appropriate environment, its preservation from physical and aesthetic sides, adaptation of nowadays requirements, and left a legacy to the next generation.
The length of the Avenue is 450m and a width of 27m. Located at downtown Yerevan, the avenue is mainly home to luxurious residential buildings, elite brand shops, commercial offices, coffee shops, hotels and restaurants. The financial situation of the government could not allow building such kind of luxury and modern Avenue, so the construction works of Northern Avenue were financed by the private sector. First the government of the country bought all the small properties, but the main part of financial attributes was financed by the private sector, so this factor couldn't leave the trail on its architectural and designing solutions. The citizens of Yerevan city and the tourists like to walk on Northern Avenue by admiring the new constructed buildings. So demolishing the monumental and valuable historical buildings and structures entails the total violates the historical environment in the core of Yerevan city. The scale and architectural character unfortunately are convent too.
To achieve sustainable planning and development it is necessary to bring the aspects of open space use and open space value together. In particular, informal uses and use strategies have to be considered and their effect on the overall planning aims studied. The study of open spaces has to include their spatial and temporal dynamics, also in relation to their interactions with the surrounding matrix. The preservation of historic open spaces, their surrounding and the historic center of the city must explicitly include a possible future development. This way the preservation of urban heritage can be a potential for urban development.
The analyze of historical center of Yerevan city and especially in new constructed parts of it shows that even the best conditions of public open spaces and public entertainment in the city core is not able to cover the architectural mistakes.

6. CONCLUSIONS

The analyses show that nowadays unfortunately the architectural-planning structure that was created in the previous period has partly changed, due to development of the city life. In these circumstances the modifications are also visible in organizations of public open spaces, which planning have to deal intensively with the question of how much of open space network has to be public and publicly available to allow for a sustainable and community oriented urban development. Urban renewal and revitalization as planning process has to deal with manifold interests and touches societal and environmental problems in consideration of historical development, and always being in charge with separate monumental buildings situated in that appropriate area.
For excluding this sort of "prevent" attitude towards the single from monument buildings up to the preservation of historical environment each of us must evaluate what the forbears inherit and recognize his own responsibility for



Scheme of Historic Architectural Heritage Deployment In Yerevan City

kipping, preserving and leaving a legacy to the next generation.

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ARCHITECTURE, TOO SLOW IN DEVELOPING?

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architecture education, architectural profession, architectural research

ABSTRACT

Changes global-wide have consequences on many levels. Does Architecture respond? Not really, she is inward focused, and shows a low innovative profile. And Education, she is, traditionally, focused on concept-design; thereby ignoring the im-portance of budgets, planning, management, and technical aspects. Its lacking in profound technical knowledge resulted in loosing authority in the building industry. A further isolation of the profession must being prevented. Marginalised in project teams, the architect does not have much authority to guard design since the technical partners do not feel responsible for human spatial quality. Regaining its influencing role can only by professionalism, improving knowledge, research and man-agement skills, and a paradigm shift, if only to counteract neoliberal violence. It is necessary that Architecture take a firm stand in the building industry as guard of spatial qualities. Finally, is Architecture not the holder of institutional knowledge?

1. INTRODUCTION

"Architecture[1] cannot being seen as Art alone in the future,
a switch aimed at evidence-applied design is needed
= Architecture & Engineering in one"

The leading thread is the — since the 60s of last century — continuously shrinking role and appreciation of the archi-tectural profession in society and building industry. There are many reasons why this happens. During decades, Architecture stayed inward focused – Design for Design. Education remained in the attitude of Being Artist. Education neglected the progress in complex building technology, and in theory. Education – later the profession — got far behind by lacking appropriate knowledge, professional skills, which resulted in drifting away from the building industry. A further deterioration was the taking over of project management by specialised project management consultants.

Architect's already subordinated role risks to be marginalised further. Especially after the 90's of last century, it re-mained silent in Architecture when sustainability, climate issues, etcetera demanded attention. Later big money caused a wrong 'order' (in Ethics) due to megalomaniac projects to set abundant capital reserve away.

To survive as profession, Education should start initiatives for new curriculum that trains future professionals in ap-plied-research, in multi-disciplinary partnerships, in acting with authority (by knowledge, and communication skills), and inno-vative and academic thinking. No more fairy-tales, just evidence based results. Moreover, a respectful profession reviews itself temporarily, engages in social and technical issues when these hit the profession. Objective is to contribute to a profound discussion on vision and mission of the architectural discipline.

2. BACKGROUND

"A doctor can bury his mistakes, but an architect can only advise his clients to plant vines."
Frank Lloyd Wright

Teaching at different universities, I wondered why architecture education was slowly in adapting new developments, and how difficult it was to implement new knowledge into curricula. Guardian English architecture critic Oliver Wainwright[2] wrote: 'Architectural education has been allowed to stagnate in the UK as a hermetic, inward-looking pursuit based on a three-part system that stems from a 1958 RIBA Conference'. Similar goes for other countries. Students design traditionally, rather than tackling contemporary issues. Their focus are extraordinary structures —

which will hardly be part of their practice — with explanations based on personal assumptions, not on evidence; not an academ-ic attitude. Wainwright: 'Criticising the impenetrable conceptualism and "fantasy realms" of many final year student projects, he suggested that the major university courses need to be "radically rethought"[3].'

A paradigm shift in the discipline is not popular. Is it fear of losing status, denying the necessity to stand for the es-sence of the discipline? Questionable is the position in the discussion of professional unions with their focus on practical is-sues: a stationary profession?

Time to regain Architecture's importance, because contractors, industry are not interested in spatial qualities despite that they engage architects as co-workers to produce necessary drawings themselves, if not designing. The same goes for spe-cialised companies in prefabricated houses and offices. We need independent architects to maintain "institutional knowledge" acting as guard of spatial human and social oriented living environment; not the Commerce.

3. METHODS

An empirical survey based on personal observations in practice and Education, by viewing recent history of the archi-tectural practice and Education in light of contemporary developments.

Articles, literature, old and recent, Internet discussions on different platforms, Wikipedia, experience in Education and Construction. It must be said, the topic is very broad, with limited literature.

This results in a 'picture' of the main problems where Architecture should respond to, to secure its future.

4. CASE HISTORY: THE LEADING THREAD

The Leading Thread in the bird's-eye view is the diminishing role of architects during the last decades. Originally, ar-chitects were leading in design and project management, then felt back in marginalised roles; and now, risking further marginal-ising?
Statement:

'The contribution to recent historical architectural development (last 100 years) was facilitated by industry developed technologies, by 3D-design programmes [easy creation of complex shapes], and the innovative and supportive structural engineers, rather than by the architectural discipline itself'

Architecture is seen as Art since Fine Arts integrated with Architecture (Bauhaus as exponent) at the beginning of the last century. Theo van Doesburg's "Rhythm of a Russian Dance" (1918)[4] inspired for instance Mies van de Rohe for his design of a country house near Berlin (1923). Today, the relation between Fine Arts and Architecture is not clearly visible. Still, archi-tects see design as Art, rather than as object of social concern.

Building-Physics made its appearance in the 1960s; it became very influential by its insights — improving building en-gineering to a great extent, also in sustainable and energy development. Despite this, Building Physics is still not an essential part of design education.

Building Technology knowledge developed increasingly; Architecture lagged behind. To coordinate all disciplines in project teams, a leading architect must possess communication skills and basic knowledge of the other disciplines, which he had not. Construction became complex, so that a project leader had to meet new skills, in which the architect was not trained. Con-sequently, the leadership was taken over by specialised project management offices.

Increasing diversity in unique building parts and systems — standardisation requirements, prefab building technology, new structural bearing systems and complex building equipment — have to be implemented in design. This demands efficient communication; in particular, to ensure that all project partners move in the same direction, despite all different individual inter-ests. Nothing changed till today given many failures in construction[5]. Architects and project partners diverted due to misunder-standings, poor communication, and failures in design, details, and exceeding budgets compulsive Design.

New technology originates new experts. According the French Dominique Raynaud[6], '…the erosion of the architectural profession is due to the growth in number of project team members, bringing the architect in minority, marginalising his influ-ence facing predominant interests of others'. He signalised a profession in crisis[7].

The moral mission of Architecture degraded by the power of market, capital, and egocentric politicians since the 90s of last century where social responsibility became secondary, comparable to the 1970s when Jane Jacobs questioned it to Modern-ism. Nowadays, star-architects compete in megalomaniac buildings with miraculous explanations. Partly because of this, young architects get a poor notion of professional moral ethics. Novelties in technology offer architects the opportunity to be the first, which ends in hopeless hypes, too. Carl Weeber put it together 'The unique is through repetition worthless, also in Architecture'[8].

Professional academic level is shown by clear analytical descriptions of projects, not these in popular magazines, nor by architects. These explanations are often an inextricable tangle of baseless assumptions. In Allison Arief's article — 'Why Don't We Read About Architecture?' — she reflects: 'because…far too often the experience of reading architectural writing feels about as pleasurable as tooth extraction'[9]. It is clear, critical discussions in magazines are rare. Where is the needed professional critic who discusses critically Architecture, instead of describing buildings?

Who is the real designer? A provocative question since complex shapes are easily to develop with help of 3D-design programs, a fascinating tool, and still, the structural engineer is needed. Anyway, what is the essential influence of the engineer in the end, and not to forget that of the building physicist? The latter defines increasingly facade qualities, the shape by stream-lining the wind, and by sun-orientation. Will this marginalises the profession further, or is an equal levelled collaboration the new challenge?

5. RESULTS

The profession pretends to be forerunner, which is doubtful; industry and science develop new technology, after which architects try to implement this in their projects. Meanwhile the question arises, who must have the upper hand in the design process, and on the realisation; the contractor, the investor, the engineer, or yet the architect?

Technical knowledge in Education is subordinate to design, going on the expense of competitive competence of archi-tects in practice, not only of the detail quality, but indirectly also of spatial quality of buildings and public spaces. Loosing quality control by being divorced[10] from production and construction makes the situation even worse – continuous poor com-munication and failures. In some cases, the architect only sees what is left of design quality after the execution has ended.

Being depended in large extent on engineers, the relation between architect and engineers is far from equal. Still, they are 'sentenced' to one another, why not accepting this? If both have basic knowledge of each other discipline, first then, they can act complementarily in the design process. Open communication and understanding are in all aspects very important.

Communication is one of the main problems in building industry. Many studies have been made on the subject, but not in respect to Architecture. Architects work from their view, which not always matches with the client's, contractor's demands and needs[11]. It is difficult to have a mutual understanding, thinking from own interests. Going beyond borders is sometimes too much, empathising with other parties difficult: 'designers and constructors do not mutually experience how their choices affect the use and maintenance'[12] .

Archipreneurship is a new development in 'young' Architecture; it may contribute to a paradigm shift. It's not really new, clever architects already initiated projects in the past, often to survive[13]. Apparently, young architects are seizing the same opportunities, seeing the challenges of 3D-printing of parts or entire buildings. Interesting aspect is, that they collaborate with other disciplines, acting as architect-contractor, architect-innovator; the competitors of the contractors of the future? Indeed, they will pave the path for changes in the Architecture Education, if the latter picks it up.

Vanishing of status (architect's too) is due to democracy writes Tocqueville[14]. Clients are self-conscious, and know what they want. Groups of individuals set up associations to develop projects themselves with the architect as advisor. Being equal with others is a raw deal for many architects. List below give an impression of the main contemporary trends (in the Neth-erlands) that affect the architectural profession not in a positive way:

• Projects increasingly awarded to large engineering firms, often turn-key, or to stardom offices
• More projects tendered as architecture assignment for contractors, developers as an integrated contract

- Less stand-alone design assignments for architects
- Through integrated contracts, the distinction between architectural (by author) design and execution of construction contracts blurs
- New specialisations within the architectural discipline due certifications; new responsibilities, new skills
- Growing popularity of combined formations, and private ones; the architect is not leading
- Increasing importance of Building Information Modelling (BIM), a virtual technology and method in the construction indus-try: expensive for architects.

6. CONCLUSIONS / RECOMMENDATIONS

Quality development starts with Education. Accent on academic analytical thinking, research and problem approach does not mean less design quality. Discussions on the profession, ethics, and actual issues must be part of the curriculum. Ar-chitecture goes further than buildings, and innovation goes further than sustainability, energy matters and romantic Architectural ideas. Success in architecture depends on skills and characteristics not typically emphasised today in university curricula or on-the-job training[15].

Architectural design should be the result of deliberations and revisions by developing concepts within necessary multi-disciplinary operating design teams. This stimulates broadening of knowledge, insights, and understanding of the team partners. Dr. Ir. Wouter Reh emphasises that ‘design thinking must remain central to the teaching and research at the Faculty, and this re-quires new scientific attention’[16] (Bold by author), which I underline.

Inclusive Design Management could be the solution for Architecture’s social and technical importance. If the architect’s knowledge, experience and desire to both design and management of the design process are appropriate, is nothing wrong with a separate design manager[17].

Research skills will enhance professional qualifications of architects. Issues as growing cities, shortness of agricultural areas and other environmental and energy issues require multi-disciplinary design teams that apply evidence-based research outcomes. Urban planning, architectural design, landscape design and geological and building physics experts must collaborate to come to integrated solutions. Surrounded by engineers, the well-skilled architect, together with the urban planner, can con-tribute in research because of their basic input in developing human oriented built environments.

The profession should take stand. Emeritus professor Carl Weeber stated that the ‘Faculty of Architecture’ of the Tech-nical University of Delft, Netherlands, should change its name into ‘Faculty of Building Engineering’ whilst Architecture could return to the ‘Academy of Architecture’[18] . Not a realistic approach, because it means a further division in understanding be-tween Architecture and building industry. An Academy is not a research institute; it brings us back to the discussion on ‘Art or Design’. In ‘The Architectural Profession: Nexus of Definition’[19] Michael Karassowitsch stated: “it was appointed that … the practice of Architecture is becoming more problematic, especially difficult to studying it when assessed in term of its cultural context where a very broad set of factors lack grounding”. Did we forget Vitruvius’s writings, where good architecture is defined as a ‘careful synthesis of form, function and technology’? Architecture, Urban Planning, Structural Engineering, Landscape Architecture disciplines should work in one building, for narrow communication.

If not Education, professional unions should establish a unity like CIAM through creating public platforms to discuss essential issues of the architectural profession for better public relations, and to demolish the negative image through focussing on Ethics rather than on professional rules. Self-reviewing is essential for timely adjustments when changes affect the profes-sion. Hossein Sadri[20] quoted in ‘Ethics in Architecture’: ‘… documents on ethics in Architecture were more focussed on im-proving the profession’s image and protection of its market share, rather than on questioning the limits of the profession’.

The title ‘Architect’ must be legally protected. IT-industry and other disciplines claim the title for developers of chips, computer programmes and such. Searching for literature, many IT-sites popped up, frustration and upmost irritating. It is a re-pudiation of the historical meaning of a respectful profession. Is the profession outlawed, not being taken seriously? What to think of “The Rising Importance of the Enterprise Architect” and “Service-oriented architecture (SOA, in Dutch an awful ill-ness)”[21]? First thought, what an interesting development in Architecture? It turned out that it was a website of an IT-developing and management firm ‘Enterprise Architect’.

"We must teach our student that they can be architects of the future, rather than its victims"
Buckminster Fuller, Architect and Philosopher; July 12, 1895 – July 1, 1983

Education as the breeding ground for new developments and dynamic, inspiring and challenging educational environment:

INCLUSIVE TOTAL-DESIGN; EDUCATION, WHERE ARE WE WAITING FOR?

NOTES

[1]ARCHITECTURE From dictionary.com: The profession of designing buildings, open areas, communities, and other artificial constructions and environ-ments, usually with some regard to aesthetic effect. Architecture often includes design or selection of furnishings and decorations, supervision of construc-tion work, and the examina-tion, restoration, or remodelling of existing buildings. (Remark: Today, the notion Architecture is being misused by IT-disciplines, something that has nothing to do with 'Building' and 'Craft', the origin of 'Architecture')

[2] http://www.dezeen.com/2013/06/03/guardian-architect...

[3] Guardian architecture critic Oliver Wainwright; http://www.dezeen.com/2013/06/03/guardian-architect…

[4] Aleksander Serafin: "Architecture towards the abstract art of the 20th Century"; Architects, 2014, 1(37); page 24

[5] http://home.kpn.nl/roosm139/Bouwschadepublikatie.htm

[6] Dominique Raynaud: 'La Profession d'Architecte a l'epreuve de l'egaitarisme contemporain'; The Tocqueville Review 29-2 (2008) 127-150; pag. 3

[7] Dominique Raynaud: 'La Profession d'Architecte a l'epreuve de l'egaitarisme contemporain'; The Tocqueville Review 29-2 (2008) 127-150; pag. 3

[8] Farewell speech of prof. Carl Weeber, Friday, June 13, 2003, Technical University of Delft, Netherlands

[9] https://urbantimes.co/2012/03/architectural-criticism/

[10] M.E.L. Hoezen and others; "The Problem of Communication in Construction"; sub-chapter 2; page 2

[11] M.E.L. Hoezen and others; "The Problem of Communication in Construction";

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[14] Dominique Raynaud: 'La Profession d'Architecte a l'epreuve de l'egaitarisme contemporain'; The Tocqueville Review 29-2 (2008) 127-150; pag. 1

[15] Role architect (bredemeyer.com)

[16] Farewell speech of prof. dr. ir. Wouter Reh, Friday, June 13, 2003, Technical University of Delft, Netherlands

[17] Ontwerpmanagement; Dr. ir. M. Prins, Dr. J. L.. Heintz, Ir. J. Vercouteren

[18] Architectural debate: "Delta Darlings", June 13, 2003; Aula of the Technical University, Delft, Netherlands; quote of emeritus prof. Carel Weeber, archi-tect

[19] The architectural profession: nexus of definition' abstract for a scientific study; Michael Karassowitsch, M.S. Arch, academy of fine arts Vienna, Austria

[20] Hossein Sadri / professional ethics in architecture and responsibilities of architects towards humanity', pag 89

[21] From: The Rising Importance of the Enterprise Architect | CIO.webarchive

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PORTUGUESE WOMEN ARCHITECTS CREATING THE FUTURE PAST

POSTER

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Keywords

Architecture, Women urban designers, Portugal.

ABSTRACT

Due to the growing concern over the topic of sustainability, architecture should assume a special responsibility conciliating landscape, history and heritage.
While progress is required by several fields, the connection to the past guarantees a link to the roots of memory as well as the role of the individual as an agent of transformation, showing alternative perspectives, authors and solutions.
This article analyses the experience of three Portuguese female architects, compared with foreign cases, who have demonstrated advanced concerns ahead of their time, contributing to a modern but sustainable development of non-European territories.
By focusing on current issues such as sustainable city planning or energy efficiency of buildings they improved the relation not only between the individuals and the territory, but also between modernization and sustainability, becoming important references in creating a better future for the territories and architectural production.

1. INTRODUCTION

The importance of architecture in landscape construction and its social responsibility is often undervalued. But today we live in a period of strong reflection and sharp criticism that does not allow frivolous solutions without considering the consequences that it leaves on the heritage of the past and its future translation. Topics such as sustainability and efficiency are now a form of culture that we all value or, at least, we refer to them with political correctness.
If in everyday life the natural, the identity and the balance is promoted, also some disciplines start to reflect these exact concerns. Architecture, in close relation with society and its needs, now takes on a different character. In this sense, consideration of the functionalist achievements of the Modern Movement, but mostly the consideration of the “other” and the “complementary” that Postmodernism has raised, we can look at the twentieth century as an essential period of the major construction technology advances, as well as a learning opportunity of its possible negative effects, revealing the need of re-identification and reconciliation with the individual and territories.
This rediscovery of new meanings that explore the past and the alternative themes, reveals the analyses of the complementary territories and authors, out of the mainstream discourse, approaching the experience of women architects as unexplored agents, and focusing their activities on non-European territories.
Women, undervalued historically, especially in male areas such as architecture, are gradually having their place in the discipline and profession, today they are constituted agents with an undeniable presence. In the transition period between the Modern Movement and Postmodernism women worked in alternative areas, with opportunity to design and build with bigger autonomy, and to explore new solutions that reconciled technical knowledge, learned at architecture schools, and unique issues connected with the territories where they were working.
Even considering that Portuguese architects had particular characteristics, since they were professionals who moved to Portuguese colonized countries, the truth is that we can find similarities with the cases of foreign architects who worked in alternative territories during the same period.
Through some recent studies, the paths of some architects have been removed from the shadow, demonstrating current concerns in recognition and valorization of the local culture and their integration into functional and modern architectural models[1]. These similarities show a larger potential integration between discipline and society,

heritage and contemporaneity as well as landscape and construction.

2. BACKGROUND

The criticism of contemporary Architecture experiences an oscillating ground in uncertainty between disciplinary morphologies and free discourse. The second half of the twentieth century experienced radical changes, creating a new reality that surpassed the individual capacity of adaptation. Today the world is totally immersed in a technological vertigo determined by an uncontrolled dynamism.
In this context, in opposition to History which tends to introduce successive models that evolve gradually and uniformly, the line of interpretation of several contemporary architectural production events presents several branches and winding.
Today this differentiation constitutes the impasse on which the Criticism itself is established, between eclectic languages, intrinsic to the speech of its professionals; and ordinary languages of general understanding.
In a reflection of what happened in the transition from Modern Movement to Postmodernism, the society tries to reformulate values such as identity and individuality in a way that they protest against models of acetic speeches, of a pure academicism, which are often seen as a form of ostentation.
The openness to new experiences, new territories and new languages led to the emergence of new approaches, to the "otherness" or, at least, less visible, marking a new culture, outsider, but which today is an important reference when we continue to search methods of adaption between nature and technology, between the environment and construction.
The models of the second half of the twentieth century demonstrate an impressive contemporaneity, with architectural studies and urbanization showing the balanced work modes, according to local cultures, valuing the best of each territory and contributing to the sustainable development of it.

3. METHODS

The Modern Movement promoted an eclectic image that would become progressively contaminated until we reach the Postmodernism. If we analyze the Domino system promoted by Le Corbusier during the 1920's and look at the Chandigardh architecture of the 1950's, the transformations of forms and volumes are evident. The women architects analysed in this article, working during this final period of the Modern Movement, demonstrate the same contamination, creating an approach between local needs and cultures with the technical and constructive modern aesthetics.
Through the review of built and unbuilt projects, as well as project reports, the communication between architecture and urban planning with the contradictory primitive and erudite culture is evident. The activity of Portuguese female architects in non-European territories, by taking into account different training opportunities and experiences, reflects a close relation, in comparison with other international project cases, with the climatic conditions and the social-economic unbalance concerns as well as the sociological approch to the native people.

4. CASE HISTORY

The study of Portuguese female architects is particularly relevant because of the socio-political context of the country that until 1974 had retained its colonial power over countries like Angola, Mozambique, Cape Verde and Macao. So, it was possible for these women to work in these areas as citizens and not as immigrants.
Architects as Antonieta Jacinto, Natalia Gomes and Maria Emilia Caria, who worked in Angola, Macao and Cape Verde, respectively, represent singular case studies, relevant due to their activities in alternative territories, in connection with local identities, but never forgetting their professional responsibility and creative capacity.
These three Portuguese architects graduated in Lisbon, being integrated with the public services, like the Ministry of Ultramarine Territories and the Public Constructions Servives. This was a particularly unusual condition considering the paternalistic ideology of the Portuguese dictatorship regime, where the entry into a professional career was not considered for the female gender.
Antonieta Jacinto, who was born in Angola, returned there after her graduation in 1957 to work in the Public Constructions Services. In early age she revealed a particular awareness for environmental questions related to architecture, by preparing the final project for the Architecture course the program of a "school center in a tropical country"[2] , whose references were based on her personal experience in her country of origin, but also by the study of the new French and English landscape design theories. Her activity in Angola was based largely on the analysis of territories, creation and development of urban planning design.

The activity of Natália Gomes is an example of the invisibility that women architects experimented in the architectural discourse. Focusing her work in Macao, in collaboration with her husband, the architect Manuel Vicente, their importance in the architectural panorama is evident by the *"analogy: Macao is to Postmodernism in Portugal and Las Vegas to the international Postmodernism"* (Figueira, J. 2009), showing thus their "Venturian" matrix.
Maria Emilia Caria, graduated in the late 1950's, became architect at the Ministry of Ultramarine Territories, coordinating several urban plans, mainly in Cape Verde, where she *"showed the prospective vision on urban dynamics, with special emphasis on the touristic development potential and the new expansion areas in the city"* (Portela, 2013). Her *"social concern for the most isolated populations and economic needs in order to integrate them into urban life"* is also relevant (Portela, 2013).
Her activity has connections with the case of Jane Drew, born in England, that became known for her studies on balanced and sustainable urban planning. On the other hand, Antonieta Jacinto's experience can be compared with Lina Bo Bardi's, who was born in Italy, but worked mainly in Brazil.

5. RESULTS

From 1950's popular architecture and in particular the cultures of indigenous and African peoples are becoming relevant case studies in the search for a richness of an alive experience. The cases analysed are examples of architects who through their activity in different territories developed a way to interpret the boundaries between the ordinary and the eclectic or between a simply functional base and a conceptual pretension of a formalism based on disciplinary History and Theory.
The particular characteristics of Brazilian culture, a country closely connected with Portugal, produced an important influence on the Lina Bo Bardi's activity. Her architecture has shown a close relation with tradition, in an unbroken continuity between past and future. This "alive past" is reflected by a vital link with reality, being possible to interpret four concepts of her work: *"compression and fusion, narrative and survival, revolution and subversion and overcoming boundaries between elements traditionally seen as antagonic"*(Oliveira, O. 2006, p. 34).
By looking at other case, the development of population settlement politics in Angola, intensified during the 1950s, that lead to an increase of settlements, assuming a more urban and ordered structure. Architects like Antonieta Jacinto were part of this general operation, they were visiting the various territories and developing projects from the small-scale of minimum housing to the urban planning scale, as for example the Fisherman's Village in Cacuaco (near Luanda) or the Henrique de Carvalho College[3].
The African experience of Antonieta Jacinto, as the Brazilian experience of Lina Bo Bardi would be marked by a close influence of the local culture, in an appreciation movement of popular art, however different of the *"romantic ideal of Ruskin and Morris (...) but giving way to improvisation, simple, cheap and local solutions"* (Oliveira, 2006, p.17).
Analysing Denise Scott Brown's activity, her passage through the Architectural Association in London, from 1952 to 1955, would permit her contact with Smithsons. Stanislaus von Moos has stated: *"Vulgarity as a positive concept had been introduced into the discussion in Britain by Smithsons. (...) the call for a deliberately ugly and vulgar architecture that Venturis would make later"* (Figueira, 2009, p. 119-120). This connection to the real, the ordinary and popular marks a relevant presence in the architecture of the Portuguese architects Manuel Vicente and his wife Maria Natália Gomes. She accompanied him on his incursions to Macau, where he developed his well-known activity, as well as in the mythical experience in the Louis Kahn's atelier[4].
These two couples have similar paths and attitudes in the sense that Denise Scott Brown and Robert Venturi drove to Las Vegas and Natalia Gomes and Manuel Vicente to Macao, referring: *"work in the ordinary, the rude, the vulgar, the current, banal, and yet there, go in and say, like the creature that I appreciate a lot, Denise Scott Brown: it is almost alright"* (Figueira, 2009, p. 236).
For the multiplicity of models and languages used in their architecture, the importance of their intermittence in territories under Portuguese administration becomes undeniable (Goa, Macao and Lisbon), also the experience in Pennsylvania with Louis Khan, constituting an important reference *"in which architecture seeks a transcendence, a monumentality and a state of absolute, and on the other hand works with the banality, build itself with symbols transforming them to his own use and benefit"* (Picassinos, 2012).
Similarly, the experience of Robert Venturi and Denise Scott Brown in Las Vegas, widely known by the *"anti heroic" attitude is connectable with the urban planning activity of Portuguese architects in Macao, considered as "discipline with an intervention capacity, with rules, integrating architecture in construction, working with what exists in constructive terms, with an idea of a territorial scale but also a certain brutalism of nature"* (Picassinos, 2012).
Finally, Maria Emilia Caria stands out for her activity in the Ministry of Overseas Territories, being divergent

from the case of Antonieta Jacinto and Natalia Gomes since her activity was not developed in the shadow of a male figure. Her urban planning studies, related to the renewal and expansion of cities in Guinea-Bissau and Cape Verde, have shown interesting features of influence on *"an organic urbanism"* (Portela, 2013, p.136). The concern about the balance between social classes is evident, and "*reading the reports and descriptive memories from the architectural plans, emerges a social concern about the most isolated populations and with economic needs, in order to integrate them in urban life"* (Portela, 2013, p.136). Her plans for Praia, Mindelo and Baía das Gatas constituted the most significant projects focusing on *"reorganization, restructuring, refurbishment and reuse. Conditioned as an economically weak, disorganized and socially polarized territory, Maria Emilia Caria was, at the early beginning, diverse from the "African Generation" who saw in the colonies a blank sheet of paper"*(Portela, 2013, p. 129).

It is interesting to compare this case with the action of Jane Drew, in collaboration with her husband Maxwell Fry and Jeanneret in India, where questions as: *"the often contradictory demands of Chandigarh's 'six climates', [and] confusing social norms"* (Joshi, 1999, p. 44) implicated a singular attitude. In fact, their relevant "experience of developing appropriate designs and technologies for tropical conditions in West Africa (Joshi, 1999, p.28) would be particularly relevant in this place. We must also consider the *"sociological methods of research that Drew had developed (...) to align their architectural ideas with what were perceived to be the local and traditional customs* "(AYRE, February 6, 2014).

At the end, all of them, working in fragile territories, with particular demands and conditions, answered with adapted and equilibrated forms of construction, materials and techniques. Through simple systems they created modern architectural models, applying a special sensibility to the people's needs, culture and desires.

6. CONCLUSIONS

Although the analysis has been conducted using paired comparison model, between Portuguese and international cases, we find that the similarities are cross-cutting between different cases presented. These similarities are established mainly through the humanistic sense of balance between opposites as high culture and popular culture. In different corners of the planet, different architects explored the *"relationship between architecture and the place, as well as the reconciliation between modern architecture and tradition"* (Oliveira, O. 2006, p. 108). In the analysed cases we find an integrated anthropological and sociological concern about the developed plans, an approach between architecture and heritage, demonstrating the application of functionalist concepts of modern architecture, creating a special responsibility with common concerns like the *"climatic conditions, ecology and the traditions well as people's needs* "(Ayre, B. February 6, 2014).

Currently, in a period when the revision of values and concerns related to sustainability and production equilibrium are presented as essential paradigms, the revision of history, criticism and discourse presents itself as something both necessary and desirable.

We conclude that these architects, visionaries for their time, brought the questions, models and solutions to the architectural debate, that still remain extraordinary contemporary references, the kind of attitude that should be adopted for the balance between development, technology and construction. We also highlight the feminine presence as an important contribution to the preservation of ancestral values such as sustainability, heritage and identity, this recognition today is making the firsts steps towards an equal position in the architectural discourse.


Maria Emília Caria
Cape Verde
Jane Drew
India
Denise Scott Brown
USA
Macao
Maria Natália Gomes
Brazil
Angola
Lina Bo Bardi
Antonieta Jacinto

NOTES

[1]"The valorisation to a real approach has established itself as a way to articulate the culture and traditions of the country with the challenges posed by modernity. To frame this approach to real, architects and urban planners took refuge on an interpretation of the vernacular to support a regionalism which, however, did not tried to reject the foundations laid by modernity". See (Agarez; Mota, 29/10/2012)

[2] At the end of the disciplinary part of the architectural course each student had to choose a theme to develop a complete project, which was called CODA (Concurso Obtenção Diploma de Arquitecto)

[3] In these projects there were used climate systems as permanent natural cross ventilation, orienting the building in relation to prevailing wind direction. Some window elements when opened are used to create shadow and thus proctect the walls from heating.

[4] Manuel Vicente became master in Architecture from the University of Pennsylvania in Louis Kahn class (1969). Maria Natália Gomes accompanied him and, between other activities, she had the opportunity to collaborate at Kahn's office, in the Congress Centre of Venice, particularly.

[5] See the book: Fernandes, José Manuel (2002). Geração Africana. Arquitectura e cidades em Angola e Moçambique, 1925-1975, Lisboa: Ed. Livros Horizonte.

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IIMPROVEMENT OF ATTRACTIVENESS OF THE LIVING ENVIRONMENT AT RUSSIAN PRIORITY DEVELOPMENT TERRITORIES

POSTER

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Keywords

living environment, priority development territories, infrastructure

ABSTRACT

Problems related to assessment of the attractiveness of the living environment were analyzed in the article. Research of the comfort and safety level of Russian cities was conducted. It was based on ratings of attractiveness of the living environment.
The following components of a comfortable and safe living environment were analyzed in the article: residential, social, engineering and transport infrastructures.
Attractiveness ratings of the urban living environment were used to justify the directions for the development of comfort and safety of populated localities.
The need to assess the attractiveness of the living environment on the basis of the social, residential, transport and engineering infrastructures within special-purpose programmes for the priority development territories (PDTs) was justified.

1. INTRODUCTION

Creation of priority development territories at the Far Eastern Federal District based on the world best practices is one of the top-priority target programmes of Russia (1). Development of the stupendous potential of this region much depends on the following matters: the extent to which living at this region of the country will be attractive to a man and the level of comfort and safety that it will be possible to provide (2-3).
Historically, big cities represent territories attractive to a man. Cities accumulate such social benefits as educational opportunities, multiple activities, and development conditions. A specific living environment is also created in cities.
First Russian priority development territories are “tied” to the largest cities of the Far East: “Khabarovsk” – with its industrial and food specialization, transport and logistics, “Nadezhdinskaya” - associated with the development of Vladivostok transport hub and “Komsomolsk” - aimed at the development of the industrial cluster. These cities are “islands” of the economic activity of the Far East. They can attract anchor investors and have well-developed infrastructures: residential, social, transport and engineering.
It is obvious that it is very important to improve the quality of the urban environment for the successful implementation of such an ambitious task as the creation of priority development territories at the Far East. According to the law on PDTs, the infrastructure of a territory of priority social and economic development is a set of land plots, buildings or structures on them, facilities of energy, communal, engineering, transport, social, innovation and other infrastructures located at the territory of priority social and economic development as well as beyond it but also ensuring functioning of the territory of priority social and economic development.
The problem related to the development and implementation of managerial decisions to ensure a normal human life at immense developing territories and elaboration of strategies for their development has come to the fore.

2. BACKGROUND

Growth poles at the territory of the Russian Federation from the point of view of conditions favorable to living, business dealing, and real estate investment were defined. The legal basis for their development was created, solid investment was provided for. The need to switch from intuitive decisions taken by even very talented managers to rational decisions based on calculations has been increasing.

Creation of favorable living conditions and a comfortable environment in cities is one of the most acute problems of modern urban development. It gives an impetus to develop methods of assessment of the comfort of living in the urban environment and it results in increasing the reasonableness of making and implementing decisions.
The following issues related to urban planning and development need to be solved:
carrying out of an objective integrated assessment of cities according to the criteria determining the level of development of all spheres of life;
leveling of all disparities in the territorial structure of cities by a number of social and economic factors;
organization of an integral system to analyze socio-economic indices of cities, compare them and carry out analytical studies aimed at identification of socio-economic development trends.

3. METHODS

The research suggests that it is possible to assess the comfort of living by different methods using various techniques. At the same time the common thing in all these methods is the difficulty of integrating data on the state of various components of the comfort of living in a single index.
The methodology of assessment of the quality of the urban living environment (hereinafter - the Methodology) developed by the Russian Union of Engineers is especially interesting (4). It was developed for the purposes of creating effective solutions in the area of urban planning and housing policy. The urban living environment (habitat) primarily consists of the results of engineering - roads, bridges, lighting, houses, yards, parking lots, subway, public use buildings (sport facilities, cinemas, hospitals) as well as utilities (heating, sewerage, gas, electricity, etc.). All these are created by engineers. That is why the responsibilities to assess the state of Russian cities, arrange them in priority order based on major living factors, draw conclusions and provide recommendations for the future are borne by engineers (5).
Use of a consistent set of indices (indicators) describing various spheres of the urban environment is the basis for the Methodology. Calculation of the indicators taken as the basis for the rating is carried out using a number of statistical and mathematical methods.
41 indicators are used to assess the quality of the urban living environment. These indicators are combined into blocks by their directions and form 13 indices on which the General Index of City Attractiveness (GICA) is based (6).
The indices reflecting the main directions in the assessment of the quality of the urban living environment are as follows: wide use of indicators characterizing the level of infrastructure development; population dynamics; transportation infrastructure; environmental conditions; housing access; housing sector development; demographic characteristics of the population; innovative activities; engineering infrastructure; human resources; social infrastructure; social parameters of the society; well-being; urban economics.
Such grading and availability of statistical data generated on the basis of the Methodology make it an effective instrument for the development of managerial decisions related to the development of territories.

4. CASE HISTORY

The research objective is implemented by means of consistent implementation of statistical analysis phases using the method of analytical grouping.
The following characteristics were selected at the first phase: housing sector development index, engineering and transport infrastructure development index. These are characteristics of the complex development of the territory.
The following task was set: to determine the dependence of the housing sector development index on the following two factors – development of the transport infrastructure and development of the engineering infrastructure of the territory that predetermine its comfort level for people.
The indices of housing sector development and engineering and transport infrastructure development set forth in the “General rating of attractiveness of urban living (habitat) based on the results of the activity of cities for 2012” were used as the data for the analysis. The rating is included into the second issue of the journal published by Russian Public Organization “Russian Union of Engineers”. A ranked list of cities located near Moscow was elaborated using the housing sector development index as a factor characteristic at the second phase of the research (7).
Based on the data included into the ranked list the following limits of three groups (intervals) were determined - lower, middle and higher. They are used to build a typological grouping of cities of the Far East by the index of housing sector development (8).
It is required to group units by a factor characteristic (in this case the index of transport infrastructure development and the index of engineering infrastructure development) at the third phase for the purposes of examination of the

relationship between the selected characteristics, calculate the mean value of the resultant characteristic for each group (housing sector development index) which variation from group to group under the influence of a grouping characteristic indicates the presence or absence of the relationship.

Group	Interval	n	Groups by the housing sector development index (line 1)		Groups by the transport infrastructure development (line 2)		Groups by the engineering infrastructure development index (line 3)	
			∑	mean	∑	mean	∑	mean
1	higher	112	34.67	0.31	50.82	0.45	47.28	0.42
2	middle	48	20.18	0.42	24.62	0.51	21.56	0.45
3	lower	5	3.25	0.65	3.57	0.71	3.02	0,60
		165	58.1		79.01		71.86	

Table 1 Typological grouping of Russian cities with a population exceeding 100,000 by the housing sector development index, transport infrastructure development index and engineering infrastructure development index

Group	Interval	n	Groups by the housing sector development index (line 1)		Groups by the transport infrastructure development (line 2)		Groups by the engineering infrastructure development index (line 3)	
			∑	mean	∑	mean	∑	mean
1	Up to 0.29	1	0.27	0.27	0.23	0.23	0,49	0.49
2	0.29-0.32	1	0.29	0.29	0.49	0.49	0,48	0.48
3	0.32-0.34	2	0.65	0.33	1.02	0.51	0,73	0.37
4	Over 0.34	6	2.09	0.35	2.61	0.44	2,24	0.37

Table 2 Typological grouping of cities of the Far Eastern Federal District of Russia with a population exceeding 100,000 by the housing sector development index, transport infrastructure development index and engineering infrastructure development index.

75. RESULTS

There are 10 (ten) inhabited localities with a population exceeding 100,000 at the Far Eastern Federal District: Khabarovsk – 607,216, Vladivostok – 603,244, Yakutsk – 299,169, Komsomolsk-on-Amur – 253,033, Blagoveshchensk – 222,192, Yuzhno-Sakhalinsk – 192,734, Petropavlovsk-Kamchatsky – 182,711, Ussuriysk – 166,819, Nakhodka – 156,422, Artem – 102,405.

Almost all abovementioned cities are within the interval corresponding to the higher limit of the typological grouping (except Vladivostok). It may be related to slower housing construction.

The analysis of interdependencies detected on the basis of the typological groupings shows that:

• development of the housing sector in Russia as a whole is accompanied by a corresponding development of the engineering infrastructure. The rate of the transport infrastructure development is lower than the rate of the housing sector development;

• priority development of the transport infrastructure and a much more lower rate of engineering infrastructure development is typical of Far Eastern cities;

• development of the engineering and transport infrastructure balanced with the growth of the housing sector is important for the creation of comfortable living conditions for a man.

6. CONCLUSIONS

An in-depth analysis of the comfort conditions in cities and overcoming of the existing imbalance in the development of the infrastructures are required for the development of urban planning solutions at the priority development territories.

6.2 billion rubles was appropriated for infrastructure development of the first priority development territories. Selection of effective solutions to ensure all components of a comfortable infrastructure should be based on a sustainable calculation based on the above mentioned factors.

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FORMATION OF A "GREEN FRAME" OF THE CITY AS A FACTOR OF SUSTAINABLE DEVELOPMENT

POSTER

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Keywords

ecological reconstruction, integration, green frame

ABSTRACT

The study analyzes the matching of master plans for development of Russian cities of the European North on the example city of Ukhta to the main provisions of the current international ideology "Sustainable Development". Ecological analysis was conducted on the following aspects: reserves of territorial development, reconstruction and new construction, the integration of urban areas, green frame the city, of traffic and pedestrian paths, open spaces and urban living environment. For the first time the northern city of Russia was proposed a systematic approach to the prospects of its development, with an emphasis on the factors of sustainable development. The basis for the development of the Concept of sustainable development of the city was its communication structure that converts to independently functioning systems of transport and pedestrian paths. Portrait of the city is complemented by a system of continuous green spaces, transfer to a suburban area of the most hazardous industries, the formation of the suburban settlements, reconstructive sealing of urban development. The proposal is to return the lost quality of the integrated environment.

1. INTRODUCTION

Urban development program of revival of Russia, adopted in 1995, reflects the General orientation of urban policy on the greening of settlements. However, the practice today points to a fundamental mismatch between the content of the new state planning policy and develop master plans of Russian cities, primarily non-capital (Grigor'ev, V. A., & Ogorodnikov, I. N. 2001). An example of this can be accepted in the 2008 and 2013 General plans of the city of Ukhta, the center of the Northern oil and gas region of Russia. In these studies, a systematic approach to the formation of prospects of development of the city by going beyond traditional methods of urban planning and design is proposed.

2. BACKGROUND

The planning Concept of the master plan relies on keeping in perspective the functional profile of the city of Ukhta with a population of about 100 thousand people as the center of the oil and gas industry of the European North of Russia for the period of 25-30 years. In its basic facilities master plans for the city declare the strategy of sustainable development of the city, which would mean the General direction of urban planning decisions on the ecological reconstruction of existing buildings in conditions of economy towards all territorial resources within the city limits.

In studies conducted to assess the environmental performance of decisions of General plans with respect to the core provisions of the new urban policy. The main discrepancies are the following: the provisions of the city development is defined outside of existing buildings without consideration seal capabilities or functional planning of the renovation of stagnant areas; not solved the problem of the protection of residential areas from the negative impacts of industry; not considered the problem of reconstruction of existing buildings and the possibility of using underground space; the green area of the city is not formed in a continuous framework of sustainable development in the conditions of the industrial city; does not create conditions for a pedestrian priority and the development of Cycling within the city. Thus, the modern master plans have traditionally focused on the use and development of new territories, but not a comprehensive solution for specific city problems through the integration of the urban fabric.

3. METHODS

The research considered the proposed alternative General plans the Concept of ecological reconstruction of the city. The Concept offers a solution to the major problems of greening the urban environment associated with architectural and town-planning aspect of its formation and development in five areas:

- the city as an integrated system – integration of industrial and residential zones of the city;
- the city is home to the pedestrian – the formation of a pedestrian network of the city;
- green city – the formation of the green framework of the city;
- architectural portrait of the city in its historical development – the formation of a system of open public spaces of the city;
- eco-friendly living environment, the city's proposal for the ecological reconstruction of the residential area of the city.

4. CASE HISTORY

The Concept provides the solution of the mentioned problems (directions) the greening of the urban environment in relation to the city of Ukhta in the next of their total content.

The city as an integrated system (Fig. 1).

The original approach to solving environmental problems of the city with creating conditions for positive change in a broken state air, soil and water components made the pronouncement beyond the urban development of the most harmful industrial enterprises, especially enterprises of oil refining complex. The compact formation of the production sites is provided the opportunity to receive additional territorial resources for the development of the city directly on previously mastered territories, which must complete an environmental clean-up and subsequent biotechnological remediation. This technique is accompanied by a reorganization of the road network with the creation of discrete, but continuous pedestrian and transport links between areas of new and existing zoning, including the suburban settlements (Pimenova, G.I., & Koptyaev, D. L. 2011). Thus, supported the idea of the city as the "Kingdom of the pedestrian".

The city is home to the pedestrian (Fig. 2).

The basic principle of the idea is the organization of such a network of pedestrian traffic, which allows you to freely cross the city to the pedestrian with a choice of routes depending on the purpose. In addition, all pedestrian ways should be accompanied by organized trails safe Cycling. The Concept is pedestrian network city framework, which reflects the social aspects of urban life (Pimenova, G.I., & Koptyaev, D. L. 2011). The architectural and design decisions of pedestrian ways allow you to see the pedestrian network also as an element of the recreational structure of the city and the theme of pedestrian ways as a green alley supports the idea of "green cities". The main prerequisites for the creation of pedestrian framework of the city seems to be the solution to the problem of storage of personal vehicles by forming an underground Parking structure and ensuring a smooth movement of vehicle and pedestrian at the intersection of paths.

Green city (Fig. 3).

The natural framework of the city by the Concept is formed as a full-fledged component of the urban ecosystem (Pimenova, G.I., & Koptyaev, D. L. 2012). Basic principles of formation of the natural skeleton are: the continuity and interrelatedness of all elements of the framework with the release of urban greenery outside of the city and its direct contact with urban forests; mosaic frame (the inclusion in the structure of gardening possible in the climatic conditions of the city of Ukhta natural diversity, species, age and functional composition of green plantations); the hierarchy of the construction of the frame (the increase of green mass with increase in the area of the territory under consideration). The Concept puts the task of forming a green framework of the city, based on his other directions is the elimination of industrial enterprises high hazard categories outside the city, the liberation of the city from natural parks, the creation of interconnected public open spaces and continuous network of pedestrian traffic (Pimenova, G.I., & Koptyaev, D. L. 2013). The provision of these conditions gives the possibility of implementing the principle: "city of greenery, but not the greens in the city."

Architectural portrait of the city (Fig. 2).

The formation of the architectural portrait of the city interprets the Concept as the creation of a continuous urban system of public open spaces, a kind of structural-planning framework of the city, concentrating the activity of city life and is included in the system of pedestrian traffic, green frame and performs the function of the boundaries of the urban tissue – building. Architectural portrait of the city must be identified through the structure of public spaces and reflect the cultural and historical stages of development of the city, creating conditions for the formation of a readable, representable and memorable image of the city (Pimenova, G.I., & Koptyaev, D. L. 2014).

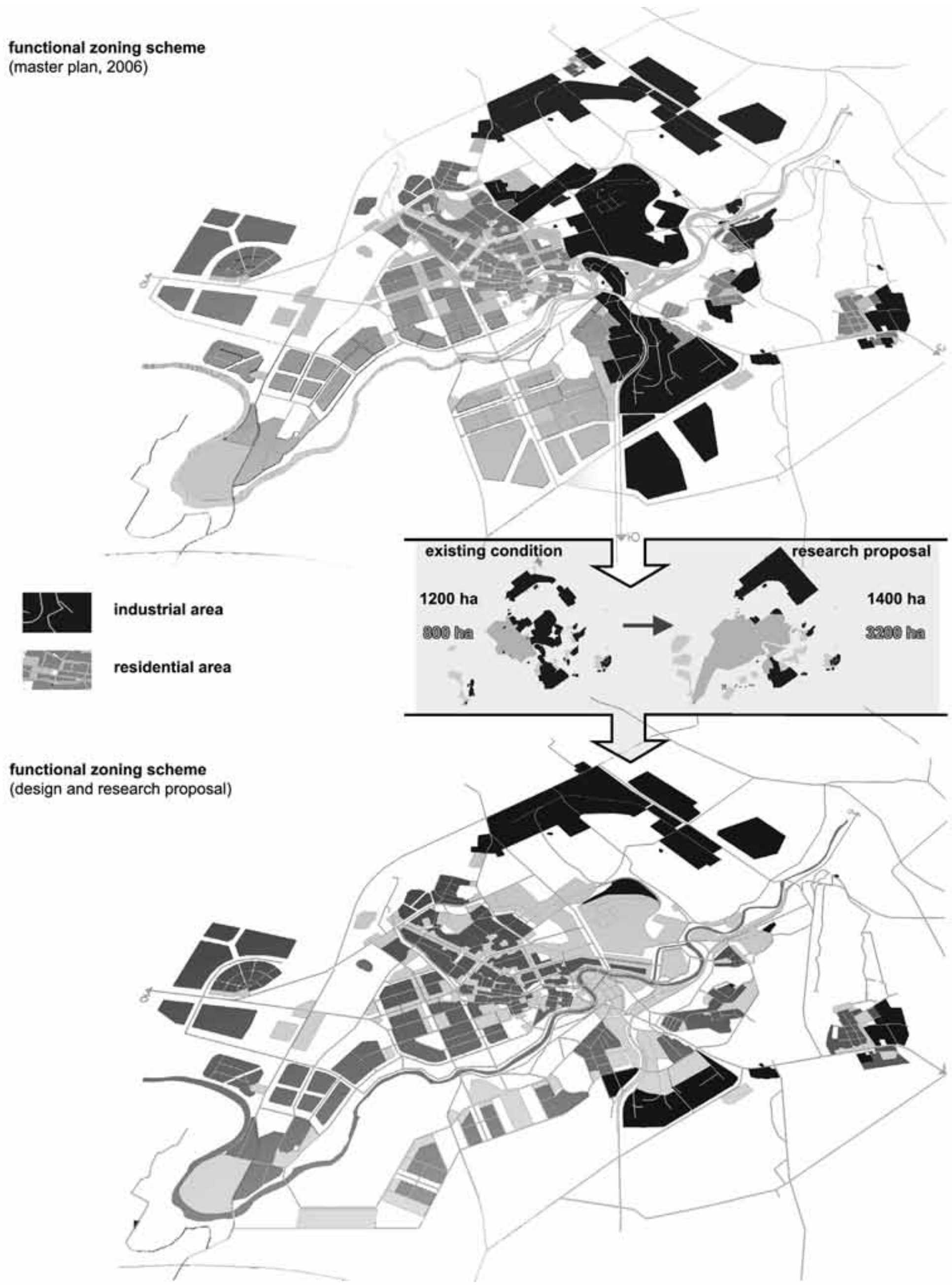

Fig. 1 The scheme of integration of the functional areas of the city (design and research proposal).

Eco-friendly living environment of the city.

The Concept, taking into account the complexities and contradictions of modern urban dwelling (physical crowding, psychological disunity of people, their alienation and irresponsibility to their surroundings) when deformed traditional and natural forms of being, does not put a traditional task to propose the architectural solution of the living environment, or through architectural solutions to determine for citizens a new way of life.

On the contrary, the Concept aims to create conditions for the formation of multivariate individualized living environment, adequate to the way of life of their inhabitants, that includes the following: reducing social and spatial scales of residential areas, neighborhoods, houses, and yards; reconstruction with the provision of accomodation is not above the fifth floor – "above the trees"; the softening of the living environment; the ratio of low-rise and high-rise buildings must comply with environmental standard: low-rise buildings – 70%, high-rise – 30%; etc.

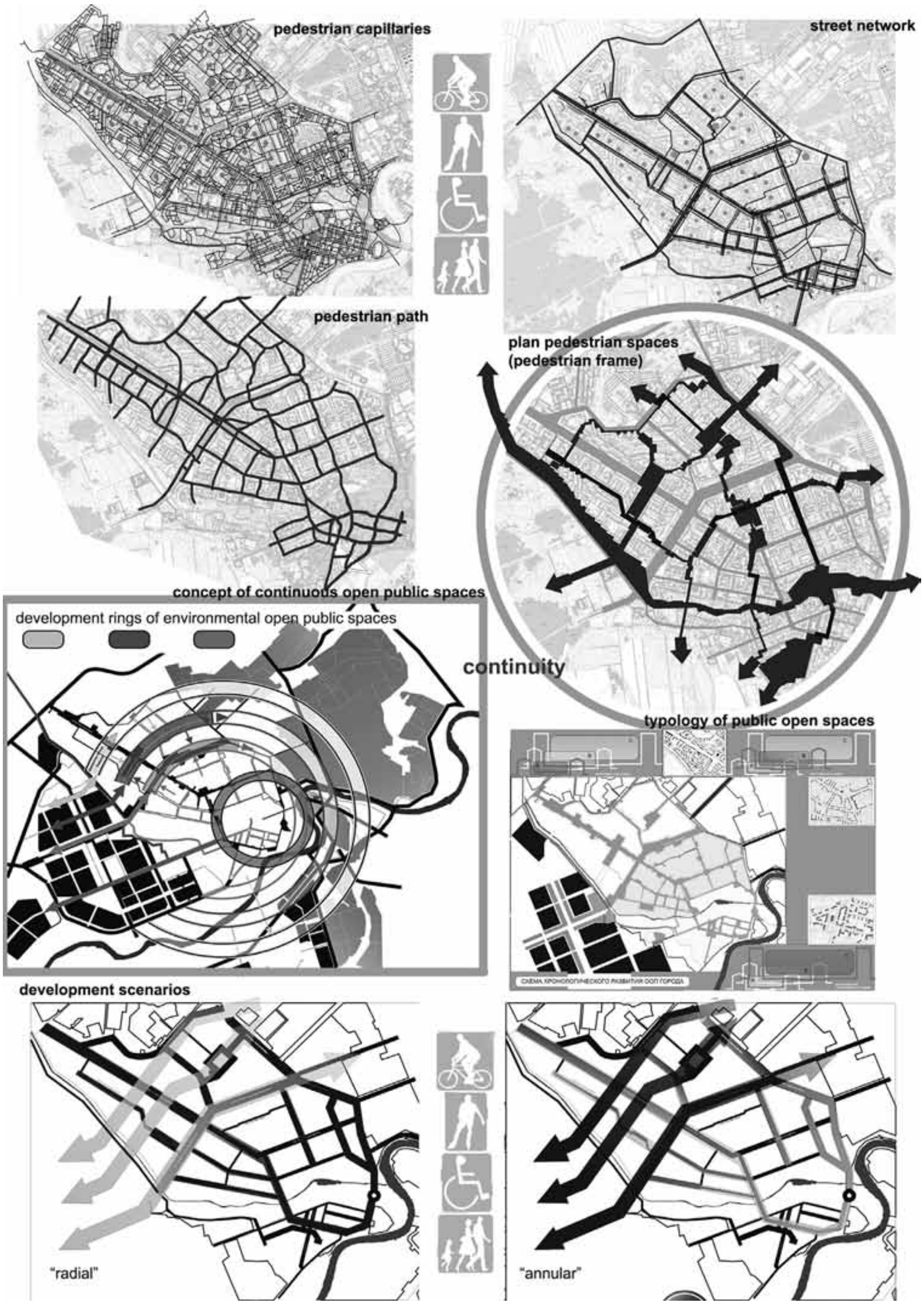

Fig. 2 The schems of rhe pedestrain frame and open public spaces of the city (design and research proposal).

5. RESULTS

Given the broad range of issues affected by the environmental reconstruction of cities as a step towards their sustainable development, this Concept includes research and proposals to address some of these issues directly relating to architecture and town planning aspects of environmental reconstruction, and does not consider specifically issues environmentally friendly solutions engineering lifelines of the city. The authors have a clear idea of the need for an integrated approach to urban issues and aware in this aspect in mind the incompleteness of the Concept, but see it as an impetus to upgrade plants for the future territorial development of the city, new vision problems of the urban environment and methods of their solution, different from the stereotypes.

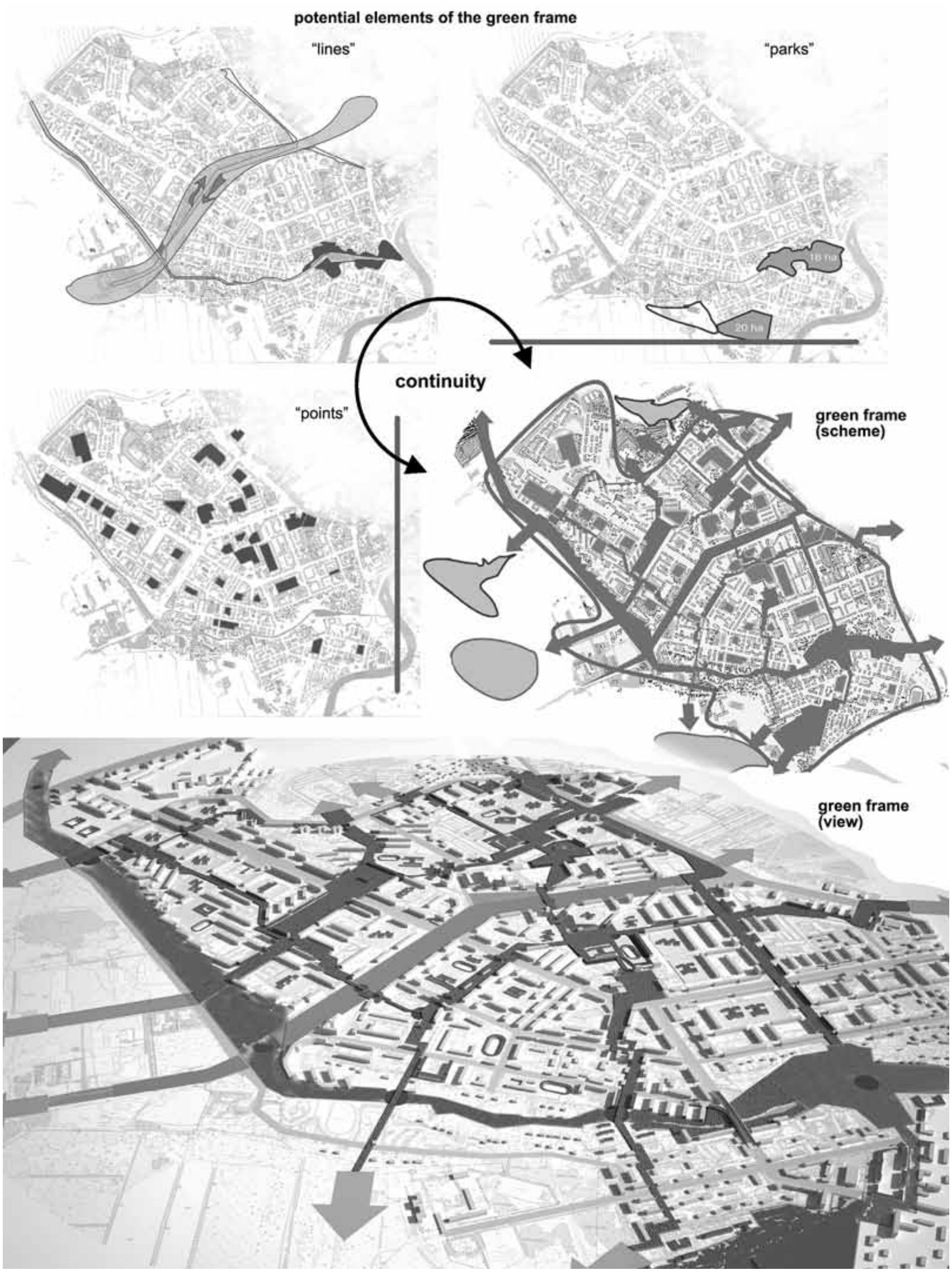

Fig. 3 The scheme of the green frame of the city (design and research proposal).

6. CONCLUSIONS

The Concept is a synthesis of developments in the five areas considered with the formation of a common solution and a common installation is to create conditions for sustainable development of the city – Ecopolis. The Concept is open for further studies and generalizations, and is aimed at maintaining the equilibrium of the ecology of culture, outside of which are not thought of sustainable development of a civilized society.

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IMPLEMENTATION OF AVANT-GARDE ARCHITECTURAL THEORY AND PRACTICE IN ARCHITECTURAL IMAGES OF SCI-FI CINEMA OF LATE XX - EARLY XXI CENTURY.

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Keywords

avant-garde architecture, cinema

ABSTRACT

In our research we select the following bunch: architectural cinematic image - socio-cultural subtext in the cinema's plot and consider some of the main areas of cooperation between the avant-garde architectural theory and social phenomena of late XX - early XXI century.
It can be argued that the cinema is an "experimental field" to check the avant-garde architectural theories and utopias. Such testing of architectural ideas in the film allows to check the attitude of society to them, weigh pros and cons, to simulate them on the screen, and only then implement them in real architectural practice. Cinema should consider avant-garde architecture as a source of inspiration and a basic tool to create architecture of the future in film's background. Undoubtedly, today the cinema can and should be considered as one of the media tools of architecture sociology.

1. INTRODUCTION

The collapse of the modernist doctrine, bearing in its rules simple recipes of happiness for consumers of architecture, constant and unchanging, without causing natural fatigue from the outright projected environment has led to changes in the architectural consciousness. "Popular culture and diversity of the media transformed the creators of the avant-garde 20-ies in a closed group, and the dream of a catalog common man who aspires to the unification of tomorrow's world, is designated as a fundamental sociological error" (Вуек 1990). The development of the media having already become classical - Television and comparatively new media of communication: the Internet, a variety of social networking and interactive projects for the exchange of information available for the user, had a strong influence on the transformation of public consciousness. In his book "Ways of seeing", John Berger states that the seeing is primary with respect to the speech: "It is seeing which establishes our place in the surrounding world" (Бергер, 2012). Visual sources have helped a philistine to feel a kind of "partnership" to the events and made him a "partner" of the processes in the world. Within the last two decades of the twentieth century, technological change has supplemented a new virtual reality with computer games and professional software for architectural design. "In today's society the importance of a phenomenon called "image" has multiplied over of the phenomenon of "thing". As a result, virtualization of modern society is reflected both in understanding the essence of architecture that organizes the material world, and the role of cinema - the modeling world of images" (Токарев, 2005). Cinema often generates architectural images using a variety of architectural utopia. Through the film, the viewer is provided with an opportunity to assess volumetric-spatial model of cinematographic works as a real architectural phenomenon, by carrying out the following three steps: observation, penetration and understanding and, finally, the inner stay or experience. Thus, this is the distinguishing feature of cinema among other arts: the fixation of the fact of movement in the virtual space of the external perception of the subject (viewer). The main hypothesis of the research is that the cinema has become a type of fixing and testing of architectural thought (sometimes projecting a reality, and sometimes utopian). It is interesting to trace the implementation of the architectural avant-garde theories and practices in the creation of architectural cinematic images and their interaction with the social and cultural connotations in the cinematographic story. Perhaps this "rollover" of reality in the world of cinematic "images" allows you to fix the visual aesthetics of the avant-garde architectural images in the mind of the potential consumer of the end architectural product. In our research, we select the following bunch: Architectural cinematic image - socio-cultural subtext in the plot and cinematographic and consider three main areas of interaction between the avant-garde architectural theory and social phenomena of the end of XX -

beginning of XXI century:
A new architectural paradigm of “postmodernism.” The phenomenon of “consumer society”;
Formation of the new architectural paradigms, based on the deconstruction of form and principles of non-linearity. The phenomenon of “virtualization” of social consciousness;
Architectural eco-utopia. The phenomenon of “a society of sustainable development”.

2. BACKGROUND

The basis of the general theoretical framework of research in architecture in the sci-fi cinema were works by Vivian Sobchak, Terri Meyer Boake, and Maggie Toy. The fundamental works on the theory of architecture by Ikonnikov A. (Иконников А. В.) and Charles Jencks, Karl Kropf allowed to study chronologically the development of major architectural utopias, manifestos and theories of XX - beginning of XXI century. The systematic approach to the research was formed by the book by Donna Goodman «A History of the Future» and essay by Eric Mahleb «Architectural Representations of City in Science Fiction Cinema». In the works by Vilkovsky M. (Вильковский М. Б.), a detailed overview of Western and Russian sociological theory of architecture is presented.

3. METHODS

The research methodology is based on a systematic approach that allows you to design a system of relations between the avant-garde art architectural theory and architectural images in the film. Historical-genetic method allows to clearly specify the scope of the study to determine the chronology and temporal relationship between the individual elements of the study.

4. CASE HISTORY

Postmodernism and the “consumer society.” A distinctive feature of post-modern doctrine was a desire to neutralize the borders between the traditional and cultural layer, so-called “mass culture”. The concept of “mass culture” was laid in the foundation of the values of the new post-war society, which was ready to consume more and more blessings of civilization, including cultural ones. The downside of the excessive consumption turned out to be junk. It should be noted that a characteristic feature of almost all science fiction films of the last two decades of the XX century becomes a wide variety of garbage. «Yet, if previously the presence of waste carried with it fear and loathing, in the 1980s, it becomes associated with a new type of beauty, once again a post-modern acceptance of a new condition and heterogeneity» (Mahleb 2010). Rubbish - as a symbol of the consumer society, as an element of the new postmodern aesthetic. “A lump from trash” (Микулина 2012), a crushed and then digitized sheet of paper due to Jenks becomes the most iconic building at the end of the XX century, the social phenomenon called “Bilbao effect”, 1). A collage has become the main method of designing in the architecture of post-modernism. In most iconic films of the era, such as Blade Runner (1982), Brazil (1985), The Fifth Element (1997), considered various kinds of “cultural garbage” as an essential element of building a holistic architectural image on the screen. This eclectic permissiveness on the screen in representatation of the architectural space also identified the main problem of the emerging architectural style –behind historical and stylistic stratifications, it is easy to miss or even lose the essence. Unfortunately, the appeals of Postmodernism theorists to use complex metaphors and cultural codes for communication with the consumer were taken literally by practicing architects and led to overreliance on historical subjects, random “devouring” of all the styles of the past, “potpourri” on historical themes. Past was dismantled into “parts” and “quotes” for constructor, from which an infinite number of options can be mechanically assembled. “And now to discover the architecture means to make an archaeological action to dig it out from under the so-called cultural backgrounds, which it is buried under” (Раппапорт 2012). Non-linear architecture and the “virtualization of society.” In the last two decades of the twentieth century due to the development of innovative technologies, architects obtained a new modeling tool (design) of virtual reality - computer-aided design. “Any previously unthinkable form - curved, organic, techno-organic - is relatively easily calculated by a computer” (Добрицина 2004). Similar trends are observed in the film. One of the first experiments with nonlinear, computer space in Hollywood became the movie Tron (1982). The film takes place in a parallel, virtual reality that is new for the viewer. A modeled computer world on the screen revealed to a viewer a basic principle of an inceptive of a new, non-linear paradigm in the real world, - randomness (randomness). The images of the new virtual reality were seen by the viewers in the architecture with no signs, values or symbols. Space, calling into question, the mechanical linear paradigm of the world order had been presented to the general audience long before their implementation as a bold architectural experiments of the 90th. Approaches that were tested in the cinematograpgy in the early ‘80s, and later applied in practice by adherents of the new architectural doctrine. For example, P. Eisenman, while designing the Holocaust memorial in Berlin in 2005, used a new design principle as the main compositional

Fig. 1 Left. Shot from Blade Runner by R. Scott, 1982. Right. Guggenheim Museum Bilbao by F. Gehry, 1997.
Sourse: http://waverunnersfastpitch.net/gehry-guggenheim-museum-bilbao-316.jpg

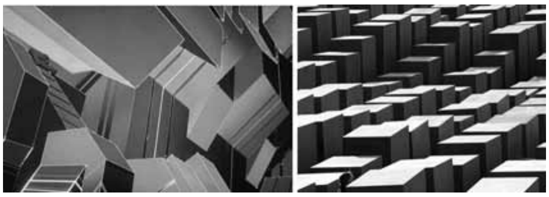

Fig. 2 Left. Shot from Tron by S. Lisberger, 1980. Right. Memorial to the Murdered Jews of Europe by P. Eisenman, 2005.
Sourse: http://blog.marklamster.com/wp-content/uploads/2009/05/1100222_7095_258cf08cac_p.jpg

Fig. 3 Left. Shot from Wall-E by A. Stanton, 2008. Right. Rapid Re(f)use by Terreform One, 2009.
Sourse: http://www.designboom.com/cms/images/-Z69/tt1.jpg

techniques: «We fed in a few basic data, and then it churned out two quite different and quite random-shaped surfaces. We put these two surfaces on top of each other and combined them with the stelae» (Rauterberg 2008), 2). Many believe that the modern design technology deprived architects to be creative and made them appendages of the technical capabilities of the machine. "Modern architecture, according to Baudrillard, does not reflect the talent of the master, and is not a work of art itself while becoming the embodiment of technical and technological possibilities of computer-aided design and construction" (Вильковский 2010). However, what Baudrillard and many architectural theorists announced to be the end of architecture, for many others has become the beginning. As the classical architecture for centuries had been exploring the abilities of an order composition and order itself, the architects of the new millennium are at the beginning of a long journey of exploration of possibilities of parametric and non-linear architecture with the help of computer technology. Moreover, perhaps, only "our imagination remains the main limitation» (Schumacher 2009) along the way. Perhaps "green architecture" and energy-saving technologies will be the new "isms" that will unite the architectural community. Marginal experiments by the "pioneers of green building" in the second half of XX century by P. Soleri, settlement Arcosanti (construction started in 1970) or J. Wines from the group SITE, project "Greening of Manhattan" (1979), were formed into a stable architectural trend of the first decade of the XXI century. The topic of sustainable development «sustainability» is one of the favorite themes of the architectural avant-garde at the end of XX to the beginning of the XXI century. Perhaps Avatar (2009) has become the most well known eco-project in Hollywood. On the background of Pandora's dizzying landscapes, a local base of earthlings appears as a "technocratic hell" with all its charms and is more like a refinery. Of course, this whole story is in fact a projection of our earthly problems, such as uncontrolled deforestation of the Amazon or excessive mining and related technological disasters. However, stunning, integral film images of Pandora's nature slammed into the subconscious mind of viewers for long, and the word «avatar" has become a household name in Singapore for emerging futuristic "Gardens by the Bay" (2012). It should be noted that the use of sophisticated forms of bionic is a widespread method in the film, when it comes to creating urban architectural images of other civilizations, which tend to live in harmony with nature and are its integral components. In the minds of the viewer, plastic and complex parametric shapes are strongly associated with extraterrestrial civilizations. Their implementation in the world is associated with considerable technical difficulties and financial costs, so any implementation of such a project is a mixed reaction from admiration to fear of the advent of "them". What can be caused by uncontrolled consumption on the background of rapid growth of the world population was formulated by film industry in a form of a game in a cartoon for all age categories Wall-E (2008). “For hundreds of years we designed cities to generate waste. It is time we design waste to generate our cities” (Joachim 2009). Megacities of waste ousted humans from their usual habitat, forced the residents to leave the planet in the hope of regeneration of natural resources. “Garbage City” is not breaking news for the inhabitants of our planet, it is just usually unnoticed. “Manhattanites toss out enough paper products to fill a volume size of the Empire State Building every two weeks” (Joachim 2009), 3). Similar film plots with the help of interaction with the architectural layer of cinematographic clearly fix in the minds of the audience the need to have a difficult but necessary road to go from a consumer society to a society of rational sustainable development.

5. RESULTS

Based on the research carried out, there are several basic mechanisms of interaction between the avant-garde theories and cinema:
due to its nature, cinematography adapts complex architectural theory to the available image-inhabitant examples. “Stylistic confusion” and abnormal external architectural interpretations are often felt in created images of architectural cinema;
the specifics of cinema allows to highlight different cultural layers within cinematographic: the overall storyline and social subtext, architecture, design, fashion, music, etc., to produce their decomposition, to consider each layer separately and then gradually align layer by layer, to carry out “reconciliation of positions”, to determine the degree of influence of other layers in the architecture and the degree of interaction of one layer to the other;
using computer technology reveals new possibilities in the design. Abilities of cinema can be used by architects for virtual experiments with form and function;
obviously, if you do not limit consumption, you have to live in enclosed spaces of megastructures and put up with restrictions.

6. CONCLUSIONS

As it is shown by the research conducted above, despite the fact that «Film has the ability to convincingly ask «what if? » (Boake n.d.), architects do not fully realize the potential and use of architectural presentations in the cinema. Certainly, to create compelling architectural images of the film industry it is necessary to establish an ongoing dialogue with the architectural community. Thus, the cinematograph will obtain in a film a quality “architectural layer ‘and architects will obtain an additional platform for experimentation and promoting their ideas to a wider audience. Analysis of the mentioned above types of relations between cinema and architecture showed that the architecture is in dire need of sustainable development of modern communication with the cinema and its innovative ideas. There is no doubt that the architect can and must consider the cinema as a tool for approbation of avant-garde architecture theory and practice.

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THE ISSUES CONTRIBUTING TO THE REALIZATION OF ABANDONED INDUSTRIAL AREAS

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Keywords

industrial, architectural, building

ABSTRACT

The article examines the realization of industrial brownfields, which includes three very important purposes, first of all recovery of environment, secondly, transformation of the social life of the population, raising of the cultural level thanks to the building of new type of residential and public buildings and finally the replacement of the abandoned brownfield areas with green areas.

1. INTRODUCTION

The conversion of industrial areas to another urban function is a global phenomenon seen in many countries that are entering or have completed the transition from an industrial society to a knowledge-based and service-based society. The examples and strategies of abandoned industrial areas usage are the proof of these processes.

2. BACKGROUND

Over the last thirty years, the desire for identity and identification has above all been projected onto maintaining and converting abandoned structures dating from the industrial era. As a contrast to the characterless buildings and cityscapes that are the same all over the world, these locations stand for a type of architecture that has specific features and relates to history and context, while at the same time offering space for current and future needs. These are powerful, unique locations in architecture and urban-planning terms, and they can become spaces full of potential.

Through their architecture, history and identity, these locations are full of meaning and significance that influences the city's character; they refer to the past and are anchored in the collective memory. They are locations that have a name, that are rooted in the city's structure and thus enable people to identify with them. In addition, they are characterized by a strong architectural language and specific spatial qualities, both in the building's interiors and in the open spaces around them. The way in which the buildings were previously used is reflected in the architectural elements. These traces give the location atmosphere and tell the story of the past. At the same time these locations also show certain adaptability to the elements that makes them viable for the future. They can accept both programmatic and semantic changes and this adaptability allows them to remain living dynamic and unique components in the city's structure. With their generous size and open ground plans, the abandoned industrial areas may be used for various purposes and may be adapted to every need.

3. METHODS

Nowadays in Yerevan environment a new architectural-urban-planning condition has started to develop that has as an issue to redefine or to reorganize the industrial areas and single factory buildings. Sure, it is still only a small percentage, but it has started. On this way one must strictly follow certain clearly regulated approaches. Presently the advanced cities of the world follow the logic of returning the urban areas to people. Today 70% of industrial areas in the city of Yerevan are abandoned idle surfaces. Functioning enterprises are only 26.5% and just 2.5% are converted. Examples are the commercial centers YEREVAN MALL (pc.01), YEREVAN CITY (pc.02), the research center SYNOPSYS ARMENIA(pc.03), the sport complex GRAND SPORT (pc.4), etc.

Abandoned industrial areas are considered primary zones of conversion, as they are situated in those areas of the

city, which have the potential of the most efficient use. [1]
To avoid the danger of mass building and to control the developments of urban planning the conversion of the abandoned areas must be solved as a system issue, consisting of architectural and building projects that guide:
- the efficient integration policy
- the selection of priority directions and the development of the main aspects of urban economy
- the record keeping, registration and efficient assessment of the stock of industrial areas
- the organization of relationship between the city administration bodies and market infrastructure objects (banks, bourses, insurance companies)
- the introduction of mortgage loan system to replace the investments.
The building of abandoned industrial areas depends also from the preserved volume in relation with the demolished volume. The complete and simultaneous demolition of existing industrial sites can lead to reduction of the availability of the areas, the disturbance of adaptability mechanism, which is unacceptable when essentially it's about improvement. In this situation it is advisable to maintain existing buildings, to convert them to buildings having other functions, thus preserving the volumes of simultaneous demounting [2].

4. CASE HISTORY

The realization of building and rebuilding may happen in the following successive phases:
- rebuilding project of the industrial zone of the city
- projects of single factory areas
- conversion projects of abandoned structures, buildings
- renovation project of the transport network
- improvement project of green areas recreation
All the versions and methods of reconstruction of industrial areas are applied in many countries in the world, but the accents and approaches differ everywhere based on various reasons – political, demographical, social, economical, temporal, etc.
Before choosing the method of reconstruction it is needed to examine the factors that influence the methods of decision-making.

Nowadays an important factor is not the volume of the industrial production, but the criteria of residential supply, health, education and environmental sustainability level. Great importance is given to the right of every citizen to participate in the decision-making, which is considered an index of the life quality. Together with this a series of factors which weren't top-priority before are now considered significant.
First of all it's the correct use of the personnel corresponding to the qualification of working resources.
The rapid introduction of the newest technologies leads to the growth of production without increasing the number of workers and at times even reducing it. It results in hardly surmountable social consequences. It becomes necessary to integrate those people in the new social environment and in this case the long-term assessment of the ecological and social consequences of the disturbance of people's lifestyle is needed. The essence of work changes. The industrial component in the composition of the city population is reduced due to the replacement of physical work with intellectual, the number of people working in the sphere of social and household services increases. The society becomes intellectual, which leads to an important factor – the informative policy of humanity [3].
Secondly, while converting the industrial areas into new urban bodies, residential infrastructures, transport issues become an important factor. The living units, districts and regions should be formed with the view of availability of various service objects and with the consideration of the transport network as a project basis. It leads to lengthening of the transport network and, therefore, to the growth of the transport role in the part of the city where the conversion should take place.
The third factor comes out of the fact that the surface occupied by numerous idle industrial areas, abandoned factory complexes form the great part of the urban area and can concede their place to water areas, green zones and free spaces which are so needed.

5. RESULTS

The shortage of natural resources can result in not only their final consumption, but also to ecological disasters. Besides, there are the issues of removal and especially elimination of waste (including hazardous waste). This is why they works should be led in the direction of detailed examination of every area and the definition of the direction of its specialization on the basis of natural conditions. For example it can be decided that a valuable landscape must be preserved as a recreation object or the air basin must be preserved, reducing the production. Thus the environment can be saved and the green area volume can be increased thanks to the industrial areas.

6. CONCLUSIONS

Humanity is approaching an invisible edge which separates the previous concepts of living space from the modern ones. The known means and ways of society development have come to an impasse. Humanity cannot develop any longer without a global development strategy.

Fig. 1 ‘’Yerevan Mall’’ shopping center on the former factory site autodetails

Fig . 2 ''Yerevan City'' supermarket, a former milling machine factory site

Fig. 3 ‘’Grand Sport’’ athletic complex, a former milling machine factory site.

NOTES

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KNOWLEDGE AND FRUITION OF THE RUPESTRIAN MONUMENT BETWEEN PAST AND PRESENT

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Keywords

rupestrian monument, Cappadocia, integrated survey

ABSTRACT

For 30 years, we conduct surveys, studies and research on the Rock Sites of Cappadocia; in last times we observe a rapid evolution of the techniques of survey and metrics data acquisition, but the aims and objectives of the research are unchanged.
The first our reliefs realized about 30 years ago in some Rock Sites of Cappadocia, although performed with manual techniques, are accurate and reliable; recently, were compared to those subsequently performed with techniques of laser-scanner: we do not find significant differences.
Although many studies and researches have been carried out recently in the Valley of Goreme, you can still find caves unpublished and unknown. In our contribution we study a small complex (two rock churches and a cave) obtained in one of the characteristic pinnacles the of Göreme Valley.
The three environments, churches particularly, are well preserved and are developed on different levels. The exterior, however, no longer has its original form. The limestone in which these monuments are obtained is very friable; for erosion due to natural phenomena (rain, wind, earthquakes in some cases), have occurred collapses, landslides and instability of the building; then even abandonment and neglect, have much changed the original external morphology.
Three years ago we performed a traditional manual relief; last year we performed a survey with the laser-scanner for a work project to test the convergence of different survey methods and data collected.

1. INTRODUCTION

The rupestrian site of the Göreme Valley (added to the list of UNESCO World Heritage site) had been studied since the time of Guillame de Jerphanion, who, from the first decade of the past century, had compiled an analytical and reasoned census of that area.
In his works de Jerphanion[1] had published the first series of survey roughly measured (sometimes simple sketches) that however provided many data about the shapes and volumes of the studied buildings.
During the 60's, Nicole and Michel Thierry[2] and than M. Restle[3] published two important works about the rupestrian art of Cappadocia. Both works contained numerous surveys, although they show "regularised" shapes of the monuments. In later decades other important works, as the ones of L. Rodley [4], S. Kostof[5] e C. Jolivet-Levy[6], through surveys and drawings, help the reading and understanding of the buildings.
During the '80s we have started studying and surveying a few churches. Unfortunately, we had published a small part of the collected data[7]. Already at that time we considered the survey like a fundamental instrument for a correct method and approach to study architectures, rupestrian or not. Initially, we made use of manual techniques, then of integrated survey, but our approach to the study of rupestrian buildings have never changed in 40 years[8].

2. THE STUDIED COMPLEX

In the summer of 2013 we travelled to Cappadocia to conduct a survey campaign connected to PRIN 2011. During an inspection performed in the surroundings of the Göreme Open Air Museum, we had the opportunity to discover an unreleased rupestrian complex composed by two small churches and a large room, completely carved in a typical "fairy chimney", called by local people "Peri bacaları".
Nowadays the studied complex can be reached through a steep slope. At the end of the path, in a small flat area, are located the entrances to the first church and to the adjacent room, now in use as occasional home and morphologi-

cally modified, changing the original shape.
The biggest church of the complex, has a trapezoidal plan (440 cm the entrance side, 365 cm the apse side, 500 cm the SW side and 332 the last) with two cap apses SE orientated[9] and decorated by “horse shoes” niches with double ring on all the walls. The room presents a low barrel vault set on the long sides. There are not frescos; the only decoration is a red, monochrome strip decorated as “dente di lupo” at the set level of the vault. Nowadays the highest chapel, is almost inaccessible, although it’s not to far from the small square; the external morphological modifications of the complex made the access very difficult[10] . The church present a squared plan (170 cm entrance side, 168 cm apse side, 151 cm the NE side and 135 the SW side) whit a cap apse (partially ruined) SE oriented in line with the entrance. On the other walls there are three arch. The elevation is interesting: four triangular connections link the squared plan to a circular ring. On it it’s setted a tambour with four low relief half columns joined by low arch supporting a little dome.
Inside the church there are some frescos dated between XI and XII centuries[11]. An unnamed Saint (probably a soldier) is painted on the entrance lunette; on the right side there is painted a prayerful Saint; on the upper arch a soldier Saint is represented; on the walls beside the apse there are pictured two Bishop Saints. On the left side wall, on the higher arch, there is painted a diptych whit a saint on horseback (probably St. George) and another very similar to the saint represented above the entrance. A Deèsis (a blessing Christ between the Virgin and Joannes the Baptist) and Archangel Michael are pictured on the two parts of the tambour. Unfortunately, we could not make an essay on the floor of the two chapels to verify trace of tombs, that the owner of the complex vaguely remembered.

3.METHODS

We wanted to compare the collected data, especially the planimetric asset of the churches, with the “manual” survey done the previous year. We established an almost perfect overlay of the papers. Our goal was that of comparing the results of a traditional survey with a high resolution digital survey. We wanted to give an evaluation on the capability to respond to the needs that a survey operation requests. The main aspect we have to consider is the capability to give a characterization of the artefact, both from the physical, material and structural point of view and from the general context.
It is also important to satisfy the various necessities that the different purposes of the survey can request. Moreover we have to consider the objective needs related to the ease of data collecting and elaboration, the simplicity of data management and interaction with other survey methods and different investigation scale.
Moreover, especially in the field of cultural heritage, a cost-benefit evaluation is very important, both from the economic and the timing point of view. Indeed, during the first year, in the summer of 2013 we realized the first direct survey with common instruments (laser meter, level etc.)[12] .
We continued with a photo-video documentation, realizing a series of panoramic views of the churches, also of the interior. The purpose of this second step was the realisation of a virtual tour and film clips. With the collected data we realized a reconstruction of the structure that was presented in 2014 during a conference on typologies of hypogeal architectures[13].
The following year, September 2014, we realized an integrated digital survey[14] with the scope of creating 3D documents, with particular care to surface modelling techniques, which is the best approach to obtain digital models that faithfully represent the shape and peculiarity of rupestrian sites, difficult to represent with traditional techniques. Using the data of the survey, realized with a 3D laser scanner (active optical system) we compared different dedicated software to interpolate points to obtain meshes and projection of photographic images on the 3d model, to carry out a faithful digital representation.

4. CONCLUSIONS

During the last years, in the field of monument surveys, we are watching a significant loss of interest for manual survey, while it is payed major attention to the survey carried out using digital techniques as the only reliable product for the study of cultural heritage. It cannot be denied that only the manual survey allows to a direct contact whit the artefact and only the physicality of this method allows to a complete and exhaustive knowledge of the monument. The graphic transcription on paper, using the traditional two-dimensional representation, although, is conditioned by an abstraction operation compared to the real perception of the object.
The traditional method, otherwise, remains an essential and necessary instrument, when the survey became an instrument for the knowledge and the analysis of the monument. Certainly we cannot deny the benefits of contemporary methods and systems of data collection. Both in survey field (laser scanner, GIS, etc.) and in documentation

sector (virtual tour, drone shooting) all this techniques are fundamental, especially in a period where the "spectacularization" of any operation is requested, also in the field of study, protection and communication of cultural heritage.

Fig. 1 Complex anonymous in Göreme Valley.

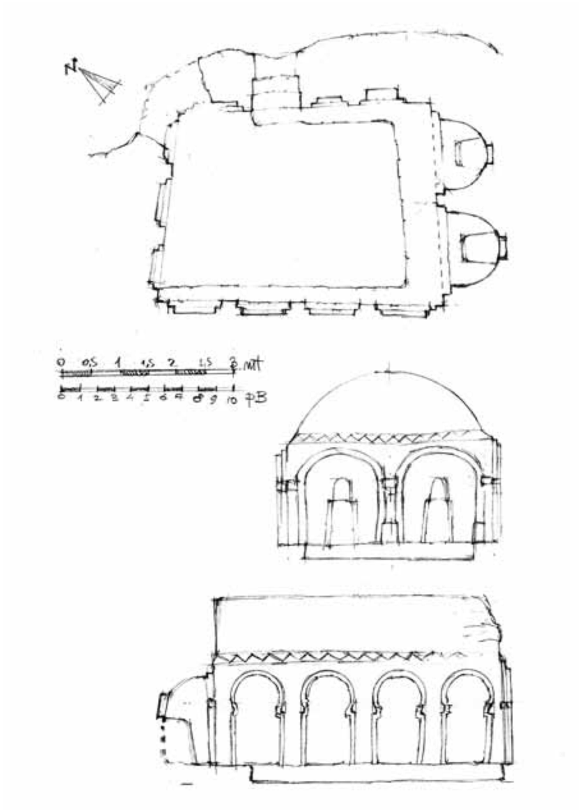


Fig. 2 Complex anonymous in Göreme Valley
Plan and sections of the lower church.

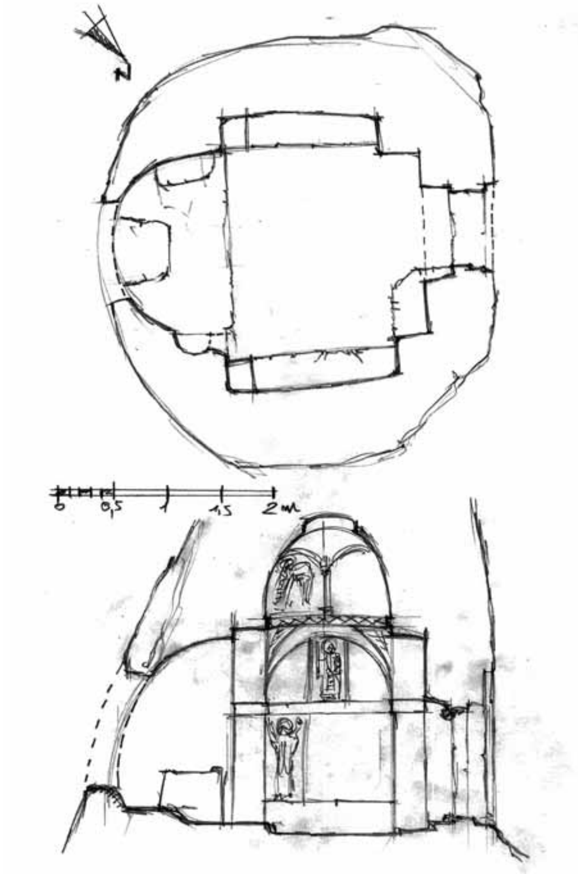


Fig. 3 Complex anonymous in Göreme Valley
Plan and sections of the upper church.

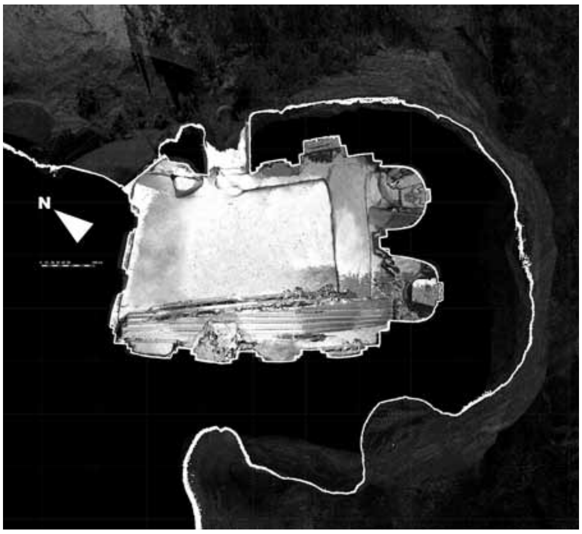


Fig. 4 Complex anonymous in Göreme Valley
Plan of the lower church: survey laser scanner.

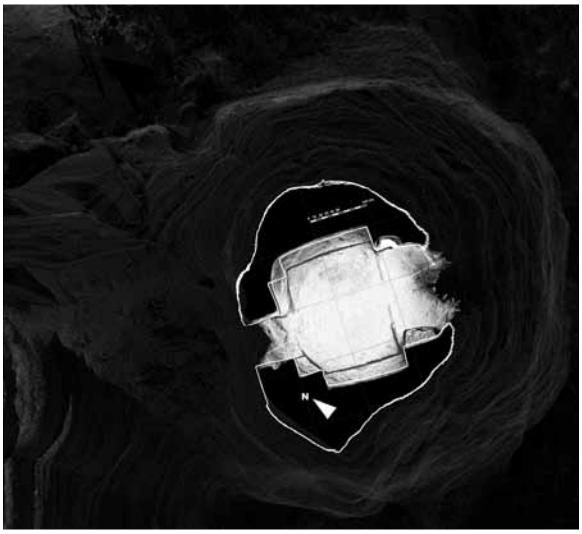
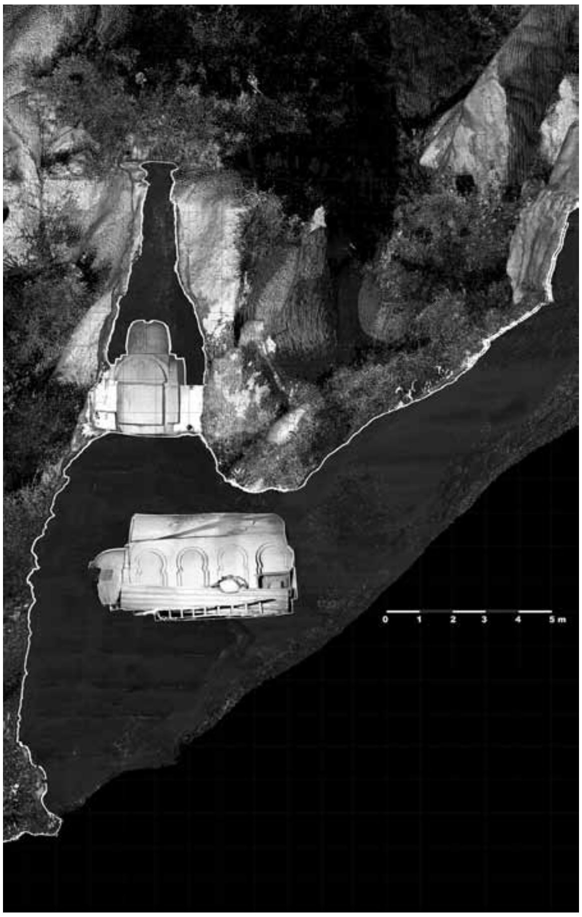


Fig. 5 Complex anonymous in Göreme Valley.
Plan of the upper church: survey laser scanner.



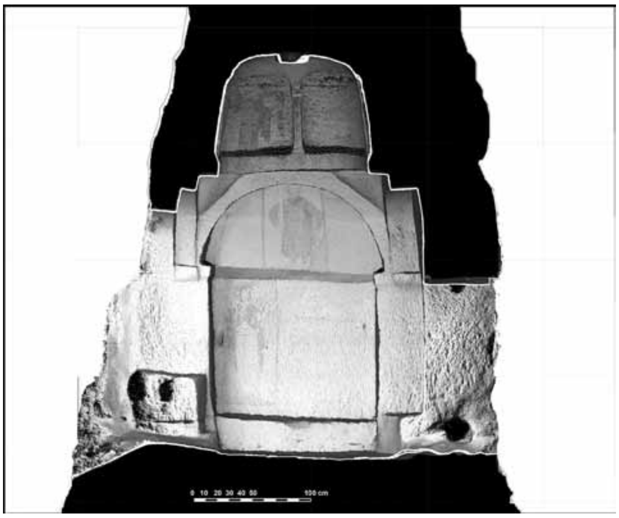


Fig. 7 Complex anonymous in Göreme Valley.
Section of the upper church: survey with laser scanner.

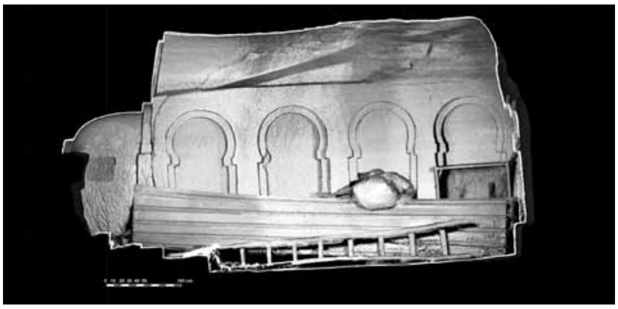


Fig. 6 Complex anonymous in Göreme Valley.
Section of the two church: survey with laser scanner.

Fig. 8 Complex anonymous in Göreme Valley.
Section of the lower church: survey with laser scanner.

Fig. 9 Anonymous complex in the valley of Göreme. Panorama: to left the pinnacle with the complex object of study. In the background at the center Tokali Kilise.

NOTES

Text by Marcello Scalzo and manual survey and graphic restitution.

To Claudio Giustiniani, traslate, laser scanner survey (coll. G. Tarabella) and graphic restitution.

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[9] Georgios Dimitrokallis (1976), Οι δίκογχοι χριστιανικοί ναοί (Le chiese cristiane a due absidi), Athenai. In the author opinion, are funerary buildings, dated, between Xth. (Yusuf Koç kilisesi in Cappadocia) and XIVth. monolithic monastic churches of St. George and St. John the Baptist in Armenia; whit some sporadic episodes in Russia and Armenia. In our case, through convincing comparison with two-apses rupestrian churches from Cappadocia and Puglia, the dating defined between XI th. and half of XII th. century.

[10] Nowadays the acces to the church is possible thanks to the availability and courtesy of Ali Bay, the owner, that we thank.

[11] The dating of the frescos doesn't necessary correspond to the dating of the buildin; often the pictural endowment was been painted long after the excavation of the church. In our case we can prudently date the lower church between the X and XI century and between the XI and XII century the other one.

[12] UNIFI research group of PRIN 2011 that operate for the documentation of the monument in 2013, add to the writing, also partecipate Claudio Giustiniani and Berna Aydın.

[13] Marcello Scalzo, Chiese rupestri di Cappadocia: alcune considerazioni su esempi "minori", in Convegno "I paesaggi del sottosuolo – geologici, archeologici, minerari e delle acque", proceed. of the confer. now being printed.

[14] In group of search UNIFI for PRIN 2011 in the summer 2014 they worked in the rupestrian site, with me, the colleagues of the University of Florence: C. Crescenzi, F. Tioli, C. Giustiniani, B. Aydın, G. Tarabella.

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THE IMPACT OF URBAN ENVIRONMENT ON ECOLOGY AN EXAMPLE OF URBAN GROWTH OF THE CITIES IN NORTHERN KAZAKHSTAN

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Keywords

urbanization, urban ecology, demographic growth

ABSTRACT

The article analyzes the state of the modern cities of North Kazakhstan region from the perspective of urban development ecology. On the basis of the general theory about bio ecological territorial systems, analysis urban areas, resourceful, infrastructure and environmental problems of cities in Northern Kazakhstan and the capital Astana. The aim of the research is - to identify the existing problems and the formation ways of improving an ecological situations in the urban environment of cities. The solution of this problem from the point of view of long-term perspective requires the adoption of fundamental measures. As a result, investigation on solution of the ecological problems in the cities of Northern Kazakhstan and the capital Astana offers the following programs, which has theoretical and practical sections.

1. INTRODUCTION

In the article the analysis of a condition of the modern cities of the North Kazakhstan region from positions of town-planning ecology is carried out. On the basis of the general theory about bioecological territorial systems, urban analyzes, resource, infrastructure and environmental problems of the cities of Northern Kazakhstan and the capital of Astana are analyzed. The aim of the study is to identify existing problems and ways to improve the formation of the ecological situation in the urban environment of the city. Numerous environmental problems of the cities, mainly the largest of them, are associated with excessive concentration on relatively small areas of population, transport and industrial enterprises, with the formation of man-made landscapes, very far from a state of ecological balance. Urbanization, on the one hand improves the living conditions of the population, on the other - leads to pollution of the environment, improving the chemical, physical and mental stress on the human body.

2. BACKGROUND

As well as around the world, in the large cities of Northern Kazakhstan and in the new capital – Astana can also possible to predict ecological imbalance among urban spaces associated with a sharp increase in the population, if not take measures to eliminate the negative influence of factors of urban pollution and environmental problems. Rapidly developing capital of Kazakhstan, Astana, is subject to high risk of deterioration of an ecological situation in the near future. Rates of demographic growth of population in the capital surpassed all predicted indicators. Already in the first half of 2003 the forecast indicator which is been the basis for development of the general plan of Astana by the architect Kisyo Kurakava which provided growth of population of the city to 800 thousand inhabitants in 2030 was considerably blocked. Currently in Astana there are more than 980 thousand people, and the last in 2014 the population of the capital of Kazakhstan increased by 38 thousand.

At the current rate of growth of the population of Astana existing for today – in 2030 population of the capital will reach 3-4 million inhabitants. This phenomenon which received the name of “urban explosion” in science became one of the most important factors of development of many countries.

The growth of the urban population in these areas is in large measure due to the constant “push surplus” rural population to the cities, especially large ones. Leading pace of population growth has led to problems with ensuring urban areas of engineering, transport and social infrastructure.

3. METHODS

The technique of research is based on comprehensive and detailed consideration of the solution of the problem, studying of objects and their features in variety of interrelations and relative independence. In work are used: system approach, analytical methods (statistical, selective), sociological researches - in the form of polls; materials of geographical atlases, climatic reference books, ecological reports, opinions of experts. The method of on-site investigations of the cities of Northern Kazakhstan and Astana was used.

4. CASE HISTORY

One of the important environmental urban development issues that have a significant negative impact on the existing natural landscape is the lack of development of recreational infrastructure of cities and the lack of landscaping. As a direct consequence of the sharp rise in the population of Astana and extremely low level of precipitation in the region, the threat of shortage of clean water in the Kazakh capital becomes every year more and more apparent. The solution of this problem with long-term perspective requires the adoption of fundamental measures. Very fast rates of development of urban areas revealed a number of the problems connected with preservation by a stable ecological situation in the city which underwent considerable deterioration for the last period. It is possible to allocate a number of the main environmental problems of Astana. The following problems concern to them:
- Urban development;
- Infrastructure;
- Resource;
- Environmental protection.

We will consider consistently these problems, deciphering each of them.
Urban development problems:
- an unbalanced transport framework of the city, failure to adapt to the increased flow of cars, so that there is increased air pollution;
- the excessive density of building owing to what there is a violation of town-planning norms on insolation and aeration of territories;
- considerable shortage of the planted trees and shrubs territories, discrepancy of the area of gardening to number of inhabitants in the cities;
- lack of the developed recreational infrastructure.

Resource problems:
- providing the necessary amount of drinking and industrial water;
- utilization of municipal solid waste and modernization of grounds on processing of waste.

Environmental problems:
- Disruption of the hydrological regime of rivers
- degradation of a soil cover.

The motor transport is one of the main sources of air pollution in the cities. It is promoted a variety of reasons:
- narrow streets;
- high density of building;
- insufficient level of gardening.

According to environmental monitoring in recent years, the atmosphere of the big cities keep 10 times more aerosols and 25 times more gas. The superdense housing estate reduces wind speed, and stagnation of air promotes concentration of highly toxic transport pollution. According to data of environmental monitoring in recent years, the atmosphere of the big cities keep 10 times more aerosols and 25 times more gas. Thus 60-70% of gas pollution makes road transport. The low level of landscaping in urban areas leads to a lack of fresh air, oxygen, pollution and gas pollution to air environment. In the cities of Northern Kazakhstan is sharply continental climate with a small amount of natural precipitation, as well as wetlands and saline soils that are not conducive to plant growth. Therefore, there is the problem of landscaping in urban areas. In particular, in the capital Astana has to plant trees several times on the same sites as they do not take root. Currently, the program is designed for landscaping Astana, which defines the stages of the landing of new trees in the city. Breeds of the trees capable to survive in severe climatic conditions are selected. Round the city the green ring is created to protect the city from strong steppe winds. It should be noted that during the Soviet period violations of town-planning norms and rules when building old part of the cities in Northern Kazakhstan took place. Houses stand on the red line close to the road, there are no protective green strips. As a result residents of older houses have no protection against noise and pollution. One important urban environmental issues that have, a material adverse effect on the existing natural landscape is the lack of a developed recreational infrastructure.

For example, in Astana the available 500 meters of a sandy beach in park on the river bank Esil don't solve a problem of relaxation almost one million residents of the city. Therefore, most of residents of the capital, using for rest vacation riverbank below the city park. The impact of natural recreation are the most negative. The coastal zone of the river outside the city for kilometers contaminated by household waste: broken glass, bottles, plastic bags, food leftovers. Garbage is also dumped into the water, and piles of garbage block the already narrow riverbed.

The solution of this problem lies in purposeful creation of scientifically based system of recreational zones with organized parking, places for bathing. These areas are not concentrated in one place and distribute along the river to reduce environmental burden in the recreation area. The complex of environmental problem is made by urban development of river banks Esil. For many years, buildings were conducted closely to river banks. Esil, proceeding on a steppe landscape, replenishment of water receives only during thawing of snow. Insignificant rainfall doesn't influence water level in the river. Construction of multi-storey buildings on river banks demands digging of ditches under installation of the pile bases that leads to an artificial drainage and outflow of water from the river. Environmentalists believe that the decline in the groundwater catchment area of the river leads to the draining of fields, meadows, forests, wetlands, and as a result - to a decrease in their productivity and degradation. The condition of the river is influenced by economic activity of people and, first of all, the dams constructed in the sixties the XX century. They block and disrupt the water flow and the hydrology of the reservoir.

In many cities of Northern Kazakhstan is still acute problem of waste disposal. Currently, waste disposed of in landfill, which is an open dump. The ground has no capital protection from the adjacent territory, it is not equipped with facilities to control the infiltration of contaminated runoff and air pollution, installation for washing machines, etc. In addition, sometimes there are cases of uncontrolled rubbish fire. By the nature of the environmental impact disposal of solid waste refers to a potentially dangerous, environmentally, economic activities. As a direct consequence of the sharp rise of the population of Astana and other major cities, the extremely low level of precipitation in the region, the lack of treatment facilities, the threat of shortage of clean water is becoming every year more and more apparent. The solution of this problem from the point of view of a long-term outlook, requires acceptance of fundamental measures.

The aim of the architectural ecology is permanent ecological education of urban residents using healthy and beautiful architectural and landscape environment. The person and society interact with the environment having impact on people.

For continuous education of inhabitants by architectural and landscape ecology it is necessary to create beautiful and healthy, pure and favorable environment for sense organs (sight, hearing, sense of smell, touch). Participation of inhabitants in maintenance of such environment promotes their interest in it. For this architecture of cities, buildings and engineering constructions have to be eco-friendly.

Parameters of ecological architecture:

- harmony of buildings and constructions and landscape;
- a nature biodiversity — flora and fauna, landscapes, their components;
- the presence of “green corridors” connecting green areas;
- matching sizes of buildings, the size of components of the local landscape and the human body, the absence of gigantism;
- granting ecologically reasonable space to inhabitants in the city and in rooms;
- ecologically reasonable gardening of the city, buildings, constructions. The use of all types of additional gardening;
- variety of architectural styles, preservation of historical building;
- existence and support of various ethnic architecture;
- maintenance of ecological balance;
- phytomelioration and permaculture;
- support of energy saving and natural technologies means of architecture, the use of the available types of renewable energy.
- Encourage the security architecture of walking and cycling;
- favorable visual environment (architectural diversity, curved shape, the variety of colors of the environment, the absence of gray boxes and others.);
- favorable sound environment of the city;
- favorable urban environment smells;
- eco-friendly materials in the construction and decoration;
- optimum pedestrian access from home (less than 20 minutes) to the park;

- Support for the existence of small animals (birds, etc.).
- eco-friendly, beautiful view from the windows of apartments;
- favorable visual environment of dwellings;
- presence of landscaping inside dwellings
- clean environment, lack of harmful pollution, physical fields.

With the development of society, and more and more deep penetration into essence of greening signs of ecological architecture will cover the increasing number of parameters of an urban environment.

Considering that environmental friendliness of the environment gives to residents only positive effects, for wide use of parameters of eco-friendly architecture practically there are no restrictions. At the same time, many factors of modern cities do not allow to apply generally useful directions of greening architecture. Thus, the growth of cities and the size of buildings, their number of floors eliminates the use of a number of provisions of environmental architecture, such as a harmonious description of buildings in a landscape, support of communication of inhabitants of the house or quarter, a short distance from home to the nearest park or square, support for walking and cycling, the creation of " green corridors "and others.

However, the objective growth of the cities has to be followed by their greening with the deep analysis and use of more perfect methods, technologies.

5. RESULTS

As a result of the conducted researches for the solution of environmental problems of the cities of Northern Kazakhstan and the capital of Astana the following program having theoretical and practical sections is offered.

Scientific and methodological section:
- creation of the regional ecological doctrine for the cities of Northern Kazakhstan;
- determination of ecological potential of the environment of the cities of Northern Kazakhstan;
- development of a urban environmental ecological framework of Astana (definition of a technique of calculation of the area of compensatory zones, techniques of calculation of an environmental pressure on environment);
- carrying out urban environmental ecological zoning of the territory of the cities of Northern Kazakhstan.

Practical section:
- carrying out an accurate standard regulation of urban development of the territory of the cities of Northern Kazakhstan;
- optimization of a transport framework of the cities, introduction of new means of transport in the capital of Astana, such as a monorail;
- justification and design of recreational system of the cities of Northern Kazakhstan;
- observance of an optimum ratio of building and gardening of the cities of Northern Kazakhstan.

6. CONCLUSIONS

Execution of this program will allow to improve an ecological condition of the cities of Northern Kazakhstan and the capital of Astana, and also to program and control an ecological situation in the region.

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THE CLASSICAL TRADITION AS THE FOUNDATION OF THE FUTURE ARCHITECTURE

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ABSTRACT

The actual idea of sustainability in architecture deals mostly with technical characteristics and ignores artistic qualities of buildings which for the centuries were considered to be the immanent virtue of the architecture along with durability and utility. Our basic theses are: 1) the ideas implied by the sustainability concept, were well known in the past and constitute sum and substance of the architectural classics; 2) these ideas should be interpreted in the terms corresponding to the age of globalization, multiculturalism and digital culture; 3) interpreted this way the classical ideas lay down the targets of the future sustainable development of architecture. We try to implement this concept to architectural theory, which may serve for building the future environmental science.

1. INTRODUCTION

The future architecture (note 1) is hardly thinkable without sustainability — the quality that means tolerance to nature, to history, to beauty of the world in all its diversity and maximum saving of resources and space (Goudie, A. 2005; Blewitt, J. 2008; Sendzimir, J. and Guy, B. 2009). The idea of sustainability derives from common dissatisfaction towards actual ecological situation, lack of harmony between the human beings and the living space, between architecture and nature. The basic thesis of the research is: the ideas implied by the sustainability concept, were well known in the past, and constitute sum and substance of the architectural classics. Today we need a new conception of the classics that corresponds to the age of globalization and multiculturalism, and sets new targets of the future sustainable development of architecture and the environment itself.

2. BACKGROUND

The actual idea of sustainability in architecture deals mostly with technical characteristics and ignores artistic qualities of buildings which for the centuries were considered to be the immanent virtue of the architecture along with durability and utility (the so called Vitruvian triade „firmitas – utilitas – venustas“) .The research deals with the idea of architecture as one of the components of the environment that took shape due to the biogenesis and anthropogenesis. The living environment is considered to be the biosphere with an ever growing anthropogenesis factor that includes the phenomenon of architectural classics perfect from the point of view of “human–nature” relationship. Architecture as an ontological phenomenon is considered to be greatly retrospective to the age when organized groups of molecules, that had been banding in a rational and a perfect way, not only formed new standards of organic life, but accumulated the qualities of an organized beauty (Christian, D. 2005, p. 78-131). Then the living space based on classical forms of habitable landscapes was born and gradually morphed during hundreds of thousands of years into anthropogenic environment. Later its organization by means of architecture established elaborate relations between cosmic space and earth, giving birth to the classics of the human environment.

3. METHODS

The architectural classics supplies the natural environment with human content by means of introduction of the system of visual signs, which had been worked out continuously through different periods of human history, often far-off in time. The necessity of the stable measurement of time and creation of the calendar led to the finding of the means of fixation of the positions of the Sun, Moon and the stars by building the different megalithic structures.

The spaces developed in the prehistoric epoch had accumulated in the monumental form the ideas of human and cosmic time, and had invented the “calendar geometry”, that united knowledge, magic, rite and the idea of order (Trigger, B.G. 2003, p. 445). That great discovery of what is nature, space and time are expressed in the oldest built ensembles: from those found in Russia, on the territories near the Altai Mountains in Siberia to the famous Stonehenge in Britain (fig. 1) - one of the better preserved monuments of the classic of the prehistoric world (Hetze, K. 1932; Burl, A. 1995; Pitts, M. 2000; Dames, M. 2004). The world of Classical Antiquity had preserved the primary ideas of the prehistoric transformation of the environment and had created an elaborated environmental language, based on mathematical proportions and idea of beauty, which were formulated in the Ancient Middle East, Egypt and finally in Greece in the concept of the Orders of architecture (Barletta, B.A. 2001).

4. CASE HISTORY

The system of orders of architecture now as ever is important for the art of construction from separate buildings to human settlements and wider — to the anthropogenesis landscapes. This concept received its eternal form in the ancient Greece, but it had used the artistic ideas of the expression from the Egyptian, Hutus, Persian and other ancient cultures (Wilson Jones, M. 2014, p. 1-13, 63-139). Later on the ancient Roman culture greatly expended the system of meaning in architecture and ever since those times the classical architecture based on five classical orders was able to express very different layers of signification — political, geographical, historical, military (Wilson Jones, M. 2009, p. 24-30). The latent classical tradition that during the period of Middle Ages went through the period of survival conserved those meanings and made them actual for future epochs (Panofsky, E. 1960; Kömstedt, R. 1957). The Renaissance that partly inherited partly revived the classical order and way of thinking, created a new system of meaning and relation between the God, nature and man, considering the latter as a “microcosm” that is related to the great cosmos (“macrocosm”) by means of harmonic proportions (Wittkower, R. 1949; Norberh-Schulz, Ch. 1974). One of the most important discoveries of the Renaissance architectural thought was that architecture should imitate nature, but not by means of accident biomorphic forms, but by means of fundamental mathematical principles that form the structure of the heaven born universe. Another idea important from the “sustainable” point of view was formulated in the Renaissance architectural treatises. It declares: good architecture is unthinkable without beauty. Beauty taken as the principle and the aim is an inherent quality that makes architecture capable to provide human well-being.

The unity of the long-live classics was nearly destroyed by the so called “clever choice” of the architecture of the XIX century (Macleod, R. 1971; Kirichenko, E. 1979) and again received more universal character in the XX century built environment influenced by the avant-garde and the neoclassicism (Miller Lane, D. 1968; Jencks, Ch. 1977; Jencks, Ch. 1987). Today we have to consider, how to include the contemporary trends of understanding the architecture and landscape to the ecologic situation with its very ancient origins and to bind together contemporary ideas of sustainable architecture and the changing history of the classics and its eternal ideas.

Architectural classics is certainly not only art, but a kind of science as well. It is a science worked through the aesthetical laws, developed by the history-long observation of the cosmos, nature and human. May be the feeling of the classics had been born when the humanity understood that the beauty means Greater good and Right order. The monumental architecture appeared exactly at the moment of unification of protoscience and protoart, both linked to the concept of the cosmic time observed by our ancestors. And this early human classic monuments showed the first example of meaningful and useful sustainability, which obtained the form of the objects of beauty created by humans.

The forms of architecture and monumental art created by man always exist on the frontier of the material and spiritual worlds. Making the built environment is the activity which brings human meaning to the mass of material and to space. Many of the most ancient monuments of architecture, which had survived till our epoch did not have any material function, but only the spiritual one. The prehistoric people had erected enormous number of constructions, opened to the surrounding world, but lacking the interiors. Huge monoliths posed upon each other or arranged according to meaningful figures, with a harmonious rhythm turned to become the friendly part of the natural environment, really making human creations the part of nature. The utilitarian construction, without any artistic qualities is unable to obtain these qualities, which make architecture part of nature friendly environment.

5. RESULTS

We consider the architectural classics to be a universal idea of the anthropogenesis environment, created by science and art together. The alliance of science and art, that produced the scientifically based laws of eternal beauty and esthetically interpreted norms of sustainability, is considered all along the Antiquities, not only the Greek and Roman ones, but the comparable periods of the other branches of human culture, for instance in ancient China, India or Americas, as well as the European Renaissance and the neoclassicism. A special consideration is given to the age of the Enlightenment that discovered richness and diversity of the classical ideal in pieces of art of various civilizations. The idea of the natural beauty as the base of the built environment, which had been elaborated by the British experimental philosophy and the theory of landscape garden as a part of classics flourished in the first half of the XVIIIth century and gave birth to the conception of the equal values existing in the landscape and belonging to different historic time, national origin and meaning. In all the European architecture from Portugal to Russia appeared buildings in Chinese, Indian, Egyptian, Gothic, even Tahitian and other very different tastes. At first that introduced a certain contradiction of Gothic versus Classic (Middleton, R. 1983), then in the XIXth century — so called “cleaver choice” of the historicism, and at last — the understanding of the values of architectural multiculturalism, which reinterpreted the unique classic ideal into a complicated, ierarchisised and based on social as well as group or individual choice (Wittkover, R. 1974). Transformations of the classical ideal in the history of architecture demonstrate eternal principles of the classics, among them: harmony with nature, social, spiritual and physical human well-being and accordance between architecture and macrocosm. But the idea of the Classic itself is undergoing in present-day art and architecture serious and inevitable changes towards the acceptance of universal aesthetic values.

Architecture today must not be considered as an ever changing chain of different buildings created for different reasons, even towns and cities, as well as it is not only built environment, used by humans, but first of all the system of meanings which regulate the relations between natural and human environment. The architecture when it changes the world obtains global characteristics, in the landscape, the biosphere and the worldwide meaning of the human existence, which the famous Russian geophysicist Vladimir Vernandsky called “noosphera”, the part of cosmic space filled with human reason (Vernadsky, G. 1998). The classic form of the visual expression of the human civilization must be perfect from at least these three points of view: don’t destroy the natural landscape, compensate the features brought in by human activities and elaborate the system of historic meanings, stored in the environment during thousands of years. It is not enough to achieve technical characteristics, necessary for the ecological survival, it’s necessary to harmonize them with artistic achievements and ideas deeply rooted in the multicultural classical tradition.

6. CONCLUSIONS

The study extends the frames of the present day conception of sustainable environment which mostly deals with the efficient use of energy and space and almost totally lacks the artistic features. It also lacks the invention of the contemporary language of understanding of the human history and philosophy of nature, of genesis of our world and its place in the ever changing Universe, which had been elaborated and expressed in the classical architectural tradition. The new concept of sustainability must include architectural theory with all its artistic content in the context of interdisciplinary environmental studies. Then the architecture of the XXI century could find its place in the “chain” of inventions of the predecessors, which still determines richness, diversity and harmony of the human world. So the study is focused on an idea of classics of the future that likewise in the past is intended to save the environment and prevent its decline and destruction.

We are determined to live in the Classic world if the human race survives. This very old architectural dream, which had perished so many times in history and had its revival as well several times, may become the leading line of the development of the built environment on our planet. But for classics to become the future of the next generation of architecture, it is necessary to understand what kind of images it will create. The numeric culture has to pass through one more architectural renaissance, very different in its features from its predecessors in history from the specific medieval renaissances to the European Renaissance of the XV-XVI centuries to the revivals of ancient Eastern cultures to the multiple in its character classical architecture of the XX and XXI centuries.

Fig. 1 The views of the Stonehendge, photo by V. Aurova.

NOTES

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THE ISSUES OF CITY ARCHITECTURE. TRADITION AND THE PRESENT TIME

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ABSTRACT

Rapid urban processes pay their attention to issues of city archtecture. Contemporary formal and functional building solutions and urban spaces make architects create local programme offer consistent with buildings context. However, designers following the beauty and perfection in their buildings ask themselves questions: How should the city space be treated? How to connect contemporary city-developing and centre-developing functions with historic urban structure ? How to reconcile proecological technology solutions with building architecture? Interdisciplinary designing requirements inspire creators to mark out new ways in architecture. Structures chosen by the author (The Shard in London, Swiss Re Bank in London., Mediatheque, Mont-de-Marsan, France) are an attempt to answer some questions. The architecture of these buildings, saving their distinction and specificity, strengthens the power of historic influence.

1. INTRODUCTION

Varying life conditions in a city make architects change the surroundings in functional - spacious and aesthetic ways. They undertake multidirectional actions to create existential comfort for users in accordance with history and contemporary cultural friends of the city space (Januszkiewicz, K. 1984) Dealing with the issue of the city architecture the author pays attention to contemporary formal and functional solutions of designed objects in the context of the surrounding buildings. The presented examples of constructions show the possibilities which are given by a progressive attitude and ways of thinking in the space shaping reference. It is clearly seen not only in big agglomerations but also in the area of medium and small towns.

2. MEDIATHEQUE AT MONT DE- MARSAN, FRANCE

An example of enriching historic urban space by the architecture of an object is a French small town Mont de- Marsan. The Mediatheque which was implemented in the centre of the settlement was recognized as one of the most successful buildings of public utility in the world. The main prize in Leaf Awards 2013 concerned the exceptional proposition of the town main square development. The contest jury highlighted unique aesthetic values which were introduced to the historic layout of buildings.
Placing the Mediatheque in the middle of the military drill square inspired the authors to creating the form of the construction. Each of the four mirror elevations is different as each of them reflects different picture of the surroundings. At night the transparent facades reveal the interior of the building. They light up and revitalize the square, changing it into a friendly inviting space. The green roof is an extension of the green slopes surrounding the Mediatheque and the greenness is the natural continuity of the historic urban layout (Hall, P. 2013).
The building of the Mediatheque, designed by archi 5 studio, has innovative construction solutions which allow to shape the functional layout of the object. Chamber zones, halls and library departments give the feeling of safety, privacy and opening to the local space context. The context is created by the architecture of buildings of former barracks enclosing the courtyard in a rectangular shape. The Mediatheque project is an answer to contemporary needs of the local community. It is a form of continuity of the former function of the town square. The object architecture integrates the surrounding frontages creating the coherent street space. The facades reflect the surrounding architecture making a dialogue with the past. The development of the square in the form of transparent public space enriches and saves the historic urban layout of the city. The Mediatheque creates a chance of revitalizing

the square surface and giving it a new meaning - the meeting place, exchanging information and cultural events. Such an action is in agreement with the standards of shaping public spaces of European cities (Sołkiewicz- Kos, N. 2014) (Fig. 1)

3. SWISS RE BANK IN LONDON

The headquarters of Swiss Reinsurance Company, realized by Norman Foster, is another building which has become an integral part of the historic landscape of the city. Situated in the centre of London it is an example of actions aiming at the best architectural and urban solutions. Its soft form demonstrates new aesthetic values and the functional solutions are the answer to contemporary technological and technical possibilities (Januszkiewicz, K. 1989-90). The Swiss Re Bank skyscraper is composed subtly into an orthogonal urban layout. The limited surface of the place forced a creation of a very tall building of a strong character. The designer decided on a tower form on a circular base. Thanks to it the construction filled the empty place in the existing urban tissue. The elements of small architecture define the historical site boundary and along with the ground floor of the Swiss Re create a new human friendly public space. The upper floors are intended for shops, offices, bars and occasional meeting places for tenants and their guests.
The streamline form of the skyscraper minimizes wind loads and the natural air movement around the construction has been used for its ventilation. The ducts system running around the building provides fresh air to office space. This unusual economical solution reduces energy usage and carbon dioxide emission.
On the top floor there is a restaurant with a glazed space from which visitor can admire the city panorama. Although London seems to be more comfortable with its past and Victorian buildings it is also open to modern skyscrapers made from glass and steel which are becoming an integral part of its cultural landscape. (Januszkiewicz, K., Siuda, M. 2004). (Fig. 2)

4. THE SHARD IN LONDON

The building “The Shard” is another example confirming the need to create formally independent objects that have become an integral part of the landscape of the city. The decision on the location of a tall building in a cramped

Fig. 1 The building of the Mediatheque (designed by archi 5 studio) Source: www.detail.de.

urban structure of the city was a response to the current needs of London in terms of new buildings and public spaces (Kennet, S.).
The design and construction of the skyscraper The Shard is a continuation of the program "More London". Its aim is to revitalize the south bank of the Thames, the area between Tower Bridge and London Bridge, and to construct there environmentally friendly office buildings and shopping centers. Such actions have already created a unique climate in the neighborhood where beside historic buildings permanently inscribed in the urban fabric of the city there appeared space created by modern objects whose main purpose is to expand the area of the urban space. And

Fig. 2 The headquarters of Swiss Reinsurance Company (realized by Norman Foster).

Fig. 3 The Shard is a 95-storey skyscraper in Southwark, London (Designed by Renzo Piano).

so, next to the famous Tower of London there was built The Shard, near the neo-gothic Southwark Cathedral , in 2002, there was built the architecturally interesting City Hall, and along the southern banks of the Thames there was renovated and reconstructed the Potter Fields park. In this way, the city authorities take up actions that aim at the best architectural and urban solutions as well as at the sustainable development of the city environment. To activate the urban environment and to take center-creating actions in the already existing city structure.

The Shard proposes a diversified utility program. The ground-floor zone houses restaurants and cafes linked with an external public square and an artistic exhibition area. 25 floors above are occupied by offices. Each of these floors has three winter gardens that are to improve the microclimate of the office space. The next floors up are occupied by restaurants (3 floors), a hotel (17 floors) and residences (13 floors). The building is crowned with a triple-level indoor gallery and a partially outdoor gallery from which you can admire the city skyline. The uniquely shaped form of the building facing towards the future and respecting the context of the environment has become a landmark and a new icon of London. The adopted functional solutions together with a diversified program offer make the area user-friendly and meet expectations of the growing and demanding population of this city (Januszkiewicz, K., Sołkiewicz- Kos, N. 2014) (Fig. 3, Fig. 4)

Fig. 4 The uniquely shaped form of the building has become a landmark and a new icon of London.

5. CONCLUSIONS

Central areas of cities are special places which, throughout history, have served different functions. An attempt to create new values in the areas inscribed in the context of cultural environment is a form of response to contemporary functional requirements and to redefined social needs. The presented structures are examples of buildings inscribed in the context of the environment and creating new space quality. The new space quality involves introduction of modern aesthetics to a historic building layout. The attractiveness of the created space encourages residents to interact with the proposed functional solutions. The created cultural spaces, evoking surprise for their innovative solutions and implementation of the latest developments, have become an important place which shapes the environment and character of urban areas where tradition and the present meet.

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MULTI-PROPOSE COMPLEX THE GREAT SILK WAY WITH DRAMA THEATRE, CERIMONIAL HALL AND EXHIBITION CENTER IN THE CITY OF TALDYKORGAN IN KAZAKHSTAN

POSTER

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ABSTRACT

Taldykorgan city – is the administrative center of Almaty region, one of the major cities in Kazakhstan, located on the Great Silk Way, which is functioning today as an international thoroughfare, transportation of freight from China to other regions and countries.
Consequently, the authors propose the idea to create extensive town-planning center on the Great Silk Way. In this regard, Multi-purpose complex is represented in the project design complying with the historical traditions of space planning of the great trade road.
The complex consists of Drama theatre, Ceremonial hall and Exhibition complex with proposed facilities of business–center with sports and fitness center, hotel with ballroom, cinema and supermarket, located around park area with fountains, open parking and square with "Zhetisu" fountain.

1. INTRODUCTION

For the Great Silk Way travelers, Semirechye appeared in its natural splendor of Zailiyskiy Alatau mountains and emerald valleys with crystal-clear rivers. Immense natural oasis in the south of Kazakhstan deserts suggested building necklaces of cities with their thriving markets, trade houses, caravanserais, handicraft enterprises. All these elements of ancient human civilization on the «Great Silk Way» became the prototype of present-day mixed use complexes and ensembles with their cultural and show institutions, business centers, hotels, service and shopping facilities.

2. BACKGROUND

Taldykorgan City with its ecologically clean biological environment at the present day appears to be the only possible town-planning establishment with a good chance to restore and carry on traditions of the Great Silk Way. The Great Silk Way is one of the greatest achievements in the history of world civilizations. Extensive networks of caravan tracks crossed Europe and Asia from Mediterranean to China and under the Ancient times and Middle Ages served as an important means for commercial relations and a dialogue between Oriental and Occidental cultures. The longest part of the silk way crossed the Central Asia and Kazakhstan territories.

3. METHODS

For the investment prospects, development of tourism, for comfortable living conditions of local people, appealing to the Great Silk Way history, while developing the complex, being inspired by the Semirechye area landscape, the project designers created multifunctional space representing mountain peaks and fertile valleys, forming the environment with cool and crystal-clear rivers and lakes.
Therefore, it was decided to form on the present-day Silk Way route a town-planning multifunctional complex with Drama Theatre, Ceremonial Hall, Exhibition Center, modern hotel complex, business center, sports and fitness block, cinemas, restaurants, cafés and a supermarket.
Provided that it shall comply with the best achievements of the worldwide town-planning qualities applicable to the construction of similar complexes and what is most important is that it shall harmonically fit in the compositio-

nal solution of the surrounding development, in its turn allowing its future prospects.
The Great Silk Way multifunctional complex architectural solution and structural-spatial concept is the construction of permanent arrangements of Drama Theatre, Ceremonial Hall, Exhibition Center, service hotel, business center with sports and fitness complex building cubic contents, symbolizing in their appearance elm and plane trees, oaks and other desert oasis trees with powerful column-trunks, supporting spreading crowns-cornices, protecting the environment from the scorching south sunshine.
The accepted motif for the structural-spatial concept of the ensemble items provides the compositional concept integrity, ensuring the creation of unusual architectural unit in Taldykorgan City, which is formed in the unified architectural style, equally important for the modern urban development.
According to the architectural concept and structural-spatial construction of the whole complex, the landmark is the Drama Theatre building.
The key architectural concept is the creation of recognizable and unique appearance of the world-class cultural and educational building, considering general planning concept of the theatre, complying with the climate conditions of the region, and meeting up-to-date requirements applicable to the facilities of such type.
In developing the conceptual design, the internal and massing planning concept corresponding to its uses and the specific character has been adopted.
In accordance with regulatory requirements and program conditions, the building schematic layout is divided into the main areas as required by the construction technology of this facility, and includes:
- spectators' rooms suite;
- stage suite with tiring-rooms
- production premises and dead storages

This approach aimed at finding solutions to problems specified has determined the approved massing and internal planning concept of the building as a whole, with the large hall accommodating 400 to be located in the center and two small halls to be located above dead storages and a large hall pocket, suggests the possibility of providing technical interconnection of all rooms and all suites of theater rooms.
Reasoning from this, the octagonal in plan building provided an opportunity for a differentiated approach to location of individual functional areas of the building relative to each other and the center the building layout, namely, the large hall with the entrance hall including the cloakroom and box office lobby located below it.
The planning concept as a whole is dictated by the use and the theater construction technology, which provide a clear distribution of staff rooms and administrative offices, rehearsal rooms and tiring-rooms on the floors. At the same time, the planning concept provides an all-round view of the area in front of the theater and the main square view with its fountain "Zhetysu".
Vertical transportation including stairs and elevators ensures connection among all functional areas of the theater.
In accordance with the conditions of the competition, the design provides for a Ceremonial Hall with a Civil Registry Office and Conference-Hall. Clear and compact planning structure with central main staircase and atrium space provides technological differentiation of all building areas.
In particular, the first and second floors accommodate the Civil Registry Office premises with champagne and registration halls interconnected by front staircase designed to connect only two floors.
The third floor has a conference room accommodating 80 with offices. The banquet hall with a kitchen and foyer is located on the fourth floor.
Along with the front staircase, the design provides for two escape stairs and elevators.
The design also provides for an Exhibition Center with a Conference-Hall and a Lecture Hall. Two-storey building, with has rectangular shape on a plan, is provided with all the required rooms.
In particular, the ground floor accommodates the following: entrance hall, exhibition hall with crush bar and administrative offices; the second floor accommodates the exhibition exposition and conference hall that will seat 400 for as well as the lecture hall that will seat 92.
At the basement car park level, the storages with freight elevators, loading room and mechanical rooms are designed.
In accordance with conditions of the competition, the authors proposed that the mixed use complex should include 14-storey stepped building of the Business-Center and Hotel with service center as well as two-storey block with cinema halls, and sports fitness center.
In addition, a basement car park accommodating 600 cars is designed under the whole complex.
The building uses the ambient energy for heat and electrical supply.
So the building energy expenses decrease, as well as an environmental impact. New alternative non-conventional and renewable power sources have been used: such as PV panels (solar batteries), low grade ground heating energy

collection systems and low-grade heat, extracted ventilation air, solar collectors and usage of high-performance sun protection glass.

The system based on solar vacuum collectors is intended for hot water production to be of the desired temperature by absorbing of solar radiation that is converted into heat to be accumulated and transferred to the consumer. The solar vacuum collectors manifold provides for solar radiation collection in any weather, regardless of the outdoor air temperature. Solar vacuum collectors are mounted immediately on the roof structure of the building; thus, roof structure area is the most effectively used for energy collection.

Another project design strategy is as follows: the use of high performance solar glass, which has a transparent coating to limit the influx of solar energy and, at the same time, provides effective light transmission as well as the energy output by the building envelope to reduce the total energy consumption of the building. The high performance solar glass expenses may be compensated by avoided lighting costs.

Structural

All the facilities of the mix use Ensemble are provided in the cast-in-place reinforced concrete frame structure being designed for the forces of the areas with seismicity of 8 points. Columns foundations are provided as free standing cast-in-place reinforced concrete footings bonded with cast-in-place framing foundation beams along the perimeter, cast-in-place reinforced concrete foundation strips are provided below the exterior and interior walls.

Roofs and floors with span lengths of more than 12, 0 metres are provided in steel frame in kind of truss girders constructed of standard rolling sections. Floors with span lengths of up to 18,0 metres are provided as standard rolled-steel joists for light loads and steel truss girders for significant useful loads. Owing to arrangement of the cast-in-place slab, vertical and horizontal bracings, floors and roofs form the rigid horizontal disc which distributes loads between the vertical structural members pro rata their stiffness performance.

All the steel members unprotected with fire-retardant finishing-coats should be coated with fire-retardant painting based on a rated fire resistance.

Along with the cast-in-place reinforced concrete frame structure, frame & bracing or frame steel structure may be used as critical structural members designed for 8 points with appropriate fire protection actions.

MEP solutions

Building MEP systems are based on up-to-date principles of providing of buildings life support systems.

Application of up-to-date MEP solutions is aimed at significant saving of labour and energy resources in course of the long-term operation of the building.

The aim of an engineering project is to create “Smart Buildings”, i.e. buildings equipped with sophisticated engineering equipment integrated in a single Complex which enables to control the whole life cycle.

The main MEP elements of the buildings of the Complex are the following systems:

- Het supply, cold supply, ventilation and air conditioning;
- Water supply & sewage;
- Power supply (duty & emergency);
- Fire Safety (fire alarm, smoke control, public address system, firefighting and etc.);
- Security (access |control, CCTV and burglar alarm);
- Lighting (routine, duty, emergency);
- Street lighting (landscape, decorative and security, accent lighting);
- TV, telephony, conference systems, structured cabling system;
- Information & process system;
- Passenger & freight elevators;
- Centralized dust removal;
- BMS;
- Use of environment energy for heat&electricity supply of the building

Pedestrian Access

For easy access from both sides of the Complex as well as inside it, driveways and walkways are arranged with landscaping and hardscape.

Transport

In course of development of the site Master Plan, bypass road connected with new streets of residential areas and access roads inside the Ensemble is provided. Underground parking with 596 car lots provided with single or double-track ramps for cars ingress and egress is designed below the all the buildings of the Ensemble.

Smoke Control

Smoke control system is provided for safe escape of people during fire in the auditorium and other premises. The specifics of engineering of such a system are to provide safety required for a large number of people present in the same room at a various height. Engineering of the smoke control system in the auditorium is carried out based on the provision of escape routes safety. Acoustic requirements cover smoke control systems. To avoid negative smoke control systems acoustic effect, smoke exhaust system diagram has been developed which includes silencer, smoke-suction valve, fan and check valve. All the system is provided with the fire-resistant insulation.

Being geared to oasis creation concept, the design provides for the site improvement – fountains, green plantations, flower beds, hard landscaping. The main Zhetysu fountain, located on the side of the main entrance, is notable for the significant water-surface area and can be used as a skating-rink during winter time.

In accordance with the regulatory requirements of the Republic of Kazakhstan the design provides for living conditions and leisure-time activities for people with limited mobility: access ways for wheelchairs, elevators and wc.

The design provides for aesthetic night lighting of the complex, which shall pretty much increase its conceptual significance and consequently its aesthetic emphasis in the urban development planning structure.

Structured Cabling System

For the provision of the Complex building with information and technical systems, such as Local Area Networks (LAN), and other means of communication, Structured Cabling System (SCS) is provided, which includes the system of telecommunication cables, patch cords and switching equipment. Switching Center is located in telecommunication space, where following is installed:

- PABX (Private Automatic Branch Exchange)
- Telecommunication cabinets, where switching, technological and active networking equipment is installed.

Television

The project provides Television Distributing Network for buildings to ensure connectivity to main television network.

Building Television System as a part of major public informational and sociocultural center shall provide access not only to TV channels widely broadcasted in the country, but also to foreign TV channels broadcasted via satellites and other communication systems.

Fire Alarm System and Public Address System

Automatic Fire Alarm System is provided by the application of heat and smoke detectors in all spaces of the Complex in accordance with the requirements of SNiP RK 2.02-15-2003, SNiP RK 2.02-05-2009* and SN RK 2.02-11-2002*, and technical documentation of equipment manufacturers as well.

Automatic Fire Fighting System power supply is provided according to PUE reliability rating I.

Fig. 1 Perspective

Intrusion Alarm System

Intrusion Alarm System is performed according to the Design Brief and in compliance with requirements of Building Codes around the perimeter of the first floor of the building, to provide door locking with magnetic contact sensors (MCS), motions sensors, and acoustic glass break detectors for windows.

CCTV

CCTV System is performed according to the Design Brief and in compliance with requirements of Building Codes to provide continuous video monitoring over the situation in public areas – halls, cashier desk, entrances and exits of working areas (areas closed for visitors), parking etc.

Building Automation System (BAS)

BAS is designed with application of Programmable Logic Controllers. Following systems are included in BAS package:

- Heating, Ventilation and Air Conditioning;
- Heat Points;
- Boiler Rooms;
- Water Supply;
- Fire Suppressing;
- Process Gas Supply System;
- Power Supply;

BAS Control Center is located on the first floor of the building, where natural lighting and direct exit to the outdoors are necessary.

System is designed with 25% reserve for flexible addition and has an ability to integrate with other building intelligent systems into unified complex.

4. RESULTS

KAZGOR Design Academy took first place in custom-made Architectural Design Competition for the “Best sketch idea for the design of Drama Theater, Hall of Celebrations and Exhibition Complex in Taldykorgan” among design companies of Kazakhstan.

5. CONCLUSION

Implementation of this project can give an impulse to the development and formation of architectural ensembles in the cities, located on the Great Silk Way, and, in particular, in Taldykorgan City.

Fig. 2 Perspective - Night view

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ASSESSMENT OF VULNERABILITY FEATURES OF TERRITORIES IN THE REPUBLIC OF ARMENIA

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Keywords

spatial planning, vulnerability, indicator

ABSTRACT

The principles of assessment of territories for spatial planning, which have found their place in Armenia and abroad, are presented. The influence of various factors on the vulnerability of territories and the selection of indicators features in the conditions of the Republic of Armenia have been studied. As a result of analysis suggestions at the level of communities (settlements) to assess the vulnerability of physical - geographical, natural resource, demographic, socio-economic factors and the selection of the methodology and application of indicators are presented.

1. INTRODUCTION

The most important for solving both vulnerability and assessment of other characteristics of territory issues is that circumstance that is the kind of range of factors and that will be the basis for assessment. In the published by the Committee 2007 of the European Ministers (CEMAT) on the spatial/territorial planning "Spatial development glossary" issues are identified as vulnerable those regions, where for various reasons is a relatively low level of economic development (http://book.coe.int).
These reasons can be:
a) geographical position, especially distant and suburban (border) regions
b) natural-climatic conditions (polar or prone to drought, also mountainous regions)
c) resettlement features (low population density, tendency to migrate
d) limited access (isolated, with insufficient transport links with the central regions)
To the number of factors also concern the presence of an abandoned economic infrastructure (subject to transform - former industrial areas).
In general, in the field of spatial planning concepts such as "Territorial development", "Territorial potential", "Territorial impact assessment", "Disadvantaged regions" and etc., involve a range of indicators that are directly related to these concepts, the most specific, measurable and available (Aloyan, A. A. and Safaryan, A. Y. 2014).

2. BACKGROUND

In the part 1.1 of general scheme of the settlement of the Republic of Armenia (http://www.mud.am/maps/tarebnak.pdf) on the basis of the analysis and assessment of territories are the following factors:
• natural-resource,
• geographical
• demographic,
• socio-economic,
• ecological.
In the project the character of the territorial distribution of settlements is represented by a number of directions: distribution of urban and rural settlements and, therefore, the distribution of population by regions, population density per unit area (100 square kilometers), the number of settlements, etc.

3. METHODS

Some researchers take as a basis the natural, economic, socio-demographic, infrastructure and geographical factors (Manasyan M. 2005). To assess the territorial distribution of settlements and overcrowding the method of "near neighborhood" may be applied also (calculation of the distance between the settlements and the ratio of their average value and the number of settlements distributed per unit area) (http://nation.geoman.ru /demogr/item/f00/s01/e0001026/index.shtml). However, in the basis of assessment of territories, regardless of the nature and the number of selected indicators, is a mechanism for the numerical calculation of different characteristics of certain territory (unit area, geographical or administrative area), which makes it possible to obtain the most objective and calculable picture (population density and population settlements, natural resources, or volumes of industrial facilities, etc.). In various studies and documents of official statistics as in Armenia as well abroad in any area in the basis calculation and information lies a unit of administrative territory (in particular, in Armenia calculations are carried out by communities, regions and republic).

4. CASE HISTORY

Such an approach is justified for countries with relatively equally populated and economically developed regions, while in Armenia, where the natural and geographical factors have left a tangible print on the spatial distribution of settlements, this approach cannot be effective enough, especially in terms of availability of objective picture for studies of spatial planning. According to the general scheme of settlement of the Republic of Armenia, 44% of territory of the country is unsuitable for resettlement and almost falls out of the active economic activity. This is mostly mountainous, with steep and rugged relief, as well as specially protected natural areas, in the past not included to administrative boundaries of the community (fig.1).Moreover, this indicator is particularly high in Tavush region, where about 2/3 of the administrative territory is practically absent active economic activity. About the half of the Ararat region is also economically not assimilated, and in the past has not been included to administrative boundaries of the communities.
It is clear that especially in the calculation for problems solutions of territorial planning results can be significantly different, depending on whether any territory is taken as a basis for calculation. In support of this we can take as an example the indicator of population density. According to official statistics, the average density of the population of the Republic of Armenia (including Yerevan) is 101.5 pers./ sq km (http://www.armstat.am/file/article/marz_12_8.pdf), while in the case of calculation for the economically developed territories this indicator is 170.3 pers./sq km. These indicators in Tavush region are respectively 47.5 pers./sq km and 141 pers./sq km. Fig. 2 shows the comparative density of population in economically developed areas and modern administrative boundaries of districts (without Yerevan).

5. RESULTS

Returning to the subject of this research - the problem of the choice of indicators to assess the vulnerability of territories, first it is necessary to define the principles that must be on the basis for the selection of indicators.
1. The indicators should be multifactorial, for a better reflect of the pattern obtained (ie, as a base we should take not only natural geographic or economic factors),
2. they should not be dependent on each other or interconnected (eg indicator of accessibility of public services depends on the distance to the nearest town or to the local settlement system center, therefore, of these we should choose only one)
3. they must be countable and reliable, regardless of the circumstances and significance attributed to them,
4. To determine the significance of indicators it is necessary take into account their character: constant (eg, mountainous location) or variable (eg, demographic indicators).

In previously published studies (Tovmasyan S.A. 2010), we considered the method of determining the degree of vulnerability of the territories where a calculation basis is supposed the number in the current territory of the settlement, that have deadlock or isolated location, the tendency of (documented) reduction of the population, population density is lower than the average republican, as well as deprived of functioning opportunity as local populations centers. The methodology of determination of vulnerability degree of separately taken territories is not available.
In the 8th paragraph of the 3rd annex of protocol decision of the Government of the Republic of Armenia (http://www.mta.gov.am/hy/conceptions) "On approval of the concept of territorial development of the Republic of Armenia" is offered at the regions level and communities the disproportionality of territorial development to assess through a modified indicator, which is considered as a uniform indicator describing the degree of poverty of territories.

The latter, in its turn equate to three indicators: unemployment, vulnerability and limited opportunities to live a dignified life and the weighted sum of indicators of inaccessibility.
It is obvious that aforementioned three indicators are interrelated, moreover, each of these is regarded as numerous indicator (respectively 5, 3 and 11) and also mutually agreed and interconnected. At the same time it is clear that the indicators have social and partly economic character and do not affect the physical and geographical and resource characteristics, which may significantly affect the results of the assessment.

6. CONCLUSIONS

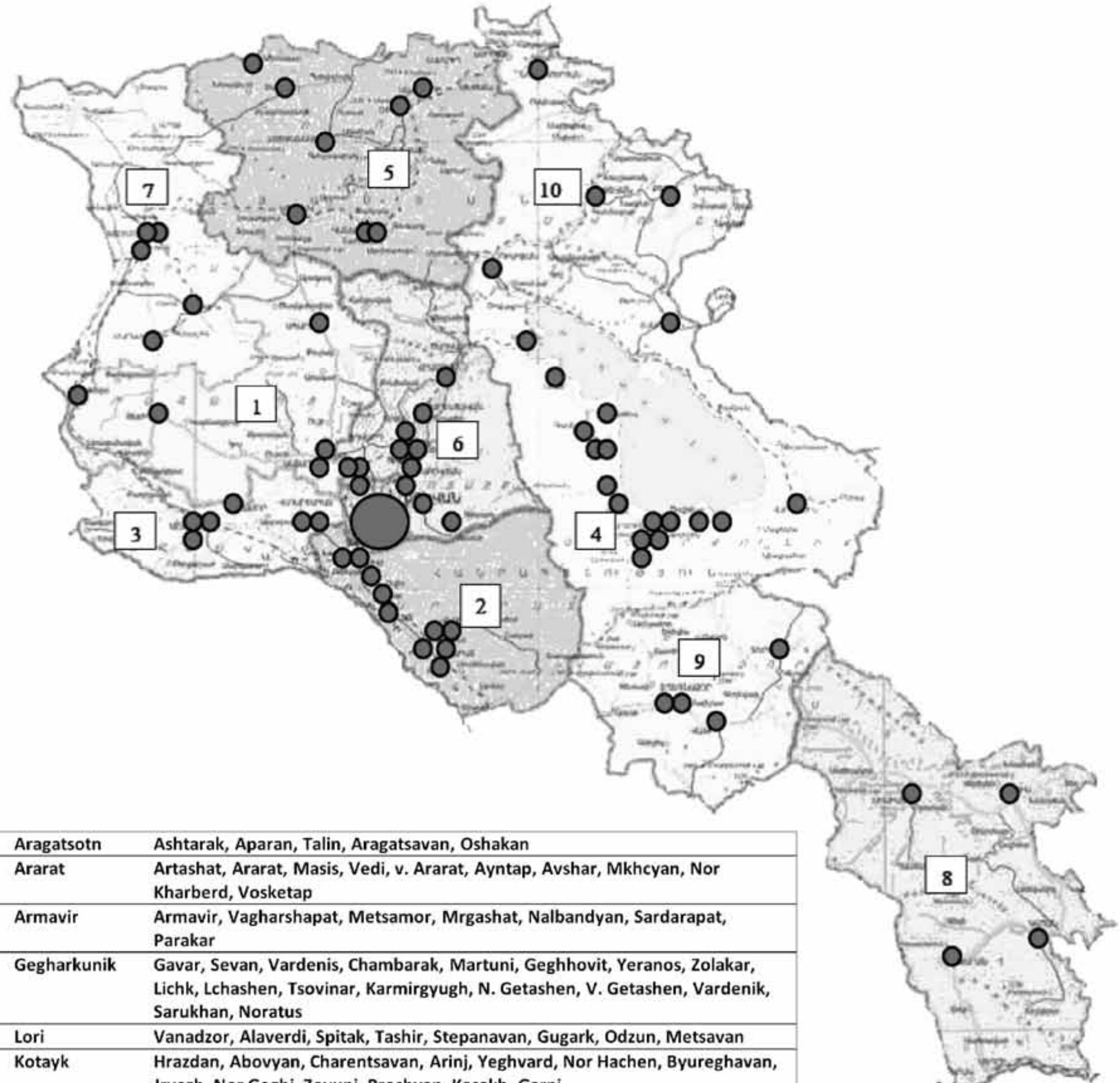
Considering the above, we think that for the vulnerability assessment at the level of communities or settlements it is necessary to apply the following range of factors:
• Physic-geographical (constant quantities characterizing the territory)
• natural resources (for a long period of times and constant quantities)
• demographic (for a short period of time variable quantities)
• socio-economic (variable quantities for a short period of time):
Each of these factors can be characterized by numerous indicators, the complete composition of which is out of the range of this study. As stated above, it is proposed to put as a basis for calculating such indicators that, not depending on each other, are available and assessable. In addition, as indicators, relating to the territories, not take into account the current administrative territory, but their economically developed zones.
Therefore:

1. From physical and geographical factors it is offered to choose the values of heights (alpine and high mountain), cross-border and (or) having oasis position in the system of settlement,

2. From the natural resource factors: the availability of land resources (perforce as well forest, water, recreation, tourism, raw materials), and in the case of rural communities is particularly important to determine for agricultural land the weight per 1 inhabitant,

3. From the demographic factors: the number of population density and dynamics of changes (volume of immigration and the trend of aging)

Of socio-economic factors - the degree of availability of public services, private profit of the community and capital costs per 1 inhabitant).
Of course, the choice of indicators can vary, depending on whether it is a city or a village, however, bearing in mind that the number of residents in some cities of the Republic of Armenia does not match the idea of the number of urban residents (in Dastakert-301 in Shamlugh-735), entry for other sides still no legal act does not define the concept of “city” and “village”, to such a division it is necessary to approach with caution. An important task is also - determination of weight for the individual indicators and principles of compatibility, that is a problem of a separate study, and it can be solved taking into account the results of expert assessments.

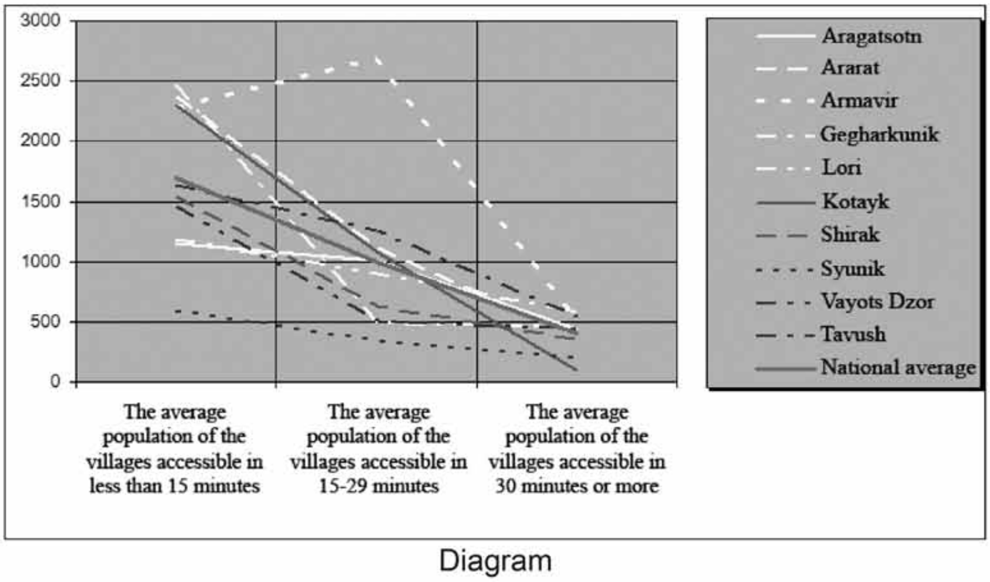


1	**Aragatsotn**	**Ashtarak, Aparan, Talin, Aragatsavan, Oshakan**
2	**Ararat**	**Artashat, Ararat, Masis, Vedi, v. Ararat, Ayntap, Avshar, Mkhcyan, Nor Kharberd, Vosketap**
3	**Armavir**	**Armavir, Vagharshapat, Metsamor, Mrgashat, Nalbandyan, Sardarapat, Parakar**
4	**Gegharkunik**	**Gavar, Sevan, Vardenis, Chambarak, Martuni, Geghhovit, Yeranos, Zolakar, Lichk, Lchashen, Tsovinar, Karmirgyugh, N. Getashen, V. Getashen, Vardenik, Sarukhan, Noratus**
5	**Lori**	**Vanadzor, Alaverdi, Spitak, Tashir, Stepanavan, Gugark, Odzun, Metsavan**
6	**Kotayk**	**Hrazdan, Abovyan, Charentsavan, Arinj, Yeghvard, Nor Hachen, Byureghavan, Jrvezh, Nor Geghi, Zovuni, Proshyan, Kasakh, Garni**
7	**Shirak**	**Gyumri, Artik, Maralik, Azatan, Akhuryan**
8	**Syunik**	**Kapan, Goris, Sisian, Kajaran**
9	**Vayots Dzor**	**Yeghegnadzor, Vayk, Jermuk, Malishka**
10	**Tavush**	**Ijevan,Dilijan, Berd, Noyemberyan**

Fig. 1 Developed urban planning and economic zones in the Republic of Armenia on the general scheme of settlement of Armenia.

Table

Marz	Villages or rural communities	Out of those					
		15 minute or less accessibility from the nearest town		15-29 minute accessibility from the nearest town		30 minute or more accessibility from the nearest town	
		amount	Percentage from the total	amount	Percentage from the total	amount	Percentage from the total
Aragatsotn	117	66	56.4	49	41.9	2	1.7
Ararat	94	82	87.2	7	7.4	5	5.3
Armavir	95	86	90.5	5	5.3	4	4.2
Gegharkunik	92	76	82.6	12	13.0	4	4.3
Lori	122	88	72.1	26	21.3	8	6.6
Kotayk	62	50	80.6	11	17.7	1	1.6
Shirak	128	66	51.6	25	19.5	37	28.9
Syunik	127	53	41.7	55	43.3	19	15.0
Vayots Dzor	52	19	36.5	20	38.5	13	25.0
Tavush	60	27	45.0	27	45.0	6	10.0
Total	949	613	64.6	237	25.0	99	10.4



Diagram

Fig. 2 Comparative indicators of population density on the economically developed areas, and administrative boundaries of the area (pers./ sq km).

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TERRITORIAL PLANNING IN UP-TO-DATE RUSSIA: DEVELOPMENT AND IMPLEMENTATION ISSUES

POSTER

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Keywords

territorial planning, stable development, social and economic development

ABSTRACT

Analysis of the territorial planning system in the Russian Federation reveals three levels of document preparation. These levels are determined by the structure of administrative-territorial division of the environments, power and responsibility of the state governmental body and local administration.
The analysis results for preparation objectives and territorial planning documents content show, in total, a fragmentary nature and incomplete specific features of issue solutioning regarding natural management and social and ecological development as well as controversial possibilities of their implementation. These specific features mostly reveal themselves at the level of territorial planning schemes of the Russian Federation. According to the Urban Planning Code of the Russian Federation, only a small number of federal ministries are responsible for preparation of such documents. These documents stipulate the structure, dates and location for the capital construction objects of federal importance. Often, these issues are not correlated properly with each other and with current and strategic objectives of the state governmental bodies and local administration.
It is required to improve the regulatory environment for the Russian Federation area management.

1. INTRODUCTION

In accordance with the definition of the Urban Planning Code of the Russian Federation, territorial planning constitutes a part of urban planning activities intended to ensure stable and safe socio-economic development of the state, its regions and urban areas. Territorial planning is conducted by the federal and regional state executive bodies and bodies of local administration [1].
Territorial planning in the Russian Federation is carried out in the form of schemes (maps) covering the earth surface areas under the jurisdiction of the Government of the Russian Federation, constituent entities of the Russian Federation and its municipalities.
Territorial planning in the cities of federal importance, i. e. Moscow and St. Petersburg as constituent entities of the Russian Federation is realized through preparation of their general development plans [2].
Though the content of the territorial planning documents is defined by the authority of the entities involved in the territorial planning in the area of land-use management and capital construction on the jurisdictional earth surface areas, i. e. land mass and water surface, still it does not cover all challenges of comprehensive, stable and safe development.
Comparative analysis of a territorial planning document in the Russian Federation reveals its specific features which correspond to the management structure of economy and social sphere of the state, regions and municipalities.

2. BACKGROUND

Federal bodies regulating development of individual economic and social sectors are responsible for preparation of territorial planning documents in the Russian Federation within the limits of their authority. At the suggestions of the Government of the Russian Federation and by the Edicts of the President of the Russian Federation, the scope of the sectors requiring preparation of territorial planning documents may vary [3].
All compulsory territory planning schemes of the Russian Federation are presently developed and approved in the following sectors: federal transport, state defense and security, education and health care. It is evident that the mentioned areas of responsibility of federal executive bodies do not cover all aspects of land and property regulations

establishing conditions of the state's stable and safe socio-economic development. The schemes contain only planned measures and activities, scheduled by the state executive bodies and related to distribution and construction of objects providing the realization of functions of the said bodies in the specified areas for the current period. The predicted duration for the territorial planning schemes, irrespective of the level of their development, is 10 years, and 20 years for the transport development scheme [4].

Territorial planning schemes of the federal level are developed based on the state plans and programs of social and economic development in respective sectors as well as other strategic planning documents which determine current, mid- and long-term objectives connected with the spatial distribution of physical infrastructure of the said sectors. Territorial planning documents specify planned location of capital construction objects identified in such strategic planning documents. Specification of such objects in strategic planning documents is reason enough to include them into territorial planning schemes of federal, regional and local levels.

The justification for inclusion of different-purpose capital construction objects into the strategic documents of not only federal, but also regional and local levels is beyond the scope of territorial planning objectives regardless of the fact that supporting materials for the development of territorial planning schemes include comprehensive analysis of the area management efficiency of a certain sector in terms of influence of its objects on the social and economic development of the state, regions and municipalities.

Territorial schemes of the entities of the Russian Federation are also broken down by the sectors [5].

They specify planned activities aimed at development of the following regional spheres:

- regional and municipal transport;
- education;
- health care;
- sport;
- prevention of natural and manmade emergency situations;
- other spheres by virtue of the authority of the entity of the Russian Federation.

As a rule, the specified information contained in the strategic documents of the entity of the Russian Federation is disclosed in industrial schemes and a consolidated scheme as a general design plan. An important part in the territorial planning documents of the Russian Federation is given to land use issues, as an inertia of the preparation procedure for the regional planning schemes developed earlier [6].

However, different-purpose territories are specified in such documents based on the principle of actual land use and planned land use boundary modifications given that such modifications are substantiated by respective Resolutions of the Governors of the regions or Presidents of the autonomous districts and republics.

Suggestions for reformation of the residential area system, planning patterns of the entity of the Russian Federation and the existing land-use system which may arise on the results of the comprehensive territory analysis lie outside the scope of regional territorial planning.

Territorial planning schemes of municipal areas as part of entities of the Russian Federation are prepared in the form of a general design plan and supplemental schemes of industrial development of individual local administration areas based on the following planned distribution of the objects of local significance:

- power and gas supply of communities;
- local roads in inter-settlement areas;
- education;s
- health care;
- physical education and mass sport;
- disposal and recycling of domestic and industrial wastes;
- other objects required for the exercise of the authority of local administration.

Territorial planning documents of the municipal areas also contain distribution of federal and regional objects, which construction is scheduled by strategic planning documents of the Russian Federation and entities of the Russian Federation [7].

In addition to different-purpose objects in the specified areas, existing and scheduled for construction on the territory of a municipal area of federal, regional and local significance, territorial planning documents also contain the designation of land use boundaries and residential area boundaries (settlements and city districts) as well as their modifications according to regulatory legal acts of the Supreme executive power bodies of the particular entity of the Russian Federation.

Despite the fact that land-use analysis is an obligatory part of a municipal area territorial planning documents, eventual suggestions for effective area management and provision of planning and construction resources for the stable and safe development, arising on the results of such analysis, are not within the scope of the authority of Area

Administration and are not included into the comprehensive socio-economic current, mid- and long-term planning.
General plans of settlements and city districts are prepared to indicate the places of planned location of objects of local significance of the particular municipality, boundaries of residential areas, including new areas established by the decision of local administration which form a part of settlements, city districts, boundaries and places of functional areas suitable for location of different-purpose objects providing conditions and infrastructural facilities for the sustainable operation of these objects [8].
General plans of settlements and city districts indicate the following objects:
- public power, heating, gas and water supply, waste water disposal;
- local roads;
- physical education and mass sport, education, health care, disposal and recycling of domestic and industrial wastes in case of the general plan preparation of a city district;
- other objects planned for construction and required by the authority of local administration of a settlement or a city district.

General plans of settlements and city districts also indicate location of federal and regional objects as well as local objects of a municipal area, existing or planned for construction on the territory of the particular settlement or city district.
The main purpose of general plans of settlements and city districts is to indicate the existing and approved administrative boundaries. The justification for modification of the boundaries and the use of the territories does not form a part of the preparation tasks of the document parts to be approved. All information contained in general plans of settlements and city districts is compiled from the regulations of federal and regional executive bodies as well as local administration of municipal areas of these settlements and city districts.

3. CONCLUSIONS

In general, territorial planning in the Russian Federation is object-oriented and serves to indicate location of different objects with a view to the exercise of the authority of regulatory bodies and local administration.
The existing legislation and regulatory system do not stipulate for the rational, effective and safe area management of the Russian Federation, its entities and municipalities.
Unfortunately, the industry-specific and object-oriented principles of territorial planning adopted by the Urban Planning Code of the Russian Federation can't reasonably facilitate the state's transition to the principles of stable development, preserves the existing non-effective in the current market conditions system of industrial allocation, does not meet global challenges, supports wasteful natural resource management, does not provide for a rational structure of Gross Domestic Product, keeping a large amount of transport and commodity costs, which holds down the rate of the state's social and economic development [9].
The regulatory environment of the Russian Federation area management needs to be reorganized from the perspective of provision and enhancement of stable and safe development of urban planning structures and socio-economic development of the country. In addition, it is required to revise the current procedure for preparation of socio-economic and territorial planning documents, as it is presently focused neither on stable development nor on environmentally-acceptable, socially-effective and ecologically-sound reformation of the functioning and planning structure of administrative territories.
A planning procedure for the environmental modification measures should consistently address the following issues:
- preparation of a theoretically substantiated concept of stable area management and rational natural resource management of the territory;
- working out of comprehensive and industry-specific development principles and strategies based on the stable area management and rational natural resource management;
- preparation of territorial planning documents with an administrative (address) reference to comprehensive and industry-specific development principles and strategies;
- development of comprehensive and industry-specific programs and plans for social and economic development of administrative areas based on the territorial planning documents;
- preparation of planning, land development and land-surveying documents for the specific territories of municipalities based on the current plans of social and economic development, with reference to the preparation of land-use and land development procedures as an individual stage [10].

As a result, different types of territories shall be established and developed, same as it was in the former port and storage territories of Hamburg [11].
The suggested model of urban development is characterized by the compliance of planning levels with urban

planning in respect of the forecasting and territorial coverage level as well as by justification of legal base for the distribution and construction of objects by the cadastral plans of plot and land, division of land zoning by the general part which is approved by the regulatory legal act of the local representative body, plans of area localization within the boundaries of territory planning structure of administrative municipality approved along with land development schemes (projects) by the executive municipal bodies.

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In the project the character of the territorial distribution of settlements is represented by a number of directions: distribution of urban and rural settlements and, therefore, the distribution of population by regions, population density per unit area (100 square kilometers), the number of settlements, etc.

URBAN SPATIAL JUSTICE OF INTRA-GENERATIONS IN PORT SUVA: ANOTHER EXISTENTIAL FORM OF NEO-URBANISM

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Keywords

urban space, environmental justice of intra-generations, city, spatial justice

ABSTRACT

Urban Spatial Justice of Intra-generations, on the basis of sustainability, emphasizes on abolition of the Dualistic contradictions between city and nature. Via form and flow the co-existing relation is created among urban space, natural space and industrial space. On the case study of Port Suva, Capital of Fiji Republic, from the viewpoint of environmental intra-generation justice, five dimensions are constructed: form, matter, flow, size and time. From this what is analyzed turns out to be: the relation between city and nature and the reliability of human-dwelling idea. Urban spatial justice is enhanced by means of the idea of humanity to maintain the harmonious coordination between man and nature, between man and space, and hence, step forward to the urban space of sustainability.

1. INTRODUCTION

Neo-urbanism, a design theory and social ideological trend, is known by some as “Neo-conventionalism” and originated in US in the 1980’s. Cultivating its innovative inspiration from traditional idea of urban design and mingled with quantitative elements of modernism, the preliminary of Neo-urbanism reconstructs a “compacted” neighboring community which enjoys great popularity from urban citizens and is characterized by strong local color and cultural indulgence. The community in particular is supposed to take the place of the “suburban model” which enjoys less affinity. Neo-urbanism advocates unique design concepts, and among other things, the concepts on how to organize and construct human-dwelling space. It is no wonder that neighborhood space, partition space and corridor space constitute the elementary elements of Neo-urbanism. Under Neo-urbanism, the ideal model for forthcoming human-dwelling space turns out to be: a compact, function-compound and pedestrian-appropriate neighborhood; partition with proper location and feature; and a corridor of functionalized sustainability with artistic beauty originating from the combination of nature and artificial community. In the 1930’s Clarence Perry asserted the theory of “Neighborhood Unit”, which was later developed by Neo-Urbanism and induced into an ideal public space, i.e. a vacant, tangible space immune from construction, and public space or public buildings should be given great priority. Compared with neighborhood unit, partition used to be taken as a zone with its function specialized and based on the concept: “specialization brings about great efficiency”. As the advancement of information revolution and environmental technology, the rigorous concept of “function-based partition” serves as, no longer, a unique classification module. The concept of partition allows more functions to be added into it and the structure of partition is set up on the basis of the module similar with neighborhood unit. In the meantime, partition enjoys apparent border and dimension, enjoys a public space with a distinguishing feature and enjoys correlated ring-road available to pedestrians, connecting the services to other areas via public transportation system.
Port Suva, Capital as well as the second most populated municipality of Fiji after Nasinu, is on the southeast coast of the island of Viti Levu, in the Rewa Province, Central Division (Fig. 1). 56% of the Suva population turns out to be Indian descendents whose ancestors took their residence in Port Suva between 1879 and 1916. They, when taking their inhabitance in Port Suva, acted as contract labors planting sugar-cane. The other residents of Port Suva belong to the races of Melanesians and Polynesians, 15% of the population being French, Australian and Chinese. Due to the fact that large land area of Port Suva is composed of coral reef and limestone (unlivable), its suburban zones come to be densely-populated, from which “Suburban Urbanization”[1] results.

Fig. 1 Port Suva, Capital as well as the second most populated municipality of Fiji after Nasinu, is on the southeast coast of the island of Viti Levu, in the Rewa Province, Central Division

2. URBAN CULTURAL TOKEN OF NEO-URBANISM AND PORT SUVA MODULE

Since Greco-Roman Culture took shape, city or polis has been rated as the core of human civilization. City is "the material token of human civilization" (From Gorgias, Plato, 1986). European urbanization in the Middle Ages eulogizes that the urban cultural token derives from the urban planning of urban basic facilities and recreational places. Urban culture also embraces regulation of urban space, rational cultivation of land and cultural policy to distribute urban dwelling, the outcome of urbanization. With regard to urban planning of Port Suva, the fundamental factor which really counts proves to be its urban culture. Urban culture is the decisive factor which lays a solid foundation for the urban image of Port Suva embodied by its substantial tokens. Urban planning turns out to be the spatial layout of urban substantial tokens. Accordingly, port Suva's urban culture determines its wholesome layout and distribution of its urban facilities.

2.1 Intra-generational Equity of Urban Space: featuring urban culture

The low-carbon city mode of Port Suva with the harmony and coexistence between "modernity and nature" has explained the philosophical thought of "Environmental Intergenerational Equity" of the West. "Environmental intergenerational equity", also known as "environmental equity of inter-generations" in philosophy, refers to the fact that the development of human society shall follow through on a sustainable mode and current and future members of the society shall form an entirety of virtuous cycle to share natural and cultural resources of the planet and enjoy the livable ecological environment. People now living on the planet are not just administrators of future environment, but also the inheritors and beneficiaries of resources and fruits of the society left by the former generation. As such, they are obliged to protect the existing environment and resources and also entitled to enjoy earth resources and environment. "Environmental intergenerational equity" principle provides insights into the issue of how to rationally and justly allocate resources and environment between current and future people who enjoy equal rights in three aspects, namely equitable use of natural resources, resources meeting personal demands, and seeking personal survival and development. People living at the moment shall leave necessary environmental and natural resources to future generations.

Page put forward the concept of "Environmental Intra-generational Equity" in 1988 at the earliest time. The concept underscores "collocation", which means that every generation is the trustee of future generation and under the entrustment of future generation, this generation is responsible for protecting the environment and handing it over to the future generation in good condition. Page's principle has been applied in Port Suva, which focuses on three significant rules. The first one is the principle of protecting selection. Current people shall preserve diverse natural and cultural resources for the future generation to avoid their limited rights and ensure they could enjoy diverse resources which are similar and made available to today's people. The second one is the principle of protecting quality. Every generation is obligated to protect the "quality" of the earth and when handing it over to the later generation, the earth isn't damaged or earth "quality" isn't exhausted. The third one is the principle of protecting contact and usage. Intergenerational members have the right to contact and use the heritage left by the former generation on an equal footing and preserve the right to contact and use for the future generation. In other words, current people are entitled to benefit from the heritage left by the former generation and future generation could also benefit from various heritages left by their former generation.

Urban environmental form embraces the senses in both time and space, connoting the strategies or solutions to taking advantage of space in “the best way”. “The best way” is applied to denote the value system and judgment cherished by urban dwellers towards life quality form both personal sphere and collective sphere. And meanwhile the urban dwellers make their judgments and evaluations towards the forthcoming environment policies to urban life. In the 19th century in Port Suva, its urban transformations made its new urban culture: to begin with, Port Suva challenged the traditional villages and towns of South Pacific Area, and ultimately new urban culture took the place of the original urban cultural mode. The perception to new urban culture derived from a new attitude towards the relation between urban ecological form and the physical conditions, spirit and virtue of urban dwellers. Accordingly, between the 1960’s and the 1980’s, which corresponded with the starting period and accelerating period of modern urban planning, the advancement of urban culture was confronted with quantitative problems of urban environmental form, and there should be coming up with new techniques to wipe out these problems. It was during the two periods that great urban transformations took place in Port Suva, to illustrate, the planning and construction of new transportation facilities, the new layout of residential district (Fig. 2), public space, health-care organizations, partition of land use and recreational facilities. These transformations mark the increasing living conditions resulting from the material and virtue carrier, i.e. city. (Fig. 2)

Fig. 2 The new layout of residential district

Beyond any doubt, urban environmental form proves to be the fundamental token of urban culture. Port Suva, as the carrier of the life and work of its urban dwellers, bears the citizen identity and cultural identity of its urban dwellers, which comprises the urban culture of Port Suva. From Port Suva as a case study, urban environmental form depends on the planning and construction of urban material space and substantial space. And urban dwellers’ awareness is expected to go to the planning of humanistic idea of urban dwelling. The goal to plan urban environmental form is to provide urban dwellers with positive ecological circulation and intergeneration-equity urban environment. Urban environmental form consists of urban substantial environment, urban spiritual environment and urban policy-making environment, which are complementing and enrich one another. How to make urban environmental form substantial attributes to “the best way” and the token of urban culture.

2.2 Urban Public Space of Intra-generation Equity: The carrier of Urban Cultural Token

Urban public space, in terms of Neo-urbanism, is all-round open to all the urban dwellers and rated as the core of urban environmental form in which all the cultural activities are going on. Diachronically and synchronically, in Port Suva, the formation of its urban public space is, first and foremost, motivated by its urban economic growth and cultural mode. Urban public space, as the substantial environment to host life, work, communication and re-creation for urban dwellers, represents urban historical legacy and landscape feature.

In Port Suva, urban public space is compared to “the sitting room of Port Suva”. “Urban public space with striking characteristics always arouses evocative resonances of its urban dwellers. When approaching the city, you will soon develop your senses of belonging and identity.” (Susan S. Fainstein, 2011)

3. URBAN SPATIAL JUSTICE: PORT SUVA MODULE

3.1 Urban Space

Urban space is, to be specific, composed of physical, institutional and cultural dimensions and subdivided into physical sphere, social sphere and spiritual sphere. Perth is divided based on these three dimensions. “Contemporary urban space is the outcome of capital production and spatial logic is subject to capital logic”.(Henry Lefebvre, 1996) City turns out to be the result of spatial production and goes against the backdrop of modern urban development, and urbanization advancement is defined by the characteristic of capital property. As the combination carrier of both modern civilization and global capitalist system, Port Suva has evolved into a spatial focus point of capital concentration and circulation. “Capital, power and other factors have been acting as part and parcel of the production and creation of spatial space” (Engels, 1884).

3.2 Port Suva Module: refraining from Urban Spatial Injustice

Urban space, as a matter of physical existence, objectively proves to be independent of human consciousness. As an object of science, urban space is labeled with “neutral”, “innocent” and “non-political”; when it comes to its nature or “intuition”, urban space is, no wonder, a political space, and its political and economic traces left by urban space in particular. Spatial possession and division is referred to as the embodiment of political and economic position, and in succession the cultural identity and social formation unique to urban space take shape (Fig. 3). Space, in essence, is by no means an object of science which keeps a remote distance between ideology and politics. On the contrary, space is permanently stamped with political identity and strategic identity. Being “neutral and non-profitable”, what’s more, space functions as a microcosm of pure latitudinarian and rational abstractness. Space taken hold of, the process of space turns out to be political and accordingly, space is dependent on politics and ideology. Urban space is treated as the relation between work force and means of production as well as the social relation of production and part of reproduction.(Fig. 3)

Fig. 3 Urban space is treated as the relation between work force and means of production as well as the social relation of production and part of reproduction.

3.2.1 Refraining from the crisis of urban sustainable development

The Municipal Government of Port Suva has started its low-carbon urban development since the 1960’s and adopted the urban development strategy of “controlling urban development size, rationally developing living quarters in city outskirts and actively developing ecological urbanization” in the 1990s. Since the early 21st century, Port Suva has witnessed the rapid entrance of low-carbon track in terms of urban spatial development, green coverage, energy consumption reduction and low-carbon work. By the early 2015, its green urbanization rate has been increased by 62%. Thanks to the dual role of urban expansion and internal spatial reorganization, suburbanization of Port Suva

has become ever evident. Rational urban management and “apple-pie ordered” urban spatial organization guarantee the rational extension of Port Suva, prevents Port Suva from loss of arable land, and narrowed the internal and suburban difference of urban space.
Port Suva and other South Pacific Island cities, though defined by different humanity history, geology and environment, urban scale and function, under the joint dynamic mechanism of low-carbon city development, demonstrate similarities in urban space: 1) stable urban form, 2) balanced spatial aggregation, 3) coexistence of horizontal and vertical urban expansion, 4) positive ecological circulation, and 5) harmony among history, convention and urbanization. While ensuring environmental quality and construction well-underway in the city, Port Suva retains historical style and traditional features, strong urban recognition of urban dwellers and diversification of city identity. As such, Port Suva has achieved sustainable development and built a low-carbon urban form amid rapid urbanization process.

3.2.2 Refraining from “Spatial Mismatch” due to accelerated urbanization

Professor Kain at Harvard University put forward the complete “Spatial Mismatch Hypothesis” or “Mismatching Space” for the first time in 1964. “Spatial Mismatch” originally referred to the fact that Ghetto had fewer job opportunities than white society and Black people were faced with greater difficulties in employment and gained lower salary, or they had to spend more time on commuting than white people, making the unemployment rate higher. Port Suva: 1) reduces the investment scale of infrastructure construction, 2) cuts back on the rapidly inflating urban space, 3)puts a lid on floating population, 4) protects arable land resources and reduces the consumption of coal, electricity and oil as transportation fuel, advocating “Pedestrian Movement” and 5) reduces the expansion of industrial zone. Supposed that it evolves into the deprivation of spatial interest by some, urbanization will surely lead to intensified contradiction and social instability. Urbanization as such is unsustainable and the urbanized development of Port Suva proves to be void of the occurrence of such scenario.

3.2.3 Refraining from the “city feature crisis”

Alongside with urbanization, there springs up modern buildings as an intruder towards traditional national buildings. It is beyond any doubt that urbanization will definitely contribute to the emergence of “urban forecast” composed of rebar and cement. Despite of the birth of modern buildings in the urban space, Port Suva has perfectly preserved its historical icons coexisting with the modern buildings, forming integrity between the tradition and the modern. Port Suva has been void of the “city feature crisis” resulting from blind urban planning manifested by 1) unrealistic “destructive enthusiasm”, that is, unrealistically elevating urban orientation and blindly building international metropolis or cosmopolitan city; 2) unrealistic urban renewal and vanity project; and 3) particularly irrational planning of transportation system, blindly chopping trees of sidewalks and broadening carriageways.

4. CONCLUSIONS

The Intra-generational Equity of urban space, from the perspective of Neo-urbanism, turns out to be integrity of a cultural system with the combination of the substantial, spiritual and ideological factors of urban environmental form. The unique urban environmental form makes a striking urban image of Port Suva as a carrier of the urban culture. The urban planning of Port Suva focuses on the harmonious development of “modernity and nature” and starts from the principle of “Environmental Intergenerational Equity” as it works to create the modes of “green city culture” and “green and ecological urban planning”. Port Suva’s cultural mode of harmony between the traditional and the modern acts as a microcosm of South Pacific Island’s urban spatial justice, which develops itself into a cosmopolitan and responds to the globalization process.

NOTE

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[1] Suburban Urbanization, as another paradigm of urbanization, is the end product by economic development. It enlarges the lad area of a suburb, and makes urban functions "suburbanized", which does NOT necessarily mean the deterioration of metropolitan area. On the contrary, it means that a city transforms its functions from being densely-populated to being sparsely-populated.

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INVESTIGATION OF DEVELOPMENT INTERACTION BETWEEN URBAN-RURAL FRINGE AREA IN BEIJING

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Keywords

rural-urban fringe, interaction, sustainability

ABSTRACT

Analyzing the morphological features of space occurring at the overlapping and interacting area between the traditional rural zone and the emerging urban zone where has been planned with the high-tech industrial parks, the paper chooses Huilongguan Town, a northwest rural-urban fringe area of Beijing, as the object to launch the investigation in way of dynamic tracing. Based on the fringe area's scale and visual characteristics such as living space, streets, residential and commercial areas, the paper explores the interactive effects and influence that arises in the process of rapid rural-urban development, as well as the rural-urban features and spatial characteristics in the area. The study could be as a reference to the policy makers as working out implementation measures in the rural and urban planning for the metropolitan Beijing.

1. BACKGROUND

Beijing is a city witnessing huge changes that will significantly impress the world. The old Beijing urban area formed since the middle and late Ming Dynasty has now expanded outward rapidly from the Third Ring Road, the Fourth Ring Road and other outer ring roads. The wide streets and intersecting overpasses have changed the urban landscape that used to be primitive and cramped. Numerous people leave their hometowns, with their dreams, and silently pack themselves into Beijing, the "inflating" city.

Changping district (115°50'17"E-116°29'49"E, 0°2'18"N-40°23'13"N) in the center of Beijing municipal jurisdictions, is close to the four downtown districts of Beijing in its southeast. (Fig1) The district covers 1,352 sq km and its terrain, consisting of three landforms of the hilly areas in the west and the north and the plain in the southeast, slopes downward from northwest to southeast. Changping county was first established during the Western Han Dynasty. In Jan 1956 it was put under Beijing municipal administration and changed to a district in Sept 1999. The district now has jurisdiction over 15 towns and four sub-district offices or regional offices.

As early as the 1980s Beijing began its suburbanization process and formed multiple sub-core districts in its suburbs. The urban population also shows an apparent decentralization toward polycentric inhabitancy. (Tieshan, SUN, 2012) The rural areas in south Changping are close to the North Fourth Ring Road, being a typical urban-rural fringe area and a key region of urban expansion. Since 2003 Changping district has taken the lead to launch a reform of the rural collective economic organization's system of property rights. In 2009 the reform on rural collective economic organizations was in full swing across the district. (Suzhen, LI. 2012) Rural land and villages near to the downtown townships have turned to gathering places of businesses, tourism and service
sectors through relocation and land conversion. The secondary and tertiary industries and population are the major driver of transformation in the usage pattern of land. (Gaohua, SU. 2009)

The Four North Villages, namely Dingfuhuangzhuang village, Shigezhuang village, Dongbanbidian village and Xibanbidian village, are located in Huilongguan town in Changping district and have adopted community-based fence-enclosed management. (Zhen, ZHENG. 2014) As far as the eyes can see, the scene on the other side of the fence is widely different from that across the street. On this side it is crowded with traveling people and vehicles and high-rises, while on the other side it has gravel roads winding and narrow paths running north and south, buildings spaced within arm's reach and almost no public spaces. (Fig2)

This is what the village-in-the-city looks like in the urban-rural fringe area in Beijing. Cottages here have changed to storied buildings, but the texture of villages remains. (Jingwen, Wang. 2010) They are the villages that "accidentally" get involved into the city during the city's development. Local original residents have mostly moved away, leaving the village-in-the-city a foothold for non-natives. Living conditions, geomorphic features and public facilities here all reflect the situations of the dwellers. This is a profile and specimen resulting from the collisions of urban and rural development.

2. INVESTIGATION AND SURVEY

In Dec 2014 we conducted an on-the-spot survey on the "Four North Villages". In addition to random interviews and 98 questionnaires, we also explored three representative places, namely the No 4 residential building in Dongbanbidian village, the street market in front of Dongbanbidian and Xibanbidian villages and Aeon shopping mall. During the process we experienced and perceived the local architecture spaces and forms on the spot and measured the street scales and walking distances between various living service facilities. Among the routine behaviors of local residents we captured representative episodes of life and carried out analysis and research from three perspectives, namely the residential form, environment and traffic and psychology.

2.1 Location, Scale, Population Types and Residential Forms

The "Four North Villages" are located in northwest Beijing outside the Fourth Ring Road. With Shanhenan Bridge in the north, Beijing-Zhangjiakou Railway in the west, Badaling Expressway in the east and Zhujiang Moer Business Area in the south, the enclosed area covers 4.33 sq km and is administratively subject to Huilongguan town in Changping district. The area, at the junction of Changping and Haidian districts, boasts convenient traffic and is only 7 km away from Chaoyang district. Changping district features emerging industries such as modern agriculture and biomedicine, while Haidian district is well known for its intensive high and new technologies such as IT and computer software development. (Anas A. 1998)
There are 2,672 registered households in the "Four North Villages" with 6,556 registered residents and 69,751 registered floating residents of 16 years of age or above. Natives and strangers intermingle here in a proportion of 1:11. (Fig3) The majority of original residents in the villages live on the "tile economy", or the "rental economy", which means they build private housing on their homestead and lease the housing to strangers. Most rental properties here are four- to six-story buildings self-built by the villagers on the homestead 10 years ago. Because the land is subject to collective ownership, such buildings are free from the restrictions for urban communities and architectural standards and are not included in the residential district planning by the government either.
Basic water and electricity supply are available in the "Four North Villages" where the administrative department will collect charges for infrastructure services. There is no pipeline gas in the village and liquid gas storage tanks are used for cooking. Small coal-fired boilers are used for heating with the basic fuel being bituminous coal. The high population density in the "Four North Villages" results in higher pressure on water and electricity supplies. The villages adopt tiered pricing for household electricity, with the villagers paying 0.4 yuan per kilowatt hour and lessees paying 1.5 yuan per kilowatt hour. Health clinics and schools are available in every village, but non-resident students need to pay additional costs. There are also primary schools and kindergartens established by strangers, but they are not approved by the local educational authority and are private and sub-standard educational institutions. The place is prone to security incidents.
Data indicate that most of the residents in the villages-in-the-city are groups working or starting businesses in Beijing aged between 20 to 35, dominated by white-collar employees and the highly educated. (Zongmin, LAN. 2012) Consistent with the abovementioned results, residents in the villages-in-the-city are aged between 21 to 35, with 95 percent of them younger than 30, while some older people are only here on a short stay in Beijing or for childminding purposes. More than half of them have a university education or above and mainly engage in software development and sales (30 percent) and IT (26 percent).

No 4 residential building in Dongbanbidian village sits in the village center. It is a four-floor collective leasing residence with no door security systems. There are a total of 76 rooms in the building for rent with 120 to 150 residents. Its main entrance faces the street and most rooms in the tower building rely on indirect lighting. The housing patterns are almost the same: 3 meters in width, 5 meters in depth and 15 sq m in area; the kitchen and washroom are separated by a light-weight wall and cover about 3 sq m, standing side by side with the entrance; the single space in the house is used as the bedroom. (Fig4)

The first household we visited in No 4 residential building in Dongbanbidian village is lived in by a family consisting of a young couple and their two-year-old child. The grown-ups have stayed in Beijing for more than five years. Stepping into the room, one can see a narrow aisle at the end of which is placed a huge bed, leaving only 40cm room each side. On one side of the aisle are the washroom and kitchen of no more than 2 sq m each, only enough for one person to turn around. The family of three live together with a sister of one of the couple in the confined space. (Fig5)

2.2 Streets and Architectural Forms

The location theory is about the place that human activities make up. It studies the spatial selection of human ctivities and combinations of human activities within the space. It mainly explores the general spatial rules for human activities. (Schmidt-Renner G. 1970) Data indicate that, bounded by traffic and geographic conditions, most residents in villages-in-the-city will choose within a radius of 0.5 km for their living necessities and various public recreational activities. (Zongmin, LAN. 2012)

Close beside the fence is the street market in front of Dongbanbidian and Xibanbidian villages. As the commercial street in the rural-urban fringe zone, the street market is 190 meters away from No 4 residential building in Dongbanbidian village. Aeon shopping mall outside the fence is the biggest shopping center within several kilometers and is about 300 meters from the street market.

Roadside stalls or carts selling snacks can often be seen along the run-down street of the market. Stalls are randomly scattered in the open spaces, constituting an interesting streetscape. These unimpressive side streets witness the hustle and bustle just like the self-forming alleys in Bianliang, capital of the Song Dynasty. The village streets possess a very comfortable scale. The street market in front of Dongbanbidian and Xibanbidian villages, with a great variety of goods available, is comparable to any business street downtown. People can find the latest and vogue fashions designs here.

Aeon shopping mall is a modern shopping center with the widest range of products available within several kilometers. Housing famous commodities from home and abroad, the shopping mall is always ablaze with lights, amazing people with its large supermarket selling international brands in such a remote area. During Christmas graceful dancing performances in the Russian style are staged here. But outside the Aeon shopping market is a totally different scene. The building retains the typical style of the 1980s, with tiling over the walls in a light brown color. Looking back to the village houses 400 meters away, one could easily mistake the place for a county in central or West China, but the luxury designs inside the building, the neat modern facilities and a variety of stylish commodities transports one back to a colorful urban world with a modern lifestyle of convenience, comfort and advanced technology. The 300-meter distance creates such a sharp spatial and temporal disparity that the fence in reality becomes the partition between urban and rural spaces.

2.3 Mentality, Pursuit and Cognitive Fracture of Residents

The last household we visited in Donbanbidian village is lived in by a young man working as a furniture salesman in Beijing. He possesses a peaceful and calm look on his face, but his eyes betray a determination. What's interesting, in his simple wardrobe, hang several neat and smart business suits. He also had a nice laptop on the desk and an iPhone thrown randomly on the bed. His house looks plain, featuring little furniture. The curtain was covered with dust, the wardrobe was of the foldaway type and there was even no chair available for us visitors to sit on in the room. He regarded his current life as a transitional stage to a more satisfactory life in the future. Maybe his spartan existence now gives him free rein to imagine a beautiful life to come.

Bargaining roadside stalls in the chilly winter vs the gorgeous and crowded modern space, the simple and crude cheap snacks vs the expensive Brazilian steak, the simply equipped living room with only one bed and one desk vs the "fashionable and modern" atmosphere in downtown streets, the oppression from living in a humble room vs the pleasures from indulgence in the consumption age, although only 15 minutes' walk apart, Dongbanbidian village and Aeon shopping mall are two totally different worlds in which people traverse everyday routines while experiencing the changes of time and gaining a detached view of the consumption ideal of urban development.

But by traversing places of huge contrasts within a short time or witnessing the dramatic changes of time or ages in almost the same space, such spatial and temporal differences resulting from the collisions will leave their mark in this changeable world, making it easy to develop cognitive fractures and emotional disorders.

Survey results show residents in the villages-in-the-city exhibit corresponding behavioral and cognitive faults because of the changes in their habitat, environment and traffic conditions from rural places to urban ones and from other cities to Beijing. The manifestations include the following:

First, the “immigrant mentality” sprawls. People living in the “Four North Villages” all hold an “immigrant mentality” to various degrees in that they feel they are on a temporary stay. They do not have high anticipation for the service facilities, ambience and neighborhood relationships. They tend to be reclusive, not following their old living customs nor getting involved too much in the new environment. Inhabitants here come and go like a merry-go-round.

Second, the sense of home and belonging is absent. People living in the villages-in-the-city never feel the place is their territory. (Duan, WU. 2005) Everybody treats himself/herself as a passerby. So neighbors are enstranged and they take a nonchalant attitude toward the lack of green space, the absence of leisure and recreational venues and even the deficient spiritual and cultural life, holding no sense of responsibility for the community.

Third, cognitive fractures grow. Lack of understanding of urban culture leads to fragmented and fractured interpretations. People living in a large-scale dimension will, because of constant alienation from nature and land, suffer gradual reductions in traditional living styles and interpersonal relationships, while people living in a small-scale dimension will develop a sense of crisis from urban reconstruction and always experience estrangement with modern living styles. (Mingkun, YAN. 2005)

Fourth, life style and customs conflict. Residents of villages-in-the-city in Beijing possess the indifference exhibited in a large-scale dimension while living in a small-scale dimension, in addition to a sense of crisis and fear from the rapidly developing modern life and urban reconstruction while living in a large-scale dimension. They thus become twin-faced people who neither fully belong to the city nor fully belong to the town.

3. DISCUSSION

The interspatial centralization and expansion of the urban population always accompany the evolution of cities. The trends of spatial distribution of urban populations in various stages will mirror some features of urban economic and social development to some extent. China’s urbanization process, under the drive of multiple forces, is undergoing fundamental changes in spatial structures. After the establishment of an urban land and housing market, economic forces become important for reshaping the urban spatial form and promoting urban space reconstruction. Yet the unique system and the various factors it relies on under the transition economy make the urban space transformation process and mechanism unpredictable and possibly treacherous.

Starting off from the humble room in Shigezhuang in the morning, stepping into the neat office buildings, having lunch at the roadside stalls and enjoying an international-style feast at a modern shopping mall…Day after day, people in villages-in-the-city in Beijing repeat the fault lines from the collisions of urban and rural development and traverse between the disconnected spaces.

This space is a concept of modernity and its development gradually becomes explicit with the development of modernity. The German philosopher Immanuel Kant believed that space is the underlying basis of human perception instead of an attribute of the physical world. So the space becomes the lens for thought with which to understand the world. (Duan, WU. 2005) In light of the general rules of urban development, spatial development should gradually radiate from the center toward the peripheries and maintain a consistency with the spatial change speed in material development. The evolution of human society does not only feature a time dimension. It also has a spatial dimension. It represents a coupling course of the undulation in the time dimension and differences in the spatial dimension (Minglun, LV. 1998). As a synthesis of the time and spatial dimensions, buildings become the framework of time and space. The confines of time and space are also evidence of the scale of environmental design and embody the fundamental implications of the architectural environment. (Yang, ZHANG. 2000). But in Beijing, the rapid spread of cities leaves many areas behind in the urban-rural fringe area. The over-wide streets cut off the continuity of urban space. The unrestricted high-rise buildings create striking mental effects, added to which are disorderly traffic systems, a severe shortage of sectorization and green space, an absence of space devoted to humans, the distress caused by having a humble living space and conditions, as well as there being abundant goods and materials and luxury consumption , so that people living in villages-in-the-city can feel the collisions in terms of living styles, production modes and incomes of urban and rural development, and the dramatic changes and alternation of time and space. The thirst for “development” or “modernization” is manipulating the complexity of the modern Chinese cultural experience intangibly and controlling the Chinese inner world and its ways of behavior. The booming progress of Beijing cannot be halted and, during the spurt of its urban and rural development process,

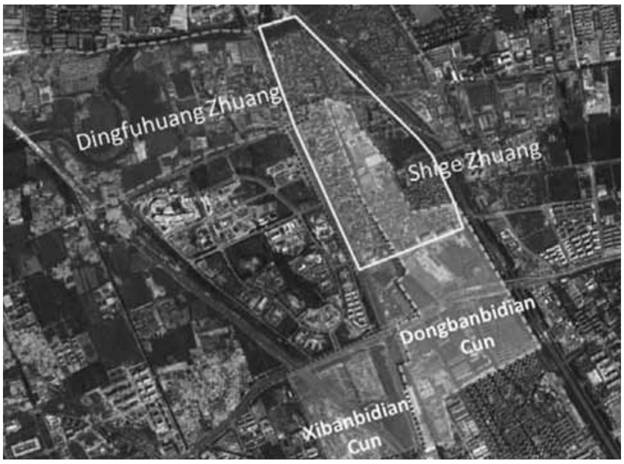

Fig. 1 The natural boundaries of the four village combined ShigeZhuang Village cluster.

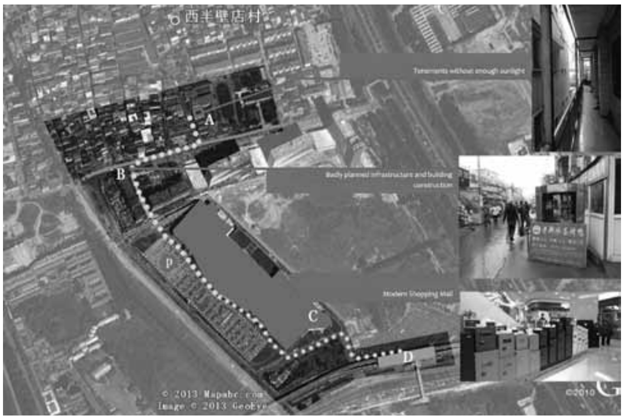

Fig. 2 Characteristics of living space in four villages.

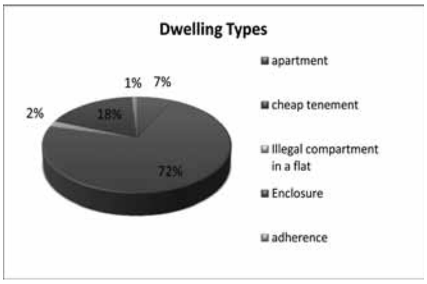

Fig. 3 Dwelling Types of four villages.

some people are forced, and inevitably, endure the faults created by time and space.

4. CONCLUSIONS

Under the influence of the information technological revolution, economic restructuring and organizational reform, study on urban space transformation has become a hot subject for urban research. The metropolitan area tends to be decentralized and shows new suburbanization features, that is, new "gathering centers" in the outskirts, or subcenters, which lead to a qualitative change in the spatial structure of the metropolitan area. (Anas A. 1998) Cities are a generator of modern lifestyles and an indicator of cultural innovation. (Yihua, LIU. 2007) As a typical product of a specific phase during China's urbanization process, villages-in-the-city miniaturize the various social problems and receive close attention from scholars within various circles. (Xiaopei, YAN. 2004) As a result it is vital to analyze and study the unique architectural and cultural phenomena in the villages-in-the-city from the perspective of "space" in architectural science, which will help to enhance cognition of inner spatial forms in the villages-in-the-city and further proffer guidance to future urban-rural planning and construction.

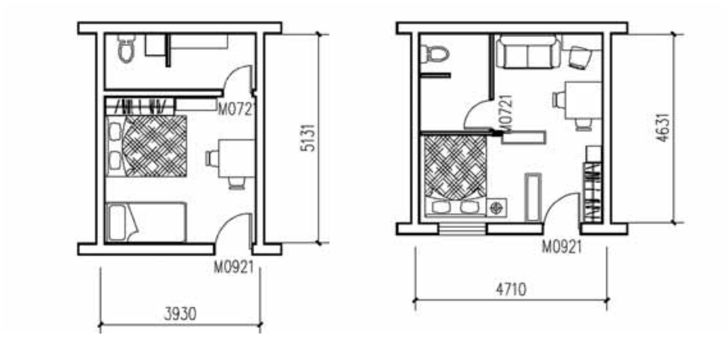

Fig. 4 Plan of apartment in Dongbanbidian Village.
(Room 4-303 of Dongbanbidian, Rent: 800 yuan/month, A family of four)
(Room 4-302 of Dongbanbidian, Rent: 800 yuan/month, A new couple)

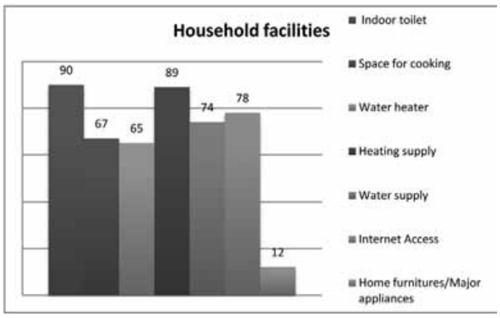

Fig. 5 Household facilities of four villages.

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LANDSCAPE MANAGEMENT IN RURBAN AREAS: LITHUANIAN CASE IN GLOBAL CONTEXT

POSTER

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Keywords

rural-urban interface, rurban landscape, landscape sustainability

ABSTRACT

Contemporary pace and scale of landscape change and massive urbanization are strongly related with the emergence of new types of landscapes that cannot be easily identified as urban or rural in the areas of rural-urban interface. This article aims at the overview on rural-urban interface in Lithuania setting it in the global context and presents the ideas and recommendations for management of such areas. The case history section presents the general problematics of rural urban interface and outlines the management challenges; the results section presents management ideas for Lithuanian rurban landscapes, which emerge both from general ecological and social challenges and from local peculiarities and identity. Management ideas and recommendations include: viewing the problem at the regional scale and the urban scale, historic continuity and innovation, ecology and ecocompensation, multifunctionality, unique image and aesthetics of rurban areas, optimization of visual diversity.

1. INTRODUCTION

The areas of rural-urban interface, which according to E. Vanempten (2009) spatially "materialise in a fragmented and dispersed way, creating diffuse heterogeneous tissue that is often neither urban nor rural but simultaneously both", is rather new spatial and social phenomenon strongly related with such contemporary socio-geographic processes as globalization and metropolization. This issue results in general or global problematics of rural urban interface - features and management challenges of rurban areas similar around the world, in developed and developing countries. However, such newly emerging areas inevitably have a historical dimension and local features caused not only by specific geographical, natural conditions of the area under analysis, but also by the rural history of land use largely influenced by agricultural politics (Palang, H. et al., 2011) of the area into which the urban area expands. The patterns of urban expansion and their changes also may cause the local peculiarities of rurban problematics. Considering this we argue that the links between the global and local in rurban studies should constitute an important sphere of research and also the understanding of these links should influence the management of these territories.

2. BACKGROUND

This article presents an overview of our research (Zaleskienė, E. and Gražulevičiūtė-Vileniškė, I. 2013; Zaleskienė, E. et al., 2013; Gražulevičiūtė-Vileniškė, I. et al., 2014) on rural-urban interface in Lithuania setting it in the global context of rurban challenges and presents the ideas and recommendations for management of such areas. The review of problematics presents the general problematics of rural urban interface in the form of the features of rurban areas and by outlining the management challenges; this section was also intended to distinguish and demonstrate global or general features, challenges and local peculiarities concerning Lithuanian rurban areas and their management. The results section - presents an outline of management ideas for Lithuanian rurban landscapes, which emerge both from general ecological and social challenges and from local peculiarities and identity. The concluding section summarizes our findings.

3. METHODS

The methods of research include the analysis of literature, maps, research on site, recording in photographs comparison, generalization, and construction of graphical schemes.

4. CASE HISTORY

The emergence of rural-urban interface and related challenges was caused by the massive urbanization and urban expansion as a consequence of industrial and agricultural revolutions. According to M. Antrop (2008), one landscape experienced through many generations was replaced with many landscapes experienced in one generation (Antrop, M. 2008) and the rurban landscape is one of this experienced varieties. During the last hundred years the areas surrounding many large cities and even moderate settlements have been radically transformed and the urban expansion causes changes of both urban and rural landscapes. The traditional development of landscapes takes on a new direction and a new rurban (rural-urban) landscape type emerges.
Researchers analyzing this phenomenon present numerous definitions and characterizations of rurban phenomenon. According to V. Dutta (2012), the landscapes emerging in the areas affected by rural and urban interface can be characterized as undefined structures, dynamic and constantly changing areas, which are often described as a transit zone between the expanding periphery of the city and nearby rural environment. According to W. Berentsen et al. (2000), rurban areas can be defined as the places where there are many people who live urban lifestyles, but in a setting that otherwise appears rather rural. D. Choy Low and J. Harding (2010), M. Buxton and D. Choy Low (2011) also present a series of characteristic of such landscapes. The remnant rural dimension as the potential source of distinctiveness and identity of such areas is often overlooked.
We consider the rurban problematics as the universal phenomenon with local manifestations and peculiarities. The existing research in this area (Gadal, S. 2010, 2011; Bardauskienė, D and Pakalnis, M. 2012; Gražulevičiūtė-Vileniškė, I. et al., 2014) demonstrates such global trends as metropolisation (spatially multi-polarized urban discontinuities, segregated socially and functionally (Gadal, S. 2011)), industrialization (industrially produced materials, rapid industrialized construction process, industrialized agriculture), commercialization (real estate developers as the main drivers of suburban construction, narrow economic outlook towards the quality of life manifesting in the lack of public spaces and infrastructure in these areas), internationalization (global cultural trends in architecture and landscape management) and environmental shifts in Lithuanian rurban landscape.
The above mentioned general trends pose general challenges. With reference to D. Choy Low and J. Harding (2010), M. Buxton and D. Low Choy (2011) general or global environmental and social challenges of management of rural-urban interface areas can be distinguished. These challenges can be identified in a broad range of countries and regions around the world and in Lithuania as well.

The environmental challenges include: weed infestation, pest animals (abandonment and renaturalization, invasive species), loss of biodiversity, changes of hydrological regime, water quality decline, intensification of agriculture and other human activities, ecosystem fragmentation etc.

The social challenges are: limited landscape management capacity of the new residents, social conflicts (between new residents and local farmers), social disadvantage, an increasing social and economic divide, a skewed population (loss of young adults, an ageing population), loss of a sense of community, intensification or decline of agriculture and the emergence of new local and regional economies.

Our research (Gražulevičiūtė-Vileniškė et al., 2014) has allowed distinguishing the local aspects of Lithuanian rurban landscapes related with:
- character of natural landscape in the zones of influence of the urban areas (clayey plains, moraine hilly terrain, and seaside plain as well as river valley landscapes etc.);

- urbanization patterns: the radical changes of urban development had conditioned that today landscapes in the areas of rural-urban interface surrounding the large cities are more often shaped not by the sharply contrasting densely built-up urban and slightly urbanized rural and natural areas, but by the scattered chaotic emergence of point-like urban insertions in the surrounding rural and natural environment;

- history of rural landscape: dynamic development of country's rural landscape has left the relicts of historic types of rural landscape of different quality and identity influencing the development and identity of rurban areas (1). Consequently, another category of rurban landscape management challenges dealing with identity, locality, sense of place exist including: the loss of scenic amenity (visual quality, beauty of particular place), rural heritage and cultural landscape preservation problems, decline of traditional rural lifestyles, change of landscape identity, landscape uniformity etc.

5. RESULTS

D. Choy Low and J. Harding (2010), M. Buxton and D. Choy Low (2011) underline that rurban landscapes and related complex social and environmental issues call for rethinking of traditional landscape planning and management approaches. Considering this and the peculiarities and challenges distinguished above, we present some ideas and recommendations for management of Lithuanian rural-urban interface areas:

Regional development.
The question of rural-urban interface should be viewed in the context of the overall country's regional development. It is clear that in the future the urban expansion and development of rural-urban interface will be the most relevant to the large urban centers, mainly to Vilnius, Kaunas, and Klaipeda, as Lithuanian residents tend to migrate to these cities and prefer living in urban periphery (Zagorskas, J. 2009) and due to the importance of these cities in contemporary strategies and plans; however the regulation of the development of the rurban areas should also be given a special attention in the attractive resort towns and valuable picturesque territories. In order to avoid the situation when the large cities grow and expand at the expense of declining regions of the country, the goal of more even regional development, placing the emphasis on small and medium size cities and towns, should not be ignored.

Urban development.
Development of the areas of rural-urban interface should be integrated in the development strategy of particular urban areas. For example, M. Pakalnis and D. Bardauskienė (2012) recommend for contemporary simultaneously demographically shrinking and territorially expanding Lithuanian cities to follow the strategy of so-called "brown urbanism" - to concentrate the efforts and funds on the re-development and re-
use of the existing abandoned or inefficiently used inner urban areas, which they refer to as "brownfields" and renovation of the existing housing and avoiding the development of unbuilt land at the fringe of the city. Even if this approach will not stop the outer urban expansion, bearing in mind the dream of individual house with garden in the outskirts of the city cultivated by many Lithuanians, such strategy would be undoubtedly beneficial for sustainable development of rural-urban interface and maintenance of identity of these areas. Such reserved attitude towards urban expansion corresponding to contemporary sociodemographic trends would also be beneficial from the ecological (energy savings, preservation of natural areas and habitats), economic (use of existing infrastructure and buildings, preservation of agricultural land), quality of life (use of picturesque areas close to the city for recreation, ecological education), heritage preservation (preservation of rural heritage and cultural landscapes) and other points of view.

Historic continuity and innovation.
The characteristic and important feature, the source of identity of rurban landscapes, even if reshaped by urbanization, is their rural dimension. The areas of rural-urban interface are the field where continuous agricultural practices and rural uses face enormous pressure for change and radical functional, land use and other innovations driven by urbanity. The territories in the zone of influence of the city intended for the future urbanization will certainly have to accommodate some innovations. However, the preservation and maintenance of rural, agricultural dimension is also important both for local identity, visual diversity, quality of life and even economic productivity of the area.

Multifunctionality.
D. Bardauskienė and M. Pakalnis (2012) describe contemporary rurban areas in Lithuania as new landscape type of low value with characteristic monofunctional residential quarters and their fragments or chaotically emerging individual buildings surrounding large cities of the country. Visually chaotic monofunctional landscapes in the areas of rural-urban interface certainly do not provide the quality of life, which new suburban settlers are searching. Multiplicity of complementary functions - residential, cultural, recreational, commercial, productive,

agricultural etc. - would contribute both to the quality of life, self sufficiency, and the links with the city of the rurban areas. The rurban areas may accommodate self-sufficient communities with infrastructure and workplaces, also provide recreational areas and agricultural production for the city. This is another reason to preserve the functioning relicts of rural landscape, productive agricultural lots, the agricultural activities as much as possible and to encourage ecological peri-urban and suburban agriculture, gardening. The relicts of historic rural landscape that had lost their original functions can be adapted to new needs without losing their identity; for example, the residencies of former manors could be converted into parks, community centers.

Ecology and eco-compensation.

The areas of rural-urban interface can play an important ecological role as well. Valuable natural areas or the relicts of historic rural landscape types can be preserved and serve both for protection of biodiversity, eco-compensation, and for ecological education and recreation of local and urban population. These green rurban areas should make an integral part of the natural framework of the city.

Distinctiveness, unique image and aesthetics.

Two aspects of identity of the areas of rural-urban interface can be distinguished: the identity of particular country, region or settlement - local identity - and the identity of particular landscape type - legibility. Our analysis has demonstrated that the main resources for local identity of rural-urban interface in Lithuania are the features of natural environment and the distinctive country's rural landscape with the relicts of historic rural landscape types - *Ikivalakinis, Valakinis, Vienkieminis and partially Kolūkinis*. Thus preservation of valuable elements of natural landscape and historic relicts of rural landscape and their integration in urban development should be viewed as very important developing and maintaining local identity of these areas. The identity of rurban landscape as a distinctive landscape type raises additional questions. The image and distinctive landscape aesthetics of the areas of rural-urban interface should be developed systematically, harmoniously integrating both rural and urban elements and emerging new suburban elements. This also includes the search for the specific architecture and urbanism solutions, reflecting the local identity and specific identity of rurban areas.

Optimization of visual diversity.

Multiplicity of contrasting and contradictory functions with different visual expression, visual chaos, uniformity of urban sprawl, and even the monofunctional areas with chaotic visual expression all these are the extremes of visual expression of the areas of rural-urban interface. The optimal visual landscape diversity in the rurban areas as well as their legibility and distinctive aesthetics are important topics for the future research. The above-mentioned historic relicts of rural landscape, fragments of natural landscape, and functioning agricultural areas as recognizable and aesthetic objects should play an important role maintaining the psychologically acceptable visual diversity in the rurban areas.

6. CONCLUSIONS

1. Contemporary pace and scale of landscape change and massive urbanization that started in the age of industrial and agricultural revolutions and now can be evidenced worldwide are strongly related with rurban problematics - the emergence of new types of landscapes in the areas of rural-urban interface. These landscapes constitute our everyday environment, but still are insufficiently researched and lack consistent management approaches.
2. As a worldwide phenomenon occurring in different localities, rurban landscapes can be characterized both by global (general) and local (peculiar) features and raise both general and peculiar management challenges. General features are linked with such phenomena as metropolisation, industrialization, commercialization and internationalization, local - with the character of natural landscape, specific urbanization patterns and their changes and the history of rural landscape and its relicts (*Ikivalakinis, Valakinis, Vienkieminis and partially Kolūkinis* in the case of Lithuania) in the zones of rural-urban interface. Management challenges can be subdivided into environmental, social (often more general), and challenges dealing with identity, locality, sense of place (local, peculiar).
3. Management ideas and recommendations for rurban landscapes should corresponding to both local and global challenges and features of these landscapes and should include but not be limited to: viewing the rurban problem at the regional scale, viewing the rurban problem at the urban scale including the reserved attitude towards urban expansion, historic continuity and innovation in the rurban areas, preservation of rural dimension, multifunctionality, distinctiveness, protection of biodiversity, eco-compensation, ecological education and recreation, unique image and aesthetics of rurban areas, and the optimization of visual diversity.

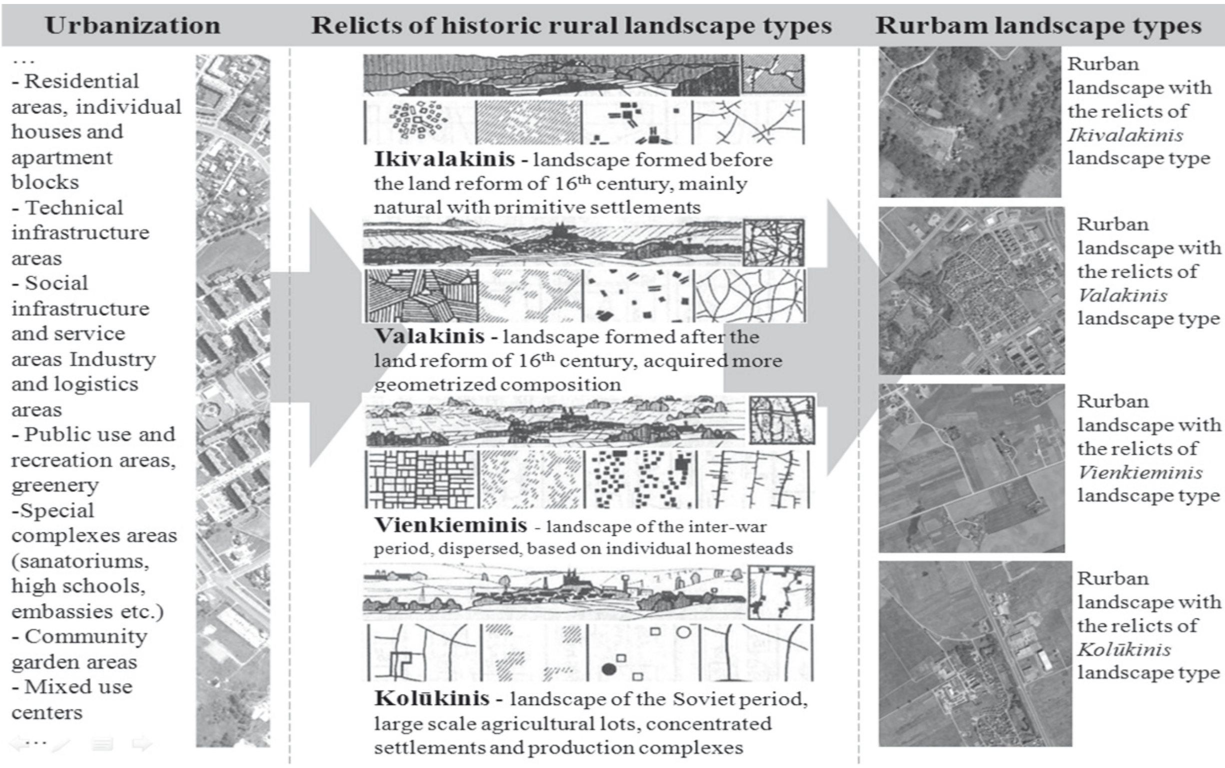

Fig. 1 The relicts of historic types of rural landscape of different quality and identity influence the rurban development in Lithuania. With reference to J. Bučas (2001), Maps... (2014), Miestų... (2009), E. Zaleskienė and I. Gražulevičiūtė-Vileniškė (2013).

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EUROPEAN AND POLISH DEVELOPMENTS IN CHURCH STAINED GLASS ART. DIFFERENCES AND SIMILARITIES

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Keywords

stained glass, contemporary, artists

ABSTRACT

While considering the latest developments in the art of stained glass in Poland we can notice its specific quality that distinguishes it from parallel European achievements in the field. It is mainly apparent in the technology which, after all, determines the form and style of glazing. In Poland, traditional stained glass craftsmanship still prevails while in other countries this has been mostly replaced by fusing and moulding techniques that impose a different form on glazing. Another significant issue is the style of Polish stained glass windows. Most of them are rather traditional representational images although they resort to simplified drawing, a synthetic form and colour. However, the aesthetic value of stained glass seems to depend mainly on the hand of the master who creates it.

1. BACKGROUND

One cannot talk about stained glass without mentioning both the designer and the manufacturer because the cardboard alone is just a drawing or painting which becomes stained glass only through transformation into a composition of glass panels. It is their choice that principally determines the quality of the realization. A colourful piece from a sampler is not indicative of the colour of a larger surface illuminated with bright light. Therefore selection of glass panels is true craftsmanship and stained glass is a result of the work of both the designer and the craftsman. The role and significance of the manufacturer, and especially of the skill and knowledge of the person that turns the picture into a 'glass' artwork cannot be overestimated.
In this respect, the latest Polish developments in the art of stained glass show some specific features that make them different form other European achievements in the field, particularly in terms of technology.

2. HISTORY

A significant development of stained glass manufacturers in Poland took place in the interwar period. The origins of many studios date back to this period. Some of them still operate while others have closed down. One centre of stained glass production worth mentioning is the city of Poznan where stained glass has been manufactured since 1908 and where designers from all over the country still travel with their designs because they consider the craftsmen who work there to be masters in glass selection and stained glass manufacture. The oldest and most famous of the studios there was that established by Dezydery Mocznay in 1908.
The city of Krakow also boasted several stained glass studios at that time. The most famous was that of Stanisław Gabriel Żeleński set up in 1902. In 1931 Roman Ryniewicz opened his own firm. His excellent knowledge of the art and craft of stained glass, perfect sense of colour, and years of collaboration with the most remarkable designers made his firm famous and respected. His descendants still run the firm and help many investors and artists realize their stained glass projects. One of his co-workers was Fryderyk Romańczyk who set up a firm with a partner in Siemianowice Ślaskie in 1934, which they called „Śląski Zakład Witrażów. Romańczyk, Heinzel – Siemianowice Śl.",(Silesian Stained Glass Studio). They designed and produced stained glass for many churches in Silesia and Silesian Coal Basin. The firm no longer exists but its works are representative of the technological aspect of Polish craft of stained glass.
When the war broke out the studio was still working. At that time, they made the imposing stained glass windows for the Church of the Sacred Heart of Jesus in Dąbrowa Górnicza – Strzemieszyce Wielkie.[1] It is a neogothic, three-nave brick.. The project envisaged three towers which have not been erected to this day. The new church was completed in 1910[2]. The stained glass windows were made in 1940 and 1941. Important decorative elements are

the stained glass windows in the presbytery, the main nave and the transept. They fall into two groups. One group includes the stained glass windows in the main nave. The stained glass windows in the other group, i.e. the ones in the presbytery and the transept, impress with their artistic quality. Each represents a male of female figure of a saint surrounded by plants and animals.
In the years 1945-1947, 28 stained glass windows form Fryderyk Romańczyk's stained glass studio were installed in the church of St.Anthony of Padua in Siemianowice Śląskie. The stained glass window featuring the Holy Spirit above the main entrance to the church was offered the church by the artist himself. Other stained glass windows show figures of saints and the stained glass window over the presbytery shows God the Father.
Fryderyk employed his sons: Jozef and Jan. When Fryderyk died in 1949, the firm was taken over by his wife, Katarzyna who managed it until 1974. From 1983, it was run by Jan's daughter – Barbara Romanczyk.
It is worth pointing out that Siemianowice Śląskie is a town which has been lucky since its Urban Conservator, Ms Malgorzata Derus from the Department of Urban Planning and Architecture has shown much interest in the past and present of the town. She has been author of many works about the history of the town and the *Programme for protection and preservation of the historical objects of the city of Siemianowice Śląskie in the years 2011-2014*[3].
The Programme includes historical objects from the XVIIIth to the XX th century. The stained glass windows have also become protected objects although the firm which used to be run by many generations of Romańczyk family no longer exists.

3. STUDIO OF WILHELM DERIX

At this point, it ought to be stressed that the new style of stained glass is directly linked with technology. While Polish stained glass windows predominantly base on the traditional technology using lead joints, European studios apply this technology only to a fraction of their realizations. Fusing or moulding have become widespread together with using adhesive to combine computer-cut glass as well as other artistic ideas that can be conceived basing on the production potential of a studio. At this point, it is worth mentioning the great German studio of Wilhelm Derix which has existed since 1868. The range and quality of their works have changed over time to suit the changing style of stained glass windows, the form of artistic expression and the material itself. Thirty years ago, Wilhelm Derix IV took over the studio and decided that his architectural art glass would meet all the technological requirements of designers. He was not afraid to take the risk involved in experimenting in order to interpret the most sophisticated artistic concepts. During the last twenty years the innovative gluing techniques have been perfected together with combining layers of glass panes and using other materials, such as plexiglass, in the process. Therefore it has now become possible to use composite glass which can be etched to produce fine compositions of glass panels of remarkable artistic quality or to add graphics in the form of prints or seemingly freely-shaped touches of enamel.
The new quality of stained glass is far from traditional both as regards technology and aesthetics. To see the changes, it is enough to look at the exhibits at the Derix studios gallery in Taunusstein where the firm is based. Although traditional stained glass is also displayed, the majority of the exhibits are totally modern both with respect to the form and technology. Disregard for the graphics of the joint is a common phenomenon these days and the size of the glass panes depends on the size of the furnace and other equipment rather than on the strength of lead or wind protectors.

4. POLISH ARCHITECTURAL GLASS

Some Polish artists also abandon the classical art of stained glass which consists in creating glazing on a plane. They focus on three-dimensional shaping of glass and providing it with features of integral artworks decorating urban and architectural interiors. They are called architectural glass.
The works of Beata and Tomasz Urbanowicz are perfect examples of this trend. The couple are architects who have become interested in interior design and stained glass. Glass, initially regarded as a cold and hard material, has proved friendly and compliant with designers' requests. The artists' works are decorative stained glass projects but their technique is different from traditional.
Impartant examples are stained glass realizations for the PKO S.A. Bank in Brzeg. For the first time, the author used fused-glass partitions between rooms which resembled watercolour painting that T.Urbanowicz also practices. Another PKO S.A. Bank in Jelenia Góra was provided with an expressive entrance zone, as the author put it. The rounded elements whose colours resemble a rainbow, as if painted with a brush, form a glazed wall which fills the interior with colour in daylight and '*illuminated at night gives the effect of colour to the "entire" city . The rainbow motif seems to have fascinated the artists for years.*[4]
The repeated references to one motif and fascination with color gamut are each time different, extraordinary and

Fig. 1 Romańczyk's Studio: stained glass in the church of God the Mather, Witold Pałka, Łaziska Górne, 1977-78.

delightful. The richness of ideas, variety of formal solutions supported by an excellent sense of glass qualities and superb technology make the works of Mr and Ms Urbanowicz captivating. They write that they are '*fascinated by the new developments in stained glass design although the term stained glass is not always adequate to how we deal with glass"*[5]. Therefore they seem to treat the term stained glass as a pretext for departing from flat glass planes for the sake of experimenting with increasingly sophisticated shapes that glass can take in the realization of new ideas. This is proved by their latest projects such as the mall called "Under the Blue Sun" situated between the main square and Kielbasnicza Street in Wrocław. Their processed glass works appear in the stylish portico and the original signboard. They have also designed and made 15 eagles – national emblems for the court buildings in Warsaw. 5 eagles size 105x86 cm and 10 bigger ones (size 150x130 cm) will be used to decorate the court rooms, conference hall and the study of the Supreme Court Chairman. The above examples are by no means an exhaustive list of their realizations which are too numerous to be mentioned here and often have little in common with the art of stained glass.

Architecture, perceived as spatial volumes interspersed with glazing, determines the form of stained glass. Designers declare that they notice and respect architecture. It imposes restrictions of varying strictness but always creates a very definite, spatial framework. One could risk a statement that the form of glazing is a resultant of the artist's own search for the way to express the intrinsic impressions and the design task to be done. In this respect, it can be worthwhile to compare a church in Poland with a church in Germany. Neither object is distinctive in terms of its cultural value, architecture or location but both objects have stained glass windows designed by outstanding artists.

5. CZELADZ, POLAND

The Polish church is in Czeladz and the guiding principle of the design has been integration of architecture and contemporary stained glass in a historical interior.

The question of harmonising contemporary stained glass with a historical interior gained prominence in the 1940s when it became necessary to restore or complete glazing in historical objects that were damaged during the war. Often the architecture of the windows in such objects indicated that stained glass had been intended for them and yet was never installed or designed due to various reasons. So the problem returned after tens or hundreds of years together with the question how to harmonise stained glass with the historical architecture and whether to use historical forms or the contemporary ones. The problem is best illustrated by the glazing in St.Stanislaus church in Czeladz. The historical interior is a live organism serving contemporary needs. Its transformation is a constant and unavoidable process. Maciej Makarewicz designed stained glass that is not restoration but rather an introduction of contemporary features into the temple without violating its historical values. In this way, the unique character of the interior has been preserved and highlighted. His stained glass seems to perfectly fit in with the historical growth of the object.

Maciej Makarewicz applied many old and proven rules. He used cold and brighter colours for the windows facing north and vivid, contrastive colours for the windows facing south. His range of colours was not very extensive since, according to him, a narrower range of colours resulted in a better visual effect. He paid attention to the quality of glass, its thickness and transparency. He used came economically only to emphasize certain forms and details. He opted for finely cut pieces which he often contrasted with large panels. He used the language of visual symbols that referred to the sacred truths of faith as he thought that iconographic religious symbols could only convey specific and comprehensible message.

6. BERLIN - GRUNEWALD, GERMANY

The second example is in Germany. A place worth mentioning is the church in Grunewald district, Berlin. The church was erected in 1902-04 and its designer was the architect Philipp Nitze. The church was destroyed in March1943 together with the six historical stained glass representations of plants and decorative motifs. In 1986, Johannes Schreiter's projects were selected for realization. The first window in the north wall was completed in January 1993, followed by the rose in the choir in September 1997 and the south wall glazing in March 2000. The colour that prevails in the north window is grey while the south window is predominantly yellow. The composition resembles faces arranged in geometric, rigorous patterns intertwined with 'partition lines' that do not always coincide with the actual lines dividing the glass. Johannes Schreiter is the unrivalled master of stained glass art in the second half of the 20th century. His recent works are a subtle play with stained glass matter. He does not abandon lead stripes but defines their thickness to one tenth of a milimetre, drawing their course on cardboard. He often prolongs the lead stripes with a vibrant painted line which , from a distance, often seems to be deliberately broken. The simplicity of graphic composition and colour are characteristic features of his works while the dynamic line makes them unique. His works are certainly groundbreaking contributions to contemporary stained glass art which have inspired many younger followers. They evoke powerful emotions and are rich in meaning. The opalescent, hand cast glass, and the mastery in using lead for joining it are combined with subtle application of colour. His works can be found in many prominent places such as the chapel in Frankfurt cathedral.

7. CONCLUSIONS

While considering the latest developments in the art of stained glass in Poland we can notice its specific quality that distinguishes it from parallel European achievements in the field. It is mainly apparent in the technology which, after all, determines the form and style of glazing. In Poland, traditional stained glass craftsmanship still prevails while in other countries this has been mostly replaced by fusing and moulding techniques that impose a different form on glazing. Another significant issue is the style of Polish stained glass windows. Most of them are rather traditional representational images although they resort to implified drawing, a synthetic form and colour. However, the aesthetic value of stained glass seems to depend mainly on the hand of the master who creates it.
Contemporary aesthetics which favours abstract compositions and simplicity of form also leaves room for realist art conventions whose literalness and imagery satisfy the artistic taste of many viewers. J.S. Pasierb writes about the acceptance and understanding of contemporary art adding that … ‘ *notwithstanding all the fascination with ‘modernity’, in broad terms, Polish culture still has a penchant for traditional forms*[6]*.*

Fig. 2 ARCHIGLASS, national emblem for the court buildings in Warsaw.

Fig. 3 Stained glass in the St.Stanislaus church, Maciej Makarewicz, Czeladz, Poland.

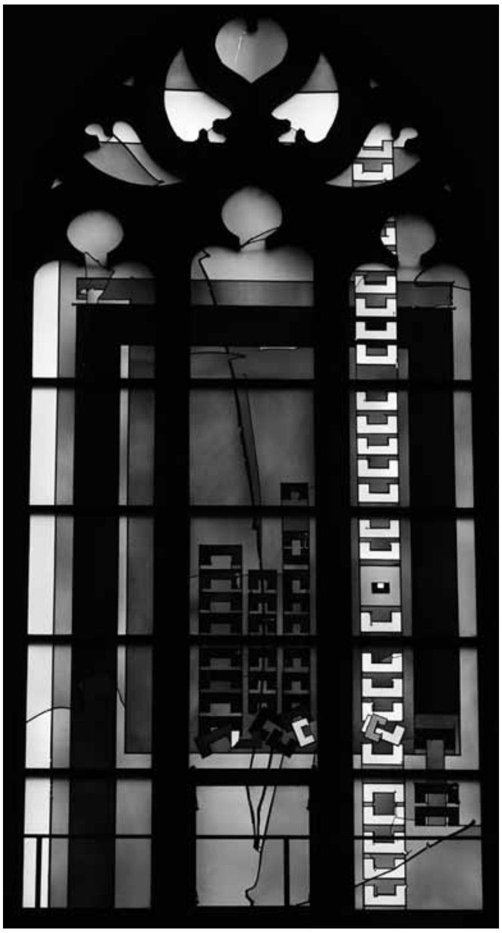

Fig. 4 Stained glass in the Grunewald-Kirche, Johannes Schreiter, Berlin-Grunewald, Germany.

NOTES

[1]In 1900-1903, a chapel was built; in 1903 the chapel started to be transformed into a church known as the Sanctuary of the sacred Heart of Jesus in Strzemieszyce Wielkie it is built of plastered brick and Szydłowiec sandstone.The presbytery faces south and is surrounded by chapels, a porch,three naves and a transept.

[2] http://www.strzemieszyce.sosnowiec.opoka.org.pl/historia.

[3] http://www.scribd.com/doc/60423768/Untitled

[4] Urbanowicz Tomasz, Magia kolorowego szkła, article [in:] Architektura &Biznes 1994, no 7/8, p.24

[5] Ibidem, p.25

[6] Janusz St.Pasierb, Światło i sól, Paryż 1983, p.50.

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SESSION 3

ENVIRONMENTAL ENGINEERING,
ENERGY, GREEN BUILDINGS

ELECTROMAGNETOELASTIC WAVES IN LAYERED PIEZOELECTRIC MEDIUM WITH ELECTRIC SCREEN

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ABSTRACT

Suggested paper is an investigation of existence and propagation of electromagnetoelastic surface waves in piezoelectric layered structure: piezoelectric half-space substrate, piezoelectric layer, dielectric medium in the presence of an electric screen in dynamic settings when the equations of motion are considered along with dynamic, i.e. complete set of Maxwell's equations for electromagnetic fields. Expressions are obtained for the wave fields in considered structure, also examined various cases of the location of the screen. The dispersion equation is derived and investigated.

1. INTRODUCTION

The present investigation is a study on the existence and propagation of electromagnetoelastic surface waves in layered piezoelectric medium with an electric screen. It is known that surface waves are widely used in technics, particularly in devices that store, process and transmit information, so research electro-elastic surface waves in the piezoelectric media has theoretical and practical value (Tiersten, H.F. 1969).

2. BACKGROUND

In this field of research investigations began in 1968 with the work of L. Bleustein (Bleustein, L. 1968) and Yu Gulyaev (Gulyaev Yu. 1969). Many of these investigations have mainly been done in quasi-static approximation when the wave character of electromagnetic field is not taken into account, and only mechanical field is considered dynamic. Quasi-static approximation does not determine electromagnetic field excited by mechanical deformation. For example it is not possible to calculate the power of electromagnetic energy radiated from a vibrating piezoelectric device. These and similar problems raise a necessity to investigate wave process in piezoelectric media in a dynamic settings when the equations of motion are considered along with fully dynamic Maxwell's equations for electro-magnetic field (Mindlin, R.D. 1978), (Yang J.S. 2000), (Danoyan, Z.N, Atoyan L.H. and Danoyan N.Z. 2010).

3. METHODS

Investigated problem is solved with the use of the complete set of Maxwell`s equations for electromagnetic field, as well as the theory of wave propagation in piezoelectric media.
Statement of the problem. We consider a layered structure consisting of elastic piezoelectric layer and a piezoelectric half-space. Both the substrate and the layer belong to the crystal class 6 mm or 4 mm. The Ox_3 axis is directed along the main direction of the piezoelectric substrate and the layer. The Ox_2 axis points down into the substrate. The layer with the thickness h_2 is rigidly linked to the substrate. The electric screen is located at the distance h_3 from the layer. The domain $-(h_2 + h_3) < x_2 < -h_2$ is assumed to be either a dielectric medium without

an acoustic contact with the layer. The layer surfaces $x_2 = 0, x_2 = -h_2$ are electrically open and the surface $x_2 = -h_2$ is free of external forces. Along with the notations x_1, x_2, x_3 we'll use also the followed notations x, y, z accordingly. We consider an anti-plane deformable conditions:

$$\vec{u} = \{0,0,u_3\},\ u_3 = w(x_1,x_2,t);\ \vec{H} = \{0,0,H_3\},\ H_3 = H_3(x_1,x_2,t),$$
$$\vec{E} = \{E_1,E_2,0\},\ E_i = E_i(x_1,x_2,t),\ i = 1,2.$$

The constitutive equations are:

$$\sigma_{13} = c_{44}\frac{\partial w}{\partial x_1} - e_{15}E_1,\ \sigma_{23} = c_{44}\frac{\partial w}{\partial x_2} - e_{15}E_2,\ D_1 = e_{15}\frac{\partial w}{\partial x_1} + \varepsilon_{11}E_1,$$
$$D_2 = e_{15}\frac{\partial w}{\partial x_2} + \varepsilon_{11}E_2,\ B_3 = \mu_{33}H_3.$$

Equation of medium motion and complete set of Maxwell's equations for electromagnetic fields are as follows:

$$c_{44}\nabla^2 w - e_{15}\left(\frac{\partial E_1}{\partial x_1} + \frac{\partial E_2}{\partial x_2}\right) = \rho_i\frac{\partial^2 w}{\partial t^2},\ e_{15}\nabla^2 w + \varepsilon_{11}\left(\frac{\partial E_1}{\partial x_1} + \frac{\partial E_2}{\partial x_2}\right) = 0,\ \frac{\partial E_2}{\partial x_1} - \frac{\partial E_1}{\partial x_2} = -\mu_{33}\frac{\partial H_3}{\partial t},$$
$$\frac{\partial H_3}{\partial x_2} = e_{15}\frac{\partial^2 w}{\partial x_1 \partial t} + \varepsilon_{11}\frac{\partial E_1}{\partial t},\ \frac{\partial H_3}{\partial x_1} = -e_{15}\frac{\partial^2 w}{\partial x_2 \partial t} - \varepsilon_{11}\frac{\partial E_2}{\partial t},\ \nabla^2 = \frac{\partial^2}{\partial x_1^2} + \frac{\partial^2}{\partial x_2^2}.$$

u_i are the components of displacement, ρ_i are the mass density, σ_{ij} are the components of the stress tensor, H_k and B_k are the magnetic field intensity and induction, D_k and E_k are the electric induction and electric field intensity, $c_{ij}, e_{ijk}, \varepsilon_{ij}, \mu_{ij}$ $(i,j,k,m,n = 1,2,3)$ are the elastic, piezoelectric, dielectric and magnetic constants. The equations in the substrate and the piezoelectric layer:

$$\nabla^2 w_i = \frac{1}{S_i^2}\frac{\partial^2 w_i}{\partial t^2},\ (i = 1,2),$$

$$S_i^2 = \frac{\bar{c}_i}{\rho},\ \bar{c}_i = c_i + \frac{e_i^2}{\varepsilon_i} = c_i\left(1 + \frac{e_i^2}{\varepsilon_i c_i}\right) = c_i\left(1 + \chi_i^2\right),\ \chi_i^2 = \frac{e_i^2}{\varepsilon_i c_i},\ c_i = c_{44}^{(i)},\ e_i = e_{15}^{(i)},\ \varepsilon_i = \varepsilon_{11}^{(i)}, \tag{1}$$

$\bar{c}$ is piezoelectrtically stiffened elastic constant, S_i are the velocities of electro-magneto-elastic bulk waves in direction of the Ox_1 axis, χ_i^2 are the coefficients of electro-mechanical coupling. The magnetic fields intensities satisfied the following equations:

$$\nabla^2 H_3^{(i)} = \frac{1}{a_i^2}\frac{\partial^2 H_3^{(i)}}{\partial t^2},\ a_i^2 = \frac{1}{\varepsilon_i \mu_i},\ \mu_i = \mu_{33}^{(i)} \tag{2}$$
$$(i = 1,2)$$

a_i are the velocities of the electro-magnetic bulk waves in the considered medium. The electro-magnetic field equation in the top dielectric layer:

$$\nabla^2 H_3^{(3)} = \frac{1}{a_3^2}\frac{\partial^2 H_3^{(3)}}{\partial t^2},\quad a_3^2 = \frac{1}{\varepsilon_3 \mu_3}$$

a_3 is the velocity of light, ε_3 and μ_3 are dielectric and magnetic constants in vacuum.

The boundary and contact conditions. On the plane at $y = 0$ continuity conditions applied for the displacement, tangential components of the electrical field intensity, the stress and the normal component of the electric displacement are:

$$w_1 = w_2, E_1^{(1)} = E_1^{(2)}, \sigma_{23}^{(1)} = \sigma_{23}^{(2)}, D_2^{(1)} = D_2^{(2)} \tag{3}$$

At $y = -h_2$ continuity conditions apply for tangential components of the electrical field intensity and the normal component of the electric displacement, the tangential components of the stress vanish:

$$E_1^{(2)} = E_1^{(3)}, \sigma_{23}^{(2)} = 0,\ D_2^{(2)} = D_2^{(3)} \tag{4}$$

The last conditions in (3) and (4) can be replaced by the continuity condition of the tangential component of magnetic field intensity:

$$H_3^{(1)} = H_3^{(2)}, \text{at } y = 0; H_3^{(3)} = H_3^{(2)}, \text{at } y = -h_2.$$

Boundary conditions at the screen ($y = -(h_2 + h_3)$) in the case of electric field screen is:

$$E_1^{(3)} = 0$$

In the case of magnetic field screen the magnetic field intensity also vanishes:

$$H_3^{(3)} = 0 \tag{5}$$

It is equivalent to the following condition: $D_2^{(3)} = 0$ (6)

In quasi-static approximation condition (6) is equivalent to the following condition:

$$E_1^{(3)} = -\frac{\partial \varphi_3}{\partial x} = 0 \tag{7}$$

or $\varphi_3 = 0$

Hence the condition (5) or (7) in quasi-static approximation corresponds to the electric field screen, but the condition (6) corresponds to the magnetic field screen. Thus the fully-dynamic approximation enables us to explain the condition on the screen in the case of quasi-static approximation.

Attenuation conditions. The solutions w_1 and $H_3^{(1)}$ attenuate in half space substrate as follows:

$$\lim w_1 = 0, \quad \lim H_3^{(1)} = 0, \quad y \to +\infty. \tag{8}$$

In particular case when the screen is at the infinity the attenuation of $H_3^{(3)}$ is as follows:

$$\lim H_3^{(3)} = 0, \quad y \to -\infty$$

Solutions in piezoelectric substrate. We'll seek the solutions of equations (1) and (2) as plane harmonic waves:

$$w_1 = W_{10}\, e^{i\left(qy + px - \omega t\right)},$$
$$H_3^{(1)} = H_{10}\, e^{i\left(qy + px - \omega t\right)},$$

$p > 0$, q are horizontal and shear waves numbers, $\omega > 0$ is the circle frequency, W_{10} , H_{10} are the amplitudes. Substituting (8) in (1), (2) and satisfying to none zero wave numbers existence condition we'll obtain the following dispersion equations:

$$q^2 = -p^2 + \frac{\omega^2}{S_1^2},\ q^2 = -p^2 + \frac{\omega^2}{a_1^2}. \tag{9}$$

From the equations (9) we have:

$$q = \pm ip\beta_1(V),\ \beta_1(V) \equiv \sqrt{1 - \frac{V^2}{S_1^2}},\ q = \pm ip\gamma_1(V),\ \ \gamma_1(V) \equiv \sqrt{1 - \frac{V^2}{a_1^2}};V = \frac{\omega}{p}$$

V is the phase velocity of the seeking surface wave. The attenuation conditions at $y \to +\infty$ are:

$$\beta_1(V) > 0$$
$$\gamma_1(V) > 0$$

it is true if q is positive. The corresponding solutions take the following form:

$$w_1 = W_{10}\, e^{-p\beta_1(V)y}\, e^{i\left(px - \omega t\right)}$$
$$H_3^{(1)} = H_{10}\, e^{-p\gamma_1(V)y}\, e^{i\left(px - \omega t\right)}. \tag{10}$$

From (10) it follows:

$$V < S_1 < a_1. \tag{11}$$

Hence if surface wave exists its phase velocity is not bigger than velocity of a bulk electro-elastic waves in substrate. Thus the wave fields in piezoelectric substrate are described by functions (11), where W_{10} and H_{10} are unknown constants.

The solutions in the piezoelectric layer. The solutions of the equations in the piezoelectric layer we seek in a following form:

$$w_2 = W_{20}\, e^{i\left(qy + px - \varpi t\right)}, H_3^{(2)} = H_{20}\ e^{i\left(qy + px - \varpi t\right)}. \tag{12}$$

Substituting (12) in the equations (1) and (2) we come to the dispersion relations:

$$q^2 = -p^2 + \frac{\omega^2}{S_2{}^2},\ q^2 = -p^2 + \frac{\omega^2}{a_2{}^2}.$$

Then we have:

$$q = \pm p\beta_2(V),\ \beta_2(V) = \sqrt{\frac{V^2}{S_2{}^2} - 1},$$

$$q = \pm i\gamma_2(V),\ \gamma_2(V) = \sqrt{1 - \frac{V^2}{a_2{}^2}},$$

since $V < a_2$, then $\gamma_2(V) > 0$. Function $\beta_2(V)$ can be both real positive and imaginary, if it is real then $V > S_2$. In that case homogeneous electroelastic waves propagate through the layer undergoing full internal reflection from layer boundaries (as in the case of the classical Love waves). If function $\beta_2(V)$ is imaginary then $V < S_2$ and through the layer will propagate inhomogeneous waves creating so called gap waves (in classical Love problem there are no such kind of waves). The waves of the magnetic field are always inhomogeneous. Hence in the layer we should take the solutions according both to the positive and negative roots:

$$w_2 = \left(W_{20}^{-} e^{-ip\beta_2(V)y} + W_{20}^{+} e^{ip\beta_2(V)y}\right) e^{i(px-\omega t)},$$
$$H_3^{(2)} = \left(H_{20}^{-} e^{-ip\gamma_2(V)y} + H_{20}^{+} e^{p\gamma_2(V)y}\right) e^{i(px-\omega t)}. \tag{13}$$

Solutions in the top dielectric layer (or vacuum). The solutions in dielectric layer we'll seek in the following form:

$$H_3^{(3)} = H_{30}\, e^{i(qy+px-\omega t)}.$$

In analogous way we obtain the dispersion equation:

$$q^2 = -p^2 + \frac{\omega^2}{a_3{}^2}$$

then we have:

$$q = \pm i\gamma_3(V),\ \gamma_3(V) = \sqrt{1 - \frac{V^2}{a_3{}^2}} \tag{14}$$

since $V < a_3$, then $\gamma_3(V) > 0$. Thus the solution is the combinations of those solutions with the wave numbers as in (14):

$$H_3^{(3)} = \left(H_{30}^{-} e^{-p\gamma_3(V)y} + H_{30}^{+} e^{p\gamma_3(V)y}\right) e^{i(px-\omega t)}. \tag{15}$$

Hence we find the solution of the problem as the sum of constituent solutions (10), (13) and (15) in substrate, layer and dielectric medium accordingly.

The dispersion equation. Substituting the solution (10), (13) and (15) into the boundary conditions and terms of damping, we obtain a system of algebraic equations for the unknown amplitudes, and the conditions for the existence of a nonzero solution of this system yields the following dispersion equation:

Substituting (57) into the first and the third equations of (52) we obtain the following homogeneous system of algebraically equations for the unknown amplitudes $W_{20}^{-}, W_{20}^{+}, \psi_{20}^{-}, \psi_{20}^{+}$:

$$\omega(\bar{e}_1 - \bar{e}_2)W_{20}^{-} + \omega(\bar{e}_1 - \bar{e}_2)W_{20}^{+} + \left(\frac{\gamma_1}{\varepsilon_1} - \frac{\gamma_2}{\varepsilon_2}\right)\Psi_{20}^{-} + \left(\frac{\gamma_1}{\varepsilon_1} + \frac{\gamma_2}{\varepsilon_2}\right)\Psi_{20}^{+} = 0,$$

$$i\bar{c}_2\beta_2 e^{ik_2\beta_2} W_{20}^{-} - i\bar{c}_2\beta_2 e^{ik_2\beta_2} W_{20}^{+} + \frac{\bar{e}_2}{\omega} e^{k_2\gamma_2}\Psi_{20}^{-} + \frac{\bar{e}_2}{\omega} e^{-k_2\gamma_2}\Psi_{20}^{+} = 0,$$

$$\omega\bar{e}_2 e^{ik_2\beta_2} W_{20}^{-} + \omega\bar{e}_2 e^{-ik_2\beta_2} W_{20}^{+} + \left(\frac{\gamma_2}{\varepsilon_2} + \frac{\gamma_3}{\varepsilon_3}\delta_3\right) e^{k_2\gamma_2}\Psi_{20}^{-} -$$

$$-\left(\frac{\gamma_2}{\varepsilon_2} - \frac{\gamma_3}{\varepsilon_3}\delta_3\right) e^{-k_2\gamma_2}\Psi_{20}^{+} = 0,$$

where
$\delta_3 = t\operatorname{anh}\left(k_3\gamma_3\right).$

The nonzero solutions existence condition of these amplitudes gives the following dispersion equation for the problem in fully dynamic setting.

$$A(k_2,k_3,\mathrm{V})\sin(k_2\beta_2) + B(k_2,k_3,\mathrm{V})\cos(k_2\beta_2) = E(\mathrm{V}),$$

where

$$A(k_2,k_3,\mathrm{V}) = \cosh(k_2\gamma_2)\gamma_2\varepsilon_2(\beta_2^2(\gamma_3\delta_3\varepsilon_1+\gamma_1\varepsilon_3)\overline{c}_2^2+\beta_1\varepsilon_1\varepsilon_3\overline{c}_1\overline{e}_2^{\,2})+$$
$$+\sinh(k_2\gamma_2)(\beta_2^2(\gamma_1\gamma_3\delta_3\varepsilon_2^2+\gamma_2^2\varepsilon_1\varepsilon_3)\overline{c}_2^2+\varepsilon_2^2\varepsilon_3(\beta_1\gamma_1\overline{c}_1-\varepsilon_1(\overline{e}_1-\overline{e}_2)^2)\overline{e}_2^{\,2})$$
$$B(k_2,k_3,\mathrm{V}) = \beta_2\overline{c}_2(\cosh(k_2\gamma_2)\gamma_2\varepsilon_2(-\beta_1(\gamma_3\delta_3\varepsilon_1+\gamma_1\varepsilon_3)\overline{c}_1+\varepsilon_1\varepsilon_3(\overline{e}_1^{\,2}-2\overline{e}_1\overline{e}_2+2\overline{e}_2^{\,2}))+$$
$$+\sinh(k_2\gamma_2)(-\beta_1(\gamma_1\gamma_3\delta_3\varepsilon_2^2+\gamma_2^2\varepsilon_1\varepsilon_3)\overline{c}_1+\varepsilon_2^2(\gamma_3\delta_3\varepsilon_1\overline{e}_1^{\,2}-2\gamma_3\delta_3\varepsilon_1\overline{e}_1\overline{e}_2+(\gamma_3\delta_3\varepsilon_1+\gamma_1\varepsilon_3)\overline{e}_2^{\,2})))$$
$$E(\mathrm{V}) = 2\beta_2\gamma_2\varepsilon_1\varepsilon_2\varepsilon_3\overline{c}_2(\overline{e}_2-\overline{e}_1)\overline{e}_2.$$

4. CASE HISTORY

The fully dynamic theory of piezoelectrmagnetic was formulated and investigated by R.D.Mindlin (Mindlin, R.D. 1978), P.C. Lee (Lee, P.C. 1991), I.S.Yang (Yang, I.S. 2000) and others. Many researchers are devoted to a surface shear wave propagation in layered structures consisting of a piezoelectric substrate and a piezoelectric conducting or dielectric layer.

5. RESULTS

We obtain the following results: 1. In fully dynamic settings the expressions and the dispersion equations defining the existence and behavior of surface electro-magneto-elastic waves in layered piezo-elastic structures in the presence of electric (or magnetic) screen is derived. 2. In the case where the screen located at a finite distance from the layer in the case of soft layer ($S_1 > S_2$) depending on the thickness of the piezoelectric layer arise modes of electromagnetoelastic waves with velocities decreasing to common limit such as velocity of the bulk wave in the layer S_2 and besides the first mode decreases from the velocity of the Blustein-Gulyaev wave. Subsequent modes velocity decreases from the bulk wave velocity in the substrate S_1. For the two other cases of screen location all the modes velocity decreases from the Blustein-Gulyaev wave velocity. 3. For the hard layer ($S_1 < S_2$) for any cases of the electric screen location waves exist in a certain, finite interval of layer thicknesses (different intervals for each event of screen location), outside this interval there are no waves.

6. CONCLUSION

On the base of obtained solutions, introducing the wave fields and the derived dispersion equations it became possible to determine the wave process in layered structures, and to describe the work of concrete piezoelectric devices.

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THE HYPER CONCENTRATED MUDFLOW STRUCTURE DYNAMIC IMPACT FORECAST

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Keywords

hyper concentrated mudflow, structure, internal friction angle, connectivity

ABSTRACT

The engineering construction is one of the efficient ways for the hyper concentrated mudflow subversive ascendant prevention. This construction is often presented as stalk-beam system and is a constructively knotty problem. Considering the phenomenon great scope and abnormality, the calculation of the constructive elements of the structure and the structure stability issues often need the individual approach. Furthermore, the impact of the flows on the constructions may be displayed differently depending on the construction type and orientation. The hydraulic parameters of the hitting power are recently approved as the operative way for mudflow dynamic impact estimation on the regulation constructions. With these parameters the hitting power size prediction connected with the Rheology is represented as K1 coefficient. For the prediction of dynamic impact on the anti-hyperconcentrated mudflow structure the main rheological characteristics (connectivity, internal friction angle, bulk density) and the hydraulic parameters of the boundary conditions for the flow of traffic in the second order differential is solved. Floods hit P power and its personnel dependences of the K1 coefficient are obtained. For the reliability of the theoretical results there are planned laboratory experiments to be carried out in the Tsotne Mirtskhulava Water Management Institute of Georgian Technical University hydraulic laboratory.

1. INTRODUCTION

Environmental impact of natural anomalies, in particular, the impact of debris flows, dramatically changing the ecological balance, harshly changes the situation. The flows intense exposures special places are the transit traffic areas and the display cones. (See the Image 1)). These are exactly the places, where the mainly residential areas, agricultural and public economy objects are located.

Fig. 1 General view of the Mleta river gorge mudflow display cone

The several hyper concentrated flows go through the display cone. The debris flows on the above mentioned places have the destructive force and can move the solid fractions. Mudflow also can block the sensitive areas of the riverbed as well as an artificial barrier to the emergence of an impending breakthrough in the form of a destructive force of dams can lead to disaster.

Because of the damage to facilities is typical for 90% of the mountain river tributaries and this kind of a large-scale and complexity of the event, this kind of the flow adapting reporting models become necessary for the differentiation of risky situations.
The regulation of these kinds of flows impact to different buildings remains one of the biggest unsolved issues of the modern world because of the flow control structures and the complexity.

2. HYPER CONCENTRATED MUDFLOW HYDRAULIC CALCULATION

The hyper concentrated flows impact on the mudflow regulation complex can occur in different ways towards the building type, the flow direction and the movement regime. Therefore, the function of the mutual manageable factors and the selection of the structure elements is directly related to the impact factor power and is very important for protecting the environment from the flow impact.

According to the reports, the low of the traffic flow number is the operative method for the dynamic impact assessment. In the flood duet when the inclined angle of the building is α1 the dynamic force of hitting (p) impact with the tilt angle equals to α is determined by the following formula

$$P = K_1 \frac{\gamma \omega v^2}{g} \cdot \frac{(1 - \cos\alpha_1)}{\sin\alpha_1} \qquad (1)$$

Where K1 is a coefficient (factor) and represents a rheological parameter function; ω-moving mudflow live section area (m2) V-hyper concentrated flow speed (m/sec),γ - volume weight (kg/m3), g - acceleration of gravity.

The reporting (calculating) attitude the coefficient K changes in a great range and its overage quantity equals to 4, 5 according to the results, obtained from the experiments.

In case of hyper concentrated flows, the coefficient K1 determination theoretical attempts are even more difficult and the proven methods and models do not allow us to determine exactly the typology and recommend the criteria which will be based on the same theoretical model selection.

The first approximate rate of the estimated coefficient K1 in assessing the impact of the coefficient K1 of dynamic hitting force, 1-1 to 2-2 at the cross section of the distance L from the traffic case (see Figure 2)), the second order equation of the flow movement may be used.

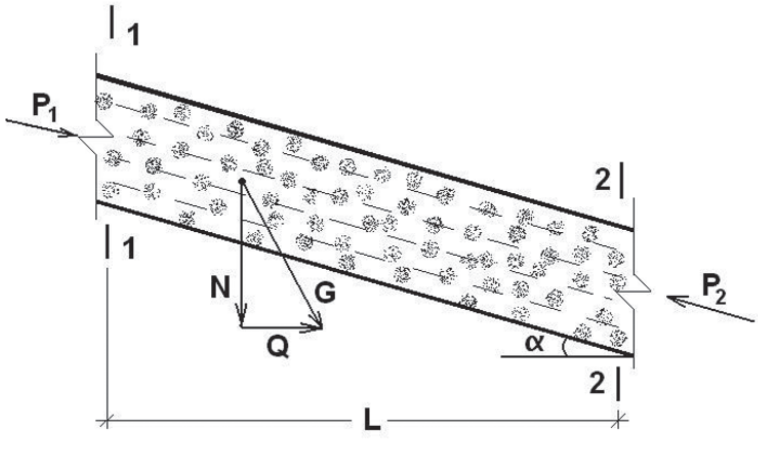

Fig. 2 The mudflow traffic chart (scheme) of accounts

$$m\frac{d^2x}{dt^2} = Q + G - R \tag{2}$$

Where m – moving flow body mass (t); G – moving flow weight; R – moving flow resistance force (б); Q – flow dynamic impact force at the 1-1 intersection.

If we display the forces of surface and volume calculation formula of the second equation, we get

$$R = mg\sin\alpha\,(\sqrt{1+tg\,2\alpha} - tg\alpha) \tag{3}$$

$$G = mg \tag{4}$$

$$Q = \frac{k_1 mV^2}{L} \tag{5}$$

Taking into the account the third, fourth and fifth images, and the second equation will take the following form:

$$\frac{d^2x}{dt^2} = \frac{k_1V^2}{L} + g\left[1 - \frac{\sin\alpha\cdot tg\varphi}{tg\alpha} - \frac{h_0}{2H}\left(\sqrt{1+tg\,2\varphi} - tg\varphi\right)\right] \tag{6}$$

Where V – is the flow average speed from 1-1 to 2-2 intersection, φ - internal friction angle, H – moving flow height (m), h0 – mudflow connectivity equivalent depth (m).

If we introduce the indications, that

$$a = \frac{k_1V^2}{L} \quad and \quad b = g\left[1 - \frac{\sin\alpha\cdot tg\varphi}{tg\alpha} - \frac{h_0}{2H}(\sqrt{1-tg^2\varphi} - tg\varphi\right] = gK_2 \tag{7}$$

Then the sixth equation will look like:

$$\frac{d^2x}{dt^2} = a + b \tag{8}$$

With the first integration of the eighth equation we will get:

$$\frac{dx}{dt} = (a+b)\cdot t + c \tag{9}$$

The constant of integration is determined by the objective conditions when $t = 0, \frac{dx}{dt} = V, V = c$

and accordingly the ninth equation will look like:

$$\frac{dx}{dt} = (a+b) + c \tag{10}$$

When $\frac{dx}{dt} = 0 \quad then \quad t = -\frac{v}{a+b}$

On the basis of the tenth equation integration we will get:

$$X = Vt + \frac{a+b}{2}t^2 + G_2 \tag{11}$$

When, t = 0, C2 = 0 and the flow movement 1-1 to 2-2 intersection distance L with the formula

$$L = Vt + \frac{a+b}{2}t^2 \tag{12}$$

As a result of the influence of gravity forces, the twelfth equation inclined bed flow evenly accelerated movement distance of equation. The second member of the left part (a+b) of the twelfth equation is equal to the magnitude of the acceleration of gravity.

Therefore it will take the following form:

$$\frac{k_1 V^2}{2L} + g\frac{k_2}{2} = g \tag{13}$$

If we solve the thirteenth equation to k1, it will be:

$$k_1 = 1{,}5(1 - k_2) \tag{14}$$

Taking into account the given importance of k2 of the fourteenth equation, the mudflow dynamic force (power) coefficient of dependence will look like:

$$k_1 = 1{,}5 \cdot \sin\alpha \frac{tg\varphi}{tg\alpha} + \frac{h_0}{2H}(\sqrt{1 + tg\,2\varphi} - tg\varphi) \tag{15}$$

And the magnitude of mudflow dynamic hitting force is calculated by the following formula

$$P = 1{,}5[\sin\alpha \frac{tg\varphi}{tg\alpha} + \frac{h_0}{2H}(\sqrt{1 + tg\,2\varphi} - tg\varphi)] \cdot \frac{\gamma\omega V^2}{g} \tag{16}$$

That is, when there is a mudflow structure regulation, the flow movement regime changes and as we see from the fifteenth and sixteenth equations, the mudflow dynamic hitting power is the function of the flow weight, floods flow, the bed of the living section of the living area, angle of internal friction and mudflow connectivity.

3. CONCLUSIONS

Thus, considering the hyper concentrated mudflows rheological properties and the flow hydraulic computation, the 16-th dependence is accepted, which can be used not only to predict hitting dynamic force (P), but the whole structure unified system calculation is possible using the variety of proven programs.

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ROLE OF PROSUMER ENERGY IN ENERGY SUPPLY TO BUILDINGS

POSTER

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Keywords

prosumer energy, civil engineering, renewable energy

ABSTRACT

The aim of this paper is to discuss the use of a technology of prosumer energy in supplying heat and electricity to buildings. Photovoltaic systems micro wind turbines and cogeneration systems that use bioliquids as well as heat pumps are of key importance to Poland. Socioeconomic benefits to environmental protection and direct benefits for prosumers are important arguments for supporting prosumer technologies.

1. MICROINSTALLATIONS FOR RENEWABLE ENERGY SOURCES

Prosumer in our study is understood to mean a physical or legal person or an organizational entity without legal personality being a producer of energy for their own needs or for sale using a microinstallation.
Microinstallation is a renewable energy source with the installed electrical capacity below 40 kW. For the thermal capacity the threshold level is 70 kW.
The concept of microinstallations in the renewable energy sector and the related definition of a prosumer have become the focus of the discussion among the producers and consumers in the European Union and in Poland, particularly in the recent years.
The fundamentals of development of the prosumer energy sector and microinstallations were created in 1980 by a writer and futurist Alvin Toffler in his classic book “the Third Wave”, where he aptly drew a vision of the breakthrough in the energy sector, which has been verified in the reality, also in Poland. The tendencies forecast by Toffler work very well as they influence on reduction of the costs of energy supply and honest division of the benefits. However, they necessitated a technological breakthrough and the law that does not inhibit bottom-up initiatives and a specific maturity of civil engineering. As early as in 2002, the renowned publication “Small is Profitable” (eds Amory & Lovins et al. 2002), demonstrated some 207 benefits of development of distributed generation for consumers and citizens). The substantial parts of these benefits are directly or indirectly connected with increasing the individual, local and national level of energy safety. Prosumer energy sector necessitates exploration, analyses, examinations and implementation to the energy systems using stages. Popularization of prosumer technologies for conversion of renewable energy leads inevitably to the real energy revolution. Microinstallations for renewable energy sources and their popularization are the first necessary and particularly important step for the energy sector to ensure further transformations.
Microinstallations for renewable energy sources as key prosumer technologies (Kurzak 2014, The National Plan of Action for renewable sources of energy, Wisniewski et al. 2013):
• solar collectors,
• biomass boilers,
• small wind power plants (micro wind turbines),
• micro photovoltaic systems,
• co-generation microsystems using biogas and bioliquids
• heat pumps,
• small water power plants.
Development of microinstallations and prosumer energy sector are incessantly connected with the construction sector. Especially in the new model of distributed energy sector, construction might be the sector of building not only green heat plants but also combined heat and power plants or green power plants.
According to the data of Eurostat, the construction sector is the biggest industrial employer in the EU that is

responsible for 20% of GDP and 40% of the final energy consumed. There are over 190,000,000 buildings throughout the EU which are candidates for transformation into micro power plants. As noted by Jeremy Rifkin, the third industrial revolution consists in transformation of almost each building into the places with two functions: place of residence and micro power plant. Analyses carried out in e.g. photovoltaic sector show that photovoltaic cells and modules can be directly installed on 15% of roofs and façades in buildings in the EU. With such investments, the power of PV systems installed in the buildings of the EU would reach 1.5 TW and would allow for covering 40% of total demand for electricity in the EU (Kurzak 2014).

Microinstallations of renewable energy sources represent the initial point and the foundation for development of microgrids, intelligent grids and broadly understood prosumer energy sector. Prosumer energy sector requires a period of incubation and is implemented into the energy systems with stages. These stages, being the steps to popularize prosumer energy using intelligent energy environment, can be formulated in the following manner:

1) development of technologies that utilize renewable energy sources,

2) transformation of building owners into prosumers and transformation of buildings into micro power plants with microinstallations,

3) development of new technologies for periodical storage of energy and using them in microinstallations,

4) utilization of Internet technologies i.e. energy Internet, for exchange of energy between prosumers (buildings) and sharing the surplus energy,

5) popularization of intelligent networks of supplying power to buildings.

Fig. 1 presents the role of OZE microinstallation in broader technological and market environment and their evolution with technological advances that take into consideration social expectations. It is hard to imagine construction and development of intelligent energy systems and prosumer energy sector without these installations. However, on the other hand, the most of microinstallations cannot be developed to larger scale nor go beyond individual applications without friendly social environment (civil energy sector), technological advances in the field of energy grids and proper model of the energy market with the space for prosumer energy sector.

2. MICROINSTALLATIONS FOR RENEWABLE ENERGY SOURCES IN POLAND BY 2020

Being an isolated segment of the renewable energy sector, microinstallations for renewable energy sources have become a component of the national energy strategy when the National Action Plan for Renewable Energy Sources (Krajowy Plan Dzialan w Zakresie Odnawialnych Zrodel Energii, KPD) was adopted (The National Plan of Action for renewable sources of energy). The plan describes a technological pathway for development of renewable energy sources by 2020. At present, this is the only formal document for planning of development of the microinstallation market in Poland as part of the renewable energy sector. KPD defines that the contribution of the renewable energy sources by 2020 should be increased to at least 15%. The document also stipulates the direct and sectoral objectives for the electrical power sector (19%), heat power and refrigeration sector (17%) and transport sector (11%).

Figure 2 illustrates a target structure of electrical energy generation and heat generation according to KPD by 2020. An important element of the expected use of renewable sources is micro power sector and microinstallations. According to the document, in order to implement the objective of the directive, it is necessary to develop small installations and microinstallations for production of electrical power, such as: small water power plants, small wind power plants (micro wind turbines), photovoltaic systems, co-generation microsystems using biogas and bioliquids and solar collectors, biomass boilers and heat pumps.

Figure 3 present projection of generation of electrical power and heat from microinstallations in 2020. The figures show the substantial contribution of distributed sources of energy which are the basis for prosumer microgeneration. The forecast level of electricity generation from different types of renewable energy sources is presented in Fig. 3a, whereas heat generation is presented in Fig. 3b. With respect to electricity, popularization of the use of photovoltaic technologies was assumed. In the most developed countries of the European Union, photovoltaic technologies have become the key part of distributed electrical power microgeneration. The leader among these countries is Germany, with over 4,000,000 of electricity producers using renewable sources of energy in 2010.

With respect to energy generation from renewable energy sources, similar to the present situation, biomass will have the dominant position in 2020. This fact is due to the distributed availability and easiness of processing.

Total energy generation from microinstallations by 2020 would reach 38.5 TWh, including 2.9TWh for electricity. Biomass boilers (82%) and sun collectors (13%) are expected to be leading prosumer technologies in the green energy sector by 2020. According to the assumptions, the greatest share in the sector of green electricity microgeneration (648,000 microinstallations) is expected for photovoltaic systems (84%), followed by small wind power plants (13%).

3. OPPORTUNITIES AND THREATS TO PROSUMER ENERGY SECTOR

Widespread implementation of energy technologies in the field of distributed energy sectors with other subsystems will allow for creation of local electrical power systems, which will translate into the reform in the whole electric power sector and popularization of its prosumer character. Initial analyses have demonstrated that development of distributed generation should contribute to development of local communities (increased role of local governments, new workplaces etc.). Among the potential benefits, one should list in particular (Kurzak 2014, The National Plan of Action for renewable sources of energy, Wisniewski et al. 2013):
• use of the technologies based on renewable energy sources;
• use of ecological sources and easily available sources;
• reduction of the effect of bigger system failures;
• development of local energy policies;
• creation and development of local energy markets, development of local governments;
• improvement in quality parameters of electric energy and, consequently, improvement in level of services for final consumers;
• avoiding or postponing the modernization or extension of power transmission lines;
• reinforcement of ties between science and industry: the need for development and implementation of new innovative technological solutions and education of modern and competent engineering staffs
• stimulation of development of new sector of the economy (power microgrids with organizational and technological facilities);
• achievement of the goals of 20-20-20 policy and other energy and environmental directives in the European Union.
The above presented benefits show that development of distributed generation might facilitate functioning of individual regions of Poland not only from technical but also from social point of view and, consequently, translate into improved level of living of Polish society. Distributed generation allows for implementation of the basic principles which are a priority for the economic development of each country, with particular focus on the energy policy, including energy independence, which has become a key problem today.
However, there are a number of barriers of economic, technological, organizational and legal nature that inhibit development of distributed supply of energy to consumers-prosumers. The key problems include:
• insufficient technological and economic maturity of renewable and alternative manufacturing technologies;
• risk destabilization of energy system assuming high share energy balance of unstable energy sources;
• lack of detailed guidelines concerning inclusion of small manufacturing units to low voltage grids;
• strong dependency on foreign technologies;
• lack of legal regulations that allow for creation of local energy markets, including the lack of a dynamic system of tariffs;
• insufficient social education in terms of ecology and technology;
• no strong relationships between science and business, without which reconstruction of the national energy sector is impossible;
• reluctance to changes;
• reluctance to reform the energy sector among big manufacturers.
Obviously, this list does not contain all the problems. However, the list shows clearly that the energy revolution is coming, with energy consumers becoming also the producers.

4. CONCLUSIONS

In the nearest years, prosumer energy will start playing an important role in development of Polish energy sector. The particular importance will be from supplying of electric energy and heat to detached houses located far from big networks of distribution of energy generated in conventional ways. Appearance of great number of prosumers will substantially affect the sector of conventional energy which will be shrinking, whereas investments in distributed sources will become attractive.
The prosumer model, which is becoming competitive for current big manufacturers, creates new business opportunities. Not only production of installations for distributed generation of energy but also their construction and customer service might be the chance for development of local economy and national industry. Prosumers also stimulate development of sustainable energy economy, reduce the dependency on consumption of fossil fuels which are harmful for human health and the environment and make the energy sector independent of the centralized

manufacturing, exposed to big failures of the whole system.

The serious challenge for the state is to prepare legal regulations to ensure harmonious development of prosumer energy sector and its coexistence in common centralized European market. The role of non-government organizations and analytical centres should be to increase social awareness of potential of prosumer energy and stimulate the debate among decision-makers and society about the role of prosumers in sustainable economy of the future.

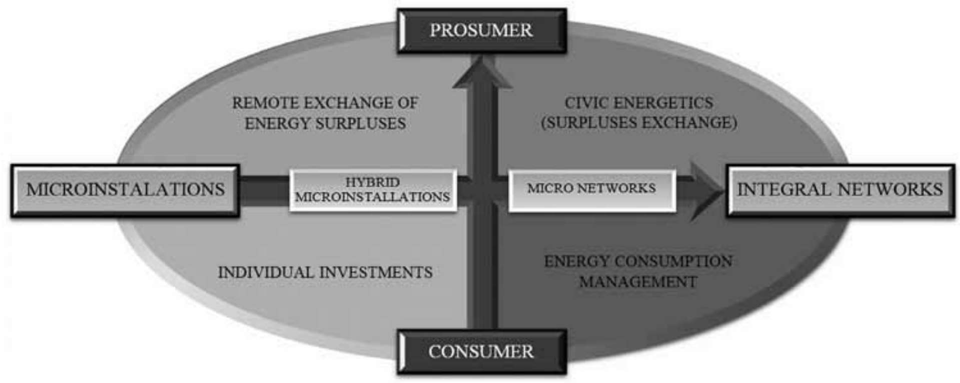

Fig. 1 Evolution of consumers into prosumers using microinstallations of renewable energy sources and their use in intelligent management of energy supply.

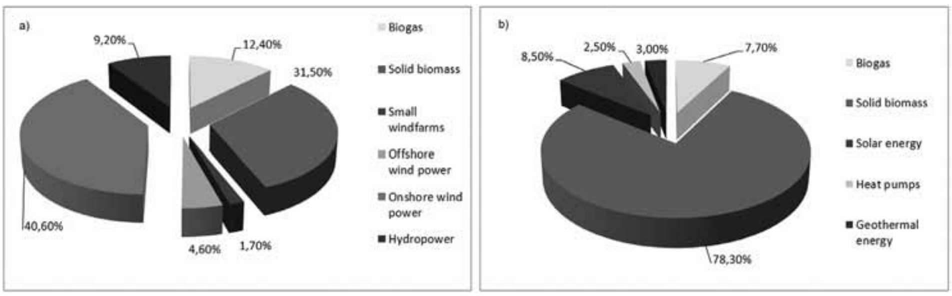

Fig. 2 a) Structure of generation of electrical power from renewable energy sources by 2020 according to KPD [3], b) Structure of generation of heat renewable energy sources by 2020 according to KPD [3].

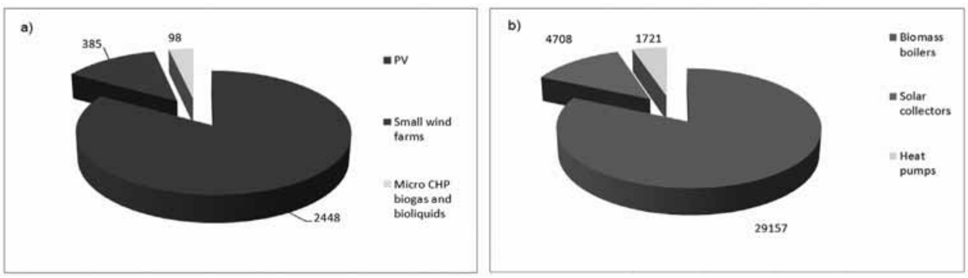

Fig. 3 a) Projection of electrical power generation from microinstallations by 2020 [GWh], [4], b) Projection of heat generation microinstallations by 2020 [GWh], [4].

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ENERGY EFFICIENCY IMPROVEMENT OF RESIDENTIAL BUILDINGS DURING THEIR MAJOR REPAIRS AND RECONSTRUCTION

POSTER

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Keywords

energy efficiency; major repairs; residential buildings

ABSTRACT
One of the most topical directions of urban development in Russia is a problem of ensuring effective major repairs and reconstruction of residential buildings. A number of legal documents, the main of which are "Energy Strategy of Russia for the period until 2030" and Federal Act No.261-FZ "Concerning Energy Saving and Energy Efficiency Improvement" (as revised on 29.12.2014) dated November 23, 2009, are accepted for ensuring energy efficiency of buildings and constructions. The main principles are revealed and the performance measures of energy efficiency of residential buildings when carrying out major repairs and reconstruction are offered on the basis of the domestic and foreign experience analysis of the state energy saving policy. The measures for energy efficiency improvement of residential buildings during their major repairs and reconstruction are developed.

1. INTRODUCTION

According to Ministry of construction and housing and community amenities of the Russian Federation the total area of buildings operated in Russia is 5, 5 bln square meters, which includes 4, 1 bln square meters of residential buildings. Year by year the residential stock of Russia becomes notably dilapidated, the working life and wear-out rate of buildings grow up: failing and dilapidated residential stock is more than 50 mn. m2 with 70 % of wear-out, 11 % of residential buildings need major repairs, and 9 % - reconstruction. According to economic forecasts in the nearest 10-15 years, losses in the residential stock in Russia will show 500 mn m2 (20 % of the total volume) (Shihaliev, S. S. 2012). Under these conditions, it is required to significantly increase the reclamation of the residential stock, which includes major repairs and reconstruction in order to provide the life of residential buildings on the basis of technical and economic working lives and enhancing of their efficiency due to implementation of new energy saving technologies. Currently the average costs for heating of residential buildings in the entire territory of Russia are 350-380 kW h/ m2 per year, which is 5-7 higher than in Germany and other EU countries (Drozdova, I. V., Malafeev, O. A., Parshin, L. G. 2008). Besides, the necessity for residential buildings energy saving events in Russia is stipulated by the constant growth of thermal energy tariffs (in the payment for housing and communal services 35% fall on thermal energy) and high heat losses in residential buildings which need major repairs or reconstruction.

According to the estimates of the World Bank and Russian researchers the major repairs and reconstruction of existing residential buildings may save 30-60 % of the energy for buildings heating (Nieboer, N., Tsenkova, S., Gruis, V., Hal, A. 2012).

2. BACKGROUND

To implement the policy aimed at energy saving the series of regulatory documents have been accepted the main of which are "Energy strategy of Russia for the period until 2030" and Federal Act No.261-FZ "Concerning Energy Saving and Energy Efficiency Improvement" dated 23 November 2009 (Shihaliev, S. S. 2012).
In the framework of energy saving strategy the state target-oriented programs have been developed and are being executed as regards enhancing of energy saving in residential buildings on regional and municipal levels. However

the efficiency of the programs implementations is not high due to the non-availability of associativity of the programs aimed at reconstruction and major repairs of residential buildings with the programs of their energy saving based on the results of mandatory and voluntary energy surveys. It leads to the situation when at design, reconstruction and major repairs the modern energy saving technologies are not used in full which results in decrease of quality and efficiency of the residential stock reclamation.

3. METHODS

The landmark method for the management of reconstruction and major repairs of residential buildings on the basis of energy saving technologies application is the special-purpose program method allowing for aligning of purposes with resources at the implementation of special-purpose programs on the federal, regional and municipal levels.

4. CASE HISTORY

The first basic document defining the directions of state policy in field of energy saving in Russia is Resolution of the government of the Russian Federation (No. 371 dd. 01.06.1992 “On high priority measures for energy saving in field of extraction, production, transportation and use of oil, gas and oil products”. Then Federal Act No.28-FZ “On energy saving” dd. 03.04.1996 was adopted. In 2003 by Resolution of the government of the Russian Federation 1234-r dated 28 August 2003 “Energy strategy of Russia for the period until 2020” was approved. One of priority tasks of the Energy strategy is enhancing of efficiency as to the use of energy resources and creation of conditions required for transition of the country economics to the energy saving path of development. In 2009 Federal Act No.384-FZ “Technical Regulations on Safety of Buildings and Structures” dated 30.12.2009 (as revised on 02.07.2013) and Federal Act Nom.261-FZ “On energy saving and energy efficiency enhancing and changes introduction to individual legislative acts of the Russian Federation” dated 23.11.2009 (as revised on 29.12.2014) which define the main directions of the state regulation in field of energy saving, enhancing of energy efficiency which impose requirements on the following: energy efficiency of buildings and structures – mandatory energy surveys; energy passport; mandatory events on energy saving in multicompartment buildings; energy efficiency of works and services; to regional municipal programs in field of energy efficiency; functioning basics of the state information system in field of energy saving; mandatory statement of information in field of energy saving and efficiency.

5. RESULTS

Energy saving solutions in course of major repairs and reconstruction of residential buildings include the following events:
- Enhancing of thermal shielding of external walls, cold attic slabs, slabs above cold basements, inclined and flat roofs, cock-lofts, windows, entrance and apartments doors; thermal losses decrease in places of common use; enhancing energy efficiency ventilation systems, heating and hot water supply systems;
- Enhancing energy efficiency of the building engineering equipment and lighting system meant for the curtilage and places of common use.
- Curtailment on demand for cold and hot water; natural and liquidated gas saving.

The selection of a method for reconstruction of a building not more than five stories in height is performed on the basis of city planning situation, physical condition, social demand for housing and value of a development plot. That said the priority is placed not on a residential building with a certain level of physical wear-out and functional depreciation, but on the development of residential area and city planning situation in whole.

In this case, we solve the three tasks: transformation of residential areas in conformity with the contemporary city planning requirements with residential development densification; improvement of living conditions of population with enhancing of apartments comfort level and development of the network and facilities of social and transport infrastructure; creation of energy-efficient residential developments areas.

In course of residential buildings reconstruction projects a special emphasis is placed on energy saving issues at the residential stock operation. In these projects, the leading role is played by the events on decrease of specific heat losses of buildings due to new space planning solutions. It is known that specific heat losses of buildings depend on the ratio between the area of external fencing to the space or area of heated premises.

The second most important set of energy saving measures is the transition in course of reconstruction to use of new types of multi-layered external fencing structures, reduced total thermal resistance of which corresponds to the applicable norms.

The third set of energy saving measures is associated with the modernization of heating and thermal equipment systems.

In the context of reconstruction, residential buildings developed in 50-60 years of the last century are of a special appeal. That period was characterized as the beginning of the mass use of the dry construction methods. Relatively low cost of energy resources in the country, understated requirements to thermal protection properties of fencing structures and dominating focus on prefabricated structural solutions for buildings made the country's residential stock energy-intensive.

The operational practice has revealed that working life and thermal protection functions turned out to be the less studied issues and differently showed up in structures of various types. Reduced thermal insulation was the drawback of one-layered concrete walls. The required temperature conditions in such buildings are provided due to heating system warm overconsumption, in other cases – due to additional weatherization of walls in course of repairs or reconstruction.

Weatherization is performed from the inside beginning with the most troubled ones (hazards of condensation on the inner wall surface) – external corners, joints, jambs – or across the whole surface of the wall.

Underlining of multi-layered walls was made of non-perfect heat insulators having relatively low thermal insulation properties and high deformability.

In course of reconstruction of walls with walls made of multi-layered panels in order to improve temperature and moisture conditions of premises and external fencing structures it is reasonable to provide for various structural planning events for energy saving – bulk widening, arrangement of greenhouses along facades, glazed recessed balconies, winter gardens.

In first prefabricated buildings, only open roofs ventilated or not with external or internal drainage system were used. The major drawbacks of such roofs are low heat protective properties and hydro isolation defects difficult to eliminate.

The most rational method for operational properties of the roof is its complete reorganization by way of replacement of an open structure for an attic one. The most reasonable solution is combination of technical reorganization (change of a flat roof for inclined one) with space planning one, i. e. use of the larger part of the attic space for residential or working premises.

In course of construction of attic stories, a restored building becomes more architecturally expressive, its operational and technological characteristics improve, the comfort level of apartments increases.

The state and regional policy in field of energy efficiency enhancing at reconstruction and major repairs of residential buildings includes the elements of the three most important directions of the state social and economic policy – city planning, residential and energy saving policy.

The complex of measures for enhancing of efficiency of major repairs and reconstruction of buildings on the basis of energy saving includes: legal and regulatory framework; institutional development, economical incentive, administrative regulation and methodological support – together making the organizational and economic mechanism for enhancing of major repairs and reconstruction of buildings on the basis of energy saving; technical and informational support.

The analysis of domestic and foreign experience as to regulation of energy efficiency of residential buildings in course of major repairs and reconstruction has allowed for identification of the following principles of buildings energy efficiency enhancing:

1. The systematization principle at the development of the uniform systematic and methodological approach to the evaluation of energy efficiency indices, technological and economic efficiency of the events on major repairs and reconstruction, monitoring and control, priority of energy efficiency in course of design, construction, major repairs, selection of equipment and suppliers.
2. The principle of consistency lies in alignment of residential buildings major repairs and reconstruction programs and those of enhancing of their energy efficiency on the federal, regional and local levels.
3. The principle of targeting is aimed at achievement of definite purposes on the basis of calculation of target indicators values.
4. The principle of information availability presupposes the creation of databases, automated control systems (ACS), information systems in field of energy efficiency; formation of the system of federal and regional efficiency operators; creation of the base of best practices as to energy saving and energy efficiency enhancing; renewal of forms of statistical monitoring of multicompartment buildings major repairs and reconstruction.

5. The principle of economic incentive lies in the implementation of the encouragement system for subjects enhancing energy efficiency of residential premises (buildings).

In order to evaluate the efficiency of energy saving events it is reasonable to use the following factors: simple and discounted payback period, expenses for the building working life, net present value, internal rate of return, return on investments, etc.

In course of performing of the technical and economic evaluation it is required to count for the whole life cycle of the facility subject to major repairs or reconstruction; model cash flows at each stage of the life cycle; for the correctness of comparison try various variants in similar conditions including discounting; count for quantitative as well as qualitative consequences of energy saving events e. g. improvement of ambience, comfort level, etc.

6. CONCLUSIONS

The issue of enhancing of energy efficiency of residential buildings in Russia is stipulated by the growth of expenses for energy resources at operation of residential buildings which need major repairs or reconstruction and constant growth of tariffs. Major repairs and reconstruction of residential buildings allow for energy consumption reduction by 40-60 %. Currently in Russia, the programs of major repairs (reconstruction) of residential buildings and programs of enhancing of residential buildings energy efficiency on the federal and regional levels (unconnected) are being implemented. Thus, the issues related to enhancing of efficiency of reconstruction and major repairs of residential buildings on the basis of energy saving lack thorough elaboration. Enhancing of efficiency of reconstruction and major repairs of residential buildings on the basis of energy saving is impossible without the state support on all the management levels. The complex of measures for enhancing of efficiency of reconstruction and major repairs of residential buildings on the basis of energy saving includes: legal and regulatory framework; institutional development, economical incentive, administrative regulation and methodological support. The events for enhancing of residential buildings energy efficiency in course of their major repairs and reconstruction have been developed. Energy saving solutions for residential buildings include the following events: buildings heat insulation: weatherization of walls, coating, basements ceilings, replacement of window assembly, balcony and entrance doors; modernization of the heating station providing for installation of units for metering, control and regulation of energy consumption; modernization or replacement of heating, ventilation, hot water supply and electric power supply systems.

The complex of energy saving events may be implemented in full provided the use of the systematic approach to modernization and reconstruction of the existing residential stock. Based on the analysis of domestic and foreign experience as regards the state policy in field of energy saving the main principles and evaluation factors are identified for energy saving events efficiency in course of major repairs and reconstruction of residential buildings.

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GREEN ROOFTOPS IN DIVERSIFIED URBAN LANDSCAPE

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Keywords

green rooftops, landscape architects, public spaces

ABSTRACT

The following work discusses the function of contemporary "green roofs" designed with the use of elaborate construction technology. It shows how a properly designed project can perform multiple functions: from enhancing recreational activities toreducing air or noise pollution, and improving the microclimate of a city. The text is illustrated with a variety of projects designed by outstanding landscape architects whowere able to restorenatural environment tourban areas. The use of modern adequately selected plant species and unique architectural compositions successfully confront the needs of contemporary architects, i.e. creating enclaves; intimate spaces separated from noise and traffic where nature can be cherished. Findings, stated in the conclusion answer the question of how these innovative ideas comply with the aestheticism of form, and how they shape recreational activities favoured in modern, but not entirely human-friendly public urban spaces.

1. GREEN ROOFTOPS OF CONTEMPORARY PUBLIC SPACES

Public gardens set on the roofs of car parks, stations, hotels, or libraries are considered ingenious, and, at the same time, perfect architectural solutions in places where the scarcity of space is a common phenomenon. Although they tend to be costly, these modern extensive parks can be treated as a significant technological accomplishment [1].

Green roofs not only reintroduce a piece of natural environment to urban areas, but also contribute to the reduction of air and noise pollution. What is more, while enhancing the aesthetic value of the area, they improve the microclimate of agglomerations. If designed properly, they fulfill recreational and regeneration function for the inhabitants. In highly developed countries such as Germany, Switzerland, the UK, Canada or Japan green rooftops are designed primarily to improve the quality of air, climate, or to create spaces that would allow certain recreation of biological life. They may also serve the traditional purpose of accumulating rainwater [2].

An example of interesting rooftop garden design is a garden set on the roof of the Museum of Modern Art. In New York. It is made of natural as well as recycled or synthetic materials such as stone, recycled glass, fiberglass, or PVC pipes. What is more, the garden is fitted with artificial rocks, and plants; mainly box trees. The flat surface of the roof, when seen from aerial view, reflects the pattern of camouflage trousers. The landscape architect responsible for the project, Ken Smith, by means of a variety of materials such as white pebble, black rubber, or smashed glass created a garden modeled on Japanese Zen gardens while, simultaneously, retaining the modern spirit of America (Fig. 1)[3].

Another inspirational project is a garden on the roof of London Great Ormond Street Hospital for Children. Its designer, a landscape architect Andy Sturgeon, successfully extracted all the possibilities that the rooftop space had to offer and, making use of the aesthetic properties of the surrounding area, he created 261 m2 of multifunctional space catering for the patients of the hospital. What he had in mind was especially their need to find serenity and joy. The garden is equipped with a plethora of platforms serving as sitting areas. Being situated on different levels, the platforms create fully or semi-enclosed areas which encourage people to integrate but also allow them to cherish certain amount of privacy. A diversity of trees and shrubs, their lavish colouring, the combination of different sorts of artificial and natural elements unquestionably aids to pleasant atmosphere during visiting hours[4].

The next project can be perceived as a stimulus for ecological awareness among children and youngsters. Gary Comer Youth Center situated in Grand Crossing, Chicago, is a rooftop garden with a mission. Designed by HoerrSchaudt Landscape Architects, the garden comprises 758 m2 of space used to teach gardening and food

Fig. 1The Museum of Modern Art in New York (Designed by Ken Smith) Source: http://kensmithworkshop.com/

Fig. 2 Gary Comer Youth Center in Chicago (Designed by. Hoerr Schaudt). Source: http://www.hoerrschaudt.com/

production.

The project, however, does not ignore aesthetic needs. Therefore students, while walking through the corridors from classroom to classroom, can admire the stunning view (Fig. 2)[5].

As a part of gardening classes, students grow herbs, flowers, vegetables, fruit, or even dig potatoes. Annually, the garden itself produces a significant amount of organic food which is further used by a cafeteria and canteen that are located on the premises of the complex. The area of the garden is also equipped with metal circles which, on one hand, serve as decoration, and, on the other, provide an additional source of light for the classrooms and the

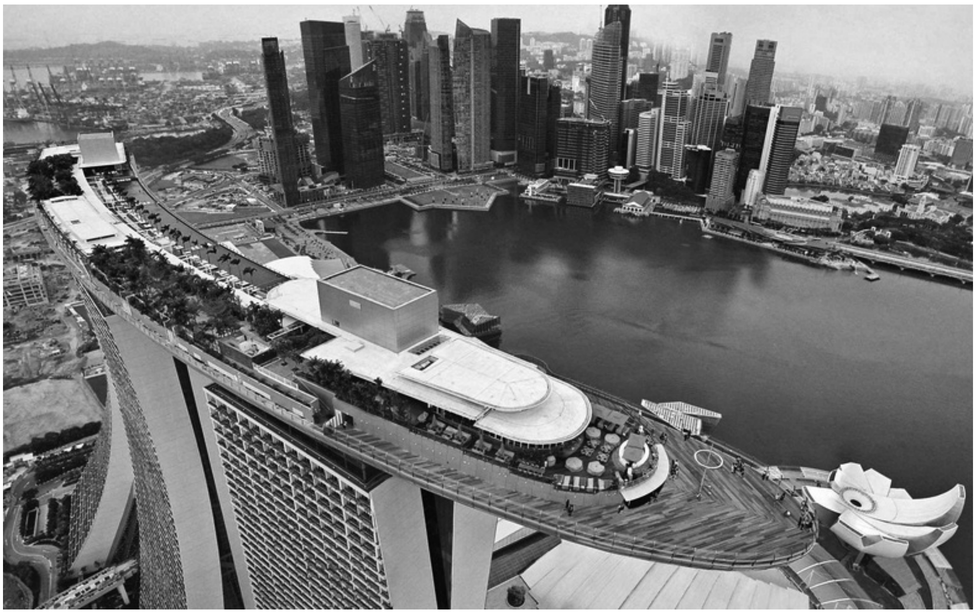

Fig. 3 Marina Bay Sands in Singapore (Designed by Peter Walker). Source: http://www.pwpla.com/

cafeteria, since they reflect sunshine. The entire complex is administered by an manager-horticulturist who is in charge of the maintenance of the complex as well as the educational programme for students.

Marina Bay Sands in Singapore is a complex consisting of three buildings joined on the top by means of 9.941m2 platform on which there are gardens, numerous restaurants, jogging paths and observation decks.

The visitors can also enjoy a stroll in a park, and admire the panorama of the city while swimming in an infinity edge pool (Fig. 3)[6.]

The entire complex may accommodate roughly four thousand people. PWP Landscape Architects lead by Peter Walker, America's foremost landscape architect whose designs are recognizable all over the world, cooperated with many horticulturists, and was able to obtain plants from different parts of the globe not only in the form of seedlings, but also trees. Consequently, the lush gardens of Marina Bay Sands comprise of 250 species of trees and 650 various plants.

Another project deserving attention is a rooftop garden located on the 17th floor of Zen World in Bangkok. The main asset of this place is the view on the panorama of the city. The investor aimed at designing the space in such a way so that the restaurant would have a cosy atmosphere. A landscape architect, Pok Kobkongsanti ((T.R.O.P terrains + open space,) created an intimate space by means of rudimentary materials. The surface area of the garden is 900 m2, and the main material used is local wood which is especially resistant to heat and incurvation. This modern garden is arranged in way that all the forms and materials enable visitors to admire plants from different angles (Fig. 4)[7].

2. CONCLUSIONS

Contemporarily designed rooftop gardens greatly enriched with modern technologies and materials enable present-day architects to use a variety of forms of designing, and, at the same time, offer opportunities for artistic and creative development. They serve not only aesthetic function as they also contribute to the improvement of energy balance of a building by providing very effective natural insulation . Astonishing gardens located on rooftops cater for people who need to relax and regenerate. What is more, they also stimulate and enhance the society's ecological awareness. Finally, such gardens may be regarded as one of the factors that beautify the panorama of any modern public space and improve its attractiveness.

Fig. 4 Zen World in Bangkok (Designed by. Pok Kobkongsanti). Source: http://www.troplandscape.com/

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TUNNEL SEWER CONDITION MONITORING

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Keywords

deep tunnel sewer, condition monitoring, tunnel sewer maintenance

ABSTRACT

The successful and efficient integration of deep level sewer tunnels to complement city's large, complex water supply, storage and treatment facilities becomes the greatest challenge for the modern fast expanding megalopolises. The growing trend of tunneling and the multi-purpose use of the underground can be observed worldwide. The economic effect, technical practicality and social impact of the construction of the deep level sewers are widely confirmed. The condition monitoring of the deep tunnel sewer has to be carried out for ensuring the proper functioning and is a basis of their regular maintenance. And also the analysis of the processes taking place in the system and timely identification of a nature of changing condition in underground structures, identification of the reasons of their emergence and forecasting of development, elaboration of necessary measures to eliminate the that negative processes.

1. INTRODUCTION

The task that comprises the condition monitoring is well ahead the purely technical issue transforming it into the cross-boundary objective covering all key aspects of the sustainable city development such an ecological, economic and social. It is necessary to consider the following:
- unlike works on a surface, the underground construction is conducted in complex, not always well studied, constantly changing and potentially dangerous hydrogeological conditions.
- the underground wastewater structures as a part of the deep tunnel sewers are often is in a condition of unstable balance which violation in some cases leads to accidents with serious consequences as for the most underground construction, and objects which are in a zone of its geomechanical influence.
- operation, conveying of domestic, industrial and storm wastewater on tens kilometers, is dynamic process with multiple-factor impact on a tunnel structure.

All those factors forms the need for comprehensive approach to an issue of maintaining the effective and comprehensive condition monitoring of the deep sewer tunnels, development and deployment of the automated systems of monitoring, development of standard documentation.

The sewage network of St Petersburg is characterized by existence of shallow lying pipelines and tunnel collectors with a diameter of 1.5 m and larger, laid at a depth of 8 to 80 m. Structurally, the tunnels consist of cast iron or reinforced concrete tubing and reinforced coating. The length of tunnels in Saint Petersburg is around 200 km.

For transferring effluents to the tunnels, sewage wells are used. These are sophisticated engineering structures that carry effluents, simultaneously enabling the maintenance personnel to come down for inspection, repair, washing, and fault rectification both in tunnels and in wells proper. The wells, too are made mostly from reinforced concrete tubing and reinforced concrete coats 15 to 20 cm thick. Fitted inside the wells are reinforced spans with a pitch of 3 to 4 m. Enclosures, ladders, and other elements of engineering support are manufactured from ferrous metal or stainless steel [1,2].

The uninterrupted operation of the sewage system is a vitally important condition for functioning of any populated area. Accidents on sewage collectors can have a hugely detrimental impact on the national budget, environment, and population. In order to avoid accidents and other malfunctions in the sewage system it is necessary to regularly monitor the sewage collectors and the structures on them. For this purpose, a special system has been developed that enables monitoring with subsequent diagnostics of structures on the network.

2. MALFUNCTIONS IN OPERATION OF THE TUNNEL COLLECTORS

The malfunction in operation of the deep lying tunnel collectors can be caused by different factors or an aggregate thereof.

Based on the current Russian regulatory documents [3], [4] and [2], and taking into consideration the previous investigations described in [5], a summarized block diagram was drawn that shows malfunctions in operation of deep lying tunnels and their causes (Fig.1). Three principally different groups of causes of pre-critical and critical situations are singled out in the block diagram. The first group of natural causes may include factors that arise naturally and cannot be eliminated. The second and third groups comprise factors arising in performance of certain technological operations.

The study of many accidents on sewage collectors shows that in 24 to 70% of cases they are caused by concrete

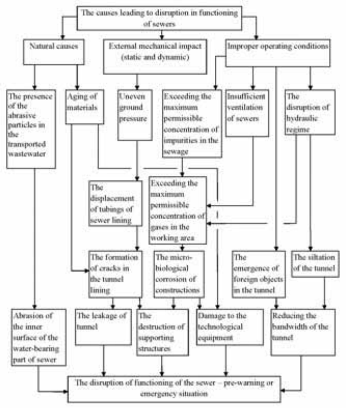

Fig. 1 Malfunctions in tunnel collectors and their causes

corrosion in the top of the pipelines and collectors whose rate may reach 5 to 40 mm per year [7, 8, 9]. Due to the catastrophically high rate of corrosion, the average service life of the collectors in Russia [10] is around 10.5 years [9], seldom exceeding 15-18 years, whereas in case of normal operation the operating life of such structures must be no less than 35-40 years [10]. The average operating life of deep lying sewage tunnels in St Petersburg is around 40 years, in special cases not exceeding 50-70 years. However, such structures must serve no less than 100 years [2]. In view of the above, significant funds are allocated to fighting corrosion, which makes microbiological corrosion of reinforced concrete collectors a serious and costly problem affecting the sewage systems across the world. In global terms, the damage sustained through corrosive destruction of sewage pipelines runs into billions of euros a year [11]. In the Flemish region of Belgium the biological corrosion of sewage collectors accounts roughly for 10% of all spending on effluents purification [8]. The recovery of all the damaged collectors in Germany costs around 100 million euros per year [12]. Other causes of collector destruction are collector tray wear, mechanical damages to collector structures brought about by external factors and the impact of chemically aggressive effluents. However, it is expressly corrosion that mainly contributes today to collector destruction. According to current literature, the concrete corrosion is induced by different groups of microorganisms, successively replacing one another. Due to the predominant role of the expressly biological factor in this process, this type of corrosion is commonly defined as microbiological rather than gas-induced (a notion widely used in domestic literature) though, indisputably, the concentration of aggressive poisonous gases in the collector’s under-top space is the primary symptom of the emerging problem. A detailed description of the corrosion mechanism based on the example of destruction taking place in the sewage collector is given in [13]. The knowledge of the time and place of when and where gas gathers in the sewage collector and to which concentration makes it possible to determine its the sources and create the concrete structure destruction models.

3. SYSTEM OF FORECASTING THE SEWAGE PIPELINE SYSTEM’S CRITICAL TECHNICAL CONDITION

A special system has been developed for inspecting and monitoring the technical condition of sewage collectors and structures on them. Figure 2 shows organization of the current inspection and gathering of information on determination of concentration of gases in the sewage tunnel and structures on it [14]. The essence of the method is in the following. Effluents flow through the sewage tunnel (1) from the upper well (Shi) to well (Shi+1) and

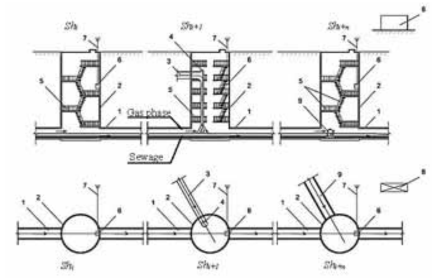

Fig. 2 The scheme of control over technical condition of sewer and its facilities
1 – tunnel sewer, 2 – shaft; 3 – inlet sewer; 4 – sewer drop; 5 – technological equipment (fencing, stairs, etc.); 6 – measuring complex; 7 – broadcasting system; 8 – storage device; 9 – connection sewer

farther on to well (Shi+n), where “n” is the number of wells in the sewage tunnel sector under consideration. The sewage wells may structurally differ from one another since they may perform different technological functions. For example, well (Shi) is used for letting the maintenance personnel into the collector for inspection, well (Shi+1) is used for connecting effluents from the above lying collector (3) made as a tube drop (4), and well (Shi+n) is used for lateral connection of the collector (9). Accordingly, effluents of different contents may flow over different portions of the sewage collectors. The effluents, in their turn, as a result of mass exchange processes, emit gas mixtures, of different contents and in different concentrations, into the collectors’ under-top space. For measuring the contents and concentrations of gases and their physical properties, a measuring unit (6) is installed on spans with technological fittings (5). The measuring unit (6) includes a gas analyzer adjusted for registering the concentration of such gases whose appearance is most likely, a thermometer that determines the gas medium and dew point temperature, an instrument for measuring humidity, and an accumulator or some other source of power. Via the transmission system (7), the obtained information comes to the storage device (8), after which it is processed and, based on processing results, the gas concentration is determined in places where changes occur or destruction symptoms are observed. If there is no transmission system (7) and storage device (8), then the measuring unit can be lowered into the well for a previously determined period of examination time. After that the information from instruments is delivered to the computer through special ports and undergoes processing. The processing results can show both the time of aggressive effluents discharge (with concentrations exceeding the MPC (maximum permissible concentration), duration of the remaining in the collector, the change of gas concentration as the effluent moves, and, finally, supply information on the technical condition of the collector and the structures on it, and provide forecast on the progress of destruction.

4. THE USE OF THE SYSTEM FOR THE FORECASTING OF THE SEWER TONNEL THE TECHNICAL CONDITION

From spring through autumn 2014 we have investigated a sector of a tunnel collector and a structure on it in St Petersburg. One of the shafts under investigation was the Shaft with a round underground structure 16.5 m deep, 8.5 m in diameter. The effluents change their direction in the Shaft. Also, in the Shaft a connection takes place from a shallow lying network (pipeline diameter 1,500 mm, lying at a depth of 5.28 m) made in the form of a tube drop. The drop standpipe is made from cast-iron pipes 900 mm in diameter and enclosed in a reinforced concrete box. The walls and spans of the Shaft are made from reinforced concrete. The technological accessories (ladders, barriers) are made from stainless steel. The visual inspection of the well showed all the symptoms of the intense destruction (Fig. 3). The Shaft operated in different technological modes. In order to register the actual operating

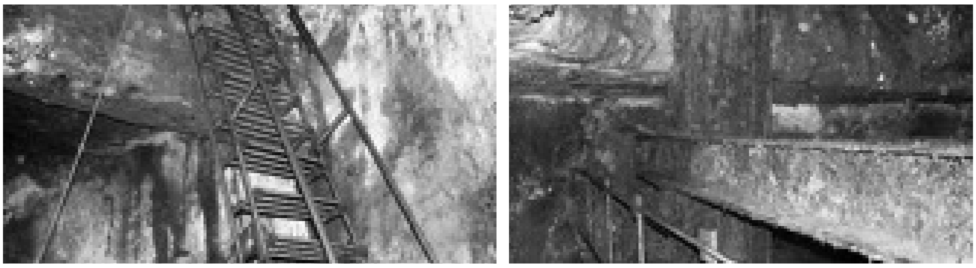

Fig. 3-4 Deterioration of building constructions of Shaft

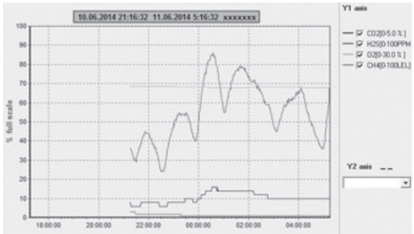

Fig. 5 Results used to determine gas concentrations in the Shaft for the second time

conditions of the structure, the gas concentration was measured in two cycles. During the first 3-day measuring cycle no significant gas concentration (exceeding MPC) was registered. It means that in the chosen period of time the operating conditions of the structure were quite satisfactory, which ran counter to results of visual inspection and the knowledge of the processes that supposedly were taking place in the structure. Therefore a second cycle of measurements was performed (Fig. 4). Unlike the first measuring cycle, in this case the analysis results fully confirm the conclusion on the process of microbiological corrosion in reinforced concrete and metal constructions of well #123. Concentration of hydrogen sulphure during the measuring never dropped to the MPC of the work zone in compliance with the Russian regulations (7 PPM). The concentration of H2S varied on average relative to 0.5%. However, also registered were sharp rises in concentration of carbon dioxide (up to 5%). Such conditions can be generally regarded as extreme and resulting in fairly fast destruction of reinforced concrete and metallic constructions. Thus, the second measuring cycle made it possible to register the operation of the Shaft in a technological mode promoting its intense destruction. The results obtained in the first two measuring cycles confirmed the supposition that the measuring of gas concentration on problem facilities should, if possible, be done permanently in accordance with the method described, or it is necessary to perform several measuring cycles for each subsystem of the structure.

5. CONCLUSION

Accidents on sewage collectors may be a result of different factors, but the main cause is microbiological corrosion. Accidents can be prevented by inspecting and monitoring the suspicious portions of the collectors and structures on them. The system of forecasting the critical condition of the sewage system pipeline is an effective means of controlling this process, which has been proved by its tests on the facilities of St Petersburg.

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SESSION 4

GEOTECHNICS, SEISMICITY HAZARD ANALYSIS AND PREVENTION

NONLINEAR CONTINUOUS PHASE TRANSITION MODEL OF ZONAL DISINTEGRATION OF ROCK MASSES NEAR DEEP-LEVEL TUNNELS

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Keywords

deep-Level rock mass, zonal disintegration, gradient, continuous phase transition, nonlinear

ABSTRACT

In rock mass near deep-level tunnels zonal disintegration phenomenon may occur. The formation process of zonal disintegration can be regarded as a continuous phase transition process of internal structure of rock mass near deep-level tunnels, so continuous phase transition model could describe the main features of zonal disintegration. A continuous phase transition model of zonal disintegration of rock messes has been developed by one of the authors by utilizing continuous phase transition theory combined with classical elasticity-plasticity theories. But the nonlinear properties of the model were not studied in details. The properties of the solution of the nonlinear continuous phase transition model are studied in this paper. Numerical methods are used to solve the nonlinear governing equation of the model, and the results are compared with linear model. The numerical results indicate that nonlinear model could describe the spatial distribution of deformation of the rock messes better.

1. INTRODUCTION

The phenomenon of zone disintegration near deep-level openings was first discovered by Russian scholars in 70- 80's last century. A series of studies have been conducted from then on. And some achievements have been reached on the forming mechanism of this phenomenon. From the viewpoint of stress state of the rock masses, E.I.Shemyakin et al. (1986, 1987, 1989) thought that the formation of zonal disintegration was caused by the splitting of the rock mass along the direction of maximum tangential compression stress. V.N.Odintsev(1994) analyzed the mechanism of zonal disintegration from viewpoint of geological structure and concluded that zonal disintegration appeared as the result of loss of stability. When instable state is reached, dynamic failure happens and a new stable structure is formed. Then the new structure would keep stable under a certain loading range. This process repeats and the zonal disintegration occurs. By using elasto-plasticity approach, and considering arbitrary elastic bulk compressibility and softening, A.I.Chanyshev(2001) developed one elasto-plastic model. Then characteristic slip lines of governing equation repeating the shape of the tunnel contour were regarded as zonal disintegration of rock masses. Gu et al (2008) thought that zonal disintegration should occur under some conditions and he experimentally reproduced principal characters of zonal disintegration. Zhang et al (2009) conducted some experimental researches with iron-crystal stand rocklike material and reproduced the regular alternating zonal failure around the tunnel. Qi et al (2012) thought that energy dissipation and self-organization takes place in surrounding tunnel rock masses, and the long-range interaction between rock particles became significant, in the plastic deformation regime. He introduced the gradient of effective plastic strain as an additional internal variable. The governing equations for deformation and fracture of surrounding circular deep level tunnel rock mass was obtained, and the solution for ideal brittle rock masses was obtained. The solution could describe zonal disintegration phenomenon very well. Zhou et al (2007) considered deep-level excavation process was a dynamic process. Kinetic equations were donated by using displacement functions. As we all know, classical theories of elasticity can describe the behavior of materials up to the elastic limit very well. But in the plastic regime, irreversible deformations appear, and consequently, a self-organization phenomenon occurs and dissipative structures are formed. Classical theories of the plasticity can approximately but not accurately describe the macroscopic mechanical behaviors of materials beyond the yield limit. Dissipative

In physics, the theory of phase transitions of second order developed by L.D.Landau (1937) is an efficient instrument to interpret many phase-transition phenomena. It has been proved by experiments that deformation process of rock under load can be regarded as a multistage process of continuous phase transition. Qi et al (2009) combined the theories of elasticity and plasticity with relevant physical phase transition theories to investigate the phenomenon of zonal disintegration of deep-level tunnels. And a continuous phase transition model was developed. It was suggested that the solution could describe the evolution process of spatial stable zonal disintegration of rock masses surrounding deep tunnels. But only solution to linear continuous phase transition equation was obtained, so non-linear continuous phase transition equation is to be investigated in this paper.

2. NON-LINEAR CONTINUOUS PHASE TRANSITION MODEL

A typical dependent relationship between shear stress T and dilatation θ with shear strain γ is showed in Fig.1 (Adigamov N.S., Rudaev Ya.I., 1999), where $\gamma = \varepsilon 1 - \varepsilon 3$.

The shear stress-strain curve can be divided into several stages as follows:

OA: The originally opened micro cracks in rocks are closed gradually with compression. The stress-strain curve is concave which shows the initial non-linear deformation, and the dilatation decreases with the increase of loading.

AB: This stage is linear elastic and stress-strain curve is approximate straight. Deformation of rock sample in this regime is reversible and independent on time effect.

BC: Plastic deformation takes place in this regime, and the stress-strain curve is convex. In this stage, micro cracks propagate stably. Cracks propagation will stop when loading stops. Point C is a turning point where the volumetric deformation changes from compression to dilatation.

CD: This phase is called as the softening stage in which stress decreases with the increasing of strain. The propagation of micro cracks is unstable. The fracture process begins to be controlled by the speed of cracks propagation. Micro cracks develop and coalesce rapidly, and macro structure surface forms. Shear strain localizations emerge and are gradually intensified. Then localizations evolve into shear bands which divide intact rock masses into pieces with certain sizes. Relative sliding and rotating between rock pieces caused by shear stress leads to a rapid volume expansion.

DE: Rock sample is separated into blocks, which can be regarded as granular media. Stress in rock sample is constant which is determined by the friction f between rock blocks.

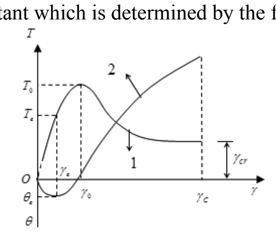


Fig. 1 The stress-strain deformation diagram for rock

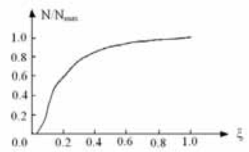


Fig. 2 The cracking-deformation dependence of rock ($\xi = \gamma/\gamma_c$)

Kinetic process of crack formation is showed in fig.2, in which denotes the ratio of the current number of cracks to the maximum number of cracks at the moment of failure. Kinetic process of cracking evolution possesses prominent features of multistage process of continuous phase transition, so it is reasonable to regard the kinetic process of cracking evolution as a multistage continuous phase transition process.

A dimensionless parameter of the following form can be introduced to describe irreversible deformation of rock.

$$\psi = \frac{\gamma - \gamma_e}{\gamma_c - \gamma_e} \tag{1}$$

where γe is the elastic shear strain limit, γc is the shear strain limit at failure, and γ is the current shear strain.

When ψ =0, energy dissipation and self-organization phenomenon begin to take place. According to the concepts of physics, ψ may be regarded as the order parameter. We consider the deformable body as a statically conservative system, in which the total energy is its potential energy H. When ψ >0, a new dissipative structure forms and synergetic effect occurs. When the limit state is reached, long-range interaction between rock particles should be taken into consideration. By analogy to the Ginzburg-Landau expansion of potential energy (Ginzburg V.L., Landau L.D., 1950), gradient term may be introduced into the free energy function of rock mass which may be expressed as follows:

$$H = -\frac{1}{2}V_2\psi^2 + \frac{1}{4}V_4\psi^4 + \frac{1}{6}V_6\psi^6 + \frac{1}{2}C(\nabla\psi)^2 \tag{2}$$

where C is the coefficient and C >0; V_2,V_4,V_6 are coefficients.

The total potential energy in the whole area is expressed as follows:

$$\Phi = \int_{\Omega} [-\frac{1}{2}\,{}_{2}\psi^{2} + \frac{1}{4}\,{}_{4}\psi^{4} + \frac{1}{6}\,{}_{6}\psi^{6} + \frac{1}{2}\,(\nabla\psi)^{2}]\,\Omega \tag{3}$$

The evolution equation of deformation may be obtained as follows (Qi Chengzhi, Wang Mingyang, Qian Qihu, 2009):

$$\frac{\delta\psi}{\delta t} = -\Gamma\frac{\delta\Phi}{\delta\psi} = -\Gamma[-V_2\psi + V_4\psi^3 + V_6\psi^5 - \nabla(C\nabla\psi)] \tag{4}$$

where Γ is a dynamic coefficient, and Γ >0.

The boundary condition is:

$$(\nabla\psi)\cdot\vec{n}\,|_{r=a} = 0 \tag{5}$$

For axial symmetry problem, equation (4) can be transferred into

$$\frac{\delta\psi}{\delta t} = \Gamma\left[C\left(\frac{\partial^2\psi}{\partial r^2} + \frac{\partial\psi}{r\partial r}\right) + V_2\psi - V_4\psi^3 - V_6\psi^5\right] \tag{6}$$

Equation (6) is a thermal diffusive type equation, and is “source item”. The physical meaning of V_2,V_4,V_6 is external field strength. For constitutive equation with softening beyond the limit of elasticity, one-to-one correspondence between stress and strain disappears. So one variable related to strain should be introduced to describe the state of medium. Damage is proportional to irreversible deformation. Thus, we choose one dimensionless parameter K, the ratio of the average distance d and the average length l of cracks, to describe damage of rock:

$$K = d/l \tag{7}$$

Investigations show that, if K is large enough the interaction between cracks can be neglected. When K is approaching to K= 3~5, materials enter rapid damage stage. The critical value *K* is almost independent on the property of materials and is called density criterion of material failure. When $K = K_* = \pi = 3.14$ stress reaches its maximum value and material enters the rapid damage stage. When $K = K_c = 1$, rock will totally fracture with residual stress.

Equation (6) can be rewritten as follows

$$\frac{\delta\psi}{\delta t} = \Gamma\left[\nabla(C\nabla\psi) - A\left(1 - \frac{K}{K_*}\right)\psi - V_4\psi^3 - B\left(1 - \frac{K}{K_c}\right)\psi^5\right] \tag{8}$$

Actually, parameter K depends on deformation of rock described by order parameter ψ. In order to simplify the analysis and reduce the order of governing equation, K is selected as an independent parameter here.

3. ANALYTICAL SOLUTION TO LINEAR GOVERNING EQUATION

Equation (6) is non-linear differential equation, analytical solutions to which are difficult or almost impossible to be found. If we neglect higher order terms of ψ in Eq.(6) we will obtain one linear differential equation as follows

$$\frac{\delta\psi}{\delta t} = K\left[C\left(\frac{\partial^2\psi}{\partial r^2} + \frac{\partial\psi}{r\partial r}\right) + V_2\psi\right] \tag{9}$$

Equation (9) may be simplified into

$$\lambda\frac{\delta\psi}{\delta t} = \left(\frac{\partial^2\psi}{\partial r^2} + \frac{\partial\psi}{r\partial r}\right) + D^2\psi \tag{10}$$

where λ is a coefficient, and $D^2 = V_2/C$. Assume that $\frac{d\psi}{dt} = \eta\frac{e^{-t/t_0}}{r^2}$, equation (10) was solved by Qi (2009).

$$\begin{aligned}\psi = &[N_0(Dr)J_1(Dr) - J_0(Dr)N_1(Dr)]\cdot\frac{\pi}{2}\cdot Dr\cdot(-0.046)\cdot e^{-t/t_0} \\ &+ 1.862\cdot[J_0(Dr) - 0.705N_0(Dr)]\cdot[1 - 0.937\cdot e^{-t/t_0}]\end{aligned} \tag{11}$$

where $Dr_0 = 3.2$, and r_0 is radius of the tunnel.

For tunnel with radius 5m, when t approaches to infinity, deformation of surrounding tunnel rock masses will approach to stable state. Assume that surrounding tunnel rock mass is in limit state and ψ=1 at tunnel wall, the spatial distribution of order parameter in the direction of radius may be obtained and is plotted in Fig.3.

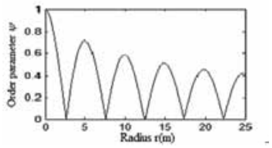


Fig. 3 Stationary deformation pattern of surrounding tunnel rock based on linear equation

In Fig.3, the oscillation nature and periodicity along radial direction are obvious. Meanwhile, the amplitude of wave decays along the radial direction. The regions between two adjacent fractured zones are weakly damaged, which is consistent with in-situ observations. The linear analytical solution may describe main features of stable zonal disintegration very well. But linear model has some disadvantages. For instance, the distance between two adjacent wave crests is constant, namely, spatial period of order parameter is constant. But in-situ observations show that distance between two neighboring fractured zones increases in the radial direction. Because of neglecting high order terms, solution to linear equation can't describe zonal disintegration adequately. Therefore the non-linear equation should be considered.

4. NUMERICAL SOLUTION TO NON-LINEAR GOVERNING EQUATION

In stable phase, $d\psi/dt=0$ and equation (8) can be rewritten

$$\left(\frac{\partial^2\psi}{\partial r^2}+\frac{\partial\psi}{r\partial r}\right)+a\psi+b\psi^3+c\psi^5=0 \tag{12}$$

where $a=V_2/KC$, $b=-V_4/KC$, $c=-V_6/KC$

It is well known that in numerical simulation step has significant effect on the stability, accuracy and rate of convergence of the calculation. In order to guarantee the stability and accuracy, small step is necessary. But small step may slow down the rate of convergence and increase time consuming. Therefore, a proper calculating step should be chosen. In order to analyze sensitivity of step coefficients a=0.4096, b=-1.6, c=2.4 is used . Solution by using three different steps h =0.25, 0.025, 0.0025m are depicted in Fig.4. Computation results by using these three steps satisfy the need for stability. The accuracy of the result with step h =0.25 m is less than that with steps 0.025m and 0.0025m. Computation results for steps 0.025m and 0.0025m are very close to each other. Here, for economizing computation time h =0.025m is selected as calculating step.

Analytical solution to equation (12) is hard to be obtained. Numerical method is used to study the properties of the equation. The distance from first fractured zone to opening wall approximately equals to the radius of the opening as shown by in-situ observations. Based on the observation data and linear solution obtained by Qi (2009), three groups of coefficients are used for analysis: (1) a=0.4096, b= -1.6, c=2.4, (2) a=0.4096, b= -1.0, c=1.5, (3) a=0.4096, b= -2.0, c=3.0 and the radius of opening is .

Finite difference method is used to solve equation (12), and the results for three groups of coefficients are showed in Fig.4.

It is clear from Fig.4 that the solution of non-linear equation has obvious quasi-periodicity, the amplitude and decay rate are remarkably affected by higher order terms of ψ, quasi-periodicity of non-linear solution, which is presented as distance between two neighboring fractured zone, increases with the distance in the radial direction,

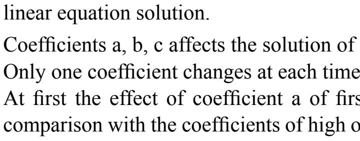


Fig. 4 Solutions of different spatial steps

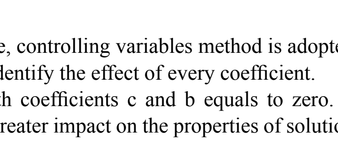


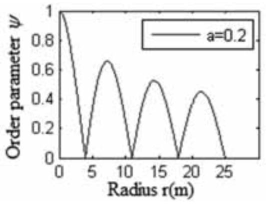
Fig. 5 Stable formation of rock obtained by non-linear equation

and is influenced by high order terms. The non-linear equation solution agrees with in-situ observations better than linear equation solution.

Coefficients a, b, c affects the solution of the equation. For convenience, controlling variables method is adopted. Only one coefficient changes at each time. In this way we can clearly identify the effect of every coefficient.

At first the effect of coefficient a of first order term is analyzed with coefficients c and b equals to zero. In comparison with the coefficients of high order terms, coefficient a has greater impact on the properties of solution. Two solutions are obtained and shown in Fig.6. It is clear from Fig.6 that with the increase of coefficient a, the period of fractured zone decreases and the thickness of fractured zones decreases. It is noticed the rate of decay of order parameter ψ in the radial direction does not change with coefficient a.

(a) a=0.2



(b) a=0.4096

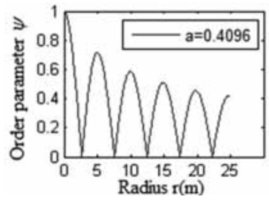
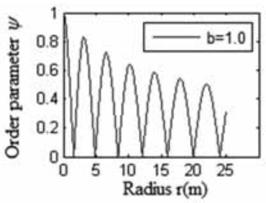


Fig. 6 The effects of coefficient a on the behavior of the solution

Then the effect of third order term coefficient b is investigated with coefficient a being equal 0.4096 and coefficient c to zero. When b>0, the period of the distribution of order parameter decreases with the increase of b, but for every fixed value of b the period along the radial direction increases.

(a) b=1.0



(b) b=0.5

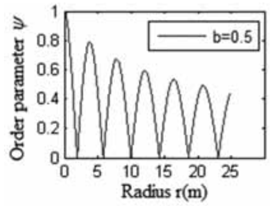
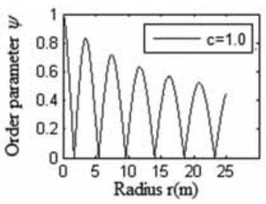


Fig. 7 The effects of coefficient b on the behavior of the solution

Finally, the effect of coefficient c of fifth order term is discussed with a=0.4096 and b=0. Here two values of c are taken:1.0, 0.5. The computation results are shown in Fig.8. It is clear from Fig.8 that the period of the distribution of order parameter decreases with the increase of c.

(a) c =1.0



(b) c=0.5

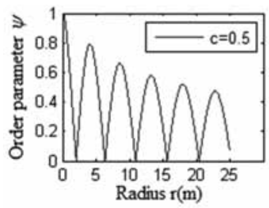
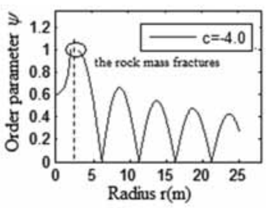


Fig. 8 The effects of coefficient c on the behavior of the solution

When coefficient c is negative and its absolute value is large enough, a new temporal-spatial pattern of deformation and failure takes place. Defects occur explosively at some distance from the tunnel wall. In this regime, rock masses may fracture rapidly and rock burst may occur. When rock fractures, a new free surface forms which can be regarded as a "false" contour of opening. The process aforementioned will repeat in rock masses behind "false" opening contour until the stress-strain state in rock mass satisfies the conditions of stability. The distribution of order parameter are depicted in Fig.9. The failures happening at some depth in the rock coincides with in-situ observation on inner rock burst. The dashed line in Fig.9 indicates the place of rock mass of fracture. Before the broken area noted in the picture, maybe there are several fractured zones which are not depicted. Behind last fractured area, the deformation of rock will repeat the stable deformation mentioned above.

(a) c =-4.0



(b) c =-5.0

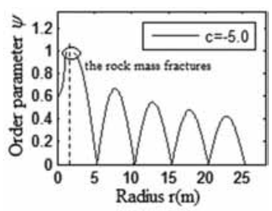


Fig. 9 The effects on the solution with different fifth order item c

5. CONCLUSIONS

Under high-level stressing irreversible deformations of rock mass take place, and consequently, energy dissipation appears and self-organization phenomenon occurs with the formation of dissipative structures. Classical theories of elasticity and plasticity cannot accurately describe the phenomenon of dissipative structures. The kinetic process of irreversible deformations of rock mass can be regarded as a multi-stage process of continuous phase transition. Therefore, in this paper continuous phase transition model is used to simulate the phenomenon of zonal disintegration. Non-linear governing equation is solved by numerical method. In comparison with linear solution, non-linear solution can describe the phenomenon of zonal disintegration better. For instance, non-linear governing equation may describe the increase of the distance between two adjacent fractured zones in the radial direction, and the occurrence of inner rock burst. The effects of coefficients on the solution are analyzed.

6. ACKNOWLEDGEMENTS

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ANALYSIS OF STABILITY OF SLOPE BASED ON FRACTAL PRINCIPLE

POSTER

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Keywords

core orientation method, occurrence of rock mass structure, fractal theory, box counting method, slope instability mechanism, fractal prediction type

ABSTRACT

Core orientation method can help to determine the rock mass structure of the landslide, and then we can assume some possible surfaces of the slope sliding base on the rock mass structure of the landslide. Combining the landslide monitoring data and the fractal theory to study the fractal characteristics of this possible surface of landslide, first of all, we must calculator the fractal dimension of these possible surfaces by box counting method, then looking for the key factors of the landslide, at last combining with the fractal theory to analyze the mechanism of slope instability. Establish the forecasted fractal dimension of sliding in the happening time: $H = G\sin\theta - T$ *The coefficient T is corresponding rock or structural plane shear strength under a particular environment. For example, under normal circumstances, we can assume H <0 or close to zero, and of course the mountain is stable at the time. But if meet with heavy rain weather, the soak strength of rock or structural plane will reduce under the rain, namely coefficient T will become smaller, then H > 0 will be present, which means that the landslide of mountain may be happened. It also tells us why mountain landslides occur more easily under a bad weather. If we can get some samples of the slope rock and do some experiments to determine its Resistance value T under different environmental conditions. Then, we can combine the forecasted fractal dimension provide some reference for the prevention of some slope instability disaster.*

Landslides is geological phenomenon that rock mass on the slope body declined along the sliding surface, it will take a series of damage for the mountain vegetation, living, transportation and industrial-agricultural production, and prevention is difficult, high cost, at the same time. The forecast of landslide need a lot of survey data[1], therefore, the current domestic can only be carried out on the key project, such as it's terrain features, causes and landslide formation mechanism, the structure of the system and system stability and targeted prevention management and so on. In this paper, we will combine the fractal theory to analysis the mechanism of landslide, the so-called fractal theory is a very active branch of mathematics in the study of the modern nonlinear science, it can help us to find the rules from the disorderly and orderly, reveal mixed and disorderly, crushing, chaos and other highly complex phenomenon, in the other word, it can help us to get some quantitative parameters from the landslide occurred complex situation, and provide some quantitative parameters for our possibility of landslide disaster, so that we can be more powerful, efficient and a wide range In the face of slope disaster's prevention.

1. THE ANALYSIS OF SLOPE INSTABILITY MECHANISM

Slope is the natural or artificial slope nearby built, and the stability analysis is to help us to see that the slop section's size is reasonable or not (the allowable slope and height) based on the engineering geological conditions, and at the same time, it can help us to check that whether the proposed section size is reasonable, but the factors whose are affecting the stability of slope is a complicated system. But no matter what factors can be centered on the landslide surface; they can be divided into two parts: one is the resistance smooth function; the other one is the promoting smooth function. Above all, we can say that the key point of mountain landslides is that the resistance smooth function is weaker than the promoting smooth function on the landslide surface [2].

Above all, we can see that the damaged or not of landslide surface is the key point to mountain landslides, which means the key of preventing and treating landslide is to find the failure surface of landslide. And taking the landslide surface as the center of researching, then to see which one is stronger between resistance smooth function and promoting smooth function. Because of the shape of landslide surface is a highly irregular surface, so in this paper, we will combine the fractal theory to study the landslide surface geometry-the fractal features, and extracting parameters-fractal dimension from No rules surface of the landslide, and try to put it into the relevant formula of evaluation of slope stability.

2. THE ANALYSIS OF SLOPE STABILITY UNDER FRACTAL THEORY

In order to accurately determine the stability of the slope in a particular situation, we should firstly clear that the resistance function of landslide surface, which is composed of two parts, the first part of the surface resistance is joint; the other part resistance is the shear strength of rock mass itself[3]. At the same time, we also need to know the proportion of joint surface on the whole hypothetical landslide damage surface, and then we can get the hypothetical landslide surface resistance. As we all know that surface is Close to the shear strength of rock mass. But on the other hand, the shear strength of joint surface cannot be got easily, the top issue of getting the shear strength of joint plane is how to obtain reasonable roughness of the joint surface, and the commonly used method is the mechanism of roughness coefficient (JRC) evaluation method, but the evaluation results of this method is based on the two-dimensional section line, underestimated the joint surface roughness has great subjectivity. This paper will combine the fractal theory to research the joint surface roughness [4].

First of all, make a brief introduction of the experiment, prepare 4 set of simulation concrete specimen, each group contains two concrete cylinder, one cylinder concrete is plane contact on the central, another cylinder concrete is the irregular shape simulation surface contact on the central, then we can begin the shear experiment, and compare

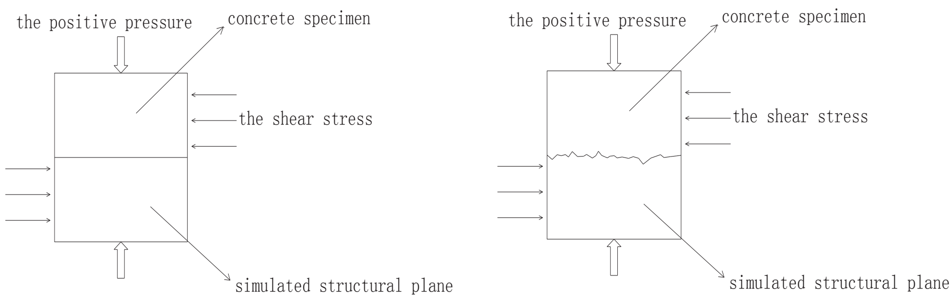

Fig. 1 The test stress diagram of joint surface simulation

the result of the two part, the specific experimental schematic diagram is shown in figure 1.

Next complete the shear experiment for the four groups of concrete specimens under the same conditions, the

	ordinary plane（Map）	simulated structural plane（Map）	The ratio（simulated structural plane / ordinary plane）
specimen 1	1.02	2.39	2.3431
specimen2	1.13	2.47	2.1858
specimen3	1.06	2.28	2.1509
specimen4	1.12	2.51	2.2411

Table 1 the experiment results of simulated structural plane and ordinary plane

experimental results contrast as table 1 show:
Then, combined with the fractal theory to study the fractal characteristics of each simulate structural plane. The simulating structure fractal dimension can be calculated by box cover method, take the concrete specimen bottom as the datum, then cover it by a grid with a certain size, measure the height between the center square of the upping simulation structure surface and the center square of the datum, and then take the ratio of the square of the length and the size of grid as the number of grid (if the number is battening N and N+1,then make the number be N+1), with the same method to calculate the grid number of other square center, and at last record all the number of grid[5]. Then change the size of the grid, and use the same method to calculate the grid number of each square center. Finally repeat the above operation... under the different grid size, we will get the total number correspond to it. For example, when the side length of grid is L_1, the total number of grid are counted as $N_{1\,(r)}$; When the side length of grid is L_2, the total number of grid are counted as $N_{2\,(r)}$, and the fractal dimension D will be valued as following:

$$D = \log(N_2/N_1)/\log(L_1/L_2)$$

In order to get fractal dimension values of simulated structural plane more accurately, we will made the side length of grid more littler as far as possible, and get more groups of corresponding data logL, logN, combine the least square method to mark its corresponding position in the coordinate system, and then we can get the corresponding

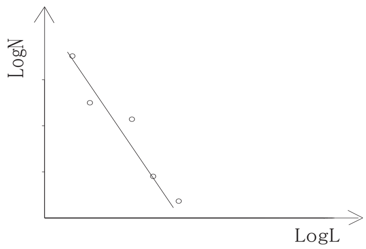

Fig. 2 fractal dimension calculation diagram

slope which is the fractal dimension of imaged face (As shown in figure 2) [6].
Then we can get four groups fractal dimension of the simulated structural surface, and combining with the shear

simulated structural plane	fractal dimension	The ratio（simulated structural plane / ordinary plane）
specimen 3	2.1674	2.1509
specimen 2	2.1933	2.1858
specimen 4	2.2360	2.2411
specimen 1	2.3309	2.3431

Table 2 fractal dimension values and the shear strength ratio

strength ratio in table 1 can make table 2 as follows:
Under the comparison of the shear strength ratio and the fractal dimension in table 2, we can find that the shear strength of simulated structural plane is bigger than the single plane shear strength, and there is some relation between them. And at the same time, the shear strength ratio is proportional to the fractal dimension[7]. So we can get shear strength τ1 of planar joint plane, then we can introduce the reference variable - fractal dimension into the formula of joint plane shear strength, and get shear strength formula of joint plane whose surface is complicated curved τ2as follows:

$$\tau 2 = R*D*\tau 1$$

D - Fractal dimension of simulation structure plane.
R – A proportion coefficient Refer to the fractal dimension value and the shear strength ratio of simulation structural plane and single plane

In conclusion, we have got the shear strength of joint plane and not joint plane, and then if we get the respectively share of the joint plane and the not joint plane in whole hypothetical surface, in the other word, we can get their respective area size, so it is easy to get the overall shear strength of the hypothetical surface T as follows:

$T=A1*\tau p +A2*\tau 2$

T- The overall shear strength of the hypothetical surface
A1 - the section area of joint plane
A2 - the section area of the not joint plane
τp - shear strength of rock mass
τ2- the shear strength of joint plane.
Now the overall resistance of landslide slope is clear. After that, we should have a analysis from the Angle of mechanics, then we can know that the gravity of the landslide themselves is the most important affection for the slope instability, and of course in some circumstances the whole weigh can be changed such as rain, man-made debris and so on. Based on analysis, we can build a formula to help us evaluation the imaginary failure surface of landslide as follows:

$H=G \sin\theta-T$
$T=A1*\tau p +A2*\tau 2$
$\tau 2 = R*D*\tau 1$

H – The evaluation value of Slope stability
G - The weight of medium which above imaginary landslide surface
θ- The angle of imaginary landslide faces relative to the horizontal plane.
The slope instability can be determined by the ratio of the evaluation value of Slope stability and the overall shear strength of the hypothetical surface. And when the ratio tend to zero, it means that the slope instability is weak. This article take slope nearby the right line export of nanshan-tunnel project as a example, which has happened landslide, after calculation $H1 / T1\to 0$, So we can take it as a reference value for judging the slope stability. On the other hand, we can do a hypothesis, suppose a slope of $H < 0$, which represents the slope own gravity force is less than the overall shear strength of the hypothetical surface, but if meet with heavy rain weather, the strength of rock or structural plane will reduce under the rain soaked, and with the help of rain its own gravity increase, and that means that the resistance function may be weaker than the promoting smooth function, and at the same time, it may appear $H > 0$ or close to zero in the above formula, then the disaster situation of slope instability may occur. It is also why mountain landslides occur easily under the bad rain weather.

3. CONCLUSIONS

Slope engineering research purpose is to through to the slope stability analysis and evaluation, to provide reasonable slope structure for practical engineering and avoid some disasters and losses caused by landslides, then help improve the overall economic efficiency, therefore, the slope stability analysis and evaluation has become core slope engineering research, this paper tries to combine the fractal theory to study the landslide surface geometry, and the relation between fractal characteristics with the resistance function, and with the introduction of the fractal dimension variable, establish and perfect the formula of slope stability, so as to provide some help to the analysis of slope stability in the project, in order to prevent the happening of the slope disasters more accurately, reduce the threat to people's property and lives.

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INVESTIGATION OF DYNAMICAL RESPONSE OF SUBWAY STRUCTURES UNDER THE INFLUENCE OF THE DIFFERENT UNDERGROUND WATER LEVEL

POSTER

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Keywords

FLAC3d, underground water level, subway structure

ABSTRACT

With the development of subway in Beijing, the effects of underground on subway become more and more important. Using Fluid-Structure interaction module in software of FLAC3d, this paper mainly simulates the structure stress and deformation of tunnel under different water levels. As the results shows, the vertical displacement of the tunnel along the longitudinal overall rise, the longitudinal deformation of tunnel is usually overall deformation and uneven displacement along the tunnel is small, which cannot lead the tunnel to happen staggered platform. On the other side, the structure stress and deformation of tunnel would change differently. According to the simulation results, it can find out the weakest location of tunnel under the underground water rising. The research could prevent the diseases caused by underground water to some extent

1. INTRODUCTION

With the south to North Water Diversion Project and a series of broaden sources of income and reduce expenditure measures to take in recent years by Beijing, Beijing Groundwater Level was rebounded[1-2]. Beijing subway line 7 in the construction process encountered backwater level higher problem[3], groundwater influence on metro tunnel structure is mainly reflected in two aspects[4]. On the one hand, the existence of groundwater will generate additional water pressure, also change the soil skeleton force of the soil, according to the principle of effective stress is pore water pressure reduces the soil effective stress, combined with water to the tunnel structure supporting buoyancy, easily lead to tunnel structure uneven subsidence and damage; On the other hand, is composed of soil and groundwater seepage stress coupling field, causing leaks and other diseases of tunnel leakage, coupled with the erosion of groundwater environment, resulting in further destruction of the tunnel structure.

On the influence of groundwater level change of tunnel structure, many experts on the theoretical analysis and numerical simulation, Furong Luo [5], Wenchun Peng [6]respectively by FLAC3D numerical simulation method. Under tendency and distribution law of the tunnel structure when the water level is rising, the change of the displacement, deformation, internal force (moment and axis force), plastic zone and so on; Jianbo Li [7]using FLAC3D software to simulate the fluid solid coupling theory of groundwater flow under the soft rock tunnel stability problems; Jianjun Liu[8] combines the seepage mechanics with the elastic-plastic mechanics, taking into account the interaction between groundwater and the soil skeleton, and establishing the mathematical model of the groundwater flow and solid coupling seepage. By summarizing the above research, this paper Beijing subway engineering examples, the simplified analysis method, of groundwater under the action of tunnel structure stress deformation dynamic behavior is analyzed.

2. FLUID SOLID COUPLING CALCULATION THEORY

Using FLAC3D simulation of fluid solid coupling effect, soil as porous media, fluid in the medium with Darcy's law and satisfy Biot solid conclusion. According to the practical engineering problems and establish a reasonable initial condition and boundary conditions to solve that any of the soil of pore water pressure and displacement.

In the consideration of the homogeneous isotropic solids, the mass balance of the liquid can be expressed as the only consideration of the small deformation of the fluid:

$$- \quad {}_{,} \quad + \quad = \frac{\partial \varsigma}{\partial}$$

when the volume of liquid source strength (1/sec) is the volume of fluid volume of the porous medium, the change of the flow rate of the fluid is changed along the i direction.
The equation of pore flow is:

$$\frac{1}{M}\frac{\partial p}{\partial t}+\frac{n}{s}\frac{\partial s}{\partial t}=\frac{1}{s}\frac{\partial \varsigma}{\partial t}-\alpha\frac{\partial \varepsilon}{\partial t}+\beta\frac{\partial T}{\partial t}$$

where M is the Biot modulus (N/m2), n is the porosity, Biot coefficient, thermal coefficient is no drainage (1/ C).
Using Darcy's law to describe the motion of a fluid, for homogeneous and isotropic solids and fluids, the density is constant, and the motion equation has the following form:

$$q_i=-k_{il}s^2(3-2s)[p-\rho_f x_j g_j]_{,l}$$

where k_{il} is medium permeability coefficient; ρ is fluid density; x_j is horizontal distance surface elevation; g_j is for acceleration of gravity along the j direction specified.
The incremental form of the constitutive equation of the porous medium is:

$$\Delta\sigma_{ij}+\alpha\Delta p\delta_{ij}=H(\sigma_{ij},\Delta\varepsilon_{ij})$$

where $\Delta\sigma_{ij}$ is Stress increment; H is a given function; $\Delta\sum_{ij}$ is Strain increment; σ_{ij} is total stress; δ_{ij} is Kronecker constant.
The relationship between strain rate and velocity gradient is as follows:

$$\varepsilon_{ij}=\frac{1}{2}(v_{i,j}+v_{j,i})$$

where v_i is Speed of a point in a medium.

2. NUMERICAL SIMULATION OF GROUDWATER LEVEL CHANGES

2.1 MODEL ESTABLISHMENT AND PARAMETER SELECTION

The model is circular tunnel, the tunnel radius is 6000mm, the lining thickness is 300cm, the model size is shown in Figure 1. Simulations ignore the influence of different soil on the simulation results, the single layer, tunnel lining using solid elements, between the lining and soil building shell element to simulate the soil around the tunnel changes, specific parameters see Table 1.
Considering the different groundwater level, the stress and deformation of the tunnel under different groundwater levels are simulated, and the simulation conditions are shown in Figure 2.

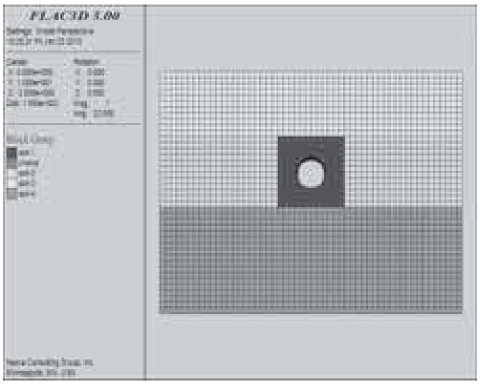


Fig. 1 tunnel model

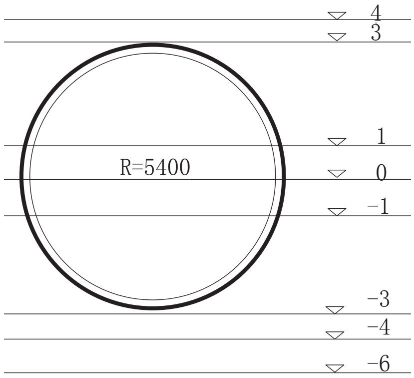


Fig. 2 different groundwater level chart

simulation parameters table Table 1

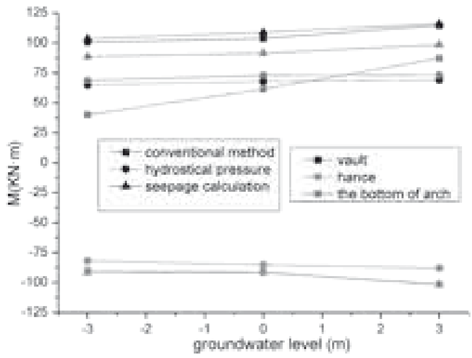
Soil	Thickness (m)	Density /kg/m^3	Deformation modulus /MPa	Poisson ratio	Internal friction angle /°	Cohesion /kPa
Silty clay	-	1970	5.6	0.3	15	35
Segment lining	0.3	2600	48	0.3	60	550

different soil permeability coefficient Table 2

Soil	*k(m/s)*	Soil	*k(m/s)*	Soil	*k(m/s)*
Clay	$<5\times10^{-9}$	Silty sand	10^{-9}~10^{-8}	Silty sand	2×10^{-4}~5×10^{-4}
Silty clay	5×10^{-9}~10^{-8}	Fine sand	10^{-5}~5×10^{-5}	Fine sand	5×10^{-4}~10^{-3}
Silt	5×10^{-8}~10^{-6}	Medium sand	5×10^{-5}~2×10^{-4}	Medium sand	10^{-3}~5×10^{-3}

2.2 CALCULATION RESULTS

According to the above data. Firstly, the conventional design method to calculate the force characteristics of tunnel structure under the water pressure. Then we simulate the tunnel structure under the action of seepage and seepage force, according to the results of calculation and simulation, combined with the actual situation, adjust and select the appropriate boundary conditions and simulation methods.



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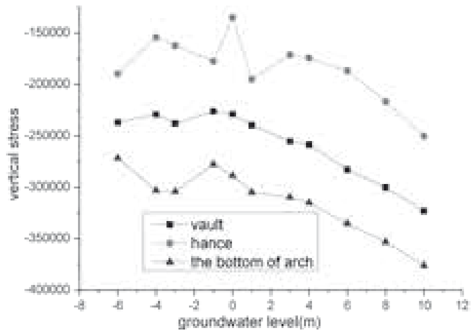


Fig. 4 vertical stress Szz

Figure 3 shows the, the results obtained by three different methods basic in the same interval, compared to the other two methods, consider seepage under the influence of the trend is more obvious, but also more in line with the results of theoretical analysis. Therefore, it can be proved that the boundary conditions adopted in the model are reasonable, and the results of seepage simulation are better.

Figure 4 shows that the structure of the tunnel from the large to the small order of the part of the arch, vault and arch. When groundwater level from -6m to 0m, the vertical stress value of groundwater is basically unchanged, when groundwater level rises from 0m, the vertical stress increases continuously.

In order to observe the whole deformation of tunnel structure under the condition of seepage, the part of the tunnel is increased along the longitudinal direction of the tunnel.

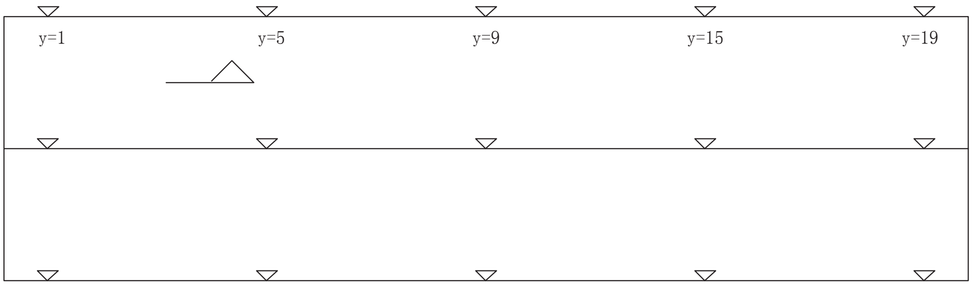


Fig. 5 Longitudinal point plan

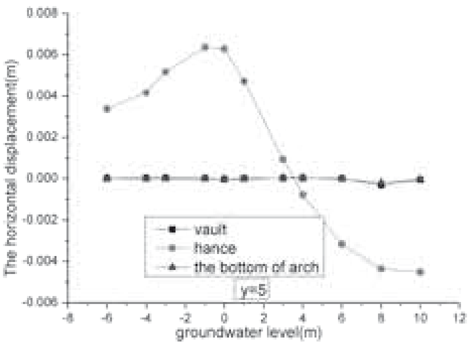


Fig. 6 Horizontal displacement at y=5 point

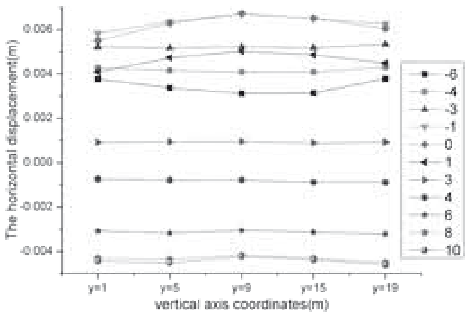
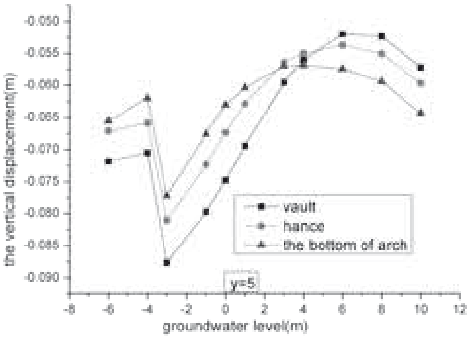


Fig.7 Horizontal displacement of different longitudinal coordinates

From Figure 6, it can be seen that the tunnel structure is not lateral displacement at the base of the vault, and the lateral displacement of the arch is obvious. Groundwater from 6 to the m, arch waist positive displacement increases; from 0m to 3m lateral displacement gradually decreases to zero; from 3m to about 9m, lateral negative displacement increases; when more than 9m, rising groundwater does not affect the basic arch waist at the lateral displacement.

From Figure 7, we can see that when the groundwater level from 6 to 3m tunnel arch lumbar lateral displacement difference is large, the tunnel prone to dislocation; when underground water level from 3m after then rising to 6m tunnel lateral displacement difference is zero, and from 6m then rising, tunnel structure lateral shift had little change.



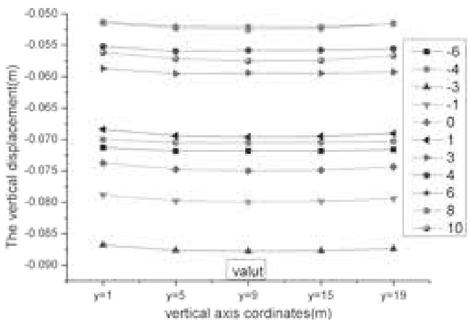


Fig. 8 vertical displacement at y=5 point

Fig. 9 vertical displacement of different vertical coordinates

Figure 8 shows, groundwater level from the -3m up to 3m, the floating of tunnel structure, the maximal displacement occurs in the vault; groundwater level from 3m to 6m, tunnel structure and the vertical displacement of the medium rise, but maximal displacement variable for arch bottom; water level continued to rise, the tunnel subsidence.

Figure 9 shows that along the longitudinal direction of the tunnel, under the influence of groundwater, the tunnel structure generally occurs as a whole broke surface or sink, rarely because of the impact of the occurrence of local dislocation phenomenon.

In conclusion, for the rise of groundwater under the influence of the tunnel structure, should pay more attention to the tunnel structure arch waist due to the uneven lateral displacement of the disease.

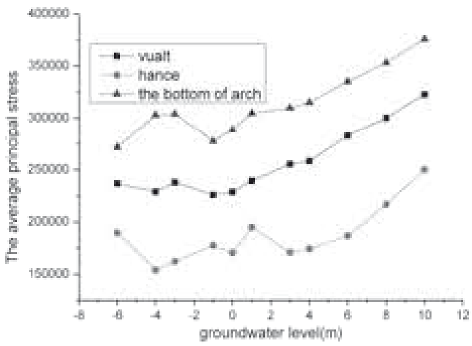


Fig. 10 average principal stress under different groundwater levels

From Figure 10, we can see that the groundwater level from -6m to m at the average principal stress force did not change significantly, when the groundwater level from m up to 10m, tunnel structure mean principal stress increases gradually, approximate linearly; the mean principal stress maximum force occurred in arch bottom, arch waist is at a minimum.

3. CONCLUSION

Considering the simulation method of conventional design method and FLAC3d software, using the FLAC3d module of groundwater seepage increased stress and deformation of tunnel structure under the condition was simulated and analyzed, the results show that, the rise of groundwater conditions, the lateral displacement along the longitudinal arch waist caused by uneven settlement to cause than vertical displacement the uneven settlement of the tunnel is more obvious, therefore, in consideration of the groundwater condition, the lateral displacement of the tunnel structure should be given more attention; groundwater level from -6m to 0m, the tunnel structure of the impact of groundwater is not obvious, when the groundwater level began to rise from 0m, the stress and deformation greatly the change of tunnel structure, this process should be paid more attention.

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CONSOLIDATION BEHAVIOR OF LAYERED CLAYS CONSIDERING SOIL STRUCTURE

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Keywords

consolidation; soil structure; pore pressure

ABSTRACT

The changes in yield stress induced by soil structure and their effects on consolidation behavior of clays are studied using the Gibson-Lo rheological model. Different forms of distribution of the yield stress are considered in the analyses. It is found that, if the average yield stress is larger, the trapezoidal distribution results in much more quickly development of consolidation than the rectangular one. However, the trend can reverse if the average yield stresses are the same.

1. INTRODUCTION

Soil structure of clays in the field can be induced by several factors including stress history, ageing, chemical bonding, biological reagents, etc. This often results in the formation of a "structured" layer on top of soft clay deposits in the field. Soil structure contributes to changes in unique reloading behavior of clays, yield stress in the upper layer. Such influences of soil structure on the mechanical behavior of soft clays have been well documented (Leroueil and Vaughan 1990; Mesri, et al. 1995). Soils in the field are not homogeneous for most of the cases. Thus it may be inappropriate to assume a homogeneous distribution of yield stress in the structured layer. In this study, effects of different types of yield stress distributions on consolidation behavior are analyzed. For the purpose of generalization of the solution, the authors adopted the rheological model proposed by Gibson and Lo (Gibson and Lo 1961) to represent the nonlinear constitutive relations of soil skeleton. The governing equation of consolidation is solved using a hybrid combination of numerical and analytical method. The effects of inhomogeneous distribution of yield stress on consolidation behavior are examined.

2. GOVERNING EQUATIONS AND SOLUTION

The schematic of the consolidation problem accounting for the effects of soil structure is shown in Figure 1(a). It can be seen that the upper clay layer is structured whereas the soft underlying layer is normally consolidated. Instantaneously applied load q induces constant total stress throughout the depth of the spectrum. The upper soil may gradually transition from structured to normally consolidated state from the top surface for the surcharge q is greater than the yield stress. Thus, the boundary between the normally consolidated and structured soil is moving downwards from the surface in this process.

The Gibson-Lo rheological model consists of an independent spring of modulus E0, a Kelvin body with spring of modulus E1, and a dashpot of viscosity coefficient η as shown in Figure 1(b), the vertical strain εz of each soil layer with this model can be expressed in an integral form as:

$$\varepsilon_z = \frac{\sigma_z'}{E_{0e}} + \int_0^t \frac{\sigma_z'}{\eta_e} e^{-\frac{E_{1e}}{\eta_{ei}}(t-\tau)} d\tau \quad \sigma_z' < \sigma_c' \qquad \text{(structured layer)} \quad (1a)$$

$$\varepsilon_z = \frac{\sigma_z'}{E_{0c}} + \int_0^t \frac{\sigma_z'}{\eta} e^{-\frac{E_{1c}}{\eta_i}(t-\tau)} d\tau \quad \sigma_z' > \sigma_c' \qquad \text{(structured layer)} \quad (1b)$$

$$\varepsilon_z = \frac{\sigma_z{}'}{E_0} + \int_0^t \frac{\sigma_z{}'}{\eta} e^{-\frac{E_1}{\eta_i}(t-\tau)} d\tau$$ (underlying layer) (1c)

where t is the time after application of the load, and τ represents a dummy variable; σz' is the vertical effective stress, respectively; the subscript e denotes conditions prior to the structured soil reaching the yield stress σc', and subscript c, after σc' is reached.

The small strain governing equation for consolidation with Gibson-Lo model incorporated results in a set of set of governing equations (Gibson and Lo (1961) and Xie et al. (2008)):

$$\frac{k_v}{\gamma_w} \cdot \frac{\partial^2 u}{\partial z^2} = \frac{\partial}{\partial t}[\frac{u}{E_0} + \int_0^t \frac{u}{\eta_e} e^{-\frac{E_{1e}}{\eta_e}(t-\tau)} d\tau] \quad \sigma_z{}' < \sigma_c{}'$$ (structured layer) (3a)

$$\frac{k_v}{\gamma_w} \cdot \frac{\partial^2 u}{\partial z^2} = \frac{\partial}{\partial t}[\frac{u}{E_0} + \int_0^t \frac{u}{\eta_c} e^{-\frac{E_{1c}}{\eta_c}(t-\tau)} d\tau] \quad \sigma_z{}' > \sigma_c{}'$$ (structured layer) (3b)

$$\frac{k_v}{\gamma_w} \cdot \frac{\partial^2 u}{\partial z^2} = \frac{\partial}{\partial t}[\frac{u}{E_0} + \int_0^t \frac{u}{\eta} e^{-\frac{E_1}{\eta}(t-\tau)} d\tau]$$ (underlying layer) (3c)

where u is the excess pore water pressure; kv is the coefficient of vertical permeability of soil; γw is the unit weight of water; and t and z are time and depth, respectively.

The solution of the set of nonlinear governing equations makes use of a hybrid combination of analytical as well as numerical methods (Ma et al. 2013a). This is done by first transforming the set of governing equations into linearized forms by discretizing the soil layers into multiple sub layers, and the time into short intervals. For these linear elastic discretized layers, an analytical solution to the governing set of equations can be derived as:

$$u_i(z, t_k) = \sum_{m=1}^{\infty} C_m g_{mi}(z) e^{-\beta_m \Delta t_k} \quad (4)$$

Where ui(z, tk) is the pore water pressure at the bottom of the ith sub layer at a selected time interval tk. Details of the solution and expressions for parameters are found in Ma et al (2013a) and Xie & Pan (1995) and are not presented here for brevity. The discretized form of these solutions for individual sub layers are then summed up numerically to obtain the solution for the entire layer.

The average degree of consolidation of a sub layer is given by:

$$U_i(t_k) = \frac{q - u_{ai}(t_{k-1})}{q} \quad (5)$$

From which the stress based degree of consolidation of the entire clay layer can be obtained by summation as:

$$U_p = \sum_{i=1}^{n} \left(U_i \cdot \frac{h_i}{H} \right) \quad (6)$$

The deformation of a sub layer is given by:

$$S_t(t_k) = \sum_{i=1}^{n} \varepsilon_{zi}(t_k) \cdot h_i \quad (7)$$

And the final settlement of the layers is:

$$S_\infty = \sum_{i=1}^{m} \left\{ \frac{C_{ei}}{1+e_{0i}} \lg(\frac{\sigma'_{ci}}{\sigma'_{0i}}) + \frac{C_{ci}}{1+e_{0i}} \lg\left[(\frac{\sigma'_{0i}}{\sigma'_{ci}})(1+\frac{q}{\sigma'_{0i}}) \right] + \frac{\sigma_c{}'}{E_{1ei}} + \frac{q-\sigma_c{}'}{E_{1ci}} \right\} \cdot h_i + \sum_{j=m+1}^{n} \left[\frac{C_{cj}}{1+e_{0j}} \lg(1+\frac{q}{\sigma'_{0j}}) + \frac{q}{E_{1j}} \right] \cdot h_i \quad (8)$$

Thus, the deformation based average degree of consolidation of the entire clay layer is given by:

$$U_s = \frac{S_t}{S_\infty} \quad (9)$$

3. MODEL PREDICTIONS

In order to investigate the effects of the distribution of yield stress, two forms of distribution, namely, rectangular and trapezoidal are made comparison in the following simulations (Figure 2). The trapezoidal distribution can be further divided into three different types:
trapezium **1**: b=1.5a, c=a
trapezium **2**: b=1.25a, c=0.75a
trapezium **3**: b=1.4a, c=0.6a
It can be seen that the area of the trapezium **1** is greater than that of rectangle, which suggests that trapezium **1** has larger average yield stress. The areas of trapezium **2** and trapezium **3** are equal to that of rectangle, indicating their average yield stresses are the same. However, slopes of the distribution are shown: trapezium **3** > trapezium **2** > rectangle. Other parameters in the analyses can refer to Ma et al (2013b).
The pore pressure profiles of rectangle and trapezium **1** corresponding to the time factor Tv = 0.05 and 0.2 are shown in Figure 3(a). It can be found that trapezium **1** dissipates the excess pore pressure much more quickly than the rectangular distribution in the whole consolidation process. Figure 3(b) presents the development of consolidation for the rectangular distributed yield stress and trapezium **1**, in which the average degree of consolidation develops faster for the trapezium **1** case, no matter how it is defined. Such observation coincides that of the pore pressure isochrones in Figure 3(a).
The pore pressure profiles of the rectangle, trapezium **2** and trapezium **3** are shown in Figure 3(c). It can be seen that the dissipation becomes more quickly as slope of distribution tends larger in the early period (Tv = 0.05). However, this trend reversed as time elapses, trapezium **3** dissipates excess pore pressure more slowly than others in latter period. The development of average degree of consolidation demonstrates similar soil behavior as shown in Figure 3(d).

6. CONCLUSIONS

In this study, the analyses mainly focus on the effects of yield stress distributions on the consolidation. It is found that, if the average yield stress is larger, the trapezoidal distribution results in much more quickly development of consolidation than the rectangular one. However, the trend can reverse if the average yield stresses are the same. Though not shown here, it is suggested that more mechanical behavior of structured clays can be revealed with the presented model and method, which includes non-linear soil compressibility, permeability, creep, etc.

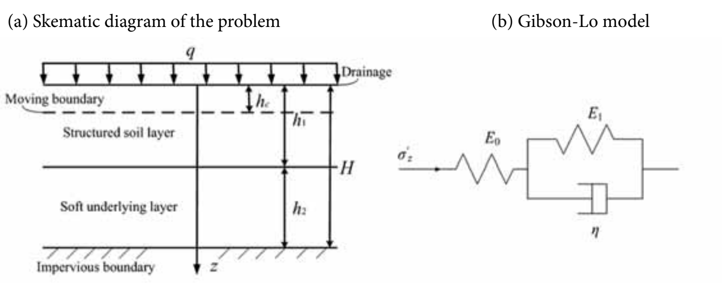


Fig. 1 Skematic diagram and soil model

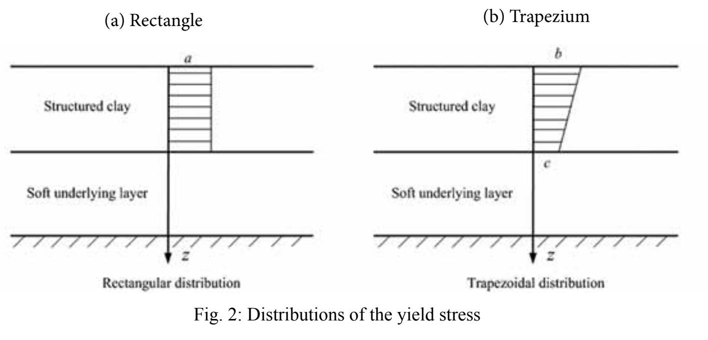
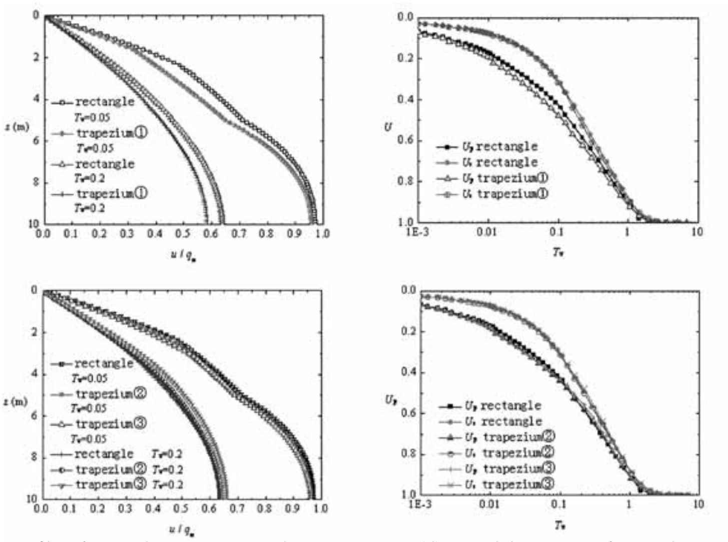


Fig. 2: Distributions of the yield stress

(a) Pore pressure profiles of rectangle and trapezium 1 (b) Consolidation rates of rectangle and trapezium 1



(c) Pore pressure profiles of rectangle, trapezium 2 and 3 (d) Consolidation rates of rectangle, trapezium 2 and 3

Fig. 3 Effects on consolidation behavior

NOTES

1. This work is a part of scientific project №14-18-01601 "*The Past and the Future of Classical Architecture"* supported by Russian Science Foundation performed in Moscow Institute of Architecture. (MARHI).
2. About the Nag el-Hagar fortress see (Wareth, U., Zignani, P. 1992; Mackensen, M. 2009; Franke, R. 2013).
3. About the temple of Roman imperial cult at Luxor see (Monneret de Villard, U. 1953; Kalavrezou-Maxeiner, I. 1975; Deckers, J.D. 1979).
4. About the fortress at Dionysias see (Schwartz, J. 1969).

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FREE TRANSVERSE VIBRATION OF LONG LARGE-CROSS-SECTIONAL UNDERGROUND STRUCTURE

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Keywords

open spaces, monumental buildings, cultural identity

ABSTRACT

The general free transverse vibration motion equation of long large-cross-sectional underground structure is derived with the comprehensive consideration of the effects of internal and external damping, shearing, cross-section rotary inertia, axial force, two-parameter soil model. Free vibration equations for several special cases may be obtained from the obtained general equation. In this way, the obtained general equation expands Timoshenko's beam theory. On the basis of nondemensionalized free vibration equation the influences of two soil model parameters on wave propagation velocities in structure and the free vibration frequency of underground structure are investigated. It is shown that in general wave propagation velocities in structure increase with soil elastic parameters. But the influence of Winkler's parameter $\bar{k}$ is significant while the effect of the second soil elastic parameter $\bar{g}_P$ is insignificant. Free vibration frequency of underground structure increase with relative wave number and soil elastic parameters. Differing from the influence of soil elastic parameters on wave propagation velocities in underground structure, the influences of soil elastic parameters $\bar{k}$ and $\bar{g}_P$ on vibration frequency of underground structure have the same order, therefore the influence of the second soil parameter $\bar{g}_P$ on free vibration of underground structure should not be neglected.

1. INTRODUCTION

Underground facilities built in seismic active areas must withstand both seismic and static loading. Historically, underground facilities have experienced a lower rate of seismic damage than surface structures. Nevertheless, some underground structures have experienced significant damage in recent large earthquakes, including 1995 Kobe, Japan earthquake, the 1999 Chi-Chi, Taiwan earthquake, and the 1999 Kocaeli, Turkey earthquake (Hashansh et al., 2001) and 2004 Baladeh, Iran earthquake (Fahimifar A., Vakilzadeh A., 2009). In recent years intensified seismic activity in China has been observed. The Wenchuan MS8.0 earthquake and Yushu M7. 1 earthquake (Li Gang et al., 2008, 2009) have caused huge human life and property loss (Yang Zhu'en et al., 2009). Therefore, seismic disaster mitigation of different structures, including underground facilities, is a long-term task for engineers and scientists (Jiang Haikun et al., 2009; Gao Mengtan et al., 2009), especially with the rapid development of large-scale underground construction in China.

For shallow underground structures far from the seismic source, the effects of surface seismic waves (Rayleigh and Love waves) are predominant (Wang J., 1993). In analysis of effects of surface seismic waves on underground structures it is usually assumed that surface waves travel parallel to tunnel axis in relation to tunnel curvature for conservatism. In seismic analysis of underground structures, one simple method is the so-called reaction displacement method, according to which the deformation experienced by structures is the same as the free field deformation. But this assumption is right only for flexible structures. The deformations experienced by rigid structures in flexible ground are less than free field ground deformations. Therefore, reaction displacement method is not able to describe the action of seismic waves on structures accurately, and it is necessary to study the interaction between structures and ground.

One approach to study soil-underground structure interaction is the quasi-static method, in which underground structures are modeled as Winkler type or Timoshenko type beams, and soil free field motion caused by seismic waves was imposed at the base of springs that represent the structure soil interaction (Constantpoulous, I.V. and

Motherwel, J.T. 1979; Navarro C. and Samartin A. 1998; St. John, C.M. and Zahrah T.F., 1987; Sanchez-Merino A.L, Fernandez-Saez J., Navarro C., 2009). But in fact, seismic soil-underground structures interaction is a dynamic problem, in many cases the internal forces of tunnels caused by dynamic seismic action are greater than that induced by the corresponding static one. Therefore, it is necessary to study dynamic seismic soil-underground structures interaction.

For large cross section structures, such as subway tunnel or station structures, cross section shear deformation, rotational inertia, axial force, internal and external damping will affect their transverse vibration when seismic waves travel parallel to structure axis. As to soil model, a simple model is Winkler-type foundation model. But Winkler-type foundation model neglects the influence between neighboring springs, therefore two-parameter soil models taking into account interaction between lateral springs have been developed (Filonenko-Borodich M.M., 1946; Hetenyi M., 1946; Pasternak P.L., 1954; Vlasov V.Z. and Leontiev N.N., 1960). Some researchers, for example (Wang T.M. and Stephens J.E., 1977; Eisenberger M. and Clastornik J., 1987; De Rosa M.A.,1995; Faruk Fırat Çalım, 2009) considered part of the above mentioned parameters in study of vibration of beams on elastic foundations.

In the present paper, we will make a trial to comprehensively consider more factors, including the underground structure cross section shear deformation, translational and rotational inertias, axial force, internal and external damping, and take into account two-parameter Pasternak soil model to deduce the governing equation of free vibration of underground structure. Then on the basis of the obtained differential equation of motion, we manage to study the effects of two soil subgrade stiffness parameters on free vibration of long large cross section underground structures.

2. THE STRUCTURE INTTERNAL DAMPING MODEL

Let w denote the transverse displacement of underground structure. The slope of the structure axis after deformation $\partial w/\partial x$ consists of two parts, the first part y is that caused by shear deformation, the second part θ is the rotation induced by bending moment, i.e.

$$\frac{\partial w}{\partial x} = \gamma + \theta \tag{1}$$

Assume that x coordinate coincides with the structure axis. In the cross section perpendicular to axis of structure, the displacement at distance y from neutral axis is $u = -\theta y$.

It is assumed here that the internal damping of material obeys to the Kelvin-Voigt law, i.e.

$$\sigma_x = E\varepsilon_x + \eta_0 \frac{\partial \varepsilon_x}{\partial t} = E\left(1 + \eta \frac{\partial}{\partial t}\right)\varepsilon_x \tag{2}$$

$$\eta = \eta_0 / E$$

where E is Young's modulus; η_0 is Kelvin-Voigt damping coefficient.

Analogously, for the simplicity of analysis we also assume that shearing force obeys the same Kelvin-Voigt law,

$$\tau = G\gamma + \eta_0' \frac{\partial \gamma}{\partial t} = G\left(1 + \eta \frac{\partial}{\partial t}\right)\gamma \tag{3}$$

Integrating the first moment of stress in Eq.(2) by y across the beam cross section height yields the bending moment across the cross section,

$$M = -EI_z\left(1 + \eta \frac{\partial}{\partial t}\right)\frac{\partial \theta}{\partial x} \tag{4}$$

where I is the inertia moment of cross section.

Taking into account Eq.(1), we obtain the expression for shearing force across structure cross section

$$Q = \mu A\tau = \mu GA\left(1 + \eta \frac{\partial}{\partial t}\right)\left(\frac{\partial w}{\partial x} - \theta\right) \tag{5}$$

where μ is the shear correction factor.

3. TWO-PARAMETER SUBGRADE MODEL

Here we will take Pasternak's model, according to which the relationship between the pressure acting on beam and the relative displacement between beam and soil subgrade W is Pasternak P.L., 1954)

$$p = k_0 w - G_p \nabla^2 w \tag{6}$$

where k_0 is the soil subgrade elastic coefficient; G_p is the second model parameter.

4. DERIVATION OF FREE TRANSVERSE VIBRATION EQUATION

For the clarity of the derivation procedure, we will consecutively consider the effect of different parameters on transverse vibration of underground structure.

3.1 EFFECT OF SHEAR DEFORMATION ON FREE TRANSVERSE VIBRATION OF STRUCTURE

At first we consider the case of pure shear deformation. Assume that the mass of per unit length structure is $m(x) = \rho A$. Due to the effect of shear, the original rectangular element changes its shape to somewhat a parallelogram. The free body diagram of structure element under pure shear is shown in Fig.1.

From the equilibrium equations in transverse direction, we obtain

$$\frac{\partial Q}{\partial x} - P - c_0\frac{\partial w}{\partial t} - m(x)\frac{\partial^2 w}{\partial t^2} = 0, \frac{\partial M}{\partial x} = N\gamma + Q \tag{7}$$

where $P = kw - \overline{G}_p\nabla^2 w$, K stands for the elastic stiffness coefficient of soil subgrade and $k = k_0 b$; $\overline{G}_p = bG_p$
where b is the width of structure; c_0 is the external damping coefficient of per unit length structure.

3.2 FURTHER CONSIDERATION OF BENDING

Under bending the relative rotation between two ends of structure element will be $d\varphi = dx\cdot\partial^2 w_\varphi / \partial x^2$, as shown in Fig.2, where w_φ is the deflection induced by moment. Because $\partial^2 w_\varphi / \partial x^2 = \partial\theta/\partial x$, we have $d\varphi = dx\cdot\partial^2 w_\varphi / \partial x^2 = dx\cdot\partial\theta/\partial x$. The free body diagram of structure element under pure bending is shown in Fig.2.

Therefore, the effect of axial force of structure on transverse equilibrium condition must be taken into account, as a result, we obtain

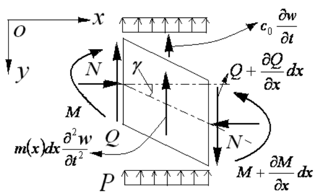

Fig.1 Free body diagram of structure element under pure shear

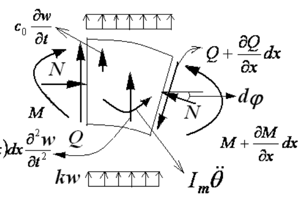

Fig. 2 Free body diagram of structure element under bending

$$\frac{\partial Q}{\partial x} - N\frac{\partial\theta}{\partial x} - kw + \overline{G}_p\nabla^2 w - c_0\frac{\partial w}{\partial t} - m(x)\frac{\partial^2 w}{\partial t^2} = 0 \tag{8}$$

3.3 FURTHER CONSIDERATION OF ROTATIONAL INERTIA

Assume that the mass bending inertia moment per unit length structure is $I_m = \rho I_z$, where I_z is the inertia moment of cross section of structure. If the rotation under bending is θ , then the rotational inertia moment of structural element with respect to the mass centroid of the element is $I_m\ddot{\theta}$, as shown in Fig.2. Therefore, rotational inertia moment should be added to equilibrium Eq.(7). As a result, we obtain

$$\frac{\partial M}{\partial x} + \rho I_z\frac{\partial^2\theta}{\partial t^2} - N\gamma - Q = 0 \tag{9}$$

There are 5 unknowns, i.e.*Q, M,* θ and *Y* appearing in Eqs.(8) and (9).

3.4 Further Consideration of Damping

Q, M and *Y* can be eliminated from Eqs. (8) and (9) by using Eqs. (4) and (5). Substituting Eqs.(4, 5) into Eq. (8) and after some operations, we obtain

$$\frac{\partial\theta}{\partial x} = \left(1+\eta\frac{\partial}{\partial t}\right)\left(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA}\right)^{-1}\frac{\partial^2 w}{\partial x^2} - \tag{10}$$
$$-\left[\mu GA\left(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA}\right)\right]^{-1}\left[kw-\overline{G}_p\nabla^2 w + c_0\frac{\partial w}{\partial t} + m(x)\frac{\partial^2 w}{\partial t^2}\right]$$

And further we obtain

$$\frac{\partial^2 w}{\partial x^2} - \frac{\partial\theta}{\partial x} = \frac{N}{\mu GA}\left(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA}\right)^{-1}\frac{\partial^2 w}{\partial x^2} + \tag{11}$$
$$+\left[\mu GA\left(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA}\right)\right]^{-1}\left[kw-\overline{G}_p\nabla^2 w + c_0\frac{\partial w}{\partial t} + m(x)\frac{\partial^2 w}{\partial t^2}\right]$$

Assume that m(x) = constant and EI_z =constant , $m = \rho A$ substituting (1,4,5) into Eq.(9) and further using Eqs.

(10), (11) yields,

$$
\begin{aligned}
& EI_z\left(1+\eta\frac{\partial}{\partial t}\right)^{(2)}\frac{\partial^4 w}{\partial x^4}+\left[(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA})\ N-\frac{kEI_z}{\mu GA}\left(1+\eta\frac{\partial}{\partial t}\right)\right]\frac{\partial^2 w}{\partial x^2}-\frac{c_0 EI_z}{\mu GA}\left(1+\eta\frac{\partial}{\partial t}\right)\frac{\partial^3 w}{\partial x^2\partial t} \\
& -\left(\frac{EI_z\rho}{\mu G}+\rho I_z\right)\left(1+\eta\frac{\partial}{\partial t}\right)\frac{\partial^4 w}{\partial x^2\partial t^2}+\frac{\rho I_z c_0}{\mu GA}\frac{\partial^3 w}{\partial t^3}+\left(\frac{\rho I_z k}{\mu GA}+(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA})\ \rho A\right)\frac{\partial^2 w}{\partial t^2}+\frac{\rho^2 I_z}{\mu G}\frac{\partial^4 w}{\partial t^4} \\
& +\frac{EI_z}{\mu GA}\left(1+\eta\frac{\partial}{\partial t}\right)\overline{G}_p\nabla^4 w-\frac{\rho I_z}{\mu GA}\overline{G}_p\frac{\partial^2\left(\nabla^2 w\right)}{\partial t^2}+(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA})\ kw-(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA})\ \overline{G}_p\nabla^2 w \\
& +(1+\eta\frac{\partial}{\partial t}+\frac{N}{\mu GA})\ c_0\frac{\partial w}{\partial t}=0
\end{aligned}
\tag{12}
$$

Eq.(12) is the general free transverse vibration equation of structure with consideration of internal and external damping, shear deformation, rotational inertia of cross section, axial force and double-parameter soil subgrade model. It is not difficult to obtain from Eq.(12) free vibration equations for different special cases.

5. FREE VIBRATION OF TUNNELS IN TWO LIMIT CASES

Now we search for the solutions to free vibration equation. Assume that the solution has the following form:

$$
w=W\exp\left[i\left(sx-\omega t\right)\right]
\tag{13}
$$

where W is the magnitude of vibration; S is the wave number; ω is the frequency of free vibration.
Substituting (13) into Esq. (12) and neglecting the internal and external damping yields

$$
\begin{aligned}
& \left[EI_z+\frac{EI_z}{\mu GA}\overline{G}_p\right]s^4-\left[(1+\frac{N}{\mu GA})\ N-\frac{kEI_z}{\mu GA}-(1+\frac{N}{\mu GA})\ \overline{G}_p\right]s^2-\left[\left(\frac{EI_z\rho}{\mu G}+\rho I_z\right)+\frac{\rho I_z}{\mu GA}\overline{G}_p\right]s^2\omega^2 \\
& -\left(\frac{\rho I_z k}{\mu GA}+(1+\frac{N}{\mu GA})\ \rho A\right)\omega^2+\frac{\rho^2 I_z}{\mu G}\omega^4+(1+\frac{N}{\mu GA})\ k=0
\end{aligned}
\tag{14}
$$

Because of the relationship between wave length λ, frequency ω, wave number S and wave velocity C ,

$$
s=\frac{2\pi}{\lambda};\omega=\frac{2\pi c}{\lambda}=cs
$$

Eq. (14) may be rewritten as follows,

$$
\begin{aligned}
& \left(EI_z+\frac{EI_z}{\mu GA}\overline{G}_p\right)(2\pi)^4-\left[(1+\frac{N}{\mu GA})\ N-\frac{kEI_z}{\mu GA}-(1+\frac{N}{\mu GA})\ \overline{G}_p\right](2\pi)^2\lambda^2-\left(\frac{EI_z\rho}{\mu G}+\rho I_z+\frac{\rho I_z}{\mu GA}\overline{G}_p\right)(2\pi)^4 c^2 \\
& -\left(\frac{\rho I_z k}{\mu GA}+(1+\frac{N}{\mu GA})\ \rho A\right)(2\pi)^2\lambda^2 c^2+\frac{\rho^2 I_z}{\mu G}(2\pi)^4 c^4+(1+\frac{N}{\mu GA})\ k\lambda^4=0
\end{aligned}
\tag{15}
$$

For short wave approximation $\left(\lambda\rightarrow 0\right)$, from Eq. (15) we obtain,

$$
\left(EI_z+\frac{EI_z}{\mu GA}\overline{G}_p\right)-\left(\frac{EI_z\rho}{\mu G}+\rho I_z+\frac{\rho I_z}{\mu GA}\overline{G}_p\right)c^2+\frac{\rho^2 I_z}{\mu G}c^4=0
\tag{16}
$$

from which, we obtain two wave velocities,

$$
c_1=\sqrt{\frac{E}{\rho}};c_2=\sqrt{\frac{\mu G}{\rho}\left(1+\frac{\overline{G}_p}{\mu GA}\right)}
\tag{17}
$$

The first wave velocity is that of longitudinal wave, and the second is the shear wave velocity. It is clear that, due to the consideration of the interaction between neighboring springs, the shearing of structure becomes more difficult. This is equivalent to the increase of shear modulus, and as a result, the shear wave velocity increases.
For long wave approximation ($\lambda\rightarrow\infty$), i.e. $s\rightarrow 0$, from Eq. (14) we obtain,

$$
\frac{\rho^2 I_z}{\mu G}\omega^4-\left[\frac{\rho I_z k}{\mu GA}+(1+\frac{N}{\mu GA})\ \rho A\right]\omega^2+(1+\frac{N}{\mu GA})\ k=0
\tag{18}
$$

from which, we obtain two frequencies

$$
\omega_1=\sqrt{\frac{k}{m}},\omega_2=\sqrt{\frac{\mu GA}{\rho I_z}(1+\frac{N}{\mu GA})}
\tag{19}
$$

The first is the vibration frequency of structure as a rigid one, and the second is the pure shear motion frequency of structure.

6. SUBGRADE PARAMETER STUDY

In the case of N=0, $\eta = 0$ and $c_0 = 0$, If the next nondimensional parameters are introduced

$$\chi = E/\mu G;\bar{k} = kr_0^2/EA;\omega_0 = \sqrt{E/\rho r_0^2},r_0 = \sqrt{I_z/A};c_l = \sqrt{E/\rho};\bar{g}_p = \bar{G}_p/(\mu GA);\Sigma = N/(EA);$$

$$\bar{t} = \omega_0 t;\bar{x} = x/r_0;\omega_0 = \sqrt{E/\rho r_0^2};\nu = r_0\omega_0/c_l;\frac{r_0^2\omega_0 c_0}{\mu GA} = \bar{c}_0,\bar{c} = c/c_l = c\sqrt{\rho/E},\bar{\lambda} = \lambda/(2\pi r_0)$$

Then from Eq.(12) we obtain the dispersion equation

$$\bar{c}^4 - \left[a_1 + a_2\bar{\lambda}^2\right]\bar{c}^2 + a_3 + a_4\bar{\lambda}^2 + a_5\bar{\lambda}^4 = 0 \tag{20}$$

where

$$a_1 = \frac{(\chi + 1 + g_p)}{\chi};a_2 = \frac{(\bar{k}\chi + 1)}{\chi};a_3 = \frac{(1 + g_p)}{\chi};a_4 = \left[\bar{k} + g_p\frac{1}{\chi^2}\right];a_5 = \frac{\bar{k}}{\chi} \tag{21}$$

As an example, we examine the structure, the cross section of which is illustrated in Fig. 3. The cross section inertia moment with respect to horizontal axis of cross section is $I_z = 313.41m^4$ Young's elastic modulus of concrete is $E_c = 2.5\times10^{10}Pa$, shear modulus is $G_c = 1.0\times10^{10}Pa$, Poisson's ratio is $\nu = 0.25$, the density of concrete is $\rho = 2.5\times10^3 kg/m^3$, the cross section area of the structure is $A = 39.64m^2$. Therefore the longitudinal wave velocity of the structure is $c_l = \sqrt{E/\rho} = 3.17\times10^3 m/s$, the cross section inertia radius is $r_0 = \sqrt{I_z/A} = 2.81m$ the soil's Young's modulus is $E_s = 1.4\times10^9 Pa$.
The area of the intermediate wall and sidewalls is $A_s = 15.06m^2$.

For a rectangular cross section, the parameter *u* is determined by the next equation (Hutchinson J.R., 2001),

$$\mu_{rec} = \frac{5(1+\nu)}{6+5\nu} \tag{22}$$

then, u may be calculated approximately by

$$\mu = \frac{5(1+\nu)}{6+5\nu}\cdot\frac{A_s}{A} = 0.33$$

Hence, $\chi = E/(\mu G) = 7.58$.

The numerical results of Eq. (22) are illustrated in Fig.4.
It is clear from Fig.4 that in general wave propagation velocities in structure increase with soil elastic parameters. However among these parameters, the influence of Winkler's parameter K is significant, and the influence of second soil elastic parameter g_p is insignificant. The wave propagation velocities for g_p=0 is almost the same as that for g_p=0.2 and g_p=0.364. Therefore in Fig. 4, the curves corresponding to g_p=0.2 and g_p=0.364 are not plotted. It is also shown in Fig.4 that the second velocity in beam in air decreases with the relative wave length, while increases in beam on elastic ground.

Using the relationship $s = 2\pi/\lambda; \omega = 2\pi c/\lambda = cs$ and introducing the next nondimensional parameters

$$\bar{s} = sr_0;\bar{\lambda} = \frac{\lambda}{2\pi r_0} = \frac{1}{\bar{s}};\bar{\omega} = \frac{\omega}{\omega_0} = \bar{c}\cdot\bar{s} \tag{23}$$

We obtain from Eq.(20) the following equation,

$$\bar{\omega}^4 - \left[a_2 + a_1\bar{s}^2\right]\bar{\omega}^2 + a_3\bar{s}^4 + a_4\bar{s}^2 + a_5 = 0 \tag{24}$$

The numerical results of Eq. (24) are illustrated in Fig.5.
It can be seen from Fig.5 that in general the vibration frequency of underground structure increases with relative wave number, and also increases with the Winkler's parameter and second soil elastic parameter. Differing from the influence of soil elastic parameters on wave propagation velocities in underground structure, the influences of soil elastic parameters and on vibration frequency of underground structure have the same order, therefore, the influence of the second soil parameter on free vibration of underground structure should not be neglected.

7. CONCLUSION

As the first step for dynamic seismic response analysis, the free vibration of long large cross-section underground structure is studied in the present paper. The general free transverse vibration motion equation of long large cross-

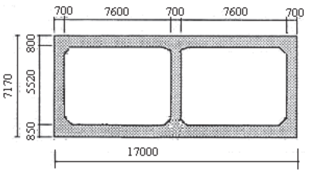

Fig. 3:The cross section of the underground structure

section underground structure is derived with the comprehensive consideration of internal damping, external damping, shear deformation, cross-sectional rotational inertia and axial force. Parameter study shows that in general, wave propagation velocities in structure increase with soil elastic parameters. However the influence of Winkler's parameter is significant, while the effect of the second soil elastic parameter is insignificant. Free vibration frequency of underground structure increases with relative wave number and soil elastic parameters. Differing from the influence of soil elastic parameters on wave propagation velocities in underground structure, the influences of soil elastic parameters and on vibration frequency of underground structure have the same order, therefore the influence of the second soil parameter on free vibration of underground structure should not be neglected in dynamic seismic analysis of underground structures.

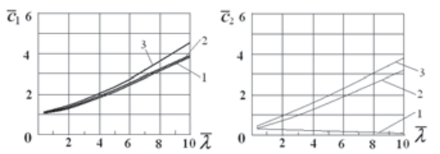

Fig.4) Relative velocity $\bar{c}_1$ and $\bar{c}_2$ versus relative wave length $\bar{\lambda}$ (curve 1- $\bar{k}=0, \bar{g}_p=0$; curve 2- $\bar{k}=0.1, \bar{g}_p=0$; curve 3- $\bar{k}=0.203, \bar{g}_p=0$)

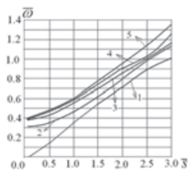

Fig.5) Relative frequency $\bar{\omega}$ versus relative wave number $\bar{s}$ (curve1- $\bar{k}=0, \bar{g}_p=0$; curve2- $\bar{k}=0.1, \bar{g}_p=0$; curve 3- $\bar{k}=0.203, \bar{g}_p=0$; $\bar{k}=0.203, \bar{g}_p=0$; curve 4- $\bar{k}=0.203, \bar{g}_p=0.2$; curve 5- $\bar{k}=0.203, \bar{g}_p=0.364$)

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RESEARCH ON SOIL-LONG-UNDERGROUND-STRUCTURE DYNAMIC INTERACTION UNDER THE ACTION OF SHEAR WAVE PROPAGATES ALONG AXIAL DIRECTION OF STRUCTURE BASED ON PASTERNAK FOUNDATION

POSTER

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Keywords

inertial force, forced vibration motion equation, Pasternak foundation model, foundation bed coefficient k_0, shear modulus G_0

ABSTRACT

To study the influence of inertia force on dynamic interaction between underground structure and soil when shear wave propagates along axial direction of long underground structure, static equilibrium equation, free vibration motion equation and forced vibration motion equation are developed based on Pasternak foundation model. By applying mode superposition method we converted the partial differential equation into ordinary differential equation. These equations are solved analytically based on differential operator method. For evaluating the influence of foundation soil rigidity on foundation bed coefficient k0, shear wave velocity vs, Poisson ratio υ, foundation soil shear modulus G0, numerical example is given and the solutions for static equilibrium equation and forced vibration equation are compared. Comparison shows that the influence of inertial force on forced vibration of structure is relatively small when foundation soil rigidity is relatively high.

1. INTRODUCTION

Domestic and foreign scholars mainly studied on horizontal seismic and vertical seismic, and obtained certain research results(Chen Can-shou et al., 2010; Guo Sheng-bing et al.,2002;Yu Xiang et al., 2001). However, the study of influence of inertial force on dynamic interaction between underground structure and soil when shear wave propagates along axial direction appears relative limited.

The Winkler foundation model(Long Yu-qiu., 1981) is widely applied in engineering. In this model, the foundation has been described by a sequence of closely spaced and independent elastic columns under normal vertical stress. The main criticism to the Winkler foundation model is due to mutual independence of foundation columns, producing some unrealistic effects as uniform displacements under uniform loads that have not been observed in experimental evidences.

Many sort of foundation have been proposed to improve the deficiency in theory of Winkler foundation model(Paola D et al., 2009). Pasternak foundation model(Huang Yi et al., 2005) is a generalization of Winkler foundation which introduced in Winkler foundation model some kind of interactions between foundation columns to modify foundation discontinuous.

In this paper, the influence of inertial force on dynamic interaction between structure and soil when shear wave propagates along axial direction of long underground structure will be studied based on Pasternak foundation model.

2. DEVELOPING GOVERNING EQUATION

The governing equation will be developed based on Euler-Bernoulli beam model(Weaver Jr W et al., 1990) and Pasternak foundation model.

The boundary of simply-supported beam and axial force will be considered, and the influence of damping will be neglected.

We invoke Euler-Bernoulli beam theory of beams: namely, that plane cross-sections initially perpendicular to axial

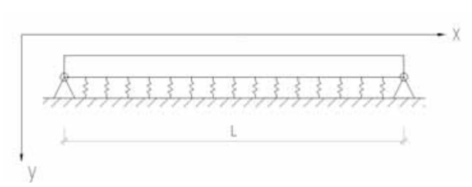

Fig.1 Analytical model of simply-supported beam

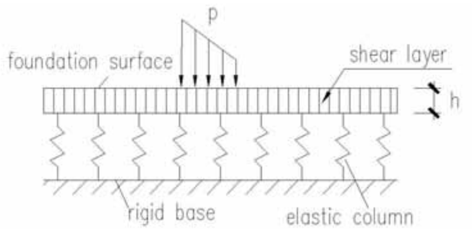

Fig. 2 Pasternak foudation beam model

of the beam remain plane and perpendicular to the neutral axis during bending. We have

$$\frac{\partial y}{\partial x} = \phi \tag{1}$$

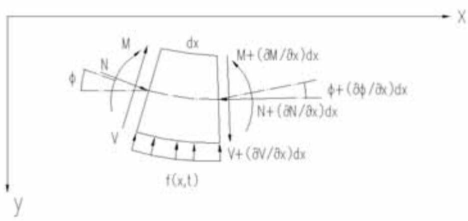

Fig. 3 Forces acting on isolated body

where y is the coordinate to the neutral surface of the beam; $\frac{\partial y}{\partial x}$ is cross section rotating angle of the beam; φ is rotating angle caused by beam bending.

The force acting on isolated body is shown in Fig. 3). Consider influence of inertial force, the vertical equilibrium equation is given by

$$f(x,t) + N\frac{\partial^2 y}{\partial x^2} + EI\frac{\partial^4 y}{\partial x^4} + m\frac{\partial^2 y}{\partial t^2} = 0 \tag{2}$$

where M is bending moment(N·m); N is axial force(N); V is shear force(N); m is mass per unit length(kg/m), ρ is mass density per unit volume(kg/m3), A is the cross-sectional area of beam(m2), m=ρA; E is Yang's modulus of materials(N/m2); I is moment of inertial of cross-section(m4); f(x,t)is foundation reaction.

Considering free vibration of the beam and Pasternak foundation model, the foundation reaction is given by

$$f(x,t) = ky - Gh\frac{\partial^2 y}{\partial x^2} \tag{3}$$

where k=k0b, G=G0b; b is the interface width between structure and foundation(m); k0 is foundation bed coefficient(N/m3); G0 is soil shear modulus(N/m2); h is depth of foundation shear layer. we have

$$ky + (N - Gh)\frac{\partial^2 y}{\partial x^2} + EI\frac{\partial^4 y}{\partial x^4} + m\frac{\partial^2 y}{\partial t^2} = 0 \tag{4}$$

Considering forced vibration of the beam, the vertical equilibrium equation is given by

$$ky + (N - Gh)\frac{\partial^2 y}{\partial x^2} + EI\frac{\partial^4 y}{\partial x^4} + m\frac{\partial^2 y}{\partial t^2} = ky_g - Gh\frac{\partial^2 y_g}{\partial x^2} \tag{5}$$

where f(x,t)=k(y-yg), yg is vertical foundation displacement(m).

Neglecting influence of inertial force, equation (4) reduce to

$$ky + (N - Gh)\frac{\partial^2 y}{\partial x^2} + EI\frac{\partial^4 y}{\partial x^4} = ky_g - Gh\frac{\partial^2 y_g}{\partial x^2} \tag{6}$$

3. EQUATION SOLUTION

2.1 SOLUTION OF FREE VIBRATION MOTION EQUATION

The free vibration motion equation (4) gives

$$ky + (N - Gh)\frac{\partial^2 y}{\partial x^2} + EI\frac{\partial^4 y}{\partial x^4} + m\frac{\partial^2 y}{\partial t^2} = 0$$

By applying method of separation of variables that assume y=φ(x)q(t) to solve free vibration mode, we have

$$[k\phi(x) + (N - Gh)\phi''(x) + EI\phi^{(4)}(x)]q(t) = -m\phi(x)q''(t) \tag{7}$$

$$-m\frac{q^{''}(t)}{q(t)}=\frac{k\phi(x)+(N-Gh)\phi^{''}(x)+EI\phi^{(4)}(x)}{\phi(x)}=u^4 \tag{8}$$

Hence we obtain

$$q^{''}(t)+\frac{u^4}{m}q(t)=0 \tag{9}$$

where $\dfrac{u^4}{m}=\omega^2$.

Hence we obtain

$$q(t)=e^{-i\omega t},\quad y=\phi(x)e^{-i\omega t} \tag{10}$$

Substituting (10) into (7) gives

$$\phi^{(4)}(x)+\frac{N-Gh}{EI}\phi^{''}(x)+\frac{k-m\omega^2}{EI}\phi(x)=0 \tag{11}$$

This has the solution

$$\phi(x)=Ce^{sx},\ \phi^{''}(x)=s^2Ce^{sx},\ \phi^{(4)}(x)=s^4Ce^{sx} \tag{12}$$

$$s^4+\frac{N-Gh}{EI}s^2+\frac{k-m\omega^2}{EI}=0 \tag{13}$$

Classification discusses are as follows:

Case1.

$$s^4+2a^2s^2-b^2=0$$

Case2.

$$s^4-2a^2s^2-b^2=0$$

Case3.

$$s^4+2a^2s^2+b^2=0$$

$$\begin{cases} a^4-b^2>0,\ s_{1,2}=\pm\alpha i,\ s_{3,4}=\pm\beta i \\ a^4-b^2<0,\ s_{1,2}=A\pm Bi,\ s_{3,4}=-A\pm Bi \end{cases}$$

Case4.

$$s^4-2a^2s^2-b^2=0$$

$$\begin{cases} a^4-b^2>0,\ s_{1,2}=\pm\alpha,\ s_{3,4}=\pm\beta \\ a^4-b^2<0,\ s_{1,2}=A\pm Bi,\ s_{3,4}=-A\pm Bi \end{cases}$$

In applying boundary conditions to determine the constants, we obtain

Case1, 2, and 3-I

$$\phi_n(x)=C_n\sin\left(\frac{n\pi x}{L}\right) \tag{14}$$

Case4-I

$$\phi_n(x)\equiv 0 \tag{15}$$

Case3-I, 4-I

The free vibration mode is complex, we do not discuss in this paper.

Case1, 2, and 3-I will be discussed in next section.

2.2 SOLUTION OF FORCED VIBRATION EQUATION

The forced vibration equation (5) gives

$$ky+(N-Gh)\frac{\partial^2 y}{\partial x^2}+EI\frac{\partial^4 y}{\partial x^4}+m\frac{\partial^2 y}{\partial t^2}=ky_g-Gh\frac{\partial^2 y_g}{\partial x^2}$$

By applying mode superposition method we will solve the equation.

$$y(x,t)=\sum_{n=1}^{\infty}\phi_n(x)q_n(t) \tag{16}$$

where φn(x) is nth vibration mode; qn(t), equals to amplitude, is generalized coordinates of nth vibration mode. For free vibration mode has been shown in last section, we just solve qn(t).

Substituting (16) into (5) gives

$$k\sum_{n=1}^{\infty}\phi_n(x)q_n(t)-(N-Gh)\sum_{n=1}^{\infty}(\frac{n\pi}{L})^2\phi_n(x)q_n(t)+EI\sum_{n=1}^{\infty}(\frac{n\pi}{L})^4\phi_n(x)q_n(t)+m\sum_{n=1}^{\infty}\phi_n(x)q_n^{''}(t)=ky_g-Gh\frac{\partial^2 y_g}{\partial x^2}$$

By applying mode orthogonality of vibration mode we simplify (17) to (17)

$$k\sum_{n=1}^{\infty}q_n(t)\int_0^L\phi_p(x)\phi_n(x)dx+(Gh-N)\sum_{n=1}^{\infty}(\frac{n\pi}{L})^2q_n(t)\int_0^L\phi_p(x)\phi_n(x)dx+EI\sum_{n=1}^{\infty}(\frac{n\pi}{L})^4q_n(t)\int_0^L\phi_p(x)\phi_n(x)dx+m\sum_{n=1}^{\infty}q_p^{''}(t)\int_0^L\phi_p(x)\phi_n(x)dx \tag{18}$$

$$=k\int_0^L\phi_p(x)y_g dx-Gh\int_0^L\phi_p(x)\frac{\partial^2 y_g}{\partial x^2}dx$$

To study dynamic response of structure when shear wave propagates along axial direction of structure, we assume that foundation vertical displacement yg is propagation of harmonic waves. We have

$$y_g=\mathrm{Re}\left[Ae^{-i(\omega_0 t-\gamma x)}\right]=\frac{a_0}{\omega_0^2}\sin\omega_0 t\sin\gamma x \tag{19}$$

$$\frac{\partial^2 y_g}{\partial x^2}=\frac{-a_0\gamma^2}{\omega_0^2}\sin\omega_0 t\sin\gamma x \tag{20}$$

where A is amplitude of shear wave, A=a0/ω02; a0 is acceleration of earthquake; ω0 is frequency of earthquake wave; γ is wave number, □ =2π/λ=2π/vT=w/v. λ is wavelength; v is wave velocity; T is of period of wave.

Substituting (19), (20) into (18), we obtain

Left=

$$\frac{L}{2}\{[k+(Gh-N)(\frac{p\pi}{L})^2+EI(\frac{p\pi}{L})^4]q_p(t)+mq_p^{''}(t)\} \tag{21}$$

Right=

$$\frac{L}{2}(k+Gh\gamma^2)\frac{a_0}{\omega_0^2}\sin\omega_0 t[\frac{-\sin(p\pi+\gamma L)}{p\pi+\gamma L}+\frac{\sin(p\pi-\gamma L)}{p\pi-\gamma L}] \tag{22}$$

Left=Right:

$$mq_p^{''}(t)+[k+(Gh-N)(\frac{p\pi}{L})^2+EI(\frac{p\pi}{L})^4]q_p(t)=(k+Gh\gamma^2)\frac{a_0}{\omega_0^2}[\frac{-\sin(p\pi+\gamma L)}{p\pi+\gamma L}+\frac{\sin(p\pi-\gamma L)}{p\pi-\gamma L}]\sin\omega_0 t \tag{23}$$

The follow special solution can be obtained by applying differential operator method:

$$q_p^{*}(t)=\frac{(k+Gh\gamma^2)\frac{a_0}{\omega_0^2}[\frac{-\sin(p\pi+\gamma L)}{(p\pi+\gamma L)}+\frac{\sin(p\pi-\gamma L)}{(p\pi-\gamma L)}]}{k+(Gh-N)(\frac{p\pi}{L})^2+EI(\frac{p\pi}{L})^4-m\omega_0^2}\sin\omega_0 t \tag{24}$$

4. SOLUTION OF STATIC EQUILIBRIUM EQUATION

The static equilibrium equation (6) gives

$$ky+(N-Gh)\frac{\partial^2 y}{\partial x^2}+EI\frac{\partial^4 y}{\partial x^4}=ky_g-Gh\frac{\partial^2 y_g}{\partial x^2}$$

Since equilibrium equation becomes static equation when inertial force is neglected, we solve the ordinary differential equation directly.
We have

$$y_g=\frac{a_0}{\omega_0^2}\sin\gamma x \tag{25}$$

$$\frac{\partial^2 y_g}{\partial x^2}=\frac{-a_0\gamma^2}{\omega_0^2}\sin\gamma x \tag{26}$$

The follow special solution can be obtained by applying differential operator method:

$$y^* = \frac{(k + Gh\gamma^2)\dfrac{a_0}{\omega_0^2}}{EI\gamma^4 + (Gh - N)\gamma^2 + k}\sin\gamma x \tag{27}$$

5. ANALYSIS OF NUMERICAL EXAMPLES

5.1 NUMERICAL EXAMPLES

We take the following parameters for calculation. The length of long underground structure is L=250m; the cross-section size is shown in Fig. 4)(the unit in Fig. 4) is [mm]); the density of concrete ρ is =2600kg/m3; the Young's modulus of concrete is E=3×104MPa; the axial pressure N=5000kN. The foundation bed coefficient is k0=4×104kN/m3; the shear modulus of soil is G0=2.89×107Pa; the width of shear layer is h=1.8m; the frequency of earthquake wave is ω0=15.7□ the acceleration of earthquake is a0= 0.2g=1.96m/s2; the shear wave velocity is vs=375m/s.

For dynamic solution:

We calculate the amplitude of qp*(t) corresponding to first 10th vibration mode. The beam displacement amplitude y of each positions (x=uL/20,u=1,2,……,19) will be obtained.

To illustrate,

First 10th vibration mode and its corresponding amplitude is given by when x=L/20

$$\begin{aligned}&\phi_n(x) = \sin(\frac{n\pi x}{L}), x = L/20\\&\phi_1(x) = \sin(\frac{\pi}{20}), \phi_2(x) = \sin(\frac{2\pi}{20}), \ldots,\\&\phi_{10}(x) = \sin(\frac{10\pi}{20})\end{aligned} \tag{28}$$

The amplitude qn of φn are as follows

q1=0.0004728, q2=-0.001329……q10=0.0003893.

According (16), we make this assumption

$$y|_{x=L/20} = \sum_{n=1}^{10}\phi_n(x)q_n \tag{29}$$

The dynamic displacement amplitude is y=0.004348 when x=L/20.

The amplitude at different sections can be calculated and is shown in Fig. 5).

As is shown in Fig. 5), the maximum dynamic displacement amplitude is y=0.00825 when x=15L/20.

For static solution:

We can calculate the displacement amplitude according to (27). The maximum static displacement amplitude is y=0.00739.

The relative difference can be calculated that Δ=10.5%. Comparison of these results shows that the influence of inertial force on displacement amplitude is relatively small.

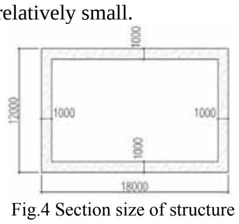

Fig.4 Section size of structure

5.2 ANALYSIS OF INFLUENCE OF PROPERTIES FOUNDATION SOIL

The foundation bed coefficient k0, wave velocity vs, and Poisson ratio υ will be changed with properties changed. In this section, referring to related specification and data, the different foundation soil will be compared and analyzed.

The other parameters is not changed except these in Tab. 1).

We will calculate each relative difference Δ corresponding to each foundation soil.

$$\Delta = \frac{y_d - y_s}{y_d} \tag{30}$$

where yd is maximum dynamic displacement amplitude, ys is maximum static displacement amplitude.

The relation between relative difference of maximum vibration amplitude and foundation bed coefficient k0 will be shown in Fig. 6).

The relative difference between dynamic and static results is less than 15% when stiffness of foundation soil is moderate hard. The influence of inertial force is more significant when stiffness of foundation soil is weaker.

6 CONCLUSION

This paper study the influence of inertial force on dynamic interaction between underground structure and soil when shear wave propagates along axial direction of long underground structure based on Pasternak foundation model. For evaluating the influence of foundation soil rigidity on foundation bed coefficient k0, shear wave velocity vs, Poisson ratio υ , foundation soil shear modulus G0, numerical example is given and the solutions for static equilibrium equation and forced vibration equation are compared. Comparison of dynamic and static results shows that the influence of inertial force on forced vibration of structure is relatively small when foundation soil rigidity is relatively high.

Tab. 1) Related parameters of different foudation soil

Species of Foundation soil	Shear-wave Velocity v_s(m/s)	Foundation Bed Coefficient k_0(N/m^3)	Poission Ratio □	Shear Modulus G(Pa)
Stiff Soil	650	10×10^7	0.15	7.8×10^7
|	512.5	6.5×10^7	0.20	5.3×10^7
Moderate Hard Soil	375	4×10^7	0.25	2.9×10^7
|	287.5	3×10^7	0.30	2.1×10^7
Moderate Soft Soil	200	2×10^7	0.35	1.3×10^7
|	150	1.625×10^7	0.40	1.1×10^7
Soft Soil	100	1.25×10^7	0.45	7.8×10^6

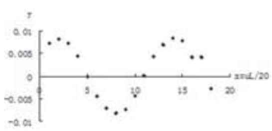

Fig.5 Vibration amplitude at different sections of long structure when inertial is considered

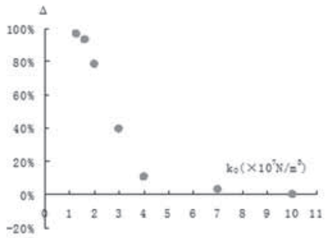

Fig.6 Relation between relative difference of maximum vibration amplitude and foundation bed coefficient k0

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DYNAMIC RESPONSE OF SHALLOWLY BURIED UNDERGROUND STRUCTURE MID-PILLAR UNDER VERTICAL SEISMIC EXCITATION

POSTER

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Keywords

vertical seismic excitation; mid-pillar; dynamic response

ABSTRACT

This paper studies the dynamic response of the mid-pillar of shallowly buried double-span underground structures under vertical seismic excitation. Half of the structure was studied because of the symmetry of the structure. To simplify the analysis, at first, structure was considered as a rigid body. The dynamic response of the structure under vertical seismic excitation was obtained by soil-structure interaction analysis. Then the mode shapes and natural frequencies of the roof slab of the structure were obtained with consideration of the bending restraint of the side walls to roof slab, and the forced dynamic response of roof slab was determined by taking the dynamic response of the structure as a rigid body obtained in the first step as input, and furthermore the shear force of slab was obtained. Finally the axial force of mid-pillar was determined.

1. INTRODUCTION

In the early seismic engineering, generally think the seismic has little influence on underground structure. Newmark N. M. [1] is the one of the earliest researchers who researched vertical and horizontal seismic peak value. The magnification factors of displacement, velocity and angular velocity were determined by them. They analyzed 33 groups' seismic data from contiguous United States. The results show that the vertical seismic acceleration peak can take as 2/3 of horizontal seismic acceleration. But a lot of seismic records show that many vertical acceleration produced by seismic not only larger than horizontal acceleration, but it is also very large in terms of the absolute value. For example, the ration of the vertical component and horizontal component in the Kobe earthquake in Japan reached 1.69, the maximum reached 0.57g. In the different of mid-pillar destruction of subway station observed circumferential directions and vertical crack or buckling or crushing in the mid-pillar part. The most serious is Dakai subway station, more than half of the mid-pillar collapse. The collapse of roof slab and settlement of overlying soil layer caused by the collapsed mid-pillar. The maximum settlement reached 2.5m. Due to bending moment in the mid-pillar of symmetric structure almost 0 under the horizontal component, circumferential directions and vertical crack or buckling or crushing in the mid-pillar part can not be considered to be horizontal seismic.

Many experts and scholars have made some achievements in the vertical seismic component influence on underground structure. Yao Xiaobin[2] developed a method of solving frequency and vibration mode of shallow buried underground structure, then get the results of wall rotational stiffness influence on frequency of roof slab. Yu Xiang[3] using impulse principle to determining the effect of vertical seismic component on subway station destruction. He found that the vertical seismic component can cause structure damage, so considered horizontal shear only is not appropriate. The destructive force of vertical seismic component is not negligible. Li Xinqiao[4] using ABAQUS to simulating the underground structure dynamic response under the vertical seismic component, horizontal seismic component, and both the vertical seismic component and horizontal seismic component. The results show that the vertical seismic component has a significant effect on the dynamic response of underground structures. Yang Chuntian[5] using impulse principle to calculating the vertical seismic excitation. Yang Chuntian quantitative analyzed the mid-pillar destruction under Kobe earthquake. The results indicate that the vertical seismic must be considered in the calculation of the underground structure. Qi Chengzhi[6] put forward a calculating method of the box-type structure. Li Changqing[7] sought the effect of buried depth on subway station dynamic response based on real size, soil condition and Kobe seismic wave of Dakai subway station through by finite element software. Wang Yue[8] thinks that effect of vertical seismic component on underground structure must focus on quantitative analysis. Qi Chengzhi researched dynamic response of shallowly buried underground structure under vertical seismic excitation, but he did not research dynamic response of mid-pillar and bottom plate in [9].

Conclusively, vertical seismic component is significant for underground structure. Because mid-pillar is the weakest part of underground structure, the dynamic response of mid-pillar under the vertical seismic component depends on the dynamic response of roof slab. This paper considered the dynamic response of roof slab first, then obtaining the dynamic response of mid-pillar from the dynamic response of roof slab. The vertical seismic excitation is rarely research at present, and researchers focused on numerical simulation, lack of theoretical models. This paper will research the dynamic response of shallowly buried underground structure mid-pillar under the vertical seismic excitation base on the model of soil-underground structure interaction. Half of the structure is taken into consideration because of the symmetry of the structure. We take the structure as rigid body and the dynamic response of structure under vertical seismic excitation is obtained by analyzing the interaction between rigid body and foundation. Then bending restraint of side wall which is replaced by bending spring is taken into consideration. Bending moments and shear forces of roof slab is obtained by inputting the dynamic response of the rigid body obtained previously as boundary condition of roof slab, and the force condition of mid-pillar is obtained. The results can serve as basis for analysis of deformation and fracture of interior mid-pillars.

2. THE DERIVATION AND APPROXIMATE SOLUTION OF THE UNDERGROUND STRUCTURES MOTION LAW

A two-span and single story building (fig.1) was selected. We considered the dynamic response of roof slab first. Then, in order to obtaining the boundary conditions of roof slab when we solved the dynamic response of roof

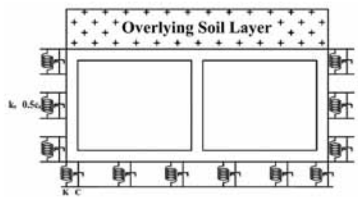

Fig.1 Underground structure model

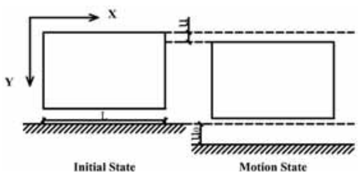

Fig. 2 The displacement diagram of soil-structure

slab, we must get the motion law of the side wall. To simplify the analysis, we take the structure as rigid body. By solving the interaction between rigid body and foundation can obtain the motion of the side wall. The displacement of underground structure is the same as the displacement of bottom plate at x=0 and x=L.

Assuming that foundation is elastic first. Winkler foundation model is selected. Assuming that elastic coefficient of underground structure bottom plate is K and damping coefficient is C. The interaction coefficient between side wall and foundation soils mass is k_s. The damping coefficient for foundation soils mass for side wall is c_s.

Then assuming that the absolute displacement of structure is u(t) and the relative displacement of structure is $\tilde{u}(t)$. $u_0(t)$ is the foundation displacement. The relationship between underground structure relative displacement and absolute displacement is determined by the following equation

$$\tilde{u}(t) = u_0(t) - u(t) \tag{1}$$

The overlying soil layer and underground structure will be regarded as a whole, the weight is M . According to the D'Alembert's principle, the motion equation of underground structure is determined by the following equation

$$\ddot{\tilde{u}} - 2\zeta\omega\dot{\tilde{u}} - \omega^2\tilde{u} = \ddot{u}_0 \tag{2}$$

where $2\omega\zeta = \dfrac{2C + c_s}{2M}$, $\omega^2 = \dfrac{K + k_s}{M}$ and $M \neq 0$.

If simple harmonic vibration is input as vertical seismic component namely $\ddot{u}_0 = a\sin\theta t$, so $u_0(t) = \dfrac{a}{\theta^2}\sin\theta t$. After solving equation we can know that free vibration will attenuate quickly. If neglect the damping influence on frequency, it will remain steady forced vibration only. Using Duhamel integral to solving equation (2), the answer is

$$\tilde{u}(t)=\frac{1}{\omega_d}\int_0^t \ddot{u}_0(\tau)e^{-\xi\omega(t-\tau)}\sin\omega_d(t-\tau)d\tau = A\sin(\theta t-\varphi) \tag{3}$$

where $\omega_d=\omega\sqrt{1-\xi^2}$ is the frequency of damping vibration, $A=\frac{a}{\omega^2}\frac{1}{\sqrt{\left(1-\beta^2\right)^2+\left(2\xi\beta\right)^2}}$, $\varphi=\arctan\left(\frac{2\xi\omega\theta}{\omega^2-\theta^2}\right)$.

We can get the absolute displacement of underground structure from equation (1) and equation (3)

$$u(t)=u_0(t)-\tilde{u}(t)=\frac{a}{\theta^2}\sin\theta t - A\sin(\theta t-\varphi) \tag{4}$$

3. THE DYNAMIC RESPONSE OF UNDERGROUND STRUCTURE ROOF SLAB

Half of the structure is taken into consideration because of the symmetry of the structure (Fig.3). To simplify the analysis, we take the bottom slab and the side wall are rigid, the roof slab is elastic. The side wall connect with bottom slab using rigid inter-jointing. Because we researched the underground structure that longitudinal size is much larger than diameter and side length, we take per unit length along the wire axis of the roof slab.

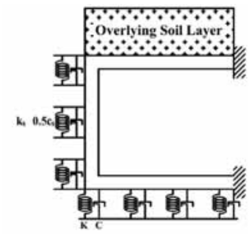

Fig.3 The simplified model of the underground structure

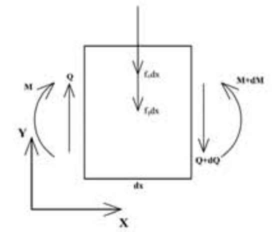

Fig.4 The force diagram of micro unit

Then assuming that the absolute displacement of roof slab is w(x,t) and the relative displacement between roof slab and side wall is $\tilde{w}(x,t)$. u(t) is the underground structure displacement. The relationship of roof slab relative displacement is determined by the following equation

$$\tilde{w}(x,t)=u(t)-w(x,t) \tag{5}$$

The length of the micro unit (Fig.4) is dx. Q is shear, M is moment, $f_I dx$ is inertia force, $f_c dx$ is damping force. The mass per unit length of beam is m. According to the equilibrium condition of vertical direction and moment, we can get the following equation

$$D\frac{\partial^4\tilde{w}(x,t)}{\partial x^4}+m\frac{\partial^2\tilde{w}(x,t)}{\partial t^2}+c\frac{\partial\tilde{w}(x,t)}{\partial t}=0 \tag{6}$$

Where $D=\frac{Eh^3}{12\left(1-\nu^2\right)}$ is flexural rigidity of slab, h is thickness of the roof slab.

Equation (6) is the free vibration equation of the roof slab, so the forced vibration equation[10] is determined by the following equation

$$D\frac{\partial^4\tilde{w}(x,t)}{\partial x^4}+m\frac{\partial^2\tilde{w}(x,t)}{\partial t^2}+c\frac{\partial\tilde{w}(x,t)}{\partial t}=m\frac{\partial^2 u}{\partial t^2} \tag{7}$$

Because equation (6) is linear, we can use the method of separation of variables to solve equation (6) [11]. The solution of equation (6) is represented by the following equation

$$\tilde{w}(x,t)=\sum_{i=1}^{\infty}Y_i(x)\phi_i(t) \tag{8}$$

Where $Y_i(x)$ is the vibration mode of beam, $\phi_i(t)$ is called generalized coordinates that is a function using time as the independent variable.

We can obtain 2 independent equations by substituting equation (8) into equation (6):

$$\frac{\partial^2\phi_i}{\partial t^2}+\frac{c}{m}\frac{\partial\phi_i}{\partial t}+\omega^2\phi_i=0 \tag{9}$$

$$\frac{\partial^4 Y_i}{\partial x^4} - k^4 Y_i = 0 \tag{10}$$

Where $k^4 = \dfrac{m\omega^2}{D}$. According to structural dynamics, the solution of equation (10) is

$$Y(x) = A_1 \cos kx + A_2 \sin kx + A_3 \cosh kx + A_4 \sinh kx \tag{11}$$

To simplify the analysis, bending restraint of side wall which is replaced by bending spring. k_φ is bending coefficient(Fig.5).

Fig.5 The simplified model of the roof slab beam

The boundary conditions of roof slab is

$$x = 0 \quad Y(0) = 0 \; Y'(0) = 0 \tag{12}$$

$$x = L \quad Y(L) = 0 \; DY''(L) = M_L = -k_\varphi Y'(L) \tag{13}$$

We can obtain equation (14) by substituting equation (12) and equation (13) into equation (11):

$$\begin{aligned} &A_1 = -A_3 \\ &A_2 = -A_4 \\ &A_1(\cos kL - \cosh kL) + A_2(\sin kL - \sinh kL) = 0 \\ &A_1(Dk\cos kL + k_\varphi \sin kL + Dk\cosh kL + k_\varphi \sinh kL) + \\ &A_2(Dk\sin kL - k_\varphi \cos kL + Dk\sinh kL + k_\varphi \cosh kL) = 0 \end{aligned} \tag{14}$$

Equation (14) can be expressed by matrix form

$$\begin{bmatrix} \cos kL - \cosh kL & \sin kL - \sinh kL \\ \begin{matrix} Dk\cos kL + k_\varphi \sin kL + \\ Dk\cosh kL + k_\varphi \sinh kL \end{matrix} & \begin{matrix} Dk\sin kL - k_\varphi \cos kL + \\ Dk\sinh kL + k_\varphi \cosh kL \end{matrix} \end{bmatrix} \begin{Bmatrix} A_1 \\ A_2 \end{Bmatrix} = 0 \tag{15}$$

A_1, A_2 , A_3 , A_4 are not equals to 0, so coefficient determinant is 0.

$$\begin{vmatrix} \cos kL - \cosh kL & \sin kL - \sinh kL \\ \begin{matrix} Dk\cos kL + k_\varphi \sin kL + \\ Dk\cosh kL + k_\varphi \sinh kL \end{matrix} & \begin{matrix} Dk\sin kL - k_\varphi \cos kL + \\ Dk\sinh kL + k_\varphi \cosh kL \end{matrix} \end{vmatrix} = 0 \tag{16}$$

Frequency equation of underground structure roof slab is determined by equation (16)

$$(\sin kL \cos kL - \cos kL \sinh kL) + \frac{k_\varphi}{Dk}(1 - \cos kL \cosh kL) = 0 \tag{17}$$

Equation (17) is a transcendental equation. We can solve this equation through trial method or numerical method. Then we can obtain the frequency equation of roof slab and the value of A_1, A_2 , A_3 and A_4 . Finally, the mode equation of roof slab can be obtained.

4. EXAMPLE

Firstly, assume that wall thickness of side wall is $\delta_w = 0.7\text{m}$, height from roof slab inside to bottom slab inside is $h_w = 5.5\text{m}$, the Young's modulus of concrete is $E = 2.35\times10^{10}\ \text{N/m}^2$, $\nu = 0.16$ is Poisson ratio, side wall flexural rigidity is $D_w = \dfrac{Eh^3}{12(1\ \nu^2)} = 6.9\times10^8\ \text{Nm}^2$, soil subgrade elastic coefficient is $k_g = 2.0\times10^8\ \text{N/m}^3$ and $k_g = 2.0\times10^8\ \text{N/m}^3$ and $\beta_w h = 0.519\times5.5 = 2.85$. Take the unit length along the axis, so this is a plane strain problem. To simplify the calculation, the rotational stiffness on the top of the side wall is the rotational stiffness of the elastic foundation beam that far end is fixed[12]

$$k_\varphi = 2D\beta \frac{\sinh\beta h \cosh\beta h \quad \sin\beta h \cos\beta h}{\sinh^2\beta h \quad \sin^2\beta h} = 7.244\times10^8\ \text{Nm}$$

Then, assume that the span and thickness of the roof slab are $L = 7\text{m}$ and $\delta_c = 0.7\text{m}$, the roof slab flexural rigidity is $D_c = \dfrac{Eh^3}{12(1-\nu^2)}$. We can obtain the first characteristic frequency and vibration mode by numerical method.

The eigenvalue and characteristic frequency of the first vibration mode are $(kL)_1 = 1.391\pi = 4.3701$ and $\omega_1 = \dfrac{(kL)_1^2}{L^2}\sqrt{\dfrac{D}{m}} = \dfrac{(4.3701)^2}{7^2}\sqrt{\dfrac{6.9\times10^8}{8880}} = 108.64\ \text{Hz}$.

The vibration mode is determined by the following equation

$$Y_1(x)=1.0149\cos kx-\sin kx-1.0149\cosh kx+\sinh kx \tag{18}$$

The simply supported beam and fixed beam characteristic frequency of the first vibration mode are $(kL)_1=\pi$ and $(kL)_1=1.5\pi$ [13]. The characteristic frequency of the first vibration mode in this example is $(kL)_1=1.391\pi$ between simply supported beam and fixed beam.

Then research the forced vibration of the underground structure.

The foundation coefficient is $k_g=2.0\times10^8\ \mathrm{N/m^3}$, the side wall shear coefficient is $k_r=0.7\times10^8\ \mathrm{N/m^3}$, the area of bottom slab is $S_b=8.4\times1=8.4\ \mathrm{m^2}$, the side wall area is $S_w=6.9\times1=6.9\ \mathrm{m^2}$.

So, $K+k_s=21.63\times10^8\ \mathrm{N/m}$.

The weight of roof slab and overlying soil is $M=14.63\times2400+8.4\times4\times1800=9.559\times10^4\ \mathrm{kg}$. The weight that underground structure take the place of soil is $M_r=53.13\times1800=9.563\times10^4\ \mathrm{kg}$, so we can obtain the following equation

$$\omega^2=\frac{K+k_s}{|M-M_r|}=\frac{21.63\times10^8}{(9.563-9.559)\times10^4}=5.407\times10^7$$

The ground vibration is simple harmonic vibration $\ddot{u}_0=a\sin\theta t=5\sin50t\ \ m/s^2$, $\zeta=0.2$ is damping ration. Free vibration will disappear, only steady forced vibration left after a while.

$$\tilde{u}=A\sin(\theta t-\varphi)$$

Where $A=\dfrac{a}{\sqrt{(\omega^2-\theta^2)^2+4\zeta^2\omega^2\theta^2}}=1.71\times10^{-15}\approx0$, $\varphi=\arctan\left(\dfrac{2\zeta\omega\theta}{\omega^2-\theta^2}\right)=0.156$.

The structure absolute motion is $\ddot{u}(t)=\ddot{u}_0(t)$ $\ddot{u}(t)=5\sin50t\ \ m/s^2$. The underground structure motion according to the motion law of soil.

We utilize mode orthogonality to solve roof slab motion equation.

We can obtain the following equation by substituting equation (8) into equation (7)

$$\sum_{i=1}^{\infty}D\phi_i(x)\frac{\partial^4 Y_i(x)}{\partial x^4}+\sum_{i=1}^{\infty}m(x)Y_i(x)\frac{\partial^2\phi_i(t)}{\partial t^2}+\sum_{i=1}^{\infty}c(x)Y_i(x)\frac{\partial\phi_i(t)}{\partial t}=m(x)\frac{\partial^2 u(t)}{\partial t^2} \tag{19}$$

The motion equation with damping is determined by the following equation. Each part multiply by the n-th member and integral equation by structural dynamics and mode orthogonality.

$$\ddot{\phi}_n(t)+2\zeta_n\omega_n\dot{\phi}_n(t)+\omega_n^2\phi_n(t)=\frac{P_n(t)}{M_n} \tag{20}$$

Where, damping coefficient is $c_n(x)=2\zeta_n\omega_nM_n$. The generalized mass M_n and generalized force $P_n(t)$ is determined by the following equation

$$M_n=\int_0^L Y_n^2(x)m(x)dx \tag{21}$$

$$P_n(t)=\int_0^L Y_n(x)m(x)\ddot{u}(t)dx \tag{22}$$

For the first vibration mode $Y_1(x)=1.0149\cos kx-\sin kx-1.0149\cosh kx+\sinh kx$, we can utilize equation (21) and (22) to solve generalized mass and generalized force.

$M_1 = 7.556m;\ P_1(t) = 30.978m\sin50t$

The generalized coordinates equation is determined by the following equation

$$\ddot{\phi}_1(t)+2\zeta_1\omega_1+\omega_1^2\dot{\phi}_1(t)=\frac{P_1(t)}{M_1}=4.1\sin50t$$

When $\zeta_1=0.1$, the stationary solution is shown in below equation.

$$\phi_1=A_1\sin(50t-\varphi_1)$$

Where $A_1=\dfrac{4.1}{108.64^2\sqrt{\left(1-\dfrac{2500}{108.64^2}\right)^2+\dfrac{4\times0.01\times2500}{108.64^2}}}=4.38\times10^4\ \mathrm{m}$ and $\varphi_1=\arctan\dfrac{2\zeta\omega_1\theta}{\omega_1^2-\theta^2}=6.66¡$.

Vibration energy can not affect the second vibration mode, and the third vibration mode frequency far more hugely than external load frequency, so we take the first vibration mode into consideration.

$$\tilde{w}=Y_1(x)\phi_1(t)=A_1(1.0149\cos kx-\sin kx-1.0149\cosh kx+\sinh kx)\sin(50t-\varphi_1)$$

The shear of the roof slab is

$$F_s(x,t)=D\tilde{w}'''=Y_1'(x)\phi_1(t)=DA_1k^3(1.0149\sin kx+\cos kx-1.0149\sinh kx+\cosh kx)\sin(50t-\varphi_1)$$

The shear of the right roof slab is

$$F_s(L,t)=F_s(7,t)=D\tilde{w}'''=6.9\times10^8\times4.38\times10^{-4}\times0.6243^3\times(1.0149\sin4.3701+$$
$$\cos4.3701-1.0149\sinh4.3701+\cosh4.3701)\sin(50t-\varphi_1)=2.9\times10^6\times\sin(50t-\varphi_1)\ \mathrm{N}$$

So, the mid-pillar force is $F = 3\times 2F_s(7,t) = 1.74\times 10^7 \times \sin(50t - \varphi_1)$ N .
In order to simplify the calculation, assume that intercolumniation is 3m, the size of mid-pillar is 1mx0.4mx5.5m , concrete strength grade is C40, the concrete young modulus $E_c = 3.25\times 10^{10}$ N/m^2 , Poisson ratio is $v_c = 0.2$, the moment of inertia of mid-pillar for the horizontal axis is $I = \frac{bh^3}{12} = \frac{1\times 5.5^3}{12} = 13.86$ m^4 .

The mid-pillar strain is $I = \frac{bh^3}{12} = \frac{1\times 5.5^3}{12} = 13.86$ m^4 .

The mid-pillar slenderness ration is $\frac{l}{b_0} = \frac{5.5}{0.4} = 13.75$. According to stability coefficient from Code for Design of Concrete Structures[14], using linear interpolation method to obtain stability coefficient is $\varphi = 0.8314$ when slenderness ration is 13.75. Compressive capacity of the rectangular section plain concrete is $N \le f_c\varphi A = 26.8\times 10^6 \times 0.8314\times 1\times 0.4 = 8.91\times 10^6$ N . Where N is design value pressure of axial direction, l is effective length of the component, b_0 is short side size of the rectangular section, φ is plain concrete stability coefficient, f_c is plain concrete axial compressive strength design value, A is cross sectional area of the component. According to calculation, the maximum force of the mid-pillar is 1.74×10^7 N that is larger than bearing capacity of rectangular section plain concrete compression member in Code for Design of Concrete Structures. That is $F_{\max} > N$, so mid-pillar will be failure under vertical seismic excitation.

5. CONCLUSION

According to simplified model, structural dynamics method and theory of elasticity in this paper, we can obtain force condition of the mid-pillar by underground roof slab dynamic response. First, we take the structure as rigid body and the dynamic response of structure under vertical seismic excitation is obtained by analyzing the interaction between rigid body and foundation. Secondly, half of the structure is taken into consideration because of the symmetry of the structure. Then, bending restraint of side wall which is replaced by bending spring is taken into consideration. Bending moments and shear forces of roof slab is obtained by inputting the dynamic response of the rigid body obtained previously as boundary condition of roof slab, and the force condition of mid-pillar is obtained. The results can serve as basis for analysis of deformation and fracture of interior mid-pillars. The vertical seismic excitation is obvious for the mid-pillar, even damage the mid-pillar according to calculation. The vertical seismic excitation effect on mid-pillar can not ignore. This paper is the foundation for analyzing the force and deformation of the mid-pillar. This paper has certain reference meaning on underground structure dynamic analysis and design.

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THE SCHEMES OF THERMAL TUNNEL THROUGH EXISTING SUBWAY LINE 6

POSTER

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Keywords

thermal tunnel, existing tunnel, deformation , FLAC^{3D}

ABSTRACT

With the development and utilization of underground space, will produce a lot of node engineering. Through existing subway structure occurs from time to time. The new line cross the existing metro will inevitably lead to changes in the structure of the force and deformation, and the deformation of subway operation and control standards are very strict, so the choice of the most appropriate construction method is very important. In this paper, the thermal power tunnel in line 6 of Beijing Metro as an engineering background, the software of FLAC3D to two kinds of different thermal tunnel construction scheme were simulated and analyzed by 3D numerical simulation. And from the three construction scheme is selected to minimize the effect of both the construction method of subway operation interval.

1. INTRODUCTION

With the rapid development of Beijing metro, Metro network is gradually formed, with the construction of new projects, there will be more and more crossing engineering, new construction will inevitably impact the surrounding Metro structure. Ministry of housing provision. If the subway construction as the center, radius 50m, the scope of protection.So in the construction of 50m within the scope of the construction of subway structure should be analysis the safety of the construction scheme, select the most appropriate construction scheme to reduce the impact of subway structure.

In this paper, the thermal power tunnel in Metro Line 6 Dong Si to Chaoyangmen station interval engineering as the basis, through the three dimensional numerical simulation analysis the deformation of tunnel of metro line 6. This paper puts forward several construction schemes, in the premise of ensuring safety and the normal operation of the tunnel structure, selected the most reasonable solution, the calculation results is highly targeted and has strong guidance to engineering.

2. PROJECT OVERVIEW

The relative position between tunnel and 6 tunnel thermal line as shown in Figure 1 and figure 2. Before the heat tunnel construction to the left and right to the shaft excavation, excavation length were 5.7m and 4.7m. The width is 5m, the left shaft excavation depth is about 11m, the right side of the shaft excavation depth is about 12m. In the shaft excavation process in order to prevent accidents, temporary support structure for supporting every angle of a layout of a (per frame for 0.5m). Diagonal brace is the use of 25A steel. Construction of vertical shaft mainly through real slag soil, silty clay, silty clay stratum weight three. Thermal power tunnel in fine sand, medium sand strata; the existing line 6 tunnel in silty clay stratum. Formation parameters are shown in table 1.

After the completion of construction excavation of shaft in shaft tunnel between thermal, thermal power tunnel horseshoe shaped wide, high are 3.3m, excavation length is about 66m. The bottom line interval distance of 6 thermal power tunnel height is about 14m. About 5.8m distance between two tunnels, tunnel and tunnel was 90 degrees heat in space. Thermal power tunnel 0.2% slope, slope from left to right. In order to avoid in the process of construction of the metro tunnel section of tunnel, heat the entire section of the grouting reinforcement (Fig. 1 in the blue region), the reinforcement length is about 46m. By using the method of deep hole grouting reinforcement, excavation contour line is in the range of 1m range. Thermal power tunnel in the grouting process to ensure that the range of grouting ahead of 10m, but also for 2m long grout stopping wall. Methods the grouting simulation measures are calculated by using the equivalent[6], in the simulation, to improve the physical and mechanical parameters of grouting range.

According to the position relationship between thermal tunnel and the existing range of line 6, put forward two kinds of construction schemes:

The first scheme, excavation thermal tunnel from the left shaft to the right shaft;

The two scheme, excavation thermal tunnel from both sides shaft to the middle;

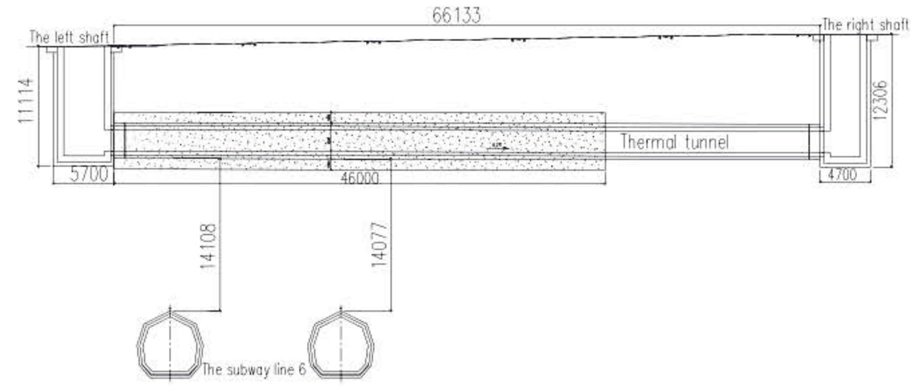

Fig.1 The relative position between tunnel and tunnel thermal line 6. Profile

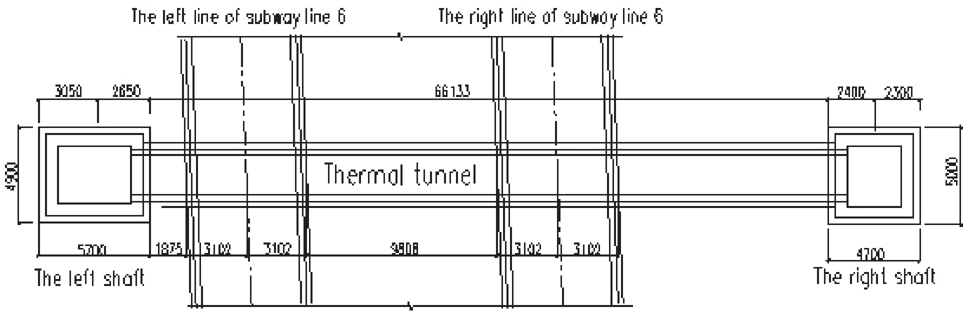

Fig.2 The relative position between tunnel and tunnel thermal line 6.Plane

Layer	Height (m)	Modulus of elasticity (N/m²)	Poisson's ratio	Cohesion (kPa)	Inner friction angle (°)	Density (kg/m³)	Tensile strength (N/mm²)
The slag soil	3.5	6e6	0.35	5	10	1650	1e3
Sandy silt	2	6e6	0.31	10	14	1950	300
Heavy silt clay	2	15e6	0.29	22	13	1985	1e3
Fine, medium sand	6	5e6	0.29	0	30	2050	200
Pebble	4	60e6	0.28	0	45	2150	150
Silty clay	12	10e6	0.31	25	18	1970	1e3

Table 1 Soil parametersμ

3. THE CALCULATION MODEL

Midas-GTS to build three-dimensional model and then imported to the FLAC3D calculated by the 3D model as shown in Figure 3, 2.5 times the influence of the structure of range in length, height from the existing line 6 tunnel at the bottom to the surface is 2 times of its effective range.
The three-dimensional model used in the numerical simulation include: thermal tunnel around the shaft, thermal tunnel , Metro Line 6, tunnel and surrounding soil.
Focus on the analysis of the security is the interval deformation of the subway line 6. Firstly, both the analysis of tunnel deformation, and then based on the results of the different construction scheme than the election.

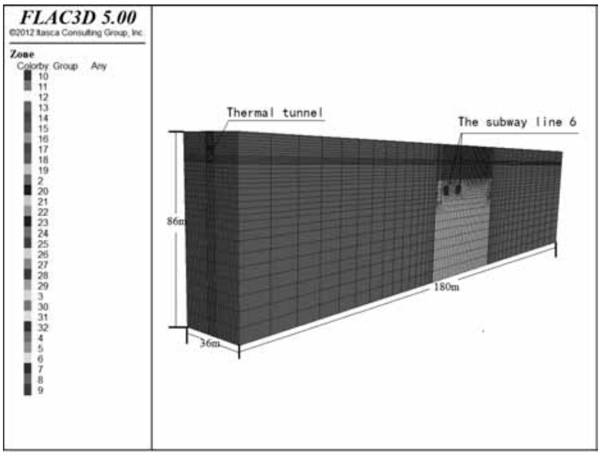

Fig.3 The calculation model of the whole

The top surface of the three-dimensional calculation model for the free boundary, boundary limit its normal constraint. The calculation model using the two kinds of construction schemes of the same. Is established by Midas, using the FLAC3D simulation of three kinds of construction schemes, just need to edit different commands.

4. THE MATERIAL PARAMETERS

As shown in Figure 4 is a schematic diagram of supporting structure. Parameter calculation of shot -crete, Second support, I-beam, shown in table 2.

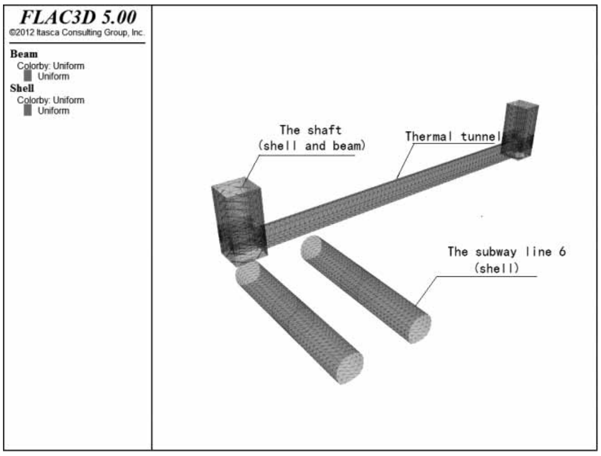

Fig.4 Supporting diagram

As shown in Figure 4, thermal power tunnel shaft, thermal tunnel, heat around the Metro Line 6 subway tunnel supporting structure adopts the structure element, solid element is used to simulate the soil around. Both the Metro Line 6, tunnel and shaft lining structure thermal shell element is used for simulation, the braces with 25A steel by using beam element.

Component	The strength grade	Modulus of elasticity（MPa)	Bulk density (kN/m^3)	The coefficient of linear expansion	Density (kg/m^3)	Poisson's ratio	Cross sectional area (m^2)
initial support	C20	25500.00	25.00	1.000e-005	2500	0.25	
layer supporting	C30	32000.00	25.00	1.000e-005	2500	0.25	
I-beam	25a	2.1e11			7800	0.20	4.85e-3

Table 2 the support parameters

5. SCHEME COMPARISON AND SELECTION

According to the three different construction scheme of tunnel excavation, analysis the effects of the existing line 6 interval. When the evaluation of the structural safety of the subway, there are two critical value. One is the thermal power tunnel after construction of the underground structure deformation value; two is the rate of deformation of subway structure thermal process of tunnel construction. This paper focuses on the analysis of two numerical.
First of all get the deformation and fitting curve after the completion of the construction of the whole tunnel. Can be seen that the overall deformation of Metro tunnel. The second thing to find the maximum position of deformation, and the variation in the construction process of reading analysis, so as to find out the deformation rate of the largest construction time.

5.1 THE FIRST SCHEME ANALYSIS

Scheme one is thermal tunnel construction from the left to the right side of the shaft. As shown in Figure 5 for the project after the completion of the construction of Metro Line 6 interval around the tunnel deformation comparison chart. The abscissa of the existing tunnel -18m~18m (full length 36m, the middle position as 0 points to consider

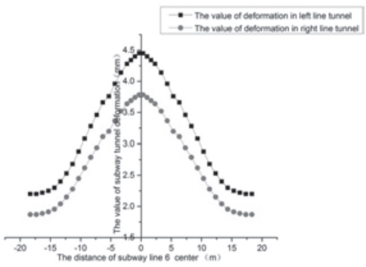

Fig.5 After the completion of the scheme one the metro tunnel deformation

the range), longitudinal deformation coordinates for the left line of subway tunnel.
Figure 5 shows the fitting curve, the line about the deformation of metro tunnel are consistent, symmetrical points on both sides of the deformation law of symmetrical distribution with 0 points.
On the whole the right line tunnel deformation at each position is less than the left tunnel, value in the range of 2.2 mm~ 4.45mm deformation in left line tunnel; the 1.87mm~3.75mm value in the range of the right line tunnel deformation. The difference About the double line tunnel about 0.5mm. The cause of this phenomenon is mainly because the distance between the left line tunnel near the left shaft. Shaft excavation has great influence on the left line.
In the end through the analysis of the subway tunnel deformation, in the center of the subway tunnel length (0 Figure), is the maximum deformation position. Figure 6 is the maximum deformation value changes in the process of construction of the value position of the curve. In order to find out the largest deformation rate through the construction.
In the actual construction process of thermal tunnel length is about 66m, the 46m in addition to the thermal power tunnel excavation has been the support and grouting reinforcement in thermal power tunnel at the bottom, so as to prevent the tunnel under large deformation. The 20m only on the thermal tunnel excavation support. Because of the need to advance the 10m grouting, and set aside the 2m grout stopping wall. So each 12m a big loop process. ultimately determine each 6m to extract a reasonable data. In Figure 6 the abscissa is the length of tunnel

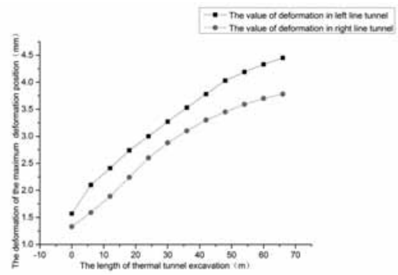

Fig.6 In the process of the first scheme construction 0 point deformation

excavation of heat, the vertical axis is the existing line 6 deformation value.

From the curve in Figure 6 can be seen, along with the construction of both the interval deformation appears the trend of becoming larger. The subway tunnel left line in tunnel excavation 5m~15m thermal deformation rate, with the construction of thermal power tunnel deformation rate decreases; the right line of subway tunnel in tunnel excavation 12m~24m thermal deformation rate.

5.3 THE SECOND SCHEME ANALYSIS

Scheme two is thermal tunnel construction from both sides to the middle. As shown in Figure 8 for comparison

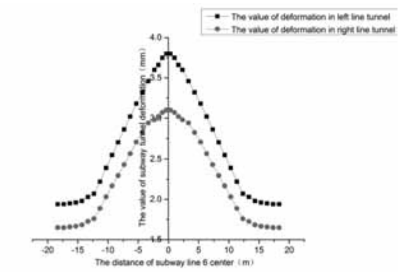

Fig.7 After the completion of the scheme two the metro tunnel deformation

with two deformation after the completion of the construction of Metro Line 6 interval around tunnel.

Figure 9 shows the fitting curve, the line about the deformation of metro tunnel are consistent, symmetrical points on both sides of the deformation law of symmetrical distribution with 0 points.

The deformation is less than the first two schemes on the whole overall program two. The deformation of the right line tunnel is less than the left line of the shield tunnel, the 1.94mm~3.8mm value in the range of deformation in left line tunnel; the 1.65mm~3.1mm value in the range of the right line tunnel deformation. The difference About the double line tunnel about 0.5mm. The program two's deformation is less than program one about 0.6mm.

Through the analysis of the subway tunnel deformation value in the end, the deformation value of the same maximum position and the first schemes. Through the analysis of the subway tunnel deformation value in the end, the deformation value of the same maximum position and the first two schemes. Figure 10 is the maximum deforma-

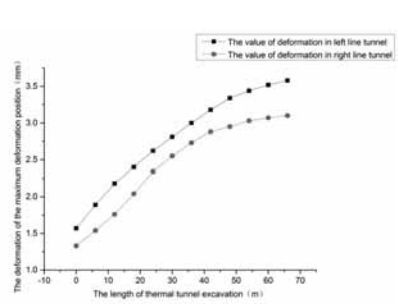

Fig.8 In the process of the second scheme construction 0 point deformation

tion value change position in the construction process of the value curve fitting.

From the curve in Figure 10 can be seen, the scheme of construction with the construction of two thermal power tunnel showed increasing trend with the deformation range. Change trend and the rate of change of a similar scheme. The subway tunnel left line in tunnel excavation 5m~15m thermal deformation rate, with the construction of thermal power tunnel deformation rate decreases; The max deformation rate position in the thermal tunnel

12m~24m excavation.
Through the analysis of the above two kinds of thermal power tunnel construction scheme, We find the maximum deformation value after completion construction and the maximum deformation rate in the process of construction. These two data is very important in the process of construction of the reference value. In this paper, the data processing, such as shown in Table 4, table 3.
After the completion of the construction about the tunnel deformation value of fitting curve and table 3 shows the sequence of construction excavation, from both sides to the middle of the deformation caused by the deformation of the construction sequence is the minimum; the maximum deformation value is excavation the Thermal tunnel

Table.3)The value of subway tunnel deformation after thermal tunnel excavation

Construction scheme	The left line deformation range（mm）	The right line deformation range（mm）	The left line of maximum deformation position	The left line of minimum deformation position	The right line of maximum deformation position	The right line of minimum deformation position	Effects of minimum construction scheme
Scheme one	2.2~4.45	1.87~3.75	Left line 0 position	Begin and end of left line	right line 0 position	Begin and end of right line	Scheme Two
Scheme two	1.94~3.8	1.65~3.1	Left line 0 position	Begin and end of left line	right line 0 position	Begin and end of right line	

Table.4)The subway tunnel deformation during thermal tunnel excavation

Construction scheme	The deformation of Left line 0 position (mm)	The deformation of right line 0 position (mm)	The left line of maximum deformation position	The right line of maximum deformation position	Effects of minimum construction scheme
Scheme one	1.5~4.45	1.33~3.75	Left side excavation 5~15 m	left side excavation 12~24m	Scheme Two
Scheme two	1.5~3.8	1.33~3.1	Both sides excavation 5~15m	Both sides excavation 12~24m	

from left to the right shaft.

6. CONCLUSIONS

Through the analysis of the thermal safety impact of construction on the tunnel line 6 subway line to the left. The following conclusions can be drawn:
1.Two different excavation step, the deformation of the excavation scheme from both sides to the middle of the existing subway tunnel left line is the smallest, the deformation value is about 3.8mm; the right line deformation value of about 3.1mm.
2.The existing line 6 tunnel deformation caused by the space reflects the obvious, construction location and spatial distance determines the existing tunnel deformation value. The closer to the existing range of line 6 is smaller, and vice versa.

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SESSION 5

CONSTRUCTION,
STRUCTURAL MECHANICS,
TRANSPORT PROBLEMS

ON TAKEN INTO ACCOUNT THE JOINT WORK STRUCTURES AND FOUNDATIONS

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Keywords

multilayer structures, system «structure-foundation-base», beam (slab) on an elastic basis

ABSTRACT

In the calculation of structures on an elastic basis is usually the design scheme of the foundation is the beam (slab), loaded on tops a distributed load corresponding to the weight of the structure. It is quite obvious that in such design scheme is not considered joint work of the foundation and structure of inter-connected bearing walls and columns.
The article discusses the modeling of the system «building - foundation - base» with the design scheme, presented two-layer beam (slab) of variable stiffness on an elastic basis. The lower layer of the beam (slab) simulates the foundation, and upper - design, at the same time is considered the own weight of each layer. As a model of elastic foundation using the Winkler foundation with variable coefficients of subgrade reaction, which allows a simple way to take into account the complex soil conditions.

1. INTRODUCTION

In the present paper is considered the problem of modeling the structure in common with the foundation and the basis, for this were used the two-layer beams and slabs models on an elastic basis with variable and constant coefficient of subgrade reaction. The method of calculating two-layer beams and slabs models on an elastic basis was described in the author's various articles [1-12], in the present describes the calculation models and generalization of the calculation results. The calculation results are compared for different models of beams and an elastic basis. For a two-layer beams models on an elastic basis the results are represented of calculation taking into account the increase of the height of the upper structure.

2. STATEMENT OF THE PROBLEM

The problem refers to the calculation of the foundation slabs, loaded with the weight of the structure and contacting with the basis [1-11]. In the traditional setting of the problem is considered a single-layer beam (slab), loaded with regular distributed load q, at the same time the weight of the structure and the weight of the foundation slab are reduced to the top plane (Fig. 1, *a*, Fig. 2, *a*) [13, 14]. For taken into account the joint work of structures and foundations in the present paper are represented the models of the two-layer beam and slab, the lower layer (h_1, E_1) of which simulates the foundation, and the upper (h_2, E_2) one -the structure, at the same time is considered the weight of each layer (Fig. 1, *b*, Fig. 2, *b*). Such statement of the problem leads to the differential equation of the beam axis bending close to the traditional one, however, it gives other results.

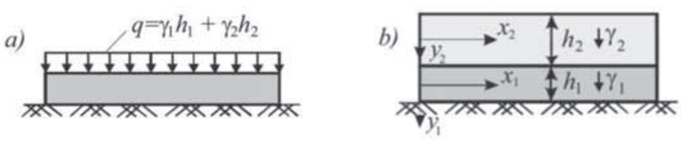

Fig. 1. The single-layer (*a*) and two-layer (*b*) beams models on an elastic basis.

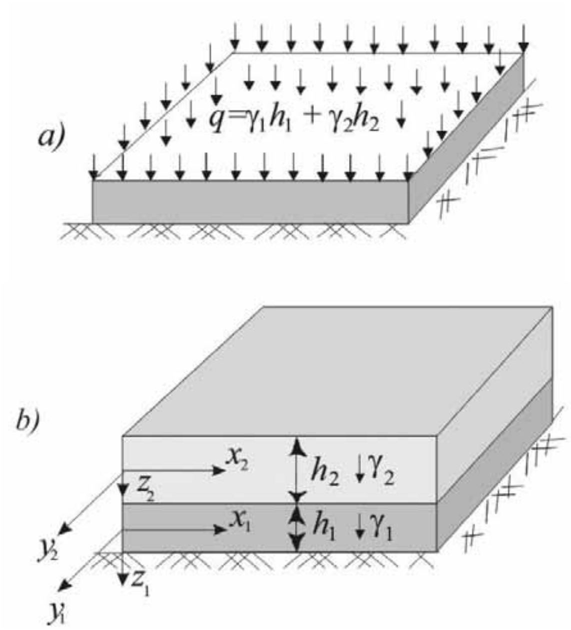

Fig. 2. The single-layer (a) and two-layer (b) slabs models on an elastic basis.

3. BASIC RELATIONSHIPS

The equation of bending, deduced on the basis of general equations of the theory of elasticity, taking into account mass forces, has the form (1) for the two-layer beam and form (2) for the two-layer slab [1, 11]:

$$D_z \frac{d^4 v}{dx^4} + Cv = q \tag{1}$$

$$\frac{D_z}{1-v^2} \nabla^2 \nabla^2 w + Cw = q \tag{2}$$

where $q=\gamma_1 h_1+\gamma_2 h_2$ – the resulted load; γ_1, γ_2 accordingly dead load (weight of material) of the foundation and the structure; C – the coefficient of subgrade reaction; v – Poisson's ratio; D_z – the reduced flexural stiffness of the cross section, which is defined by

$$D_z = E_1 I_1 + E_2 I_2$$

Here E_1, E_2 – the elastic modulus of each layer; I_1, I_2 – the moments of inertia of each layer relative to the centroid of cross section.

The equations (1), (2) differ from the traditional equation of beam and slab bending on elastic base presence the reduced flexural stiffness and the fact that the load is not reduced to the top side of the foundation slabs, and represents the volume forces (Fig. 1, *b*, Fig. 2, *b*).

Knowing the decision of the equations (1), (2), it is possible to calculate the stresses, according to the equations given in [1-2, 10-11].

4. CALCULATION EXAMPLE

Let us consider the bending of the two-layer beams with variable cross-section along the length, freely supported on an elastic basis of Winkler's type, with the following characteristics: L = 30 *m*, b = 1 m; h_1 = 1 m, $E_1 = 10^7$ kPa, γ_1= 25 kN/m^3; at $x \in (0, 5)$ m and at $x \in (25, 30)$ m, h_2 = 0, E_2 = 0, γ_2= 0; at $x \in (5, 25)$ m h_2= 0, 3, 6, 9, 12 m, E2 = 10^6 kPa, $\gamma_2$2.5 kN/m3; at $x \in (0, 10)$ m and $x \in (20, 30)$ m, C_1 = 50000 kN/m3, *x* (10, 20) m, C_2 =0.5C_1 (Fig. 3, *a*).

For comparison is considered a variant, when along the whole length of the contact $x \in (0,30)$ m the coefficient of subgrade reaction $C_0 = C_1$ = const.

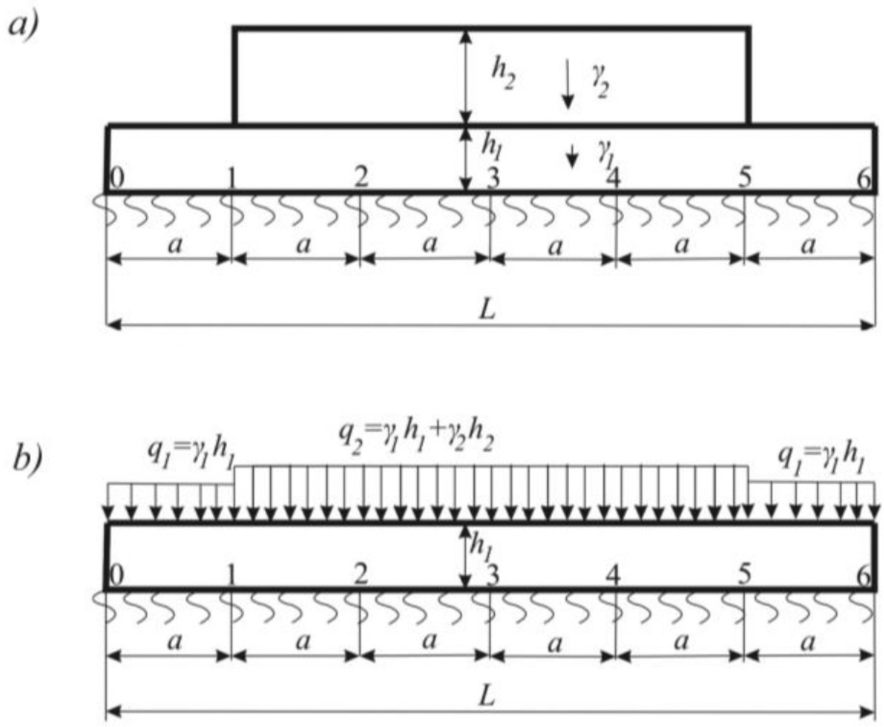

Fig. 3. The two-layer and the single-layer beam models of variable stiffness on an elastic basis.

The analytical solution is obtained using the method of initial parameters [4, 5, 7, 13]. The beam is divided into several sections, for each section is written the expression of deflection, which is equal to the corresponding settlements of the surface basis. The change of stiffness on length of each segment is assumed constant, i.e. the beam is considered piecewise-constant stiffness.

Let the beam has 6 sections of equal length and numbered from 0 to 6 (Fig. 3, a). In deriving of the formulas deflections from of the basis reaction $y_i(p)$ in general curvilinear diagram of reaction is replaced by a piecewise-linear with breaks at the points i = 0, 1, 2,…, 6. Due to the symmetry would be only four unknown values of basis reaction at 0, 1, 2 and 3 ($p_0 = p_6$, $p_1 = p_5$, $p_2 = p_4$, p_3).

After determining the basis reaction are calculated the internal forces, according to the formulas, given in [13], and vertical displacements.

Also, the problem considered in the traditional statement (Fig. 3, b), i.e. is solved the problem of bending a single-layer beam with constant cross-section along the length, freely supported on an elastic basis of Winkler's type, with the characteristics which are specified higher for the lower layer of the two-layer beam, with one exception. The bending of this beam is considered under the action of the variable surface distributed load. Also as in the two-layer beam is considered the situation, when $x \in (0,30)$ m C_1 = const = 50000 kN/m^3, and the situation, when at x□(0,10) m and $x \in (20,30)$ m C_1 = 50000 kN/m3, $x \in (10,20)$ m $C_2 = 0{,}5C_1$. The problem in such statement is solved similar to the previous, only the flexural rigidity of the beam is constant along the length.

5. RESULTS OF THE CALCULATIONS

In order to compare the results of the calculations in Table 1 are given the values of the maximum bending moments, shear forces and the maximum vertical displacements, which are obtained by calculating the two-layer and single-layer beams models on an elastic basis with variable and constant coefficient of subgrade reaction. The table shows the results for the height of the structure equal to 9 m.

The results of the calculations.

The calculation model	Coefficient of subgrade reaction	The maximum value of vertical displacements, [cm]	The maximum value of bending moments, $[\mathrm{kN \cdot m}]$	The maximum value of shear forces, [kN]
The single-layer beam model	constant	0.114	10.5	22.1
	variable	0.235	32.2	23.6
The two-layer beam model	constant	0.119	1369	160
	variable	0.139	2016	218.5

Table 1 - The results of calculations

The stress can be determined using the maximum values of the internal forces, according to the equations given in [1, 2]. The values of the normal stresses are presented in the form of diagrams σ_x and shear stresses - in the form of diagrams τxy (Fig. 4). The results of calculation received with the increasing height structure. The numbers of the graphs correspond to values h2: 1 - h2 = 0, 2 - h2 = 3 m, 3 - h2 = 6 m, 4 - h2 = 9 m, 5 - h2 = 12 m.
Fig. 4. The diagrams of normal (σ_x) and shear (τ_{xy}) stresses for the two-layer (a) and single-layer (b) beams models on an elastic basis with constant coefficient of subgrade reaction.

As can be seen from Figure 4 for the two-layer and the single-layer beam models with the same characteristics of the base at q = const = $1h_1$, i.e. at $h_2 = 0$, the ordinates on the stress diagrams take up zero values. And this is because by Winkler's model with constant coefficient of subgrade reaction when the load on the beam uniformly distributed along its length vertical displacements of beam will be the same everywhere, so that the bending moment and shear force at any section of a beam equal to zero.
Note the following features of the normal (σ_x) and shear (τ_{xy}) stress diagrams in two-layer beams (Fig. 4, a):
• The diagrams of normal stresses σ_x on the interface of the two layers have a discontinuous jump, because the elastic modulus of foundation and structure materials are different (see the formulas to determine the normal stresses [1, 2]).
• Throughout the height of cross section in going from one layer of the beam to the other, if in the diagrams of normal stresses (σ_x) there is a discontinuous jump, in the shear stress diagrams (τ_{xy}) there are no discontinuous jumps, but in this level there is a break in the shear stress diagrams.
Considering the overall differences between the statements of the problem we note the following differences in the results.
• With consideration of the two-layer and the single-layer beam models with the same characteristics of the base, the values of internal forces, generated in two-layer beams, are obtained much more.
• If the weight of layers of beam is reduced to a surface load, only the lower layer bends, with consideration of the two-layer, both layers deform in common, thus the neutral axis displace towards the top layer, whence it follows that the foundation slab can be located under tension conditions, as is the case in this example.
The calculation of slabs on an elastic basis with variable and constant coefficient of subgrade reaction was described in the author's articles [10-12]. The calculation of slabs bending is carried out by the finite element method or finite difference method.

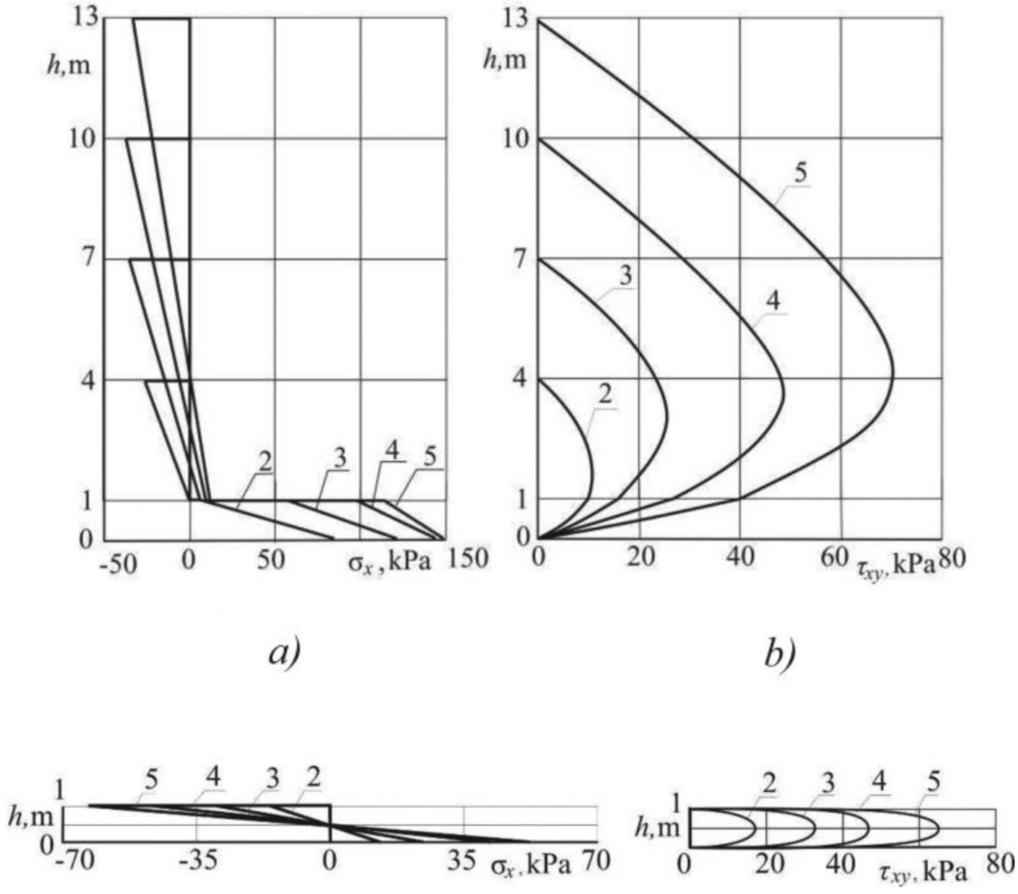

Fig. 4. The diagrams of normal (σ_x) and shear (τ_{xy}) stresses for the two-layer (a) and single-layer (b) beams models on an elastic basis with constant coefficient of subgrade reaction.

6. CONCLUSIONS

On the basis of the calculations can make the following conclusion: for the calculation of the «structure-foundation-basis» on the stage of pre-proposals it is advisable to apply the simplified model as a two-layer beams and slabs on an elastic basis. For a more reliable determining the stress-strain state of the system «structure-foundation» on an elastic basis appropriate to carry out calculations by use of the contact model in the form of a two-layer beam or slab on an elastic basis of Winkler's type with variable coefficient of subgrade reaction, which is allows to take into account such factors as the changes of the rigidity base and the stiffness of the upper structure.

Thus, the use of the contact model in the form of a two-layer beam (slab) on an elastic basis of Winkler's type allows significantly simplify the calculation of the joint work of «structure-foundation-basis» and the formula for determining the stresses given in [1, 11] can serve for determining the stress-strain state of the system «structure-foundation-basis» on the stage of pre-proposals.

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INFLUENCE OF STRESS-STRAIN STATE OF REINFORCED CONCRETE FLAT PLATE ON ITS PUNCHING SHEAR RESISTANCE

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Keywords

reinforced concrete, flat plate system, punching shear

ABSTRACT

The comparison analyses of punching shear of reinforced concrete (RC) plates with columns of rectangular and circular cross sections are presented in the work. Punching shear resistance of flat plate in multistory RC buildings was checked by the building codes of Republic of Armenia (RA) and the codes of various countries taking into account seismic action both in horizontal and vertical directions. The presence of opening and its position and size influence on punch shear strength are investigated in the article. The plates with and without openings, with two types of column sections have been considered. Finite Element (FE) models were used for analyses of systems. FE analyses have been used for estimation of bearing capacity of plate. Some recommendations for calculation and design of flat plate are proposed in the article.

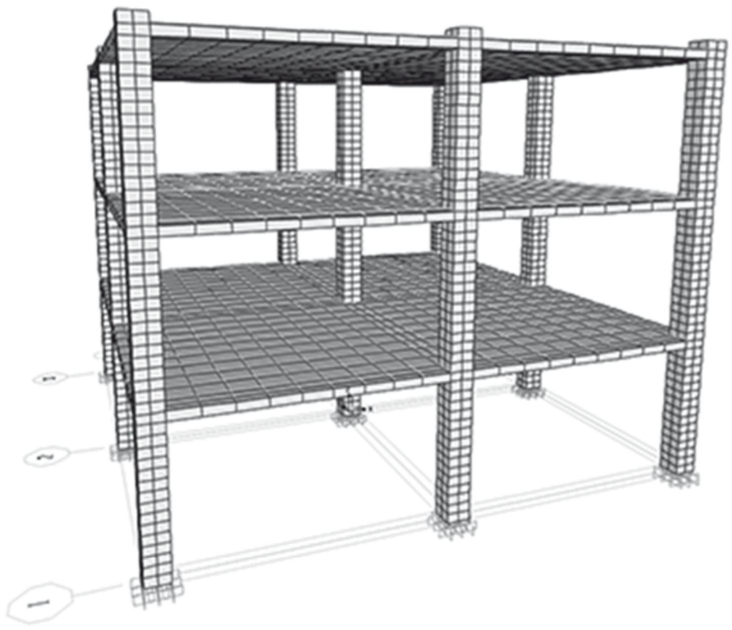
1. INTRODUCTION

RC buildings with flat plate systems are became widespread in the RA for last decades. In this system a flat slab is based directly on the columns without both capitals and dropping panels at supporting parts, where the thickness of slab is permanent. The main types of residential buildings were constructed in RA are RC frame and shear wall-frame system, where RC slabs are directly supported on girders. Flat plates in comparison with flat slabs with beams have some advantages, where the main of them are formwork cost reduction, effective height increase, free architectural design of rooms, without depending on the position of girders in plan; therefore the flat plate systems are going to be used increasingly in Armenia.

The stress-strain state of RC flat plate influence on its bearing capacity, therefore investigation of various factors is important for safe application of them. The punching shear resistance is one of the main conditions for providing the bearing capacity of RC plates. The calculation methods existing in almost all standards are different and based on semi-empirical equations. Some parameters influencing to the resistance of punching shear does not participate in the calculation method existing in the building code of RA, where the main of them is a bending moment arises from the deformation of columns. The presence of openings in plates beside of columns reduces the punching shear strength of them. Seismic forces increase the bending moments in bearing structures significantly thus damage risk or even failure of plate system during earthquake action is raised (Dadayan, T.L. 2011).

2. BACKGROUND

The in situ reinforced concrete flat plate structure is investigated in the article. 3-story residential RC building with openings in flat plate and without them is considered. All stories height is 3.2 m, the thickness of RC slab is equal to 20 cm. The calculations are implemented not only for square cross section of column, but also for circle cross section. The cross section sizes of square column are 50×50 cm and the diameter of circle column is equal to 57 cm. The building has two 6m spans in X and Y directions (fig.1). All loads is assumed by the building codes (the floor design live load for residential building is 2.0 kN/m2). The main concrete B25 is used for analyses (cubic strength of concrete 25.0 MPa, design strength of concrete (SNiP 2.03.01-84. 1985) is equal to 14.5 MPa, modulus of elasticity is equal to 30000 MPa). As reinforcing steel is used A500C (tensile strength of steel is equal 500.0 MPa, design tensile strength of steel is 435.0 MPa).



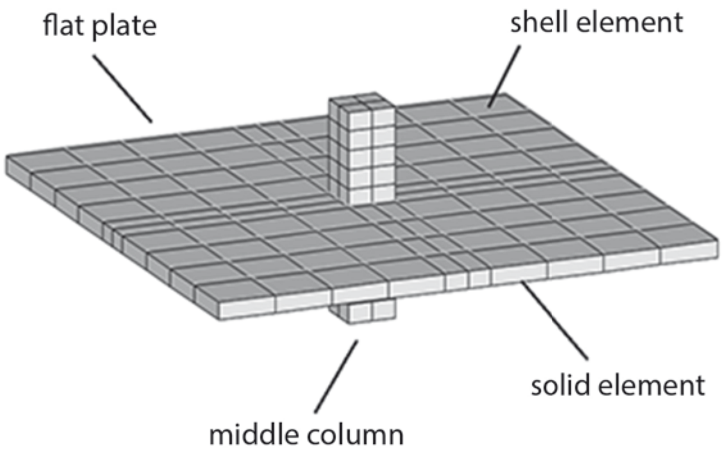


Fig. 1. 3D FE Model of RC building and connection of middle column and flat plate.

3. METHODS

The investigation was carried out by numerical analyses of methods existing in building codes of RA together with usage of software program is based on FE analyses. According building code of RA (SNiP 2.03.01-84. 1985) the punching shear resistance is calculated by concentrated forces F (Fig. 2). According different building codes and standarts (Obrien, E. , Dixon, A. & Sheils, E. 2012) the calculation under punching shear is performed for flat reinforced concrete members (slabs), when there are existed the concentrated forces and the bending moments.

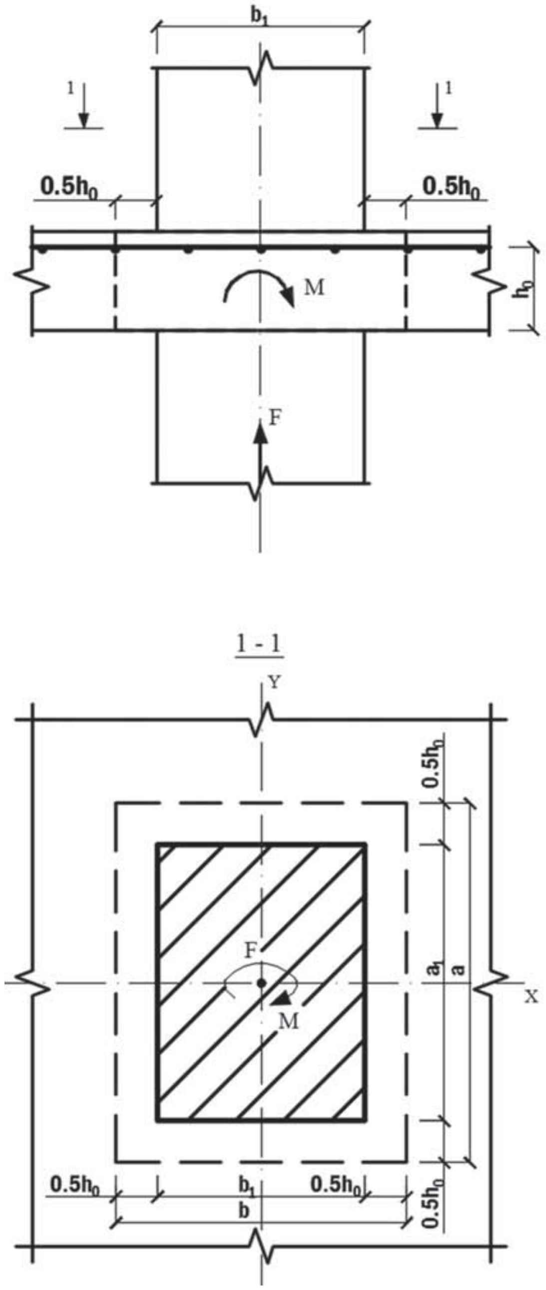


Fig. 2. Section and plan of slab and column showing control perimeters for punching shear at an internal column .

In accordance with building code (SP 63.13330.2012. 2012) the strength computation of elements with transverse reinforcement under punching force taking into account the concentrated force and bending moments mutually of two perpendicular planes are determined from the following condition:

$$\frac{F}{F_{b,ult}+F_{sw,ult}}+\frac{M_x}{M_{bx,ult}+M_{sw,x,ult}}+\frac{M_y}{M_{by,ult}+M_{sw,y,ult}}\leq 1 \quad , \tag{1}$$

where: F, Mx, My – concentrated force and bending moments in X and Y direction, from external load; Fb,ult, $M_{bx,ult}$, $M_{by,ult}$ – ultimate force and bending moments in X and Y direction, are carried out by concrete; $F_{sw,ult}$, $M_{sw,x,ult}$, $M_{sw,y,ult}$ – ultimate force and bending moments in X and Y direction, are carried out by stirrups.

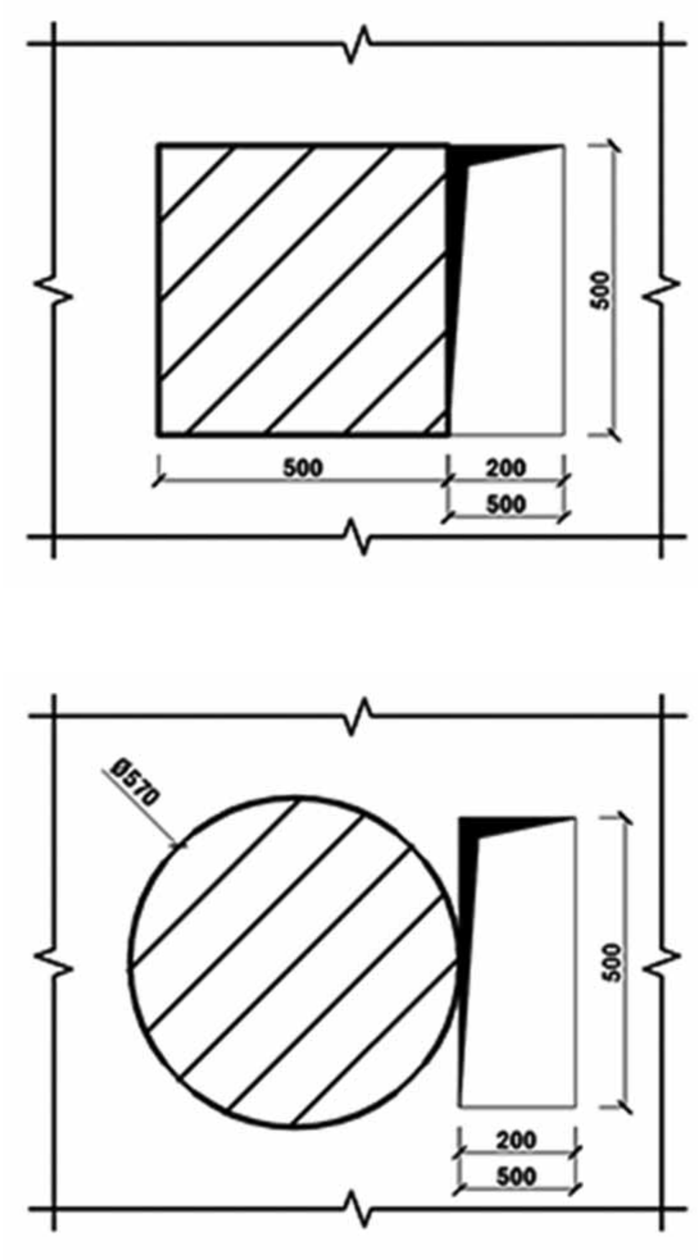


Fig. 3. Dimensions and position of openings.

Horizontal forces are chosen according of RA building code for all possible zones and types of subsoil (RABC II-6.02-2006. 2006), bending moments are calculated from forces, where maximum value is chosen from ultimate condition for resistance of flat slab at punching shear. FE models were done in order to study stress-strain state of flat plate. The models have been prepared by shell elements, for longitudinal reinforcement and solid element for concrete parts (CSI Analyses reference manual. 2014), (Rombach, G.A. 2011). For comparison analyses it is researched two types of column without and with openings in slabs (fig. 3).

Table 1

Parameters		Parameters of the flat plate depend on the value of shear (horizontal) forces					
		50 kN	75 kN	100 kN	150 kN	170 kN	200 kN
F	kN	360					
M	kN·m	35	52.5	70	105	119	140
u	m	2.72					
$F/(R_{bt} \cdot u \cdot h_o)$	-	0.687					
W_{bx}, W_{by}	cm^2	0.617					
F_b	kN	524.0					
F_{sw}	kN	0	131.0	145.0	299.0	361.0	454.0
$F/(F_b+F_{sw})$	-	0.687	0.550	0.538	0.437	0.407	0.368
M_b	kN·m	119					
M_{sw}	kN·m	0	15.3	32.9	67.9	81.9	103
$M/(M_b+M_{sw})$	-	0.294	0.391	0.461	0.561	0.592	0.630
q_{sw}*	kN/m	0	31.1	66.5	138.0	166.0	208.5
A_{sw}	cm^2	0	0.204	0.436	0.9	1.09	1.36
A_{sw} (total)	cm^2	0	2.77	5.92	12.2	14.6	18.5
$F/(F_b+F_{sw})+M/(M_b+M_{sw})$	-	0.981	0.941	0.999	0.998	0.999	0.998
** - the space of reinforcement is equal 200 mm*							

Fig. 4. Section and plan of slab and column showing control perimeters for punching shear at an internal column .

Perimeter of design cross section, section modulus of concrete and transverse steel reinforcement in two directions, uniformly distributed forces in stirrups and required cross section area of transverse reinforcement are shown in the table 1.

4. RESULTS

Received results by FEM analyses are shown, that the shear stresses without openings in slabs under dead load are not exceed 0.5 MPa, however with 20×50 opening these stresses are equal to 1.3 MPa and with 50×50 opening equal to 1.4 MPa. Implementation of calculation taking into account the bending moments are shown, that the values of shear stresses are nearly the same for both openings.

5. CONCLUSIONS

The shear stresses at intersection part of column and slab with opening nearly are not changed depend on size of opening. The differences between tangential stresses from slab openings next to column and solid slabs are equal to 3.5 ... 4.8 times, consequently near of openings it is required additional reinforcement.

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STUDY OF THERMOELASTIC STIFFNESS CHARACTERISTICS OF DOUBLE-LAYER CONICAL WASHERS

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Keywords

screw connection,stiffness, equilibrium

ABSTRACT

The paper presents the problem of conical elastic bimetal washers stiffness characteristics study under vibrations used in screw connections taking into consideration the thermal field.Applying solid sections hypothesis proposed by the author and respective equilibrium equations compression force as well as the washer upsetting dependency formula was obtained when the temperature is taken into account. Respective dimensionless curves have been plotted. Correlations of basic geometrical and mechanical characteristics of conical washers have been found for cases where unstable equilibrium states occur. As a result of the research optimal values of the washer general properties' relations have been revealed for maximum stiffness providing cases.
It is suggested to make a change in the zone of screw connections resulting in improvement of stiffness behaviors for conventional flat washers.

1. INTRODUCTION

Reliability of threaded fasteners used in different devices, mechanism and machines is a very important especially in cases they are applied in vibrating and temperature conditions. On the other hand few papers are available devoted to the role of washers in nut connections. This paper is intended to help eliminate the risk of unscrewing and loosening of bolt connections working in objectionable vibrating systems. For the first time it is suggested to use bimetallic conical washers where both vibration and temperature change is considered.

2. BACKGROUND

It is well known (Wright d. 2008), (Silberstein D. 2008) that there is large c of conical washers which have found wide application in mechanical engineering, construction and in many other sectors of national economy. Study of stiffness characteristics of this type of washers using engineering approach has been carried out in (Feodosiev V.I. 1973), where a formula of dependency between the pressing force of the washer and its under that force has been derived. In (Grigorian A.L. et al) an attempt was made to solve the problem using a bimetallic washers.

3. METHODS

The study is based on the theory of plates elastic deformations and suggested by the author rigid sections hypothesis. As a result a simplified engineering practical formulae for calculation of suggested washers stiffness have been derived.

4. CASE HISTORY

In the above mentioned work ((Feodosiev V.I. 1973) for a conical monometallic washer a formula was derived to determine dependency between the pressing force and deflection of the washer under that force

$$P_0 = \frac{w}{h}\left[\left(\frac{H}{h} - \frac{1}{2}\frac{w}{h}\right)\left(\frac{H}{h} - \frac{w}{h}\right)\right. \tag{1}$$

where P_0 is a dimensionless parameter corresponding to the pressing force, W is the deflection of the washer, h is the thickness of the washer's wall, H is the initial height of the washer. It was shown that for $H/h \geq \sqrt{2}$ values in characteristics of the washer negative stiffness zones are occurred as shown in Fig.01.

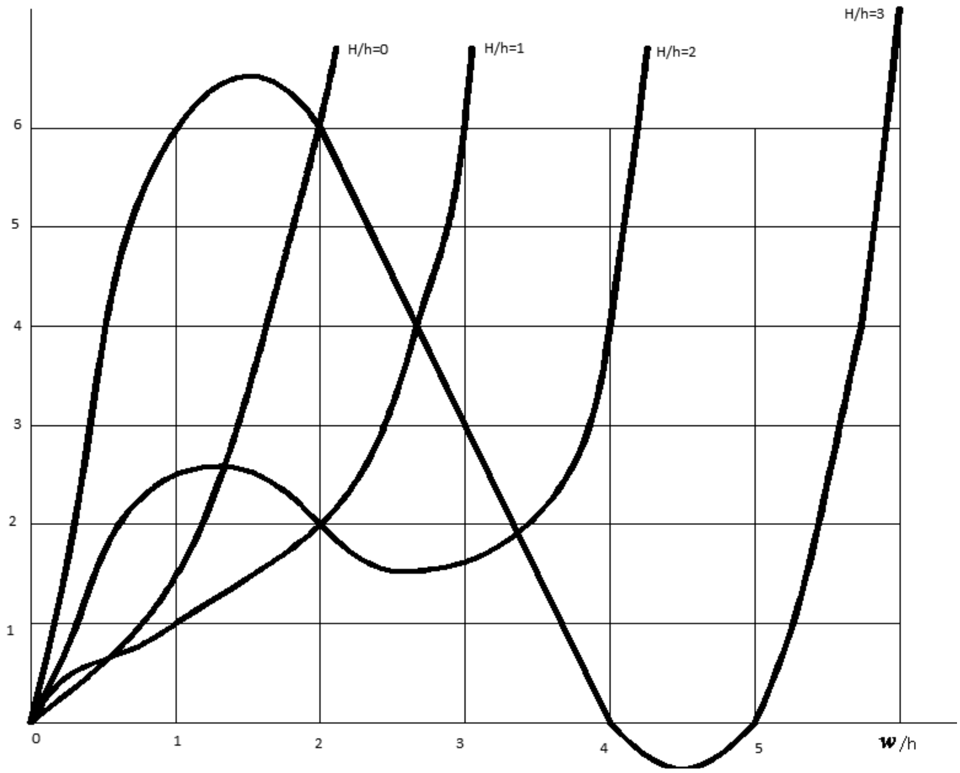

Fig. 1. Washer stiffness for different values of H and h ration.

In such cases the pressing force of the washer essentially decreases and therefore in vibrating threaded fasteners their application effectiveness reduces. Upon examining stiffness characteristics presented in Fig.1 one can arrive at a conclusion that in threaded fasteners working in the above said conditions it is preferable to use standard flat metallic washers (H/h=0), making respective design modifications as shown in Fig.02 .In (Grigorian A.L. et al) a formula for calculation of the pressing P_0 force was derived for bimetallic washers working in a uniform thermal field

$$P_0 = \frac{w}{h}\left[\left(\frac{H}{h} - \frac{w}{2h}\right)\left(\frac{H}{h} - \frac{w}{h}\right)(1+\xi\eta) + \frac{4\xi\eta + \left(\frac{1-\xi\eta^2}{1+\eta}\right)^2}{1+\xi\eta}\right] +$$

$$+\alpha_1 t(1-k)^2\left(\frac{b}{h}\right)^2\left[6(\gamma-1)\frac{\xi\eta}{(1+\xi\eta)\ln k} - \left(\frac{H}{h} - \frac{w}{h}\right)(1+\gamma\xi\eta)\right], \tag{2}$$

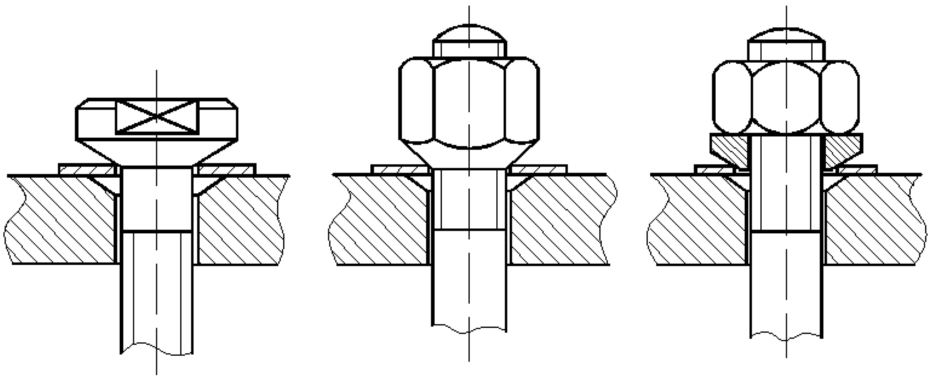

Fig. 2. Suggested modifications of bolt connections.

where P0 is a dimensionless parameter representing the pressing force, w is the deflection of the washer, h=h1 +h2 where h1 and h2 are thickness of respective layers of the bimetallic washer, H is the height of the unloaded washer, , where E1, E2 are the layers materials elasticity moduli, respectively, where , are coefficients of thermal expansion, respectively, t is the change of temperature, where a, b are internal and external radii, respectively.
The case when the conical spring washer is tighten flat by the nut that is is of special interest in terms of reliability of securing devices in mechanical systems. Below is the formula for calculation of the value of pressing force deflecting the washer

$$P_{0work} = \frac{H}{h} \cdot \frac{4\xi\eta + \left(\frac{1-\xi\eta^2}{1+\eta}\right)^2}{1+\xi\eta} + 6\alpha_1 t(\gamma-1)(1-k)^2\left(\frac{b}{h}\right)^2 \frac{\xi\eta}{(1+\xi\eta)\ln k}, \quad (3)$$

from this a simple condition for providing positive values of the temperature component follows P0work dependency from values of various members of Eq.(3)

$$t(\gamma-1)<0 \quad \text{or} \quad t(\alpha_2-\alpha_1)<0.$$

5. RESULTS

The shortage of natural resources can result in not only their final consumption, but also to ecological disasters. Besides, there are the issues of removal and especially elimination of waste (including hazardous waste). This is why they works should be led in the direction of detailed examination of every area and the definition of the direction of its specialization on the basis of natural conditions. For example it can be decided that a valuable landscape must be preserved as a recreation object or the air basin must be preserved, reducing the production. Thus the environment can be saved and the green area volume can be increased thanks to the industrial areas.
As a result of the present work we have arrived to the following conclusions:

• when a bimetallic disk spring washer is under high temperature conditions (t>0),
condition should be provided.

• when a bimetallic disk spring washer is under low temperature conditions (t<0),
condition should be provided.

• from Fig.03 is seen that the temperature change influences essentially on the thread fastening reliability.

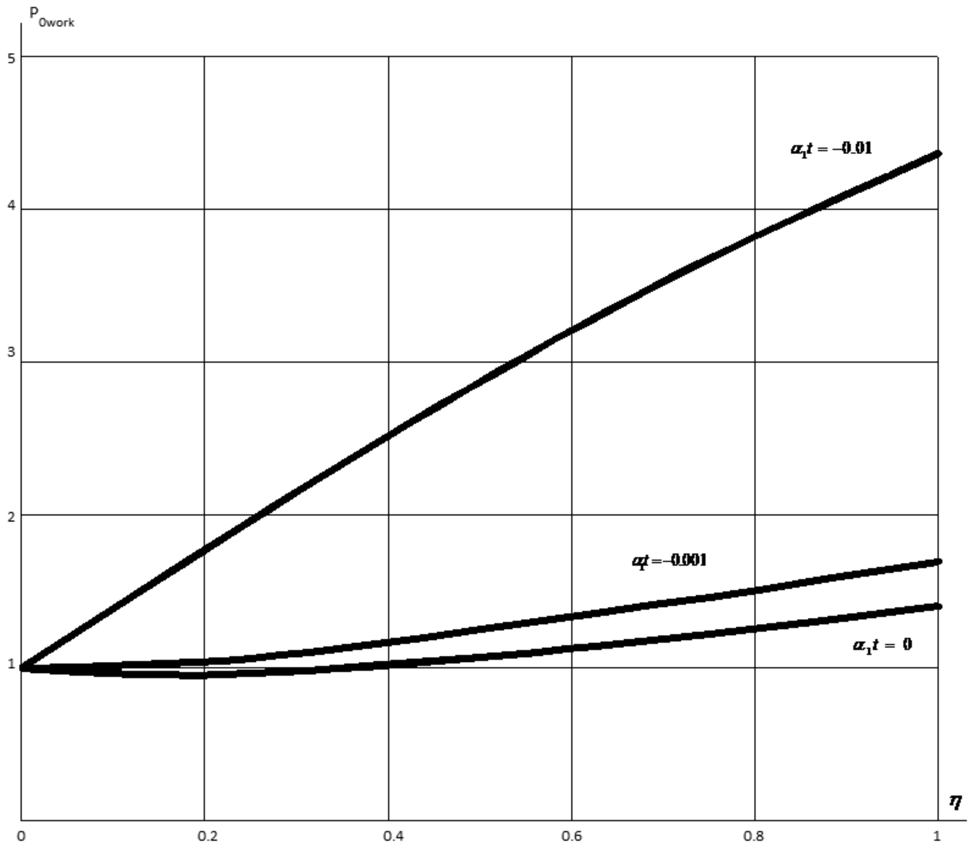

Fig. 3. . P_0work dependency from values of various members

$(H/h = 1; \xi = 0.1; \gamma = 3; k = 0.25; b/h = 13)$

6. CONCLUSIONS

In threaded joints being under conditions of vibration, by creating conical pits, with the help of usual flat washers axial pressing force can be obtained which approximately twice or three times excesses the pressing force obtained by traditionally used conical washers (cups).

Studying the characteristics of rigidity of bilaminar conical washers, it was found out that temperature change of the operating environment can be directed onto the reliability improvement of spiral combinations working in vibration conditions.

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ON A CLASS OF CONTACT PROBLEMS AND PROBLEMS OF THE MECHANICS OF CRACKS FOR PIECEWISE HOMOGENEOUS ELASTIC BODIES

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Keywords
contact problem, crack, oscillation

ABSTRACT

A class of contact problems of the theory of elasticity and related problems in the mechanics of cracks are considered. The class includes the following problems:
a. A plane contact problem on indentation of a punch into an elastic half-plane taking into account adhesion forces;
b. An axisymmetric contact problem on indentation of a circular punch into an elastic half-space taking into account adhesion forces; and a similar problem on an axisymmetric stress state of a piecewise homogeneous elastic space with a penny-shaped crack;
c. A problem of a stress state of a piecewise homogeneous elastic semi-infinite plate with a collinear system of cracks or with thin rigid inclusions.
A characteristic feature of this class of problems is the phenomenon of the oscillation– a process when contact stresses and dislocations densities infinite times change their sign as the endpoints of contact areas or cracks are approached. Oscillations considerably complicate the problems. An efficient method to overcome these difficulties is proposed.

1. INTRODUCTION

Contact problems of the theory of elasticity and problems of the mechanics of cracks are often encountered in structural mechanics when calculating foundations of buildings and constructions on deformable soil foundations, in technical calculations of bending of beams and plates on elastic foundation, in mechanics of composites, in fracture mechanics, and in many areas of applied mechanics and engineering practices.
Oscillation of the main mechanical quantities of these problems as a special kind of stress concentration, characterized by a large and rapidly changing gradient, significantly affects the regularities of their changes and, as a final result, significantly affects the strength characteristics of engineering structures and their parts. Therefore, the investigation of this kind of problems, including the development of efficient methods of qualitative and quantitative assessments of the oscillation phenomenon, has both theoretical and practical interest.

2. BACKGROUND

In the framework of classical elasticity theory, a series of results for this type of contact problems are presented in the works of Muskhelishvili (1966), Galin (1980), Mossakovski (1954), Popov (1973), Spence (1973), Galin (Ed) (1976), and results for problems of the cracks mechanics are discussed in the works of Erdogan (1963), Cherepanov (1974), Murakami (1987), Savruk (1988).

3. METHODS

In this paper, a different approach to the described class of problems is applied where the solution of this kind of problems is reduced to the solution of singular integral equations (SIEs) of the second kind, by the method of integral transforms. Kernels of these SIEs in general case are represented as sums of their principle singular parts in the form of the Cauchy kernel and regular parts in the form of continuous functions of two variables. Further, in governing SIEs, oscillation parts of solutions are separated and, as a result, the transformed SIEs is obtained. A well-known numerical-analytical method for solving the SIE (Erdogan, Gupta, and Cook, 1973), (Theocaris and Iokimidis, 1977) is used for these SIEs based on the Gauss quadrature formulas for integration. The method of separating the oscillation part of the solution is suggested. The effectiveness of the proposed method is illustrated by the example of a plane contact problem, considering the adhesion forces.

4.1 THE PLANE CONTACT PROBLEM

Let an absolutely rigid punch, the base surface of which is described by equation $y=-f(x)$ in the right Cartesian coordinate system Oxy, be indented into an elastic foundation under the action of a vertical force *P* applied eccentrically and a horizontal force *T*. The elastic foundation is modeled for simplicity as a lower elastic half-plane $y \le 0$ with the modulus of elasticity and Poisson's ratio . We assume that the contact area of the punch with the elastic foundation is a line segment $L=\{y=0,\ -a \le x \le a\}$ where the pressure of the punch of intensity $p(x)$ on the half-plane and tangential contact stresses of intensity $\tau(x)$ apply, i.e.

$$\sigma_y \Big|_{y=-0} = -p(x);\ \tau_{yx}\Big|_{y=-0} = -\tau(x)\ (-a \le x \le a) \tag{1}$$

and the rest of the half-plane boundary $L'=(-\infty,\infty)\setminus L$ is free from forces. Besides, we assume that tangential contact stresses are so small that they cannot cause a sliding motion of the punch along the elastic half-plane boundary, i.e. it is supposed that

$$|\tau(x)/p(x)| < \rho \tag{2}$$

where ρ is the coefficient of the Coulomb dry friction. These assumptions result in a model of contact when in the process of elastic deformation the punch is completely adhered to the half-plane. This model holds for the central part of the punch where the condition (2) is certainly satisfied, while near the end points of the punch, in the areas of very small dimensions, this condition may be violated.

In the discussed problem formulation, it is required to find contact stresses, that is functions $p(x)$ and $\tau(x)$, for which it is required to derive the governing equation of the problem.

For this purpose, considering the first boundary value problem of the theory of elasticity (Muskhelishvili, 1966) for a half-plane $y \le 0$ with the boundary conditions (1) and based on the Lame two-dimensional differential equations for displacements using the Fourier integral transform in the variable x, we obtain the following formulas for displacement components – in horizontal direction $u(x,0)$ (along *x* - axis) and in vertical direction $\mathrm{v}(x,0)$ (along - axis):

$$u(x,0)=\vartheta_1\int_{-a}^{a}\ln\frac{1}{|x-s|}\tau(s)ds-\vartheta_2\int_{-a}^{a}sign(x-s)p(s)ds+const\ \ (-\infty<x<\infty),$$

$$\mathrm{v}(x,0)=-\vartheta_1\int_{-a}^{a}\ln\frac{1}{|x-s|}p(s)ds-\vartheta_2\int_{-a}^{a}sign(x-s)v(s)ds+const,$$

$$\vartheta_1=2(1-\nu^2)/\pi E,\qquad \vartheta_2=(1+\nu)(1-2\nu)/2E. \tag{3a-d}$$

Now, let us write the conditions of contact of the punch with an elastic half-plane (Galin, 1980), (Shtaerman, 1949)

$$u(x,0)=0;\quad \mathrm{v}(x,0)=f(x)-\delta\qquad(-a<x<a;\ \delta=const)$$

or after the differentiation with respect to *x*

$$u'(x,0)=0;\quad \mathrm{v}'(x,0)=f'(x)\qquad(-a<x<a). \tag{4}$$

Further, substituting expressions for $u(x,0)$ and $\mathrm{v}(x,0)$ from (3a-d) into (4) and introducing complex combinations

$$u'(x,0)+i\mathrm{v}'(x,0);\quad \chi(x)=\tau(x)-ip(x)\qquad (-a<x<a),$$

after simple transformations, we get the following SIE:

$$-ith(\pi\mu)\chi(x)+\frac{1}{\pi}\int_{-a}^{a}\frac{\chi(s)ds}{s-x}=g(x)\qquad (-a<x<a),$$

$$th(\pi\mu)=\vartheta_2/\vartheta_1=(1-2\nu)/2(1-\nu)\quad (0<\nu<1/2);\quad g(x)=if(x)/\vartheta_1. \tag{5a-c}$$

From (5b) it follows that $\mu=(2\pi)^{-1}\ln(3-4\nu)$, whence $0<\mu<(2\pi)^{-1}\ln 3\approx 0{,}17485$. The solution of SIE (5a-c) must satisfy the conditions of equilibrium of the punch:

$$\int_{-a}^{a}p(x)dx=P;\quad \int_{-a}^{a}\tau(x)dx=T;\quad \int_{-a}^{a}xp(x)dx=bP+cT$$

or the following conditions in the complex form:

$$\int_{-a}^{a}\chi(x)dx=T-iP;\quad -\int_{-a}^{a}x\,\mathrm{Im}\,\chi(x)dx=bP+cT. \tag{6a-b}$$

Here and are the distances from lines of forces and to the axes and , respectively.
After entering dimensionless coordinates and quantities

$$\xi=x/a,\quad \eta=s/a;\quad \chi_0(\xi)=\chi(a\xi)/E;\quad g_0(\xi)=f'(a\xi)/2(1-\nu^2)$$

the governing SIE (5a-c) get the following form:

$$-ith(\pi\mu)\chi_0(x)+\frac{1}{\pi}\int_{-1}^{1}\frac{\chi_0(\eta)d\eta}{\eta-\xi}=g_0(\xi)\qquad (-1<\xi<1) \tag{7}$$

and the conditions (6a-b) become:

$$\int_{-1}^{1}\chi_0(\xi)d\xi=T_0-iP_0;\quad -\int_{-1}^{1}\xi\,\mathrm{Im}\,\chi_0(\xi)d\xi=b_0P_0+c_0T_0;$$
$$\left(T_0=T/aE;\ P_0=P/aE;\ b_0=b/a;\ c_0=c/a\right). \tag{8a-b}$$

4.2 THE AXISYMMETRIC CONTACT PROBLEM

Let a circular punch with the surface of revolution $z=-f(r)$ be indented into an elastic isotropic half-space $z\le 0$ with elastic constants (E,ν), referred to a cylindrical coordinate system r,φ,z, under the central vertical force. We again assume that the punch is adhered to the elastic foundation. Then, in the formulation set out in the preceding paragraph, using the Hankel integral transform, the solution to this axisymmetric contact problem, taking into account adhesion forces, can be reduced to the solution of the following system of the Fredholm integral equations of the first kind:

$$\begin{cases}\pi\vartheta_1\int_0^a W_{00}(r,\rho)p(\rho)\rho d\rho+2\vartheta_2\int_0^a W_{01}(r,\rho)\tau(\rho)\rho d\rho=\delta-f(r)\\ 2\vartheta_2\int_0^a W_{10}(r,\rho)p(\rho)\rho d\rho+\pi\vartheta_1\int_0^a W_{11}(r,\rho)\tau(\rho)\rho d\rho=0\quad (0<r<a),\end{cases} \tag{9}$$

from which the unknown functions $p(r)$ and $\tau(r)$, contact stresses with opposite signs, are determined. Here a is a radius of the circular area of contact, δ is a vertical settlement of the punch which is necessary to determine and

$$W_{mn}(r,\rho)=\int_0^\infty J_m(\lambda r)J_n(\lambda\rho)d\lambda \qquad (r,\rho>0;\ m,n=0,1)$$

is the known Weber-Sonin integral (Bateman et al, 1953) with Bessel function $J_n(r)$ of the first kind of index

Further, in (9) passing to the dimensionless variables and using the well-known relationship between the Cauchy operator and Abelian operators (Gakhov 1977)

$$\int_0^1 \frac{\varphi(s)ds}{s^2-x^2}=\frac{d}{dx}\int_0^x \frac{tdt}{\sqrt{x^2-t^2}}\int_t^1 \frac{\varphi(s)ds}{\sqrt{s^2-t^2}},$$

the system of equations (9) can be reduced to the following SIE similar to (5a-c):

$$\Omega_0(x)-—th(\pi\mu)\int\frac{(s)ds}{s\quad x}=h_0(x) \qquad (-1<x<1). \tag{10}$$

Here $\Omega_0(x)$ is a complex combination of functions expressed in terms of the original functions $p(r)$ and $\tau(r)$ by Abelian integrals. The SIE (10) is considered under the conditions analogous to (6a-b).

The governing SIE of an axisymmetric problem for the stress state of a piecewise-homogeneous elastic space with penny-shaped crack in the plane of interface of heterogeneous spaces has a structure quite similar to (10), from where the dislocations density on circular crack edges is determined.

4.3 THE PIECEWISE-HOMOGENEOUS ELASTIC SEMI-INFINITE PLATE WITH A COLLINEAR SYSTEM OF CRACKS

Let a semi-infinite piece-homogeneous elastic plate referred to a right rectangular coordinate system consist of a strip $\Omega_+=\{-\infty<x<\infty; 0\le y\le h\}$ with height of h and of the bottom semi-infinite elastic plate $\Pi_-=\{-\infty<x<\infty; -\infty<y\le 0\}$ and, besides, let the strip have elastic constants (G_+,ν_+), and the plate have constants (G_-,ν_-), where $G_\pm$, $\nu_\pm$ are the shear modules and Poisson's ratios, respectively. Then, let the piece-homogeneous plate have an arbitrary finite number of internal collinear cracks in the joint line of heterogeneous materials $y=0$

$$L=\bigcup_{p=1}^{N}\left(a_p,b_p\right)\left(a_p<b_p,\ p=\overline{1,N}; b_p<a_{p+1},\ p=\overline{1,N-1}\right)$$

Normal and tangential stresses of intensities $p_\pm(x)$ and $\tau_\pm(x)$ act on the cracks edges, i.e.

$$\sigma_y\Big|_{y=\pm 0}=-p_\pm(x),\ \tau_{yx}\Big|_{y=\pm 0}=-\tau_\pm(x) \quad (x\in L)$$

Here the sign $+$ refers to the upper cracks edges and the sign -- refers to the lower edges of the cracks. It is assumed that there are no stresses on the upper face $(y=h)$ of the strip Ω_+.

It is required to determine important characteristics of fracture mechanics such as dislocation densities on the crack edges, their openings, normal and vertical breaking stresses out of the system of cracks on $L'=(-\infty,\infty)/L$ and their SIFs.

Based on the expressions (3a-d), in which constants $\vartheta_j\ (j=1,2)$ should be replaced with corresponding constants for the generalized plane stress state of the plate Π_-, and on similar expressions for components of displacements of boundary points for the elastic strip Ω_- using the Fourier integral transform, the solution of the posed problem for dislocations density $w(\xi)$ can be reduced to the solution of the following SIE:

$$-i\,\mathrm{th}(\pi\mu)w(\xi)+\frac{1}{\pi}\int_{-1}^{1}\frac{w(\eta)d\eta}{\eta-\xi}+\frac{1}{\pi}\int_{-1}^{1}K(\xi,\eta)w(\eta)d\eta+\frac{1}{\pi}\int_{L_0}L(\xi,\eta)\overline{w(\eta)}d\eta=g(\xi)\ \ (\xi\in L_0),$$

$$\mu=\frac{1}{2\pi}\ln\left[\frac{G_+ + G_-(\xi-\nu_+)/(1+\nu_+)}{G_- + G_+(\xi-\nu_-)/(1+\nu_-)}\right] \tag{11}$$

where $K(\xi,\eta)$, $L(\xi,\eta)$ and $g(\xi)$ are known functions whose expressions are not presented here, and L_0 is a system of intervals (α_p,β_p) obtained from corresponding intervals of the system L while passing to the dimensionless coordinates (ξ,η). The SIE (11) should be considered under conditions of continuity of displacements at cracks endpoints:

$$\int_{\alpha_p}^{\beta_p} w(\eta)d\eta=0 \qquad \left(p=\overline{1,N}\right). \tag{12}$$

The governing SIE has the form similar to (11) - (12) if the system of cracks is replaced by a system of thin rigid inclusions.

5. RESULTS

The solution of the SIE (7) is represented by the formula (Gakhov, 1977)

$$\chi_0(\xi)=(1-\xi)^{-\frac{1}{2}-i\mu}(1+\xi)^{-\frac{1}{2}+i\mu}\varphi_0(\xi) \qquad (-1<\xi<1) \tag{13}$$

where is the function in Holder classes on [-1,1]. It is evident that as oscillating changes its sign infinite times. Let us separate the oscillating part in (13)

$$\chi_0(\xi)=\left[\psi_0(\xi)+A\xi+B\right](1-\xi)^{-i\mu}(1+\xi)^{i\mu}\Big/\sqrt{1-\xi^2}\,;\ \ \psi_0(\xi)=\varphi_0(\xi)-A\xi-B \tag{14}$$

where constants A and B are defined from conditions $\psi_0(\pm1)=0$, whence

$$A=\frac{1}{2}\left[\varphi_0(1)-\varphi_0(-1)\right];\quad B=\frac{1}{2}\left[\varphi_0(1)+\varphi_0(-1)\right].$$

Let us substitute (14) into the SIE (7) and in the condition (8a), and assume that for simplicity $b=c=T=0$, hence the moment condition (8b) is identically satisfied and after simple transformations we come to the SIE

$$-i\,\mathrm{th}(\pi\mu)\omega_0(\xi)+\frac{\sqrt{1-\xi^2}}{\pi}\int_{-1}^{1}\frac{\omega_0(\eta)d\eta}{(\eta-\xi)\sqrt{1-\eta^2}}=\sqrt{1-\xi^2}\,f_0(\xi)+h_0(\xi) \qquad (-1<\xi<1),$$

$$f_0(\xi)=g_0(\xi)-\frac{A}{\pi}I_\mu^{(1)}(\xi)-\frac{B}{\pi}I_\mu^{(0)}(\xi),\ \ h_0(\xi)=i\,\mathrm{th}(\pi\mu)(A\xi+B)(1-\xi)^{-i\mu}(1+\xi)^{i\mu},$$

$$I_\mu^{(j)}=\int_{-1}^{1}\frac{\eta^j(1-\eta)^{-i\mu}(1+\eta)^{i\mu}d\eta}{(\eta-\xi)\sqrt{1-\eta^2}} \qquad (-1<\xi<1;\ \ j=0,1),$$

$$\omega_0(\xi)=(1-\xi)^{-i\mu}(1+\xi)^{i\mu}\psi_0(\xi),\ \ \omega_0(\pm1)=0$$

(15a-f)

and to the conditions

$$\int_{-1}^{1} \frac{\omega(\eta)\,d\eta}{\sqrt{1-\eta^2}} = C \qquad \left(C = -iP_0 - \frac{\pi}{\operatorname{ch}(\pi\mu)}\left(B + 2i\mu A\right) \right). \tag{16}$$

Here we have used the following expressions for integrals

$$I_\mu^{(0)} = \pi/\operatorname{ch}(\pi\mu), \quad I_\mu^{(1)} = 2\pi i\mu/\operatorname{ch}(\pi\mu).$$

Since $\psi_0(\pm1) = 0$ it immediately follows from (15e) that $\lim_{\xi\to\pm1} \omega_0(\xi) = 0$, i.e., there are no oscillations near the end points of the contact area.

Further, according to the known procedure (Theocaris and Iokimidis, 1977), (Shtaerman, 1949) the SIE (15a-f) - (16) is reduced to a system of linear algebraic equations of the type

$$\sum_{m=1}^{n} L_{rm}^{(n)} \omega_0(s_m) = a_r \qquad \left(r = \overline{1, n+1} \right). \tag{17}$$

From (17) the values of the unknown function $\omega_0(\xi)$ in Chebyshev node $s_m = \cos\left((2m-1)\pi/2(n+1)\right)$ $\left(m = \overline{1, n+1}\right)$ are determined where n is a natural number. This system admits an efficient solution by means of which the constants A and B can be determined.

6. CONCLUSION

Analytical and numerical-analytical studies of the governing SIEs of the discussed class of physical problems have shown rather high efficiency of the proposed method of separating the oscillation part of the solution. In particular, numerical results, obtained by solving the system (17) with several right-hand sides for which the SIE (7) - (8a-b) admits the exact solution, have been compared with these exact solutions. The comparative analysis shows that numerical and exact solutions coincide with a high degree of accuracy.

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STABILITY OF ELASTIC TOROID-SHAPE SHELLS

POSTER

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ABSTRACT

Isotropic toroid-shape shells, which can be used for covering large span building structures, are being considered. A mathematical model of their straining with account for geometrical nonlinearity is described. Equations of mixed type, easy to handle if roller supports apply to the configuration, are used to investigate panel stability of such shells.
The performed calculations make it possible to reveal peculiarities of the stress-strain state of the shells and their geometric characteristics influence on the value of the critical loss stability load.

1. INTRODUCTION

Shells are rich in forms and their rigidity is high enough, thus they are applied in diverse engineering fields. In construction, a wide variety of shell types, including toroid-shape shells, are used to cover large span structures.
Quite many publications are devoted to studying of toroid-shape shells [1–11]. Basically, closed shells are studied [1, 2, 4, 10]. Stability studies are reflected in works [3–6, 8]. Some works consider the momentless theory of shells [5–7]. Besides, there are works focused on investigating stability of toroid-shape shell panels [6, 11] based on the finite element method.
The concerned works do not sufficiently reflect the stress state in toroid-shape shell panels. But it is very important, as the panel angular points can have dangerous stress concentrations.

2. WORK OBJECTIVE

The objective of this work is studying stability of diverse toroid-shape shell panels and the stress state as well as developing recommendations on such structure studies.

3. MATHEMATICAL MODEL OF TOROID-SHAPE SHELL

Assume that forming sector A_1O_1M is offset from the axis of rotation by distance d and the side of sector A_1O_1 is parallel to the axis of rotation (fig. 1). The angle between the tangent line to curve A_1M, drawn in point A_1, and leg A_1O_1 is right ($\pi/2$).

For toroid-shape shells (see fig. 1), Lame parameter $A = r$ (arching circle radius $MO_1 = r$), $B = d + r\sin(x)$,

$k_x = \dfrac{1}{r}$ $k_y = \dfrac{\sin x}{d + r\sin x}$. As the differential of the arc length of the line, drawn on the shell surface, is determined from equation $dS = \left(ds_1^{\,2} + ds_2^{\,2}\right)^{\frac{1}{2}}$, where $ds_1 = Adx,\ ds_2 = Bdy$, then Lame parameters A and B are the coefficients, by which the differentials of curvilinear coordinates must be multiplied in order to achieve the differentials of coordinate line arc lengths:

$$dS_1 = r\,dx,\quad dS_2 = MO_3dy = \left(d + r\sin x\right)dy,\quad R_1 = r\,,\ R_2 = MO_2 = r + \frac{d}{\sin x}.$$

Strains in the median (coordinate) surface of toroid-shape shell will look as

$$\varepsilon_x = \frac{1}{r}\frac{\partial U}{\partial x} - \frac{W}{r} + \frac{1}{2}\left(\frac{1}{r}\frac{\partial W}{\partial x} + \frac{U}{r}\right)^2;$$

$$\varepsilon_y = \frac{1}{d + r\sin x}\frac{\partial V}{\partial y} + \frac{r\cos x}{r(d + r\sin x)}U - \frac{\sin x}{d + r\sin x}W + \frac{1}{2}\left(\frac{1}{d + r\sin x}\frac{\partial W}{\partial y} + \frac{\sin x}{d + r\sin x}V\right)^2; \quad (1)$$

$$\gamma_{xy} = \frac{1}{r}\frac{\partial V}{\partial x} + \frac{1}{d + r\sin(x)}\frac{\partial U}{\partial y} - \frac{r\cos(x)}{r(d + r\sin(x))}V + \left(\frac{1}{r}\frac{\partial W}{\partial x} + \frac{U}{r}\right)\left(\frac{1}{d + r\sin(x)}\frac{\partial W}{\partial y} + \frac{\sin x}{d + r\sin(x)}V\right).$$

Be

$\varepsilon_x^z, \varepsilon_y^z, \gamma_{xy}^z$

where $\varepsilon_x^z = \varepsilon_x + z\chi_1;\ \varepsilon_y^z = \varepsilon_y + z\chi_2;\ \gamma_{xy}^z = \gamma_{xy} + 2z\chi_{12};\ \gamma_{xz} = kf(z)(\Psi_x - \theta_1);\ \gamma_{yz} = kf(z)(\Psi_y - \theta_2),$

$$\theta_1 = -\left(\frac{1}{r}\frac{\partial W}{\partial x} + \frac{U}{r}\right);\ \theta_2 = -\left(\frac{1}{d + r\sin(x)}\frac{\partial W}{\partial y} + \frac{\sin x}{d + r\sin(x)}V\right).$$

The functions of curvature change χ_1, χ_2 and torsion χ_{12} will look as

$$\chi_1 = \frac{1}{r}\frac{\partial \Psi_x}{\partial x};\quad \chi_2 = \frac{1}{d + r\sin(x)}\frac{\partial \Psi_y}{\partial y} + \frac{r\cos(x)}{r(d + r\sin(x))}\Psi_x; \quad (2)$$

$$2\chi_{12} = \frac{1}{r}\frac{\partial \Psi_y}{\partial x} + \frac{1}{d + r\sin(x)}\frac{\partial \Psi_x}{\partial y} - \frac{r\cos(x)}{r(d + r\sin(x))}\Psi_y.$$

Stresses for elastic isotropic material of the shell will look as

$$\sigma_x = \frac{E}{1-\mu^2}(\varepsilon_x^z + \mu\varepsilon_y^z);\ \sigma_y = \frac{E}{1-\mu^2}(\varepsilon_y^z + \mu\varepsilon_x^z);\ \tau_{xy} = \frac{E}{2(1+\mu)}\gamma_{xy}^z;\ \tau_{yz} = \frac{E}{2(1+\mu)}\gamma_{yz};\ \tau_{xz} = \frac{E}{2(1+\mu)}\gamma_{xz}. \quad (3)$$

$$N_x = \frac{Eh}{1-\mu^2}(\varepsilon_x + \mu\varepsilon_y);\quad N_y = \frac{Eh}{1-\mu^2}(\varepsilon_y + \mu\varepsilon_x);\ N_{xy} = \frac{Eh}{2(1+\mu)}\gamma_{xy};\ M_x = \frac{Eh^3}{12(1-\mu^2)}(\chi_1 + \mu\chi_2);$$

$$M_y = \frac{Eh^3}{12(1-\mu^2)}(\chi_2 + \mu\chi_1);\ M_{xy} = \frac{Eh^3}{24(1+\mu)}2\chi_{12}.\ Q_x = \frac{kEh}{2(1+\mu)}(\Psi_x - \theta_1);\ Q_y = \frac{kEh}{2(1+\mu)}(\Psi_y - \theta_2) \quad (4)$$

Unless transverse shifts are taken into account, $(\Psi_x - \theta_1) = 0, (\Psi_y - \theta_2) = 0,$ and the above formulae are simplified. Stress concentrations decrease with hinge-moving fixing of shell configuration. Thus, equations of mixed form are used for calculations, as with this type of configuration fixing these equations are the most reasonable. Loads will be expressed through the stress function $\Phi(x, y)$ as:

$$N_x = \frac{1}{B}\frac{\partial}{\partial y}\left(\frac{1}{B}\frac{\partial \Phi}{\partial y}\right) + \frac{1}{A^2 B}\frac{\partial B}{\partial x}\frac{\partial \Phi}{\partial x};\quad N_y = \frac{1}{A}\frac{\partial}{\partial x}\left(\frac{1}{A}\frac{\partial \Phi}{\partial x}\right) + \frac{1}{AB^2}\frac{\partial A}{\partial y}\frac{\partial \Phi}{\partial y};$$

Using the third equilibrium equation and equation of strain compatibility, we'll obtain mixed-form equations [12] but they will not be given here due to their awkwardness.

4. ALGORITHM FOR STUDYING STABILITY OF TOROID-SHAPE SHELLS

Using the Bubnov-Galerkin method to solve the resulting combined mixed-form equation with approximation of function $W(x, y)$ and $\Phi(x, y)$ as:

$$W = \sum_{i=1}\sum_{j=1} W_{ij}\sin\frac{i\pi x}{a}\sin\frac{j\pi y}{b},\quad \Phi = \sum_{i=1}\sum_{j=1}\Phi_{ij}\sin\frac{i\pi x}{a}\sin\frac{j\pi y}{b}, \quad (5)$$

we'll obtain combined nonlinear algebraic equations that can be briefly written as:

$$F_{\Lambda}(X) - C_q q = -F_N(X), \tag{6}$$

where $X = (W(I), \Phi(I))^{\mathrm{T}}$; $F_{\Lambda}(X)$ and $F_N(X)$ are linear and nonlinear parts of the combined algebraic equations; $C_q q$ is load term. To solve the combined nonlinear equations (6), we will apply the iteration method
.

$$F_{\Lambda}(X_i) - C_q q = -F_N(X_{i-1})$$

Moreover, X_0 is found by solving equation $F_{\Lambda}(X_i) - C_q q = 0$. Successively changing stress q from 0 to the value, where iterations fall apart, we find critical stress q_{kr} .

5. CALCULATIONS

We will consider a steel toroid-shape shell panel $E = 2{,}1 \cdot 10^5$ MPa, $\mu = 0{,}3$ subject to constant transverse stress with hinge-moving fixing of the configuration. Table 1 shows critical stresses (*d=2* m) for different parameters of toroid-shape shell panels. The calculations are performed with keeping nine terms [13] in factorization (5).
Table 1. Critical stresses with different parameters of toroid-shape shells

No.	a	b	h , m	r , m	q_{kr} , MPa	No.	a	b	h , m	r , m	q_{kr} , MPa
1	Pi/2	Pi/2	0.1	13	1.596	15	Pi/2	Pi/4	0.05	5	1.6812
2	Pi/2	Pi/2	0.1	25	0.1448	16	Pi/2	Pi/4	0.025	13	0.284
3	Pi/2	Pi/2	0.1	5	3.7572	17	Pi/2	Pi/4	0.025	25	0.1188
4	Pi/2	Pi/2	0.05	13	0.0308	18	Pi/2	Pi/4	0.025	5	0.758
5	Pi/2	Pi/2	0.05	25	0.3872	19	Pi/2	2Pi	0.1	13	2.3744
6	Pi/2	Pi/2	0.05	5	1.7608	20	Pi/2	2Pi	0.1	25	1.4508
7	Pi/2	Pi/2	0.025	13	0.3972	21	Pi/2	2Pi	0.1	5	3.8624
8	Pi/2	Pi/2	0.025	25	0.1936	22	Pi/2	2Pi	0.05	13	1.1816
9	Pi/2	Pi/2	0.025	5	0.8544	23	Pi/2	2Pi	0.05	25	0.7256
10	Pi/2	Pi/4	0.1	13	1.2028	24	Pi/2	2Pi	0.05	5	1.79
11	Pi/2	Pi/4	0.1	25	0.52	25	Pi/2	2Pi	0.025	13	0.5892
12	Pi/2	Pi/4	0.1	5	3.6508	26	Pi/2	2Pi	0.025	25	0.3632
13	Pi/2	Pi/4	0.05	13	0.59	27	Pi/2	2Pi	0.025	5	0.8688
14	Pi/2	Pi/4	0.05	25	0.242						

Here, a – angle of turn along coordinate x ; b – angle of turn along coordinate y ; h – shell thickness.
Fig.2 shows fields of bending and stress intensity for variant 1 (see Table 1) with $q_1 = \frac{1}{6} q_{kr}$, $q_2 = \frac{1}{2} q_{kr}$, $q_3 = \frac{5}{6} q_{kr}$ (0.3, 0.8, 1.3 MPa respectively).
Fig.3 shows fields of bending and stress intensity for a closed toroid-shape shell (variant 19) with the relevant stresses.

6. CONCLUSIONS

Accordingly, critical stress increases with rising shell thickness , reducing bend radius , rising angle of turn.
As may be inferred from the above calculations, toroid-shape shell panels demonstrate stress concentrations near value $x = 0$. The same stress concentrations are also observed for closed toroid-shape shells, even when the shell configuration has hinge-moving fixing. Even greater stress concentrations can be seen in case of rigid and hinge-nonmoving fixing of configurations.
Development of plastic strains and creep strains is possible in places of stress concentration. Consequently, structural reinforcement is needed in those places to reduce stress concentration.
The relevant theories must be used to take into account plastic strains and creep strains [14]. 1.

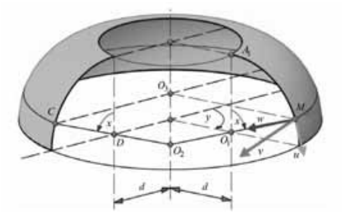

Fig. 1. Toroid-shape shell..

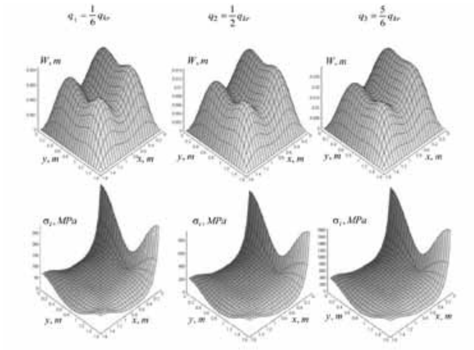

Fig. 2. Fields of bending and stress intensity for variant 1 with different stresses.

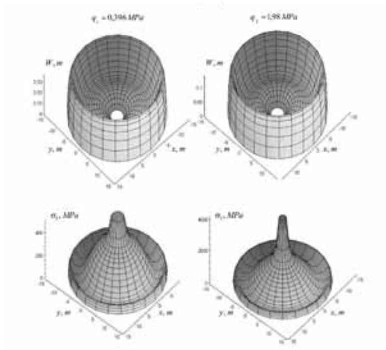

Fig. 3. Fields of bending and stress intensity for variant 19 with different stresses.

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GIS-MODELLING OF TRANSPORTATIONS IN THE LOGISTICAL CLUSTER OF ST. PETERSBURG

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Keywords
logistics, cluster, GIS

ABSTRACT

The purpose of the article is the investigation of structural and technological aspects of GIS-modeling of the transport and logistical cluster of the megalopolis using the example of Saint Petersburg. Implementation of the "Hub-and-Spoke" concept in the area of the St. Petersburg agglomeration is being considered, and in terms of the "Foreland-Hinterland" concept the sea front of the Big Port is being investigated as well as its inner overland spheres. Conceptual, logical and physical models of a cluster are built in ArcGIS environment – a geodata base containing classes of freight-generating and freight-absorbing objects, traffic network elements as well as connections between all of them. The geodata base is being filled in with certain information concerning the St. Petersburg agglomeration. Fragments and objects of the estimated investigation of freight flows are chosen. Mobility plans serving for the subsequent investigation on a great number of senders, receivers and possible routes are formed in ArcGIS Network Analyst.

1. INTRODUCTION

In the first quarter of the 21st century it was required to form 80 multimodal transport and logistics centers (MTLC) of various levels in Russia. One of the most important among them is the MTLC St. Petersburg located at the beginning of the Russian part of the transport corridor from Northern Europe to Asia. Two central aspects of the modern approach to creation of MTLCs are cluster ideology and geo-information technologies. The article is concerned with their involvement.

2. BACKGROUND

It may seem surprising, but some consider the cradle of the Italian Renaissance to be the cradle of clustering as well (Sheffi, Y. 2012). The big breakthrough in the world of construction and development occurred here precisely during the Renaissance, and particularly on the basis of the emerged economic system and creative attitudes and implementations, which nowadays are called clusters. Boccaccio, Dante, Leonardo and other artists and educators lived and worked in this city. Their work grew up on the basis of developing crafts and logistics providing them with paints and other expensive materials. In turn, they promoted scientific and social thought.

The term "cluster" first appeared in the work of J.H. Thünen in the analysis of the impact of economy sectors location on their cost-effectiveness (Thünen, J.H. 1826). A. Marshall theoretically described the phenomenon of clustering, which consisted in knowledge cross flow in close community, leading to synergetic effect (Marshall, A. 1920). M. Porter gave the modern definition of a cluster as a group of geographically adjacent interconnected companies and organizations associated with them, operating in a particular area, complementing each other and reinforcing the competitive advantages of both individual companies and the group as a whole (Porter, M.E. 1990).

If we turn back to Italian city-states, we should note that upon competition between Florence, Venice and Genoa, close economic interaction and cross-flow of knowledge in the dense geographic area led to consolidation of these cities within a single state.

Thus, in summary, we should note that the cluster model, i.e. the principle of concentration of production facilities and human capital in one area, passed multiple verifications during the history of mankind.

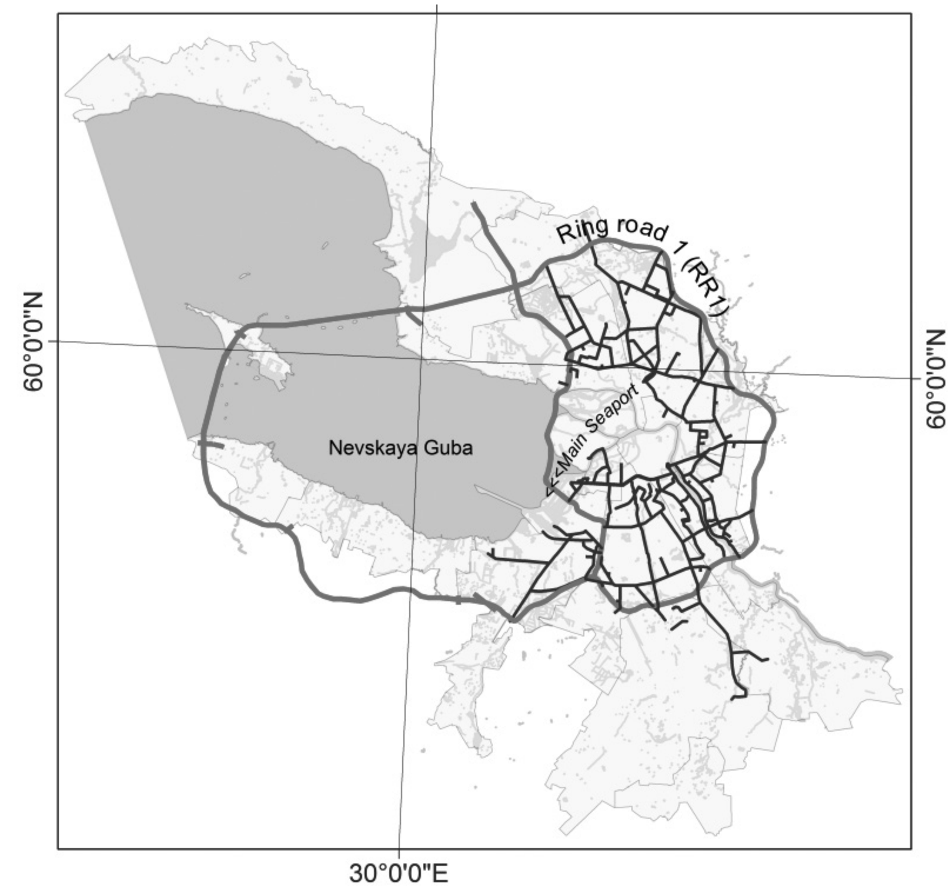

Fig. 1. SN truck framework of Saint Petersburg.

3. METHODS

The research is based on the concept of transport geography (Rodrigue, J.P. 2012), which states that the objective of transportation is to transform geographical attributes of the freight, people or information from their point of departure to destination, providing them with added value during the transport process.

The spatial basis of logistics, its infrastructure is a spatial network (international transport corridors (ITC), urban roads, supplies, trade connections). MTLCs are ITC hubs ensuring coordinated interaction between all kinds of transport and other participants of the logistics process. It is MTLC that is the basis of clustering of transport and logistics activities in the region. More than 70 MTLCs of the international level currently operate in the world's biggest transport hubs. They are interconnected through intermodal transport corridors with regional logistics systems connected.

In world practice, a scheme of freight distribution is developed in agglomerations including MTLCs. Among them are gateway schemes for multimodal transport and hub schemes for unimodal transport (Rodrigue, J.P. 2012). For the world's ports these hubs lie on boundaries of forelands and hinterlands. Freight distribution from gateways and hubs to a variety of inland terminals located in the hinterland is carried out under the "Hub-and-Spoke" scheme (Roso, V. et al. 2009). Co-location of gateways and hubs with industrial agglomerations (such as Saint Petersburg) significantly complicates spatial business objectives and demands involvement of GISs (ArcGIS level) for their solution (Macharis, C. et al. 2009), with their powerful tools and a wide set of methods. This approach is used in the present research.

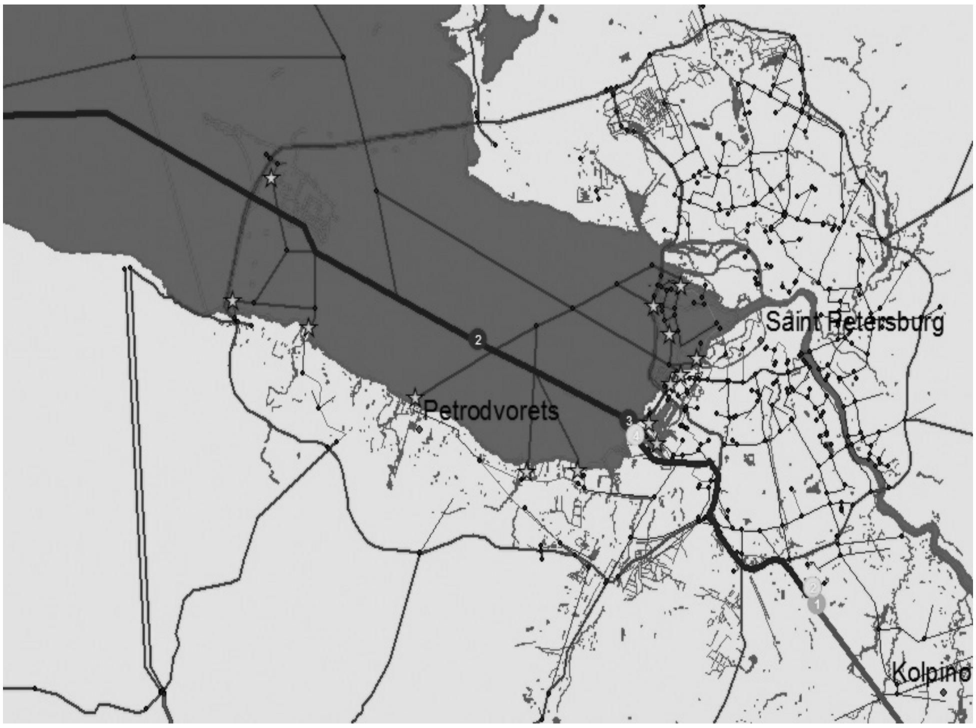

Fig. 2. Connections of networks of marine fairways (Forward) and roads (Hinterland) in BP freight areas (indicated by asterisks).

4. CASE HISTORY

Implementation of the “Hub-and-Spoke” concept against the background of the Saint Petersburg agglomeration problems (SPbA) has its own peculiarities. SPbA is a monocentric urban agglomeration formed around Saint Petersburg. Besides of Saint Petersburg, it consists of a part of the Leningrad Region. The agglomeration covers 50-80 km from the center of Saint Petersburg. Population of SPbA amounts to approximately 6 million people, and its territory is 14 thousand km. Transport links within the agglomeration are provided by commuter trains and motor transport. The spatial structure of SPbA is the following: a) the agglomeration core (within the ring road (RR1); b) the first zone of satellite settlements (near the RR1); c) the second zone of satellite settlements (in the waist area of the future ring road (RR2).
Along with the problem of optimum location of the inland terminals for SPbA, the related issues need to be addressed as well: relocation of various old inland warehouses of the Big Port (BP) from the central part of the city to the periphery; development of new onshore BP sites; improvement of the street network (SN); design of a framework for SN highways for freight transport (truck framework); implementation of agglomeration road network configuration for solution of triple objective:

1) ensuring the transport needs of own industrial complex;
2) providing freight transshipment in the seaport;
3) transparent transit of external freight flows of ITC No. 9 and other transit corridors.

BP terminals of Saint Petersburg process about 50% of all container freight transshipped in the seaports of Russia. In 2013, the turnover of containers in BPs of Saint Petersburg reached 2515 thousand TEU. The share of Saint Petersburg and the region in total volume of quality warehouse stock of the country is 17%. However, to date, the volume of vacant space in the warehouse market of Saint Petersburg and the region has reached its minimum – it is close to zero. Rapid development of terminal and warehouse infrastructure is required. On the territory of marine areas of BP several types of transport interact, terminal and logistics operations are carried out, customs and phytosanitary control is performed, etc. Alignment of information on vehicles and freight movement is required not only in terms of maritime transport, but also in terms of coordination of plans of shipping and stevedoring companies, as well as overland carriers, terminal and warehouse services operators and government agencies for effective

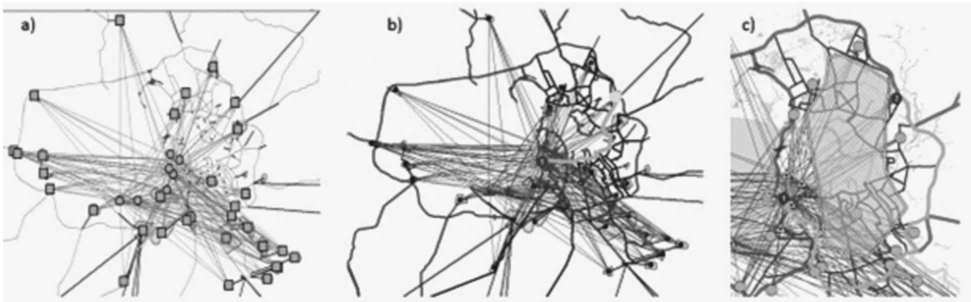

Fig. 3. OD-matrix (a) and two traffic options for one direction of the “Hub-and-Spoke” scheme – through traffic (b) and bypass (c).

functioning of these BP areas. Existing technological processes of freight handling in BP seaports rely primarily on paper documents, so they cannot provide the required level of data transmission efficiency (Administration of the Sea Ports 2014).

The basis of the model of transport and logistics cluster (TLC) in our case is a geodata base (GDB). The process of creating GDB in ArcGIS is formalized to the maximum and passes through the sequence of this GDB model, i.e. conceptual, logical, and, finally, physical model. Specific GDB is filled in with object classes and relationship classes. The geodata base developed by us includes classes of freight-generating, freight-absorbing and freight-processing objects, elements of the road network, as well as classes of connections between them all. To perform network analysis, a three-level hierarchy structure of SN model system was developed on the basis of the publication of (Li, Y. 2008) was formed: “central line of the road – traffic corridor – traffic lane» (Kotikov, Ju. 2009). Fig. 1 shows an SN truck framework of Saint Petersburg, designed in ArcGIS Network Analyst (Kotikov, Ju. 2015).

Modeling of facility placement along roads is carried out in ArcGIS with the aid of linear coordinates of the m axis of the road, and in the transverse direction it is carried out with the aid of the offset lateral displacement operation from the axis. Shape of two-dimensional objects is supported by the class of polygonal spatial objects. Binding of the object centroid is made to the center line of the road. Placement of terminal and warehouse facilities (TWF) in small-scale simulation is carried out like placement of transport facilities along roads.

A centroid or gate can serve as a reference point. In large-scale simulation, placement of extended and composite TWF is performed by mapping coordinates. Connection with the road network is provided by connectors.

Data collection and geodata base filling with information on SPbA was carried out: SN attributes, BP freight areas of Saint Petersburg, railways and freight stations, sea and river routes (fairways), terminals and warehouses. Fig. 2 presents objects of the following networks together: road network and maritime fairways within Saint Petersburg, as well as centroids (asterisks) of the main freight areas where “sea to land” (and vice versa) freight transshipment, i.e. from one network to another, takes place. Traffic regulations and other attributes determining navigation are imposed against the listed networks (Kotikov, Ju. 2009).

The basis for optimization calculations for a variety of freight traffic routes are mobility plans of senders and recipients (Kotikov, Ju. et al. 2013). Fig. 3 a) shows the Euclidean (“air”) mobility plan (ODmatrix) for a group of BP terminals and inland terminals. Herewith, physical transport distances are recorded in tables of OD-cost matrix.

Fig. 3 illustrates comparison of two options of traffic routing from a PB terminal to an inland terminal: option b) – through SN freight framework with the possibility of movement through the hinterland; option c) – using the RR1 when movement around the city is prohibited (with imposed polygonal limitation). A route sheet allows analyzing time and route, fuel consumption, etc. Given vehicle loading, their number, type and other data, we can proceed to calculation of the traffic volume – first through one cell of the mobility plan and, as a result, through whole generalization (Kotikov, Ju. 2015).

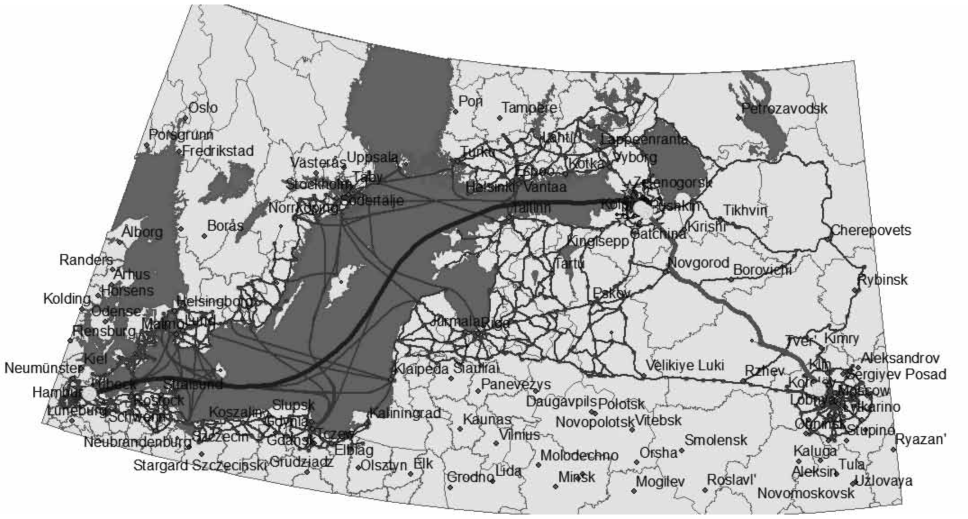

Fig. 4. Presentation of multimodal transportation: Hamburg – Saint Petersburg – Moscow.

When using multiple objective functions (time, distance, fuel consumption, etc.), layers corresponding to OD-cost matrix are formed, designed for further analysis and optimization for all routes of one type of transport within the transport hub. When it is possible to use one of several types of transport for transportation from the BP to inland terminals (e.g. road, rail, barge), the choice of specific transport type (modes) for an agglomeration fragment is carried out on the basis of the results of comparison of optimum modal implementations.

Effectiveness of multimodal transportation through the given hub is determined by the results of simulation for the entire chain of delivery. We are improving the option of GIS-modeling of Saint Petersburg transport gateway introduction into the European transport and logistics network (Kotikov, Ju. 2015). Fig. 4 shows an example of GIS-modeling of multimodal container transportation of freight on the following route: Hamburg – Lubeck Terminal – Saint Petersburg BP container terminal – Shushary inland terminal – Moscow.

Detalization of passage through Saint Petersburg is shown in Fig. 2: the sea part of the route to the BP in Saint Petersburg is highlighted with blue color, delivery from the BP to Shushary inland terminal is highlighted with purple, and main road transportation to Moscow is highlighted with orange.

5. RESULTS

Thus, the created geodata base (GDB) allowed to realize an original method of research in GIS freight flow environment in the "Hub-and-Spoke" scheme of the seaport, and it could become the basis for theoretical optimization of structure and location of the inland seaport terminals, as well as improvement
of the road network.

6. CONCLUSIONS

In opinion of the authors, the above methodology for modeling relationships within the logistics cluster and computational studies of freight flows of multimodal transportation in the ArcGIS environment possesses novelty. Herewith, the authors, being aware of insignificance of the presented study against the background of all problems related to development of a modern logistics cluster of Saint Petersburg, consider this study to be a possible conceptual foundation of the transport component of this cluster.

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RESEARCH ON SEISMIC DYNAMIC RESPONSE OF SUBMARINE TUNNEL

POSTER

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Keywords

submarine tunnel, water pressure, Winkler foundation model, natural frequencies, vibration displacement

ABSTRACT

The seismic dynamic response of submarine tunnel under high water pressure is a problem in need of further study. Based on Winkler's foundation model, the dynamic interaction between tunnel and foundation under seismic excitation is investigated and the motion equation of submarine tunnel is obtained. And the water pressure effect on the structure natural frequencies and structural displacement is determined. Investigation shows that the effect of high water pressure on structural seismic dynamic response should not be neglected.

1. INTRODUCTION

Sea-crossing traffic mainly adopts two approaches, namely, bridge and submarine tunnel. Due to the following advantages: being unsusceptible to the atrocious weather, little influence on the environments of both seas and islands, non-interference with the aquatic shipping, and strong resistance to the war damages (Shi Xindong et al., 2010), submarine tunnel has its superiority over other approaches for sea-crossing traffic and becomes more important as the lifeline for connection among cities, regions, and even countries in recent years.

Earlier aseismic studies show that underground structures displace with the foundation during earthquakes and are restrained by the surrounding mediua. With the weaker earthquake-induced damage to the underground structures in comparison with the ground construction, damaging effects were usually not taken into consideration (Dowing C.H and Rozen A, 1978; Duke C. M. and Leeds D. J., 1959). This conclusion was confirmed by the worldwide few reports of earthquake damages to underground structures in the past. But the subway structures and other underground structures in Kobe were severely damaged by the great Hanshin earthquake in 1995 (Zhang Wei, 1995; Wang Ruimin et al., 1998; Yang Guang et al., 2005; Hiroomi iida et al., 1996), which made experts to begin to question the traditional idea on aseismic resistance of underground structures. Since then a wave of research on aseismic underground structure started. At present, researches on the seismic resistance of underground structures are mostly concentrated on Metro stations and land tunnels, while researches on the dynamic response of lining structures of submarine tunnels under the influence of water pressure are relatively fewer. Chen Xianghong et al. (2012), by using ANSYS software, analyzed the change of dynamic water pressure and the vibration response of the tunnel lining in different directions of seismic excitation and at different buried depth. He believed that the dynamic water pressure has a great effect on internal forces of the shallowly buried submarine tunnels when the seismic excitation contains vertical component, which cannot be ignored during the analysis; but the seismic response of underground structure changes slightly when the buried depth exceeds a certain value. Zhang Xiaoling et al. (2008), by using ADINA software, analyzed the dynamic response of submarine pipeline under seismic excitation and the change of pore water pressure of soils around the pipeline, discussed the influence of the different radius of pipeline, pipe wall thickness, and parameters of soil property on the results, analyzed the excess pore water pressure in the seabed soils around the submarine pipeline and its change, and made transient liquefaction analysis. Peng Haikuo et al. (2008) conducted a numerical simulation on the seismic response of the immersed tube tunnel, which showed that dynamic water pressure has little influence on the immersed tube tunnel under only horizontal seismic excitation, and when the vertical seismic component is considered, the influence of the dynamic water pressure is greater and at the same time the water depth has greater influence on the dynamic water pressure and the internal force of structures.

Generally speaking, because the submarine tunnel is constructed at the bottom of the sea as special kind of underground structures, and it is in a very complex engineering geological and hydrogeological environment, there exist a lot of uncertain factors such as fault fracture and crushed zone, which make it hard to repair after the construction of submarine tunnels, thus the consequences of the damage induced by an earthquake are incalculable. Therefore, the study on the dynamic response of submarine tunnels under seismic excitation seems to be particularly important. For traditional linear underground structures, when transverse vibration of the structure under shear seismic wave propagating alone axial direction is studied, attention is generally focused on the influence of one or several of the following factors such as transverse shear deformation, rotation inertia, axial force, internal damping, external damping (Stephen N.G., 2006; Majkut L., 2009; Bogacz R. et al., 2008; Xu Yingqian et al., 2012). For study on the influence of high water pressure on structural transverse vibration, the numerical simulation is mainly adopted, but currently there is a lack of theoretical research in a systematic way. In view of this, based on the interaction between soil and underground structure, and the knowledge of the structure dynamics and elasticity theories, the influence of high water pressure on the structural natural frequencies and structural transverse vibration is studied in this paper. First, the structural free and forced vibration equations are derived by using equilibrium condition and differential relationships. Then, the effect of water pressure on structural natural frequencies and structural transverse vibration are respectively obtained by using method of separation of variables and inputting the seismic wave. Numerical example on the influence of water pressure under seismic excitation on the natural frequencies and the vibration displacement of submarine tunnel structures is given at last.

2. BACKGROUND

1.1 Model selection

Winkler's foundation beam model (Winkler,1867) (see Fig.1) is the most simple linear elastic foundation model put forward by the Czech engineer Winker when he analyzed railway rail under the basic assumption that ground reaction force $p(x,t)$ at each point of the surface of soil medium is merely proportional to the vertical displacement $w = w(x,t)$ of that point and has nothing to do with the soil and other points on the foundation interface. This assumption may be expressed as follows:

$$p(x,t) = k_0 w(x,t) \qquad (1)$$

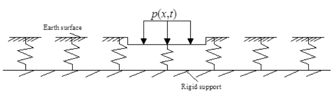

Fig.1) Winkler foundation model

To study the motion of linear structural and its stressing state along the direction of structural length, the coefficient of subgrade reaction per unit area k_0 in Eq.(1) should be replaced by the subgrade reaction coefficient per unit length k . Using the equation $k = k_0 b$, Eq. (1) becomes:

$$p(x,t) = kw(x,t) \qquad (2)$$

Due to its simplicity and linear feature, Winkler model is often used to simulate the interaction between soil and structure in the design and analysis of underground structures.

1.2 The axial force of submarine tunnel under water pressure

At present, three kinds of estimation method, namely, reduction factor method, full water head method and possible maximum water head method, are usually adopted to determine the water pressure of submarine tunnels. Among the three methods, the reduction factor method is widely used. Additionally, analytical method and numerical method sometimes are also used. In this paper, the water pressure is obtained by full water head method and is considered as a hydrostatic pressure. For the submarine tunnel, the water pressure is a prominent factor affecting not only the transverse stress of the structure, but also the longitudinal axial forces of the structure. The tunnel is a linear structure, both ends of which can be viewed as hinged on the ground, so this problem can be viewed as a plane strain problem. Assuming that the water pressure is expressed as q_w , according to elasticity theories:

$$\begin{cases} \sigma_{\mathrm{r}} = -\dfrac{b^2 q_{\mathrm{w}}}{b^2 - a^2}(1 - \dfrac{a^2}{r^2}) \\ \sigma_{\grave{e}} = -\dfrac{b^2 q_{\mathrm{w}}}{b^2 - a^2}(1 + \dfrac{a^2}{r^2}) \end{cases} (a < r < b) \tag{3}$$

Further using generalized Hooke's and the condition $\varepsilon_{\mathrm{z}} = 0$, we obtain:

$$\sigma_{\grave{e}} = \upsilon(\sigma_{\mathrm{r}} + \sigma\ ) = -\frac{2\upsilon b^2 q_{\mathrm{w}}}{b^2 - a^2} \tag{4}$$

Then the axial forces caused by water pressure can be obtained approximately by using the following equation:

$$N_{\mathrm{w}} = \sigma_{\mathrm{z}} \cdot A = -\frac{2\upsilon b^2 q_{\mathrm{w}}}{b^2 - a^2} \cdot \pi(b^2 - a^2) = -2\upsilon\pi b^2 q_{\mathrm{w}} \tag{5}$$

Assuming that the initial axial pressure of the lining structure is N_0 , then the total axial pressure along the structural axes direction is as follows:

$$N = N_0 + N_{\mathrm{w}} = N_0 + 2\upsilon\pi b^2 q_{\mathrm{w}} \tag{6}$$

where σ_{r} , $\sigma_{\grave{e}}$ and σ_{z} respectively represent the radial stress, circular stress and axial stress of the lining structure; and respectively represent the inner radius and outer radius of the lining structure.

1.3 Derivation of motion equation

The following assumptions are made in establishing the beam vibration equation: I. Winkler foundation beam model is adopted; II. The influence of staggered joints as well as the bolted connection is not taken into consideration, and the structure is considered as structure with uniform equal rigidity; III. The influence of the buried depth on the dynamic response of the structure is not taken into account; IV. The influence of shear deformation and rotational inertia during motion is not considered; in other words, it is assumed that the slope of the beam deflection curve is only caused by bending moment; V. Damping effect is ignored. Here a simplified tunnel model is shown in Fig.2. The lateral load on the model includes subgrade reaction force and inertial force, and the flexural rigidity in the axial direction x is denoted as EI , the mass per unit length as $m(x) = \rho A$, the lateral displacement of model as $w(x,t)$.

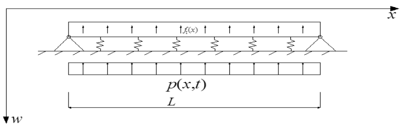

Fig. 2 Analytical model of simply-supported beam

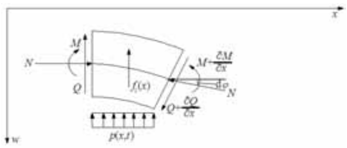

Fig. 3 Forces acting on isolated body

As shown in Fig.3, an arbitrary isolated segment is taken from the beam with bending under the action of bending moment. The relative rotation of the right end of the segment with respect to the left end is $\mathrm{d}\varphi = \mathrm{d}x \cdot \partial^2 w / \partial x^2$ Because of the relationship $\partial^2 w / \partial x^2 = \partial\theta / \partial x$, we can obtain $\mathrm{d}\varphi = \mathrm{d}x \cdot \partial^2 w / \partial x^2 = \mathrm{d}x \cdot \partial\theta / \partial x$ (where θ represents the slope of the deflection curve generated by bending moment). In addition to the bending moment M , shearing force Q, axial force N , subgrade reaction force $p(x,t)$ and inertial force $f_{\mathrm{I}}(x)$ according to D'Alembert's principle also act on the segment.

According to the equilibrium of the segment in the vertical direction, we obtain:

$$p(x,t) + \rho A \frac{\partial^2 w(x,t)}{\partial x^2} + N\frac{\partial\theta}{\partial x} = \frac{\partial Q}{\partial x} \tag{7}$$

Because the influence of shear deformation and rotational inertia is not considered, the slope of the deflection curve is merely caused by bending moment. Considering differential relationship $Q = \partial M \ / \ \partial x$, $\partial\theta / \partial x = \partial^2 w(x,t) / \partial x^2$, $M = -EI_{\mathrm{z}} \cdot \partial\theta / \partial x = -EI_{\mathrm{z}} \cdot \partial^2 w(x,t) / \partial x^2$, and substituting Eq.(2) into Eq.(7), we obtain the free vibration equation of tunnel under water pressure

$$EI_{\mathrm{z}} \frac{\partial^4 w(x,t)}{\partial x^4} + (N_0 + 2\upsilon\pi b^2 q_{\mathrm{w}})\frac{\partial^2 w(x,t)}{\partial x^2} + kw(x,t) + \rho A \frac{\partial^2 w(x,t)}{\partial t^2} = 0 \tag{8}$$

where E represents Young's elastic modulus of lining structure (N/m2), I_z represents the cross-section inertia moment of lining structure(m4), υ represents Poisson's ratio of lining structure.

In fact, there exist literatures which have deduced the more general vibration equation of underground structure with consideration of the following factors such as damping, shear deformation and rotational inertia, axial force and the foundation parameters (Chen Canshou et al., 2011), while this paper we only considers bending under the influence of water pressure.

If the forced vibration is considered, reaction forces of subgrade becomes $p(x,t)=k[w(x,t)-w_g(x,t)]$ (where $w_g(x,t)$ represents free-field vertical seismic displacement of the foundation), then the forced vibration equation of tunnels can be expressed as :

$$EI_z\frac{\partial^4 w(x,t)}{\partial x^4}+(N_0+2\upsilon\pi b^2 q_w)\frac{\partial^2 w(x,t)}{\partial x^2}+kw(x,t)+\rho A\frac{\partial^2 w(x,t)}{\partial t^2}=kw_g(x,t) \tag{9}$$

2. SOLUTION OF THE VIBRATION EQUATION

2.1 Determination of the natural frequencies

To determine the vibration mode and natural frequencies of the tunnel, method of separation of variables is adopted. Assuming that the solution has the form $w(x,t)=W(x)T(t)$, substituting it into Eq.(8), we obtain:

$$\frac{W^{(4)}(x)+\dfrac{N_0+2\upsilon\pi b^2 q_w}{EI_z}W''(x)+\dfrac{k}{EI_z}W(x)}{W(x)}=-\frac{\rho A}{EI_z}\cdot\frac{\ddot{T}(t)}{T(t)} \tag{10}$$

The two sides of Eq.(10) are respectively the function of x and t. For any independent x and , Eq.(10) can only be equal to a constant. Here let λ^4 denote the constant and introduce the parameter $\omega^2=EI_z\lambda^4/\rho A$, then we have:

$$\ddot{T}(t)+\omega^2 T(t)=0 \tag{11}$$

$$W^{(4)}(x)+\frac{N_0+2\upsilon\pi b^2 q_w}{EI_z}W''(x)+\frac{k-\rho A\omega^2}{EI_z}W(x)=0 \tag{12}$$

Eq.(11) is the undamped vibration equation of system with single-degree of freedom, whose solution is $T(t)=A\cos\omega t+B\sin\omega t$ with the coefficients A and B being determined by the initial conditions T(0) and $\dot{T}(0)$. Eq.(12) is the forth-order constant coefficient linear differential equation with general solution $W(x)=C_1\cos\alpha x+C_2\sin\alpha x+C_3\cosh\beta x+C_4\sinh\beta x$.

Based on boundary conditions $W(0)=W''(0)=0$ and $W(L)=W''(L)=0$, the vibration mode functions may be obtained as $W_n(x)=C_n\sin(n\pi x/L)$(where $n=1,2,3,\quad\infty$. Then substituting it into Eq.(12) , the natural frequencies of the structure are easily obtained:

$$\omega_n=\sqrt{\frac{EI_z(\frac{n\pi}{L})^4-(N_0+2\upsilon\pi b^2 q_w)(\frac{n\pi}{L})^2+k}{\rho A}} \tag{13}$$

From the above equation, it can be seen that the natural frequencies of the tunnel lining structure decrease with the increase of water pressure on the lining structure, showing that the equivalent structure stiffness gradually decreases. When the water pressure reaches the critical magnitude $q_w^{cr}=\frac{1}{2\upsilon\pi b^2}[k(\frac{n\pi}{L})^{-2}+EI_z(\frac{n\pi}{L})^2-N_0]$, the structural natural frequency becomes zero, i.e., the structure cannot vibrate, and researches on this situation will make no sense. However, whether the water pressure on the lining structure can reach the critical water pressure and how much the water pressure affects the natural frequencies will be demonstrated in the subsequent numerical example.

2.2 Solution of the forced vibration equation

The solution of Eq.(9) consists of two parts:

$$w(x,t)=w_c(x,t)+w_p(x,t) \tag{14}$$

where the first term on the right side represents the solution of free vibration of the structure depending on the initial disturbance on the structure; the second term represents the particular solution of forced vibration of the structural system under external excitation. In the vibration process, due to the influence of damping, the first term will decay fastly and disappears eventually and only stable pure forced vibration depending on the external disturbance is left.

When solving the forced vibration equation, the following assumptions are often made: subgrade and underground structure are homogeneous, isotropic, and linear elastic medium; the complexity and randomness of seismic wave

are neglected; the incident wave is shear wave propagating alone the tunnel axial direction.
Assuming that the displacement of free-field soil medium at some point is $w_g(x,t)$ with the amplitude D, and the tunnel lateral displacement at corresponding moment is $w(x,t)$, which is similar to $w_g(x,t)$ in shape but different in the amplitude. As shown in Fig. 4, an interaction coefficient R is the ratio of these two quantities.

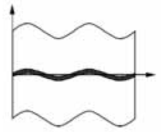

Fig.4) Displacement of tunnel-soil medium

Assume that seismic wave in the stratum has the form of simple harmonic wave, which can be expressed as follows:

$$w_g(x,t) = D\sin(\gamma x - \theta t) \tag{15}$$

And the vibration mode of the structure also has the harmonic form:

$$w(x,t) = RD\sin(\gamma x - \omega t) \tag{16}$$

where $\gamma = 2\pi / \lambda$ denotes the wave number with λ being the wavelength of seismic wave; θ is the seismic wave frequency; ω is the natural vibration frequency.
In order to determine the structure deflection, the interaction coefficient R needs to be determined first. Therefore, substituting Eq.(15) and Eq.(16) into Eq.(9), we obtain:

$$[EI\gamma^4 - (N_0 + 2\upsilon\pi b^2 q_w)\gamma^2 + k - \rho A\omega^2]RD\sin(\gamma x - \omega t) = kD\sin(\gamma x - \theta t) \tag{17}$$

And further the interaction coefficients can be obtained as follows:

$$R = \frac{k}{EI\gamma^4 - (N_0 + 2\upsilon\pi b^2 q_w)\gamma^2 + k - \rho A\omega^2}\frac{\sin(\gamma x - \theta t)}{\sin(\gamma x - \omega t)} \tag{18}$$

Substituting Eq.(18) into Eq.(16), we obtain:

$$w(x,t) = \frac{kD\sin(\gamma x - \theta t)}{EI\gamma^4 - (N_0 + 2\upsilon\pi b^2 q_w)\gamma^2 + k - \rho A\omega^2} \tag{19}$$

Comparing Eq.(16) with Eq.(19), it is easy to see that the structural vibration frequency is equal to the frequency of external load, i.e. $\omega = \theta$. As a result, the interaction coefficient becomes:

$$R = \frac{k}{EI\gamma^4 - (N_0 + 2\upsilon\pi b^2 q_w)\gamma^2 + k - \rho A\theta^2} \tag{20}$$

Substituting Eq.(20) into Eq.(16), the structure deflection can be obtained:

$$w(x,t) = \frac{kD\sin(\gamma x - \theta t)}{EI\gamma^4 - (N_0 + 2\upsilon\pi b^2 q_w)\gamma^2 + k - \rho A\theta^2} \tag{21}$$

3. NUMERICAL EXAMPLE

Take a circular submarine shield tunnel as an example, the lowest point of which is 130m below the water surface. Therefore, the water pressure is about 1.3MPa. Other parameters are as follows: the tunnel length is L=200m, the outer diameter is D=16.7m, the inner diameter is d=15.7m, the density of concrete lining is $\rho = 2600\mathrm{kg/m^3}$, Young's elastic modulus of concrete is E=3.0×104MPa, Poisson's ratio is $\upsilon = 0.3$, the initial axial pressure is N0=50000kN, the coefficient of subgrade reaction is k0=2.0×107N/m3, the earthquake intensity is PGV=0.3m/s (equivalent to 8 degree earthquake), the seismic displacement amplitude is D=2.9cm, the seismic wave length is λ=100m, the seismic wave velocity is v=180m/s, the seismic frequency is θ=11.31rad/s, the displacement function of seismic oscillation is $w_g = 0.029\times\sin(0.0628x - 11.31t)$ .To study the effect of water pressure on the structural natural frequencies, the structure stiffness, the mass of unit length and the frequency of seismic oscillation remain constant. According to Eq.(13), the first ten order natural frequencies of the structure without considering the effects of water pressure and with considering the effects of water pressure of 2MPa can be obtained respectively. The calculation results are shown in Fig.5 and Fig.6.
It can be seen from Fig.5 that the water pressure has a great influence on the low order frequencies of the structure, but its impact on the high order frequencies of the structure can be ignored. According to Fig.6, it can be seen that as the water pressure increases gradually, the first three order natural frequencies of the structure decrease approximately linearly, and when the water pressure increases to the critical water pressure, the natural frequency of the structure becomes zero, namely, the structure does not vibrate, which illustrates that the water pressure has some restriction effects on the structure and hinders the vibration of the structure. When the effects of water pressure on the vibration of lining structure is studied, the maximum displacements are considered. Fig.7 and Fig.8

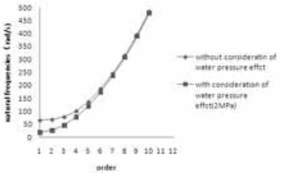

Fig. 5. Comparison of structure natural frequencies without and with consideration of water pressure effect

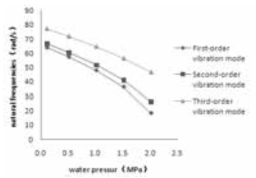

Fig. 6. Comparison of structure natural frequencies under different water pressure

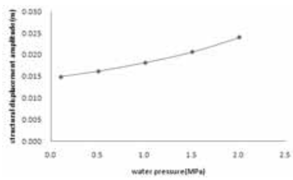

Fig. 7. Comparison of structural displacement amplitude under different water pressure

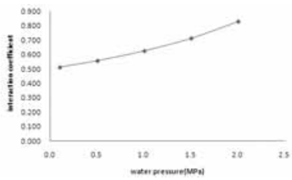

Fig. 8. Comparison of structure interaction coefficient under different water pressure

respectively show the variation of the structural vibration displacement amplitude as well as that of the interaction coefficient between the foundation and structure under different water pressure. It can be seen from Fig.7 that the vibration displacement amplitude of the structure gradually increases with the increasing of water pressure. This is probably because that with the gradual increase of water pressure, the natural frequencies of the tunnel structure decrease, showing that the structure stiffness gradually decreases, so that the vibration displacement amplitude of the structure increases. It also can be seen from this numerical example that the effect of water pressure on the structural vibration displacement amplitude has exceeded 8%, so the influence of water pressure on the structural vibration displacement amplitude should not be neglected. As shown in Fig.8, the influence of water pressure on the mutual interaction coefficient is also very significant. As the water pressure increases gradually, the interaction coefficient also gradually increases. This shows that due to the existence of water pressure, the influence of seismic oscillation on the dynamic response of the structure is also strengthened, showing the accretion effect of the water pressure on the structural vibration displacement amplitude.

4 CONCLUSIONS

Based on Winkler's foundation model and relevant knowledge of structural dynamics and elasticity theories, the free vibration equation of tunnel structures and the forced vibration equation caused only by bending are deduced in this paper. And the natural frequencies of the structure and the structure displacement under the influence of water pressure are also obtained. According to the numerical results of the example, the water pressure influences on the low order natural frequencies of the structure remarkably, while its impact on the higher order natural frequencies of the structure can be ignored, and the displacement amplitude of the structure increases with the increase of water pressure. Therefore, for the tunnels under high water pressure, the influence of water pressure should be taken into account.

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THE FAILURE MECHANISM AND FINITE ELEMENT ANALYSIS OF RECYCLED CONCRETE TWO-WAY SLABS STRENGTHENED WITH CFRP LAMINATES

POSTER

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Keywords

CFRP, recycled concrete two-way slabs, failure mode, failure mechanism, nonlinear finite element

ABSTRACT

This paper is a detailed study on the recycled concrete two-way slabs strengthened with CFRP laminates and failure mechanism can be given. Then the damage morphology of the recycled concrete two-way slabs strengthened with CFRP laminates can be deduced. Further, by using the ABAQUS nonlinear finite element software to simulate the punching failure of the recycled concrete two-way slabs strengthened with CFRP laminates. And we can get the reasonable results through contrasting the outcome of several different ways of pasting CFRP and the reasonable choice of the material property parameters, the geometric parameters, the boundary conditions.
Then we can design and optimize a more reasonable project combined with the result. In this paper, the conclusion can be used to provide the basis and reference in improving the punching shear capacity of the recycled concrete two-way slabs.

1. INTRODUCTION

The modern economic of China is developing rapidly, the city is increasingly updated. And construction update rapidly. But conventional architecture development model is based on high consumption of energy and resources and environmental pollution. It's neither the concept of sustainable development nor in harmony with nature, and produces a large amount of construction waste. On one hand, recycling waste concrete can reduce the natural sand and gravel mining and save large amounts of energy, on the other hand, it can solve the difficult problem of handling large amounts of waste concrete. To make the recycled concrete can be widely applied in practice, there is a lot of theoretical work needs to do. Currently, the most widely used Concrete floor system is flat structure at home and abroad, and the most widely used floor system is two-way slab structure. As we all know, the two-way slab structure is widely used in apartments, office buildings, hotels, factories and so on because of its simple structure, clear force pathway, big headroom of the structure and other characteristics. But when the design of slab-column connections is unreasonable, this structure may be punched. To improve this properties, a large number of expert at home and abroad have done a series of studies and tests, and they put forward many valuable suggestions and theories. At present, the accepted method of improving punching performance of flat structure is increasing thickness of slabs, but sometimes increasing in thickness will be restricted, or the structure which needs to be strengthened has been completed, it is necessary to consider other ways to increase its punching ability. While whether recycled concrete slabs can be used in structure is still studying, and how to increase its load limit so that it can be applied to actual projects remains the point of the study on recycled concrete slab-column structure, and there is few study on slabs strengthened with CFRP laminates.

2. Failure pattern and mechanism of the recycled concrete two-way slabs strengthened with CFRP laminates

2.1 Failure pattern

Studies have proved that normal flat plate structure's punching failure surface go through the base of slab-column, and inclination is about 26°[1]. Most of the cracks of slabs is diagonal, they start from the corner of the loading area to the corner of slab diagonally. As the load increases, new diagonal cracks appear continuously, and a number of diagonal cracks appear at each corner, square cracks come around the area of load. When slab damages, its surface caves in, underside dislocates obviously and then a circle punching cone forms. According to Zheng Jianchun's research[2] about concrete two-way slabs strengthened with CFRP laminates, Slab cracks can be divided into two types, The failure pattern of recycled concrete two-way slabs strengthened with CFRP laminates is similar according to the finite element analysis: (1) Bending cracks of positive moment which are radiated on the underside diagonally, and square cracks load on underside around load zone. And a number of diagonal cracks appear at each corner. Cracks expand from the intersection of CFRP laminates to the corner of slabs, they are wide near the loading area, and gradually decrease towards the corners of the slab. (2) Circular punching cracks on the underside located approximately on the position of the two external bands. Compared with the normal concrete slab, the bottom of punching-shear cone and CFRP reinforcement area is similar, the crack width of the slabs strengthened with CFRP laminates is smaller.

2.2 Failure mechanism

The border locations of pillars will be subject to moment and shear together when the slabs are applied by concentrated forces. Radial slab would be subject to negative moment, and tiny circular cracks will appear in weak position of concrete slabs firstly, then the negative moment will led radial cracks around pillar. These cracks extend from the pillar, cross and destroy. The Stress of concrete and reinforcement under the pillars is maximum.
The failure mechanism of recycled concrete slabs strengthened with CFRP laminates is similar. The punching capacity of recycled concrete slabs are mainly formed by vertical force of recycled concrete shear, dowel action and bite force around punching cracks. Strengthening with CFRP laminates can reinforce bending strength of recycled concrete slab and increase the height of concrete compression zone, and shear can be increased correspondingly. At the same time, CFRP reinforcement reduces the crack width of concrete slab and increase the bite force of the concrete. These are the main reasons how CFRP laminates can reinforce the punching shear capacity of the recycled concrete two-way slabs.

3.Finite element analysis of recycled concrete two-way slabs strengthened with CFRP laminates

3.1 Selection of finite element software
Finite element analysis of reinforced concrete is a very efficient and easy method to solve concrete structure questions with the help of computer and finite element principle and mechanical property. As there are many types of materials, we choose ABAQUS as nonlinear finite element software which can do better in nonlinear material.

3.2 Properties of materials
The material parameters of the simulation is in table 1, parameters that are not specified in the table can be selected in Code for design of concrete structures (GB50010-2010) [3].

Material	Concrete	Reinforcement (slab)	Reinforcement (column)	Hoop (column)	CFRP
Strength grade	C40	HRB400	HRB400	HRB335	CFS-I
Density(KN/m³)	25	78.5	78.5	78.5	300（g/m2）
Elastic modulus（*104N/mm²）	3.25	20	20	20	24
Poisson ratio	0.2	0.3	0.3	0.3	0.3

3.3 Material constitutive relationship

Since punching strength of concrete slabs depends mainly on the uniaxial tensile strength, I choose the uniaxial stress-strain curve in Code for design of concrete structures (GB50010-2010) as the parameters of concrete, other parameters and constitutive relation formula are based on Code for design of concrete structures (GB50010-2010) Appendix C-2.
And the uniaxial stress-strain curve of recycled concrete is based on the models Professor Xiao Jianzhuang[4] and Professor Li Jiabin[5]propose. Considering the ABAQUS program on setting characteristics of plastic damage model for concrete, the equation proposed by Professor Guo Zhenhai[6]should be used to fit the compressive stress-strain relationship of recycled concrete.

Expression is:

$$x = \varepsilon / \varepsilon_0$$

$$y = \sigma / f_c$$

Then:

$$\begin{cases} y = ax + (3-2a)x^2 + (a-2)x^3 & 0 \le x < 1 \\ y = \dfrac{x}{b(x-1)^2 + x} & x \ge 1 \end{cases} \qquad \text{Type-1}$$

According to Professor Xiao Jianzhuang's suggestion about recycled concrete,

$$a = 2.2(0.748r^2 - 1.231r + 0.975)$$

$$b = 0.8(7.6483r + 1.142)$$

r means the replacement rate of recycled coarse aggregates, and it is 40% in this simulation, so a=1.267 and b=3.630, so recycled concrete compressive stress-strain curve is in Figure 1(a).
To recycled concrete tensile stress-strain relationship,

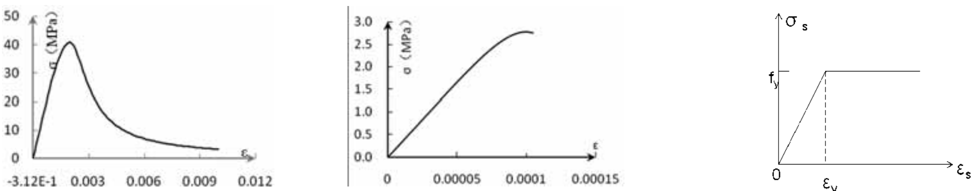
$$x = \varepsilon / \varepsilon_t$$

$$y = \sigma / f_t$$

Then:

$$y = ax - (a-1)x^6 \qquad \text{Type-2}$$

As the replacement rate of recycled coarse aggregates is 40%, a=1.22, so recycled concrete tensile stress-strain curve is in Figure 1(b). And steel reinforcement stress-strain curve is in Figure 1(c).



(a) (b) (c)

Fig 1 Curve of constitutive relation

3.4 Geometric parameters

There are 6 pieces of concrete two-way slabs in this simulations, 1 ordinary recycled concrete slabs, 5 recycled concrete two-way slabs strengthened with CFRP laminates. And there is a square column on the center of the slab. The layout of slab-column is in Figure 2. The different ways of pasting is in Figure 3. The dimensions of component is in table 2.

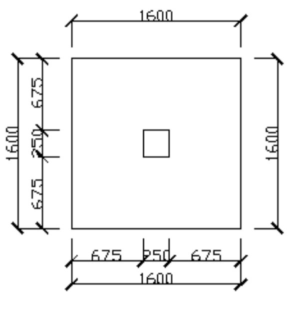


Fig. 2 Layout of slab-column

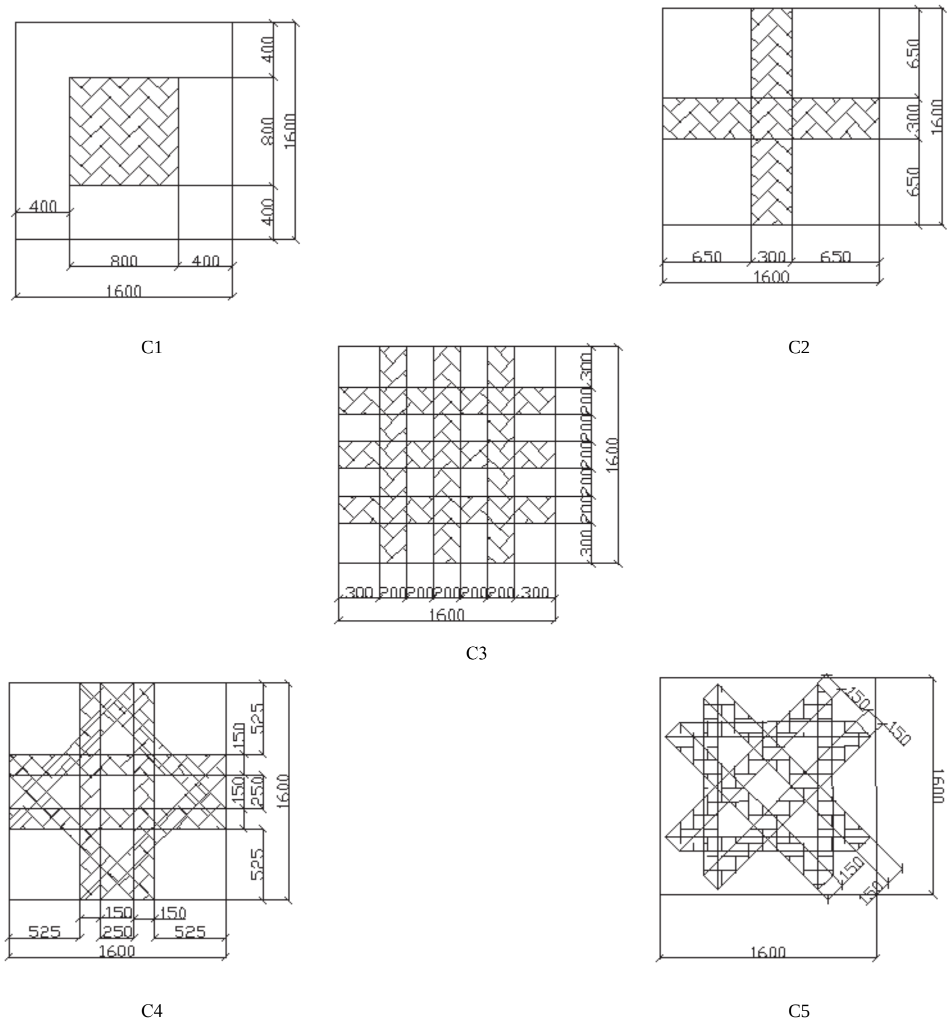


Fig. 3 Layout of CFRP.

Number of component	Plate thickness（mm）	Size（mm）	Steel reinforcement	reinforcement ratio
RCB-1	120	1600*1600	HRB33512@100	0.942
CRCPB-1	120	1600*1600	HRB33512@100	0.942
CRCPB-2	120	1600*1600	HRB33512@100	0.942
CRCPB-3	120	1600*1600	HRB33512@100	0.942
CRCPB-4	120	1600*1600	HRB33512@100	0.942
CFRPB-5	120	1600*1600	HRB33512@100	0.942

Note: RCB means recycled concrete two-way slabs; CFRPB means recycled concrete two-way slabs strengthened with CFRP laminates.

3.5 The boundary conditions

The model of simulation is simply supported on four sides and without constraint of edge beam, so the four corners of slabs will tilt. In order to make constraint of support gradually release as the load increases in the simulation, nonlinear springs are set at all support in the vertical direction. Nonlinear springs only withstand pressure, and they can constrain the displacement in the horizontal direction, nonlinear spring parameter is 100 after calculation.

3.6 Division of selection of cell and grids

The simulation uses the ABAQUS finite element analysis software, concrete slabs and concrete short columns are

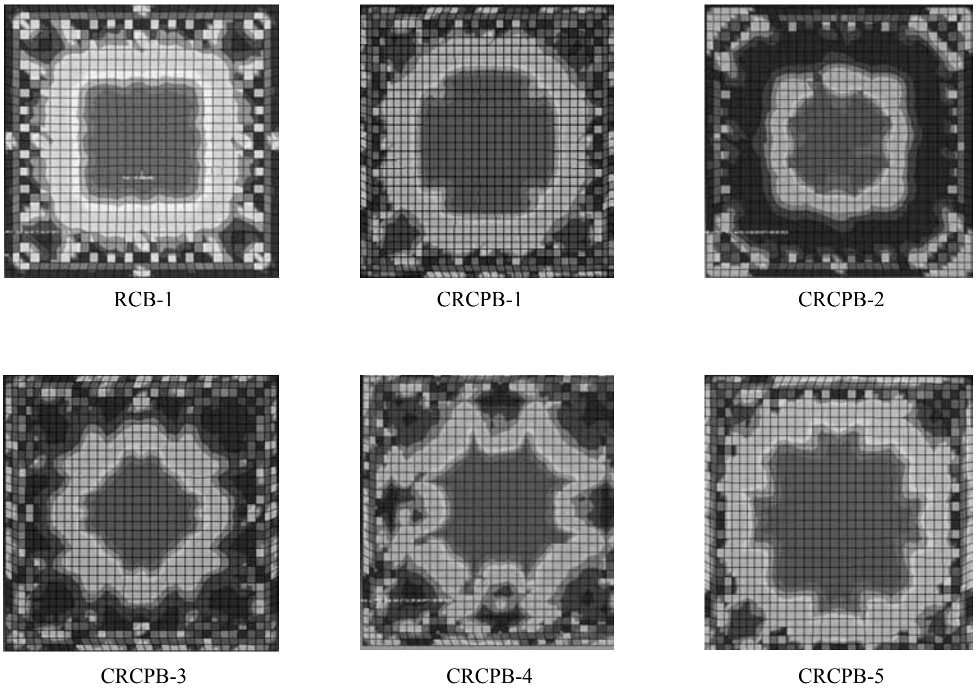


Fig. 4 Damage failure surface of concrete slab.

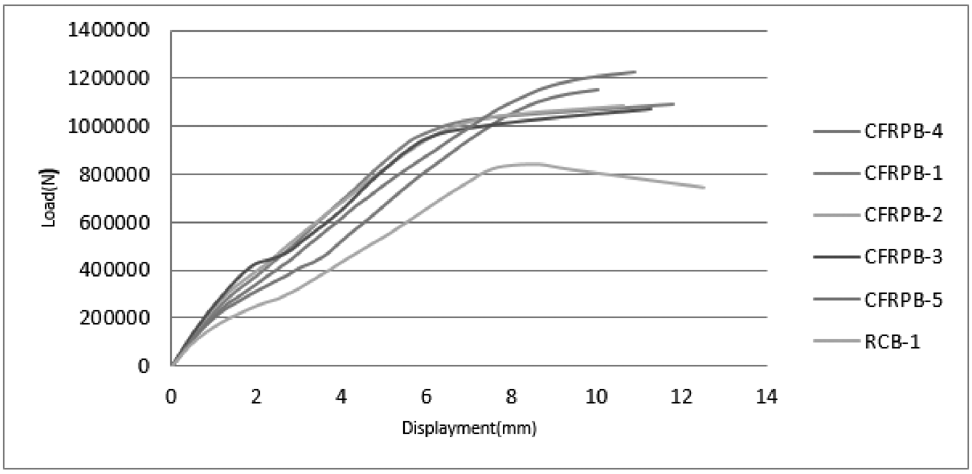


Fig. 5 Load-deflection curves.

three dimensional solid model, and they are divided into three cells thickness direction, and unit type uses hexahedral, grid size is 50mm; Reinforcement is three-dimension linear model, grid size is 50mm, unit type uses truss; CFRP is the shell model, grid size is 50mm, unit type uses M3D4R.

3.7 The results of finite element simulation

The result of ABAQUS simulate about the damage failure surface of concrete slab and load-deflection curves is shown in the pictures below.

4. CONCLUSIONS

The paper introduces nonlinear finite element calculations which is based on ABAQUS finite element simulation considering concrete plastic damage and tilt of slab corners. There are 6 models in this simulation, 1 of which is normal recycled concrete and the other 5 are recycled concrete two-way slabs strengthened with CFRP laminates. Contrasting the results of simulation we can draw the following conclusions:
It can be seen that recycled concrete has much punching bearing capacity according simulating, so we can use it

in practical engineering to save resources and improve the environment by improving its punching performance.
It can be proved that the punching bearing capacity of recycled concrete two-way slabs strengthened with CFRP laminates is much bigger than that of normal recycled concrete when contrasting the simulation results of them.
According to the results, capacity of recycled concrete slabs strengthened with CFRP increases with the increase of CFRP area, but the increasing breadth of capacity gradually reduces.
Simulation results show that stress of CFRP edge is big, so it can be inferred that the edge of CFRP is easy to tear and peel in actual process tests, so turn up anchorage and increasing the edge must be done in the tests to make sure the CFRP not tear or peel.

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PUNCHING SHEAR RESEARCH ON RECYCLED CONCRETE TWO-WAY SLABS WITH ANCHOR BOLTS

POSTER

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Keywords

experimental study, punching shear capacity, anchor bolts, recycled concrete two-way slabs, failure mechanism

ABSTRACT

This paper is a experimental study on 5 kindsof recycled concrete two-way slabs with anchor bolts (each kind have 2 slabs) and 1 slab without anchor bolts, failure mode and failure process are given. Further, through the analysis of the test datas, present the increased degree of the punching shear capacity of recycled concrete two-way slabs with anchor bolts. Through the comparison of several kinds of recycled concrete two-way slabs with anchor bolts' punching shear capacity, gives the suitable distance between the first row of anchor bolts and column,also gives the suitable distance between the anchor bolts them-selves The conclusion of this paper can be used to provide the basis and reference in improving the punching shear capacity and ductility of the recycled concrete two-way slabs.

1. INTRODUCTION

In recent years, some domestic and foreign experts have strengthened research on recycled concrete, but almost all the studies focused on the materials' performance, studies on performance of recycled concrete structures were very little. Because of the good economic benefits, simple form, simple and clear way of force transmission, the small thickness of the slabs and so on, no matter in abroad or at home, the structure of reinforced concrete two-way slabs is still the most widely used in the concrete flat structure. In this structure, the design of slab-column connections was reasonable or not is very important, if the slab-column connections designed was unreasonable, it will lead to the structure occur brittle punching failure. Therefore, how to improve the recycled concrete slabs' punching performance and ductility are the focus and difficulty of the study of the recycled concrete slabs, and have massive significance.2. Failure pattern and mechanism of the recycled concrete two-way slabs strengthened with CFRP laminates.

2. EXPERIMENTAL RESEARCH AND ANALYSIS OF RESULTS

2.1 Testing program

The strength of recycled concrete used in this test is C40, coarse and fine aggregate replacement rates were 40%,60%, the concrete mix ratio is shown in table 1.

Table 1 The mix proportion of concrete（kg/m3）

Name	Water consumption	The amount of cement	Natural coarse aggregate	Natural fine aggregate	Recycled coarse aggregate	Recycled fine aggregate	Fly ash	Water reducinggagent
Recycled concrete	181	353	609	267	406	401	85	5.3

The test designed 1 recycled reinforced concrete slab, 10 recycled reinforced concrete slabs with anchor bolts (the 10 were divided into 5 species, two slabs in each). All concrete plates used double-deck reinforcement. For slabs, the thickness is 150mm, the thickness of the protective layer is 25mm, the steel bars are HRB335 and its' diameter is 14, the distancre between the steel bars is 50mm in the edge of the slabs, the others is 100mm. All the columns in the slabs are located in the middle of the slabs, the height of columns is 400mm, the size of the columns is 300mm×300mm, the columns' reinforcement are 8 HRB400 which diameter is 16mm, the stirrups are HRB400 which diameter is 10mm, the thickness of the protective layer is 30mm. The design of anchor bolts referenced Kang Jing Tongji University[1], detailed informations as the following tables and pictures show.

Table 2 The parameters of the test plates

Number	The thickness of slabs（mm）	The size of the slabs (mm)	Reinforcement of the slabs	The average reinforcement ratio (%)
RCB-1	150	1600*1600	HRB335 14@100	1.026
MRCB-1	150	1600*1600	HRB335 14@100	1.026
MRCB-2	150	1600*1600	HRB335 14@100	1.026
MRCB-3	150	1600*1600	HRB335 14@100	1.026
MRCB-4	150	1600*1600	HRB335 14@100	1.026
MRCB-5	150	1600*1600	HRB335 14@100	1.026

Note：RCB- Recycled concrete two-way slabs；

MRCB- Recycled concrete two-way slabs with anchor bolts；

Table 3 The parameters of the anchor bolts

Members' number	The distance between the first row of anchor bolts and column edge S (mm)	The space between anchor bolts D (mm)	The number of anchor bolts	The length of bottom anchor plates L (mm)
MRCB-1	25	50	5	255
MRCB-2	30	50	5	260
MRCB-3	35	50	5	265
MRCB-4	25	70	5	335
MRCB-5	25	90	5	415

The reinforcement of plates:

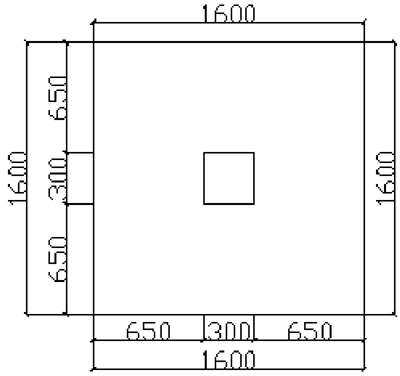

Fig. 1 The plan of all the slab-column connections

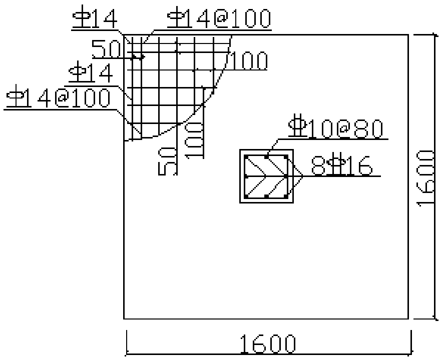

Fig. 2 The reinforcement drawing of all the slab-column connections

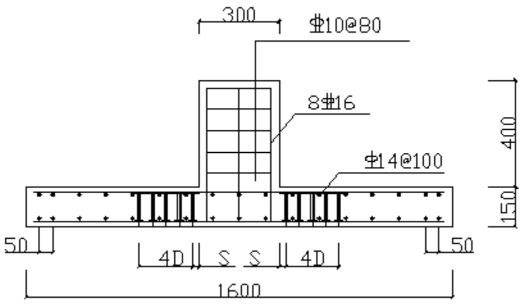

Fig. 3 The profiles of the recycled concrete two-way slabs with anchor bolts

Anchor bolts:

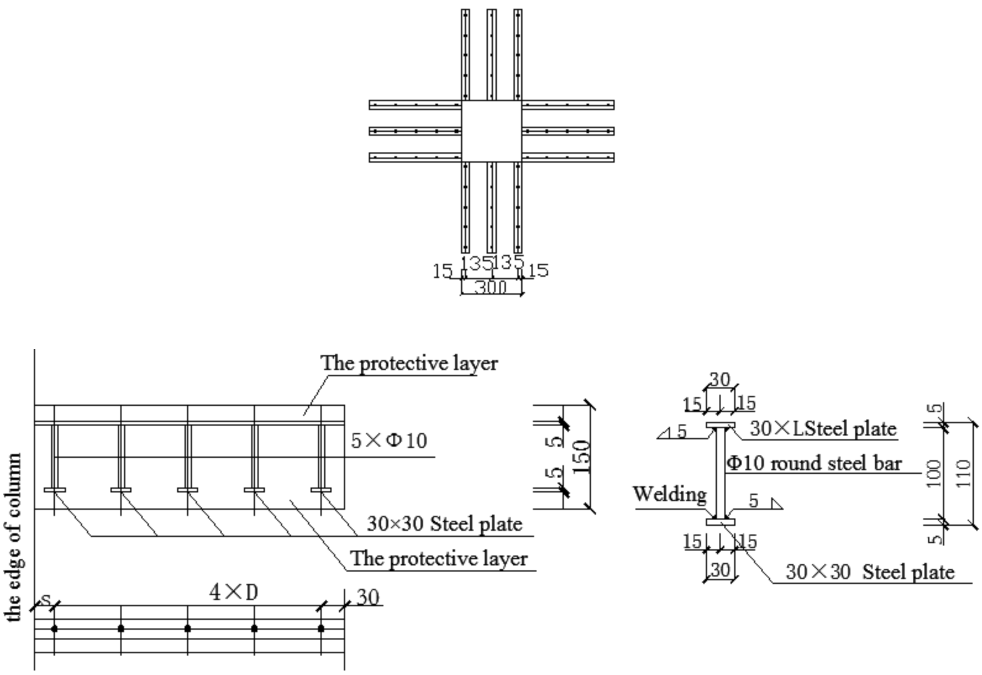

Fig. 4 The plan and the comprehensive charts of anchor bolts.

2.2 Test loading device

The test loading device assembled by the following equipments, including 1 support force frame, 4 steel beams, 1 lifting jack, 1 counter force beam and the appropriate number of acquisition boards. Test loading device as shown in Figure5. According to the "Standard Test Method for Concrete Structure"[2], the supports of the two-way slabs used the rollers and balls, the specific situation as shown in Figure6.

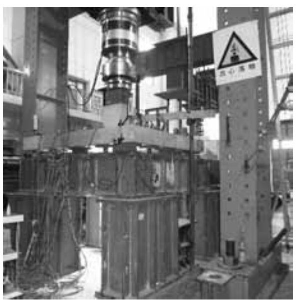

Fig. 5 The picture of test loading device.

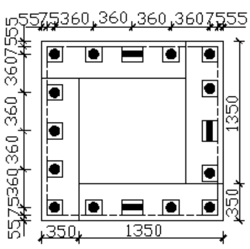

Fig. 6 The abutments' layout of the slabs.

2.3 The results and analysis of test

2.3.1 The results

Using EXCEL software to deal with the datas get through the collectors, then get the effects about the punching shear capacity and the ductility of test plates by the first row of anchor bolts away from the columns' edege, the results as shown in the following pictures.

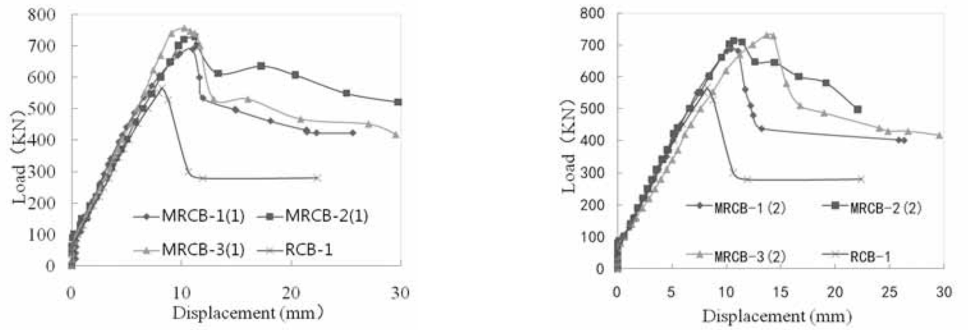

Fig. 7 The effects about the punching shear capacity of test plates by the first row of anchor bolts from the column's.

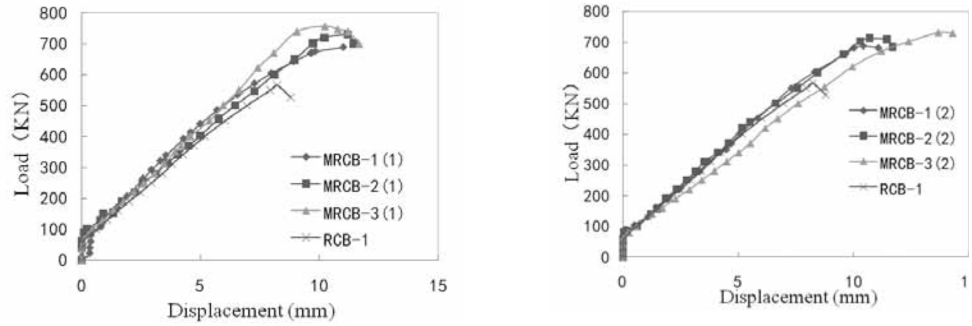

Fig. 8 The effects about the ductility of test plates by the first row of anchor bolts from the column's edege.

According to the above picture Fig.7, we can know the punching shear capacity of recycled concrete slabs with anchor bolts are improved. From the collected datas, the punching shear capacity of the RCB-1, MRCB-1(1), MRCB-1(2), MRCB-2(1), MRCB-2(2), MRCB-3(1), MRCB-3(2) are 565.86KN, 689.11KN, 686.59KN, 730.3KN, 712.98KN, 757.33KN, 731.43KN, we can see with the distance between anchor bolts and the column edge icreasing, the punching shear capacity increased. We can know when the distance between first row of anchor bolts and the column edge is 35mm, recycled concrete slab MRCB-3(1)'s punching shear capacity is 757.33 KN, which is the maximum punching shear capacity. The punching shear capacity of the MRCB-3(1) is the 1.33 times than the RCB-1. Take the same recycled concret e two-way slabs' average punching capacity, the punching shear capacity of the MRCB -1, MRCB-2, MRCB-3 are 687.85KN, 721.64KN, 744.38KN. The punching shear capacity of the MRCB-1, MRCB-2, MRCB-3 are the 1.21, 1.28, 1.32 times than the RCB-1. According to the previous scholars' studies [3], [4], [5] , When the first row of anchor bolts from the column distance exceeded a certain value, the punching shear capacity will no longer increasing, there must be a suitable distance between first row of anchor bolts and the column. According to the literature[3], [4], [5] , this paper gives a suitable distance between first row of anchor bolts and the column is about 40-55mm.

According to the above picture Fig.8, we can know the ductility of recycled concrete slabs with anchor bolts are improved. The displacement of column of MRCB-1(1), MRCB-1(2), MRCB-2(1), MRCB-2(2), MRCB-3(1), MRCB-3(2) have also improved. According to the experimental phenomena, the recycled concrete slabs with anchor bolts will not declined sharply, and this time lasted about 20s, which can protect people's lives and property and give people a chance to escape.

Using EXCEL software to deal with the datas get through the collectors, and get the effects about the punching shear capacity and the ductility of test plates by the distance between anchor bolts, the results as shown in the following pictures.

According to the above picture Fig.9, we can know the punching shear capacity of recycled concrete slabs with anchor bolts are improved. From the collected datas, the punching shear capacity of the RCB-1, MRCB-1(1), MRCB-1(2), MRCB-4(1), MRCB-4(2), MRCB-5(1), MRCB-5(2) are 565.86KN, 689.11 KN, 686.59 KN, 705.54 KN, 702.05 KN, 670.79 KN, 663.84 KN, we can see with the distance between anchor bolts icreasing, the punching shear capacity increased first and then decreased. We can know when the distance between anchor bolts is 70mm,

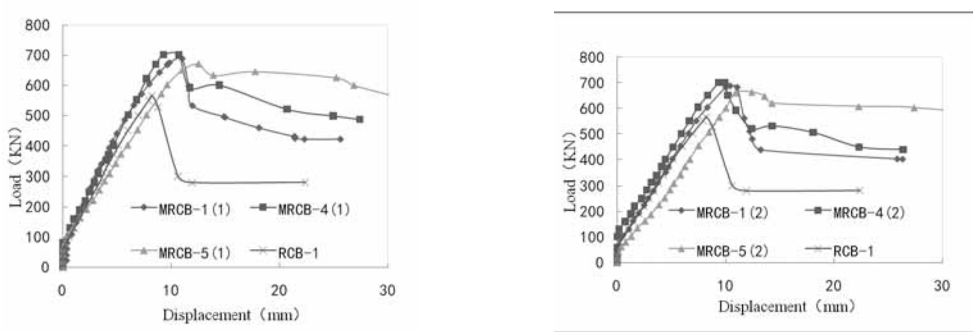

Fig. 9 The effects about the punching shear capacity of test plates by the distance between anchor bolts.

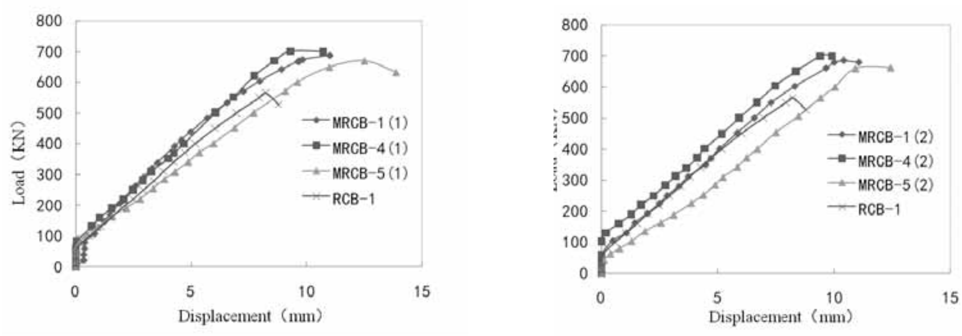

Fig. 10 The effects about the ductility of test plates by the distance between the anchor bolts.

recycled concrete slab MRCB-4(1)'s punching shear capacity is 705.54KN, which is the maximum punching shear capacity. The punching shear capacity of the MRCB-4(1) is the 1.25 times than the RCB-1. Take the same recycled concrete two-way slabs' average punching shear capacity, the punching shear capacity of the MRCB-1, MRCB-4, MRCB-5 are 687.85KN, 703.80KN, 667.32KN. The punching shear capacity of the 687.85KN, 703.80KN, 667.32KN are the 1.21, 1.24, 1.18 times than the RCB-1. According to the results, this paper gives a suitable distance between anchor bolts and the column is about 70mm.

According to the above picture Fig.10, we can know the ductility of recycled concrete slabs with anchor bolts improved. The displacement of column of MRCB-1 (1), MRCB-1(2), MRCB-4(1), MRCB-4(2), MRCB-5(1), MRCB-5(2) has also improved. According to the experimental phenomena, the recycled concrete slabs with anchor bolts will not declined sharply, and this time lasted about 20s, which can protect people's lives and property and give people a chance to escape.

2.3.2 The punching failure process of recycled concrete slabs with anchor bolts

This experiment from loading to the punching failure, the results are similar to the ordinary concrete two-way slabs with anchor bolts which had studied by the scholars before. The whole punching shear process can be divided into three stages.

The first stage: before the first crack appearance, the deformation and deflection of two-way slabs are very small, In this process the slabs has been in the stage of elasticity; When the loading value reaches the 20%-30% failure load, the first crack appearance in the slab-bottom, the first crack almost below the column, belong to the typical flexural cracks. At this time, the load-displacement curves of the test plates are straight lines.

The second stage: from the first crack to punching failure, with the increaing of the load, the cracks begin to expand, these cracks are mainly radial cracks, then the radial cracks extension and bifurcation, some steel bars near to the columns yield, the plates' deflection become large, the radial cracks continue to extend and bifurcation, eventually these cracks extend to the supports, and some small radial cracks derive circumferential cracks; When the distance between the anchor bolts is small, the first row of anchor bolts started to make contribution to punching shear, the circumferenti- al cracks around the columns begin to expand, then the other anchor bolts start to make contribution to punching shear capacity; when the anchor bolts yield, the cracks gradually extend, connected together and become wider; When the distance between the anchor bolts is big, it is possible to form some new cracks between the anchor bolts, then the first row of anchor bolts start to make contribution to punching shear capacity, the circumferential cracks around the columns begin to expand, then the other anchor bolts started to make contribution to punching shear capacity; when the anchor bolts yield, the cracks gradually extend, connected together and become wider; When reaching the failure load, the columns start to fall slowly, several main cracks widened, this process has a certain sign; The load-displacement curves of the test plates become slowly rising curves, which have some certain yield lines.

The third stage: after punching failure, the test plates punching shear capacity falled less obvious; The ultimate bearing capacity is almost stable at 65%- 80% punching shear capacity,In this process, the load-displacement curves of the test plates become into a slow decline curves.

3. CONCLUSIONS

This paper made punching shear test on the recycled concrete two-way slabs with anchor bolts, through the observation of experimental phenomena and analysis the datas, we can get the following conclusion:

(1) All the punching shear capacity of test plates with anchor bolts have increased; The punching shear capacity have increased from 17% to 34%; The ductility of the test slabs with anchor bolts have improved; The failure state of the test slabs with anchor bolts have also improved,which become ductile fracture;

(2) In this paper, with the distance between anchor bolts and the column edge icreasing, the punching shear capacity increased;

(3) With the distance between anchor bolts icreasing, the punching bearing capacity increased first and then decreased; According to the results, this paper gives a suitable distance between anchor bolts and the column is about 70mm.

(4) Through the experiment research, the development of cracks of recycled concrete two-way slabs with anchor bolts is similar to ordinary concrete two-way slabs with anchor bolts; This process can be divided into three stages: the elastic stage, the cracks development and yield stage, the failure stage.

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HIGH EFFICIENCY PASSIVE SOLAR SYSTEM AND MATHEMATICAL MODEL FOR ITS CALCULATION AND DESIGN

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Keywords

solar passive house, heating-cooling, wall-collector

ABSTRACT

In this article high efficiency passive solar system is suggested. Methods for discovering of constructive, energy and economical characteristics are developed. Based on these methods a mathematical model for optimizing of design parameters that provide high energy efficiency and cost effectiveness of suggested solar house is developed. The conditions of least cost energy supply in solar houses were revealed.

1. INTRODUCTION

Preliminary investigation shows that at present widely used solar passive “House-Collectors” and “Wall-Collectors” systems (Bainbridge, D. 2011), (Holloway, D. 2000), (EU Commission, 1996. Overall Energy Policy and Advantages of Renewable Energy Technologies) and (Crosbie, M. 1997) in wintertime cold climatic conditions do not provide enough high energy efficiency and cost effectiveness. For this reason they are used mainly in rather warm wintertime climatic conditions. To maintain comfortable internal microclimatic parameters passive solar houses are usually furnished with rather powerful water heating booster boilers and heating systems. As a result in conditions with low or negative outside temperatures such houses consume approximately the same quantities of fuel and energy as ordinary houses. For improving energy efficiency and cost effective characteristics of solar houses it is becoming necessary to develop new type of more efficient and simple passive solar systems.

2. BACKGROUND

Instead of existing type of “Wall-Collector” it is suggested to employ new solar house structure in which the south facing thick wall (thromb wall) is replaced by a thin metal sheet with low thermal resistance. The metal sheet southern wall is separated from ambient air with a transparent sheet, for instance, flat glass. The glass sheet is placed in optimal distance from metal sheet. The metal sheet wall does not have widows. The internal surface of metal wall is covered by dynamic insulation which is removed at daytime and closed at nighttime. For reducing heat losses the all other walls and ceiling are well insulated. Suggested construction is displayed in the fig.1.a.

The passive heating of the house is executed in the following way: during winter sunny hours sun rays penetrate through glass cover (1) of south wall and are absorbed by dark surface of metal wall (3). The quantity of absorbed heat is conditioned by intensity of solar radiation I, W/m2 and coefficient of absorption P of the surface of metallic wall. As a result the metal wall and the air in the gap are heated. Therefore, heat flow arises into the house.

During daytime sunny hours the dynamic insulation is removed from internal surface of south wall, and at nighttime it automatically covers the wall surface. At night and deem sun hours the heating of the house is fully realized by booster heating system. As the upper side of the air gap is covered by glass horizontal sheet, the sun rays penetrate simultaneously through both vertical and horizontal glass surfaces. The rays refracted in horizontal and vertical glass surfaces are superposed on the outside surface of south wall. Therefore, intensity of radiation on the south wall grows. The described phenomenon is shown on the fig.1.b.

Application of optical trigonometry rules allowed finding out the following formulas for determining the illuminated specific surfaces of the south wall:

- by rays refracted in vertical glass cover- $$f_{ilmum.vert} = (h - 0.38\delta_{gap})/bh,$$ (1)

- by rays refracted in horizontal glass cover- $$f_{ilmum.horiz.} = 1.28\delta_{gap}/bh,$$ (2)

- by superposed rays refracted in vertical and horizontal glass covers- $$f_{ilmum.s.wdl} = f_{s.w.}\left(1 + \frac{0.9\delta_{gap}}{h}\right)$$ (3)

where: δ_{gap} – width of the air gap, m; b –length of the gap, m; h – height of the house, m:

The specific heating demand of suggested passive house at daytime $Q_{hd.day}$, kW is determined by the difference of heat gains through south wall and heat losses from the house using the following expression:

$$q_{hd.day} = q_{oth.wall} + q_{vent} - q_{\text{int}} - q_{gain.s.w.} \quad (4)$$

As follows from (4) the positive value of qhd.day means that heat gains through south wall are lower, than heat losses through all other constructions. In such case the house requires daytime booster heating. If qhd.day is negative then the house does not require boiler heating. By the results of calculations graphs were plotted as shown on the fig.2a. From the graphs can be concluded that daytime specific heating demand qhd.day, W/m3 of non insulated passive house in the range of outside temperatures t_{out}= -12oC to - 0.8oC is positive, therefore, the house needs booster heating even at day time. Under outside temperatures tout exceeding t_{out} >-0.8oC there is no need for booster heating. Even 0,1m thick thermal insulation of constructions widens outside temperature range of non booster heating from t_{out} = -12oC to +15oC. This fact gives evidence concerning high efficiency of suggested passive solar house.
Nighttime specific heating demands $q_{hd.n.}$ are determined by the following sum of heat losses qh.loss through all external constructions:

$$q_{hd.n.} = \Sigma q_{h.loss.} + q_{vent.} - q_{\text{int}}, \quad (5)$$

The values of nighttime heating demands are determined by calculations. The results of calculations are represented by graphs, plotted in fig.2b.
For revealing advantages of suggested passive heating system over “House-Collector” and “Wall-Collector” the values of outside temperatures in case of which self-heating regimes of solar houses take place for all three types of houses were determined. It is obvious that the lower self-heating temperatures, the higher energy efficiency of passive system. The results of comparison are given in the fig.3a. From the fig.3a is clear that the temperature of self-heating of suggested new passive solar system is the lowest for both day and nighttime. Therefore, the newly suggested system is the most efficient.
To discover expediency and practicability of application of the suggested system, there has been investigated its energy efficiency and cost effectiveness by mathematical modeling. As indicator of applicability is accepted the value of annual expenditures Ts, $/m2 for heating and cooling, referred to 1m2 of the house which is determined by the following formula:

$$T = \Sigma K / Y + \Sigma U, \quad (6)$$

where: ΣK - total capital investments on heating and cooling of new solar system, $; ΣU– total annual operational cost of the system, $/year; *Y*- life cycle or payback period of the system.
Total capital cost includes all investments for building’s construction, insulation and labor cost for mounting of heating and cooling equipment.
Total annual operational cost includes all investments for purchase of fuel, energy, other materials and scheduled repairs of the house and equipment. The complex of all equations obtained above forms the mathematical model of the system, composed by applying the rules of system analysis methods (Melentev, L. 1983). Software was composed in C++ programming language to accomplish computer aided calculation and optimization of the system. The annual expenditures T_s, $/m2 for round year heating and cooling, referred to 1 m2 of the house Ts, $/m2year was accepted as the criteria of optimization. The results of optimization calculations are represented in

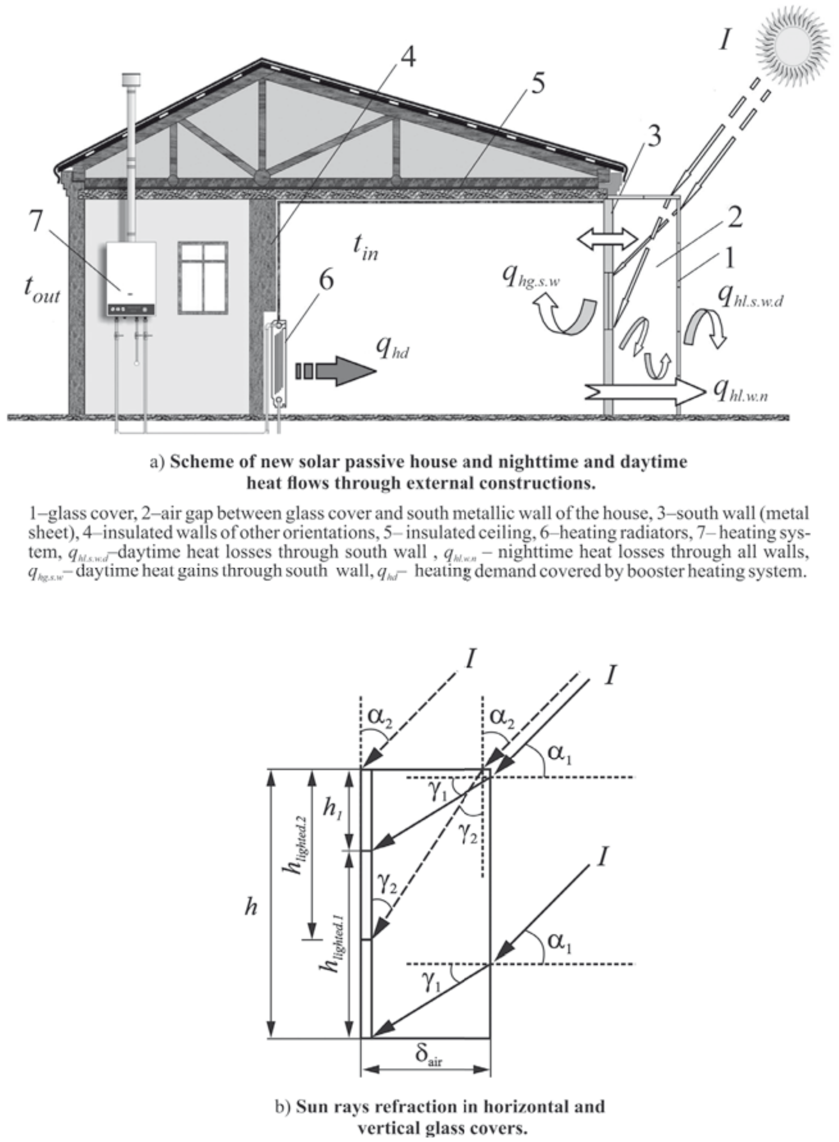


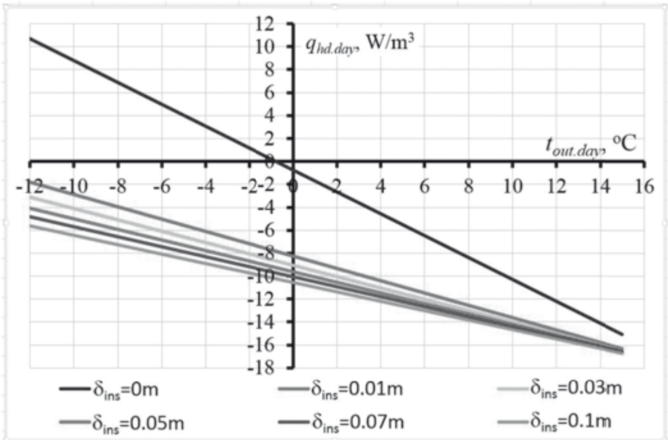
Fig. 1 New solar passive house and sun rays refractions in the glass cover of air gap.

form of diagrams in fig.2c.

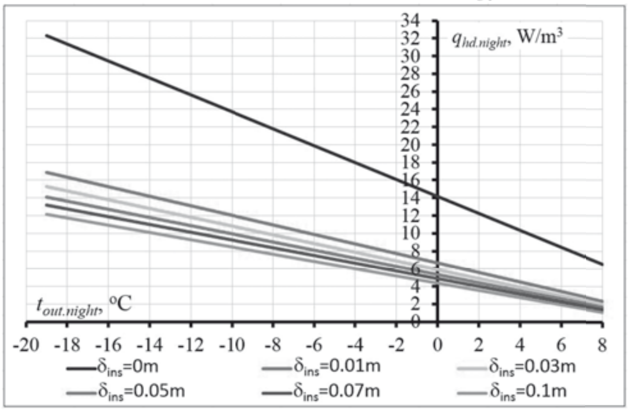
Fig.2c shows that if capital investments are put into effect by bank loan the least cost of heating and coo-ling makes $T_{s.min.b}$=13$/m2per year which occurs in case of payback period $Y_{opt.}$ = 26 years. The fig.2c shows also that if capital investments are put into effect by own account of the investor the least cost of heating and cooling makes

$T_{s.min.o.acc.}$= 8.2 $/m2per year that occurs in case of same $Y_{opt.}$= 26 years of payback period. Increase of the payback period decreases the heating and cooling specific cost which is desirable for occupants, but is not acceptable for investors. To satisfy both sides the mutually acceptable payback period is taken Yopt. = 7 years. For this condition investigation was accomplished to compare least costs of heating and coo¬ling Ts.min. of new and ordinary houses of the same sizes. The results of investigation are represented in the fig.3b. The fig.3b represents comparative optimal data for suggested new passive system and ordinary house. Actually the table shows the higher energy and cost effectiveness of the suggested new solar system.

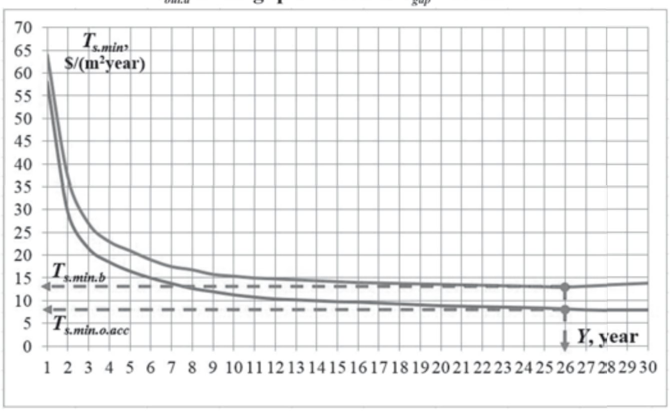
3. CONCLUSIONS



a) Specific values of suggested passive house's daytime heating demands $q_{hd.day}$, W/m^3 at different daytime outside temperatures $t_{out.d}$ in case of δ_{gap}= 2.4m air gap width.



b) Nighttime specific heating demands $q_{hd.n}$, W/m^3 at, various outside temperatures $t_{out.d}$ if air gap's width is δ_{gap}= 2.4m.



c) Diagram of least costs $T_{s.min}$, \$/m^2 per year of heating and cooling of solar passive new system.

Fig. 2 Daytime and nighttime specific heating demands of new solar passive house and diagram of its optimization .

1. Specific least cost Ts.min of round year heating and cooling of new solar house in DTs =1.92$/m2year or in 12,1% is cheaper than for ordinary house. Therefore, the new solar house is more effective.
2. Compared to ordinary house in new system total capital investment in 2.5% is less, annual operational cost is reduced in 21.4% and greenhouse gas emissions are less in 35%.

Number of glass cover panes of south walls of solar houses	Temperatures of self-heating of solar passive systems					
	House-collector δ_{ins} = 0.1m		Wall-Collector, δ_{ins}= 0.1		Suggested new passive solar system δ_{ins}=0.1m	
	$t_{out.day}$	$t_{out.av.}$	$t_{out.day}$	$t_{out.av.}$	$t_{out.day}$	$t_{out.av.}$
1	-14.5	10.25	-0.8	8.35	-25	3.75
2	-13	8.55	-4.4	7.55	-18.5	5.25
3	-9.3	8.45	-4.6	7.45	-12.6	6.35

a) Temperatures of self-heating of solar passive systems

Optimal values	**new passive**	**ordinary house**	**savings**
Annual specific investment by bank loan, \$/m^2	17.42	19.52	2.10
Annual specific investment by investor's account, \$/m^2	13.97	15.89	1.92
Optimal thickness of building's insulation, δ_{ins}, m	0.03	0.01	-
Daytime specific heating demand, $q_{hd.d}$, W/m^3	6.21	10.62	4.42
Nighttime specific heating demand, $q_{hd.d}$,W/m^3	15.80	21.60	5.81
Seasonal daytime heating demand, $Q_{hd.day.seas.}$, kWh	926.63	1586.19	659.56
Seasonal nighttime heating demand, $Q_{hd.night.seas.}$, kWh	8490.58	12902.36	4411.78
Total seasonal heating demand, $O_{hd.seas}$. kWh of the house	9417.2	14488.55	5071.34
Specific cooling demand of the house, q_{cd}, W/m^3	9.49	12.13	2.64
Total seasonal cooling demand, $O_{cd.seas}$. kWh of the house	4098.3	5238.7	1140.4
Installed power of booster boiler. Q_b, kW	6.95	9.46	2.51
Seasonal quantity of heat, supplied by boiler, $Q_{b.seas.}$, kWh	9592.1	14685.3	5093.2
Seasonal gas consumption by boiler, $B_{gas.seas.}$, m^3/seas.	1145.72	1754.07	608.35
Cost of boiler, K_{boil} , \$	746.94	981.89	234.95
Cost of building's insulation, K_{ins}, \$	594.00	186.43	-407.57
Cost of refrigerator, $K_{ref.}$, \$	819.66	1047.74	228.08
Total capital investments, ΣK, \$	5000.83	5130.25	129.42
Annual repair cost, $U_{rep.}$, \$/year	156.71	224.24	67.53
Cost of seasonal gas consumption, $U_{gas.}$, \$/seas.	90.51	138.57	48.06
Cost of seasonal consumption of electricity by refrigerator , $N_{refr.}$, \$/seas.	38.74	49.52	10.78
Seasonal operational cost, ΣU, \$/seas. The least cost of heating and cooling $T_{s.min.}$, \$/m^{2}per year	593.35 8,2	754.37 10.12	161.02 1.92

b) Comparative optimal data of new passive heating – cooling and ordinary house systems

Fig. 3 Outside temperatures of self-heating of solar passive systems and its optimal data.

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THE MODIFIED METHOD OF RECTANGULAR FINITE ELEMENTS WITH SIXTEEN DEGREES OF FREEDOM FOR SOLVING THE PROBLEMS OF PLATE BENDING

POSTER

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ABSTRACT

Considered the method of finite element of rectangular shape with sixteen degrees of freedom to meet the challenges of the cross plate bending, taking into account the boundary conditions for all the points of the contour of the middle plane of the plate, the terms of the continuity of generalized displacement and torque across the line of contact between adjacent elements, the continuity conditions of bending moments and shear forces at grid points.

1. INTRODUCTION

The finite element method is a widespread and one of the most effective methods for solving complex problems of building mechanics, underlying in the base of all modern software package designed to perform the calculations of building structures on a computer. However, when solving problems some difficulties arise related to both: satisfaction of the conditions of continuity of displacements and tension between finite elements, as well with the account of the implementation of the geometrical and static boundary conditions for all the points corresponding to the contour lines of the plate, etc..

A modification of the method of finite elements of rectangular shape with sixteen degrees of freedom is considered by which the solution of plate bending problems are reduced to quadratic programming problems. This approach made it possible to include in the restrictions of quadratic programming all the necessary conditions, such as: conditions for fulfilling the geometrical and static boundary conditions for all points of the contour of the middle plane of the plate, conditions of continuity of bending and twisting moments, shear forces along the entire line of contact between adjacent elements.

2. BACKGROUND

In (Zienkiewich, O.C. and Taylor, R.L. 2000) considered the finite element method of rectangular shape with sixteen degrees of freedom, in which the problem of bending plates are reduced to the solution of linear systems of equations. It proves that along the interface any adjacent edges of adjacent elements receive the same generalized displacement and torque. However, this approach does not allow to take into account other conditions, such as the condition of continuity of bending moments and shear forces at the nodal points of the boundary conditions for the fulfillment of all conditions to the median plane of the contour points, and so on. etc.

3. METHODS

This article describes a modification of the method of finite elements of rectangular shape with sixteen degrees of freedom, in which the problem of bending plates are reduced to quadratic programming problems. Median plane of the plate we will represent as a set of $\overline{n}$ finite element of rectangular shapes. In each node of a finite element the plate will be introduced in four generalized movement: w^S – movement in the axial direction z, the two angles of rotation $\theta^S = \partial w^S / \partial y$, $\omega^S = -\partial w^S / \partial x$ about the axes X, Y and the shift angle $\gamma^S = \partial^2 w^S / \partial x \partial y$. The nodal values of generalized movement $f_i^S = (w_i^S, \theta_i^S, \omega_i^S, \gamma_i^S)^T, i \in \{1,2,3,4\}$ for s finite element in the plane *xy* we define the vector $w^s = (w_1^s, w_2^s, ..., w_{16}^s)^T$. Schematic image of finite element in the plane *xy* is shown in fig.1. a. Displacement of points of the middle surface of finite element we approximate bicubic polynomial and replace it convenient for the practical use of the following expression:

$$w^s(x,y)=\sum_{i=1}^{16} w_i^s \Phi_i(x,y) \quad . \tag{1}$$

Here $w_i^s, i \in \{1,2,...,16\}$ the nodal values of the generalized displacements of finite element, which for a rectangular finite element are defined by the relations:

$$w_1^s = w^s(0,0)\,,\; w_2^s = \frac{\partial w^s}{\partial y}(0,0)\,,\; w_3^s = -\frac{\partial w^s}{\partial x}(0,0)\,,\; w_4^s = \frac{\partial^2 w^s}{\partial x \partial y}(0,0)\,, \ldots,\; w_{16}^s = \frac{\partial^2 w^s}{\partial x \partial y}(a,0) \tag{2}$$

$\Phi_i^s(x,y), i \in \{1,2,...,16\}$ –Hermite functions (Fagan, M.J. 1992), (Timoshenko, S. and Woinowsky–Krieger, S. 1956), (Zienkiewich, O.C. and Taylor, R.L. 2000). When $\xi = x/a, \quad \eta = y/b$ for a rectangular finite element we have:

$$\begin{aligned}
&\Phi_1^s(\xi,\eta) = 1-3\xi^2-3\eta^2+2\xi^3+2\eta^3+9\xi^2\eta^2-6\xi^2\eta^3-6\xi^3\eta^2+4\xi^3\eta^3\,,\\
&\Phi_2^s(\xi,\eta) = b(\eta-2\eta^2-3\xi^2\eta+\eta^3+2\xi^3\eta+6\xi^2\eta^2-3\xi^2\eta^3-4\xi^3\eta^2+2\xi^3\eta^3)\,,\\
&\Phi_3^s(\xi,\eta) = a(-\xi+2\xi^2-\xi^3+3\xi\eta^2-2\xi\eta^3-6\xi^2\eta^2+4\xi^2\eta^3+3\xi^3\eta^2-2\xi^3\eta^3)\,,\\
&\Phi_4^s(\xi,\eta) = ab(\xi\eta-2\xi^2\eta-2\xi\eta^2+\xi^3\eta+\xi\eta^3+4\xi^2\eta^2-2\xi^2\eta^3-2\xi^3\eta^2+\xi^3\eta^3)\,,\\
&\Phi_5^s(\xi,\eta) = 3\eta^2-2\eta^3-9\xi^2\eta^2+6\xi^2\eta^3+6\xi^3\eta^2-4\xi^3\eta^3\,,\\
&\Phi_6^s(\xi,\eta) = b(-\eta^2+\eta^3+3\xi^2\eta^2-3\xi^2\eta^3-2\xi^3\eta^2+2\xi^3\eta^3)\,,\\
&\Phi_7^s(\xi,\eta) = a(-3\xi\eta^2+2\xi\eta^3+6\xi^2\eta^2-4\xi^2\eta^3-3\xi^3\eta^2+2\xi^3\eta^3)\,,\\
&\Phi_8^s(\xi,\eta) = ab(-\xi\eta^2+\xi\eta^3+2\xi^2\eta^2-2\xi^2\eta^3-\xi^3\eta^2+\xi^3\eta^3)\,,\\
&\Phi_9^s(\xi,\eta) = 9\xi^2\eta^2-6\xi^2\eta^3-6\xi^3\eta^2+4\xi^3\eta^3\,,\\
&\Phi_{10}^s(\xi,\eta) = b(-3\xi^2\eta^2+3\xi^2\eta^3+2\xi^3\eta^2-2\xi^3\eta^3)\,,\\
&\Phi_{11}^s(\xi,\eta) = a(3\xi^2\eta^2-2\xi^2\eta^3-3\xi^3\eta^2+2\xi^3\eta^3)\,,\\
&\Phi_{12}^s(\xi,\eta) = ab(\xi^2\eta^2-\xi^2\eta^3-\xi^3\eta^2+\xi^3\eta^3)\,,\\
&\Phi_{13}^s(\xi,\eta) = 3\xi^2-2\xi^3-9\xi^2\eta^2+6\xi^2\eta^3+6\xi^3\eta^2-4\xi^3\eta^3\,,\\
&\Phi_{14}^s(\xi,\eta) = b(3\xi^2\eta-2\xi^3\eta-6\xi^2\eta^2+3\xi^2\eta^3+4\xi^3\eta^2-2\xi^3\eta^3)\,,\\
&\Phi_{15}^s(\xi,\eta) = a(\xi^2-\xi^3-3\xi^2\eta^2+2\xi^2\eta^3+3\xi^3\eta^2-2\xi^3\eta^3)\,,\\
&\Phi_{16}^s(\xi,\eta) = ab(-\xi^2\eta+\xi^3\eta+2\xi^2\eta^2-\xi^2\eta^3-2\xi^3\eta^2+\xi^3\eta^3)\,.
\end{aligned} \tag{3}$$

Starting from the expression for the potential energy of deformation in bending plates In (Timoshenko, S. and Woinowsky–Krieger, S. 1956), we find the value of the potential energy of bending of S rectangular element illustrated in fig. 1. a.

$$\Omega_s = \frac{D}{2}\int_0^a\int_0^b \left\{[\nabla^2 w^s(x,y)]^2 + 2(1-\nu)[(\frac{\partial^2 w^s}{\partial x \partial y})^2 - \frac{\partial^2 w^s}{\partial x^2}\frac{\partial^2 w^s}{\partial y^2}]\right\} dxdy \quad , \tag{4}$$

where $D = Eh^3 / 12(1-\nu^2)$ - the rigidity of the plate in bending, -the thickness of the plate, -modulus of elasticity; -Poisson coefficient.

Substituting the values $w^s(x,y)$ of the expression (1…4), the potential energy of bending of finite element plates represented in the form:

$$\overline{\Omega}_s = 0{,}5(w^s)^T k^s w^s\,, \tag{5}$$

where $k^s = \frac{D}{ab}\left\|\bar{k}_{ij}^s\right\|$ stiffness matrix the components of which are defined by the formula:

$$\bar{k}_{ij}^{s} = \int_0^a \int_0^b \left\{ \nabla^2 \Phi_i^s \nabla^2 \Phi_j^s + 2(1-\nu)\left[\frac{\partial^2 \Phi_i^s}{\partial x \partial y} \frac{\partial^2 \Phi_j^s}{\partial x \partial y} - \frac{1}{2} \frac{\partial^2 \Phi_i^s}{\partial x^2} \frac{\partial^2 \Phi_j^s}{\partial y^2} - \frac{1}{2} \frac{\partial^2 \Phi_i^s}{\partial y^2} \frac{\partial^2 \Phi_j^s}{\partial x^2} \right] \right\} dxdy \; . \tag{6}$$

We denote by $P_S = (P_1^S, P_2^S, ..., P_{16}^S)^T$ vector of nodal loads equivalent to the external load, for which in the case of a uniformly distributed load [3], we have

$$P^S = \frac{qab}{4}(1, \frac{b}{6}, -\frac{a}{6}, \frac{ab}{36}, 1, -\frac{b}{6}, \frac{a}{6}, -\frac{ab}{36}, 1, -\frac{b}{6}, \frac{a}{6}, \frac{ab}{36}, 1, \frac{b}{6}, -\frac{a}{6}, -\frac{ab}{36})^T \; . \tag{7}$$

Work of nodal loads of finite element plates is given by:

$$\hat{\Omega}^S = (w^S)^T P^S. \tag{8}$$

We find the potential energy of the system for finite element (Zienkiewich, O.C. and Taylor,R.L.2000) :

$$\Omega^S = \overline{\Omega}^S - \hat{\Omega} = 0{,}5(w^S)^T k_S w^S - (w^S)^T P^S. \tag{9}$$

Based on the principle of minimum potential energy of the system, for determining the the required vectors $w^S, s \in \{1,2,...,\bar{n}\}$ we obtain the following quadratic programming problem:

$$\min\left\{ \sum_{s=1}^{\bar{n}} (0{,}5(w^S)^T k^S w^S - (w^S)^T P^S) \,|\, \text{boundary conditions} \right\}. \tag{10}$$

For bending moments, torque and shear forces, we have (Zienkiewich, O.C. and Taylor, R.L. 2000)

$$M_x = -D(\frac{\partial^2 w}{\partial x^2} + \nu \frac{\partial^2 w}{\partial y^2}) \, , \; M_y = -D(\frac{\partial^2 w}{\partial y^2} + \nu \frac{\partial^2 w}{\partial x^2}) \, , \; M_{xy} = -D(1-\nu)\frac{\partial^2 w}{\partial x \partial y} \, . \tag{11}$$

$$R_x = -D\left(\frac{\partial^3 w}{\partial x^3} + (2-\nu)\frac{\partial^3 w}{\partial x \partial y^2} \right), \; R_y = -D\left(\frac{\partial^3 w}{\partial y^3} + (2-\nu)\frac{\partial^3 w}{\partial y \partial x^2} \right). \tag{12}$$

The nodal values of bending, torque and shear forces $R_i^S = (M_{x,i}^S, M_{y,i}^S, M_{xy,i}^S, R_{x,i}^S, R_{y,i}^S)^T, i \in \{1,2,3,4\}$ for rectangular finite element is denoted by the vector $M^S = (M_1^S, M_2^S, ..., M_{20}^S)^T$. Taking into account the relations (1) and (3) of the formulas (11) and (12), we find the components of a vector $M^S = (M_1^S, M_2^S, ..., M_{20}^S)^T$.We consider three cases of boundary conditions.

3.1. The edge of the plate is clamped.

In this case, on this edge are equal to zero deflection and rotation angles matching the contour line around the edges. If we assume that any of the sides $x = 0$, $x = a$ or $x = 0$, $x = a$, rectangular finite element plates can be clamped edge, then for these sides we respectively obtain:

$$w^S = 0 \,|_{y=0,b} \, , \; w^S = 0 \,|_{x=0,a} \, , \tag{13}$$

$$\theta^S = 0 \,|_{y=0,b} \, , \; \omega^S = 0 \,|_{x=0,a} \, . \tag{14}$$

Taking into account the notation $w^S = (w_1^S, w_2^S, ..., w_{16}^S)^T$ for the vector of nodal displacements, from correlation (13) - (14) we find:

$$w_1^s = 0 \, , \; w_5^s = 0 \, , \text{ on the line } \; x = 0 \, ; \; w_{13}^s = 0 \, , \; w_9^s = 0 \, , \text{ on the line } \; x = a \, ; \tag{15}$$

$$w_1^s = 0 \, , \; w_{13}^s = 0 \, , \text{ on the line } \; y = 0 \, ; \; w_5^s = 0 \, , \; w_9^s = 0 \, , \text{ on the line } \; y = b \, . \tag{16}$$

$$w_3^s = 0 \, , \; w_7^s = 0 \, , \text{ on the line } \; x = 0 \, ; \; w_{15}^s = 0 \, , \; w_{11}^s = 0 \, , \text{ on the line } \; x = a \, ; \tag{17}$$

$$w_2^s = 0 \, , \; w_{14}^s = 0 \, , \text{ on the line } \; y = 0 \, ; \; w_6^s = 0 \, , \; w_{10}^s = 0 \, , \text{ on the line } \; y = b \, . \tag{18}$$

3.2. The edge of the plate is freely supported.

In such a case, this edge are equal to zero deflections and bending moments. Here, together with the conditions (13) should take place the following boundary conditions

$$\frac{\partial^2 w^s}{\partial x^2} + \nu \frac{\partial^2 w^s}{\partial y^2} = 0 \,|_{x=0,a}\,, \quad \frac{\partial^2 w^s}{\partial y^2} + \nu \frac{\partial^2 w^s}{\partial x^2} = 0 \,|_{y=0,b}\,. \tag{19}$$

Considering the formula (1), (3) and (11) from (19) for the nodal points of the contour of midplane plate we find

$$a^2(6w_1^s - 4aw_3^s - 6w_{13}^s - 2aw_{15}^s) + \nu b^2(6w_1^s + 4bw_2^s - 6w_5^s + 2bw_6^s) = 0\,,(20) \tag{20}$$

$$a^2(6w_5^s - 4aw_7^s - 6w_9^s - 2aw_{11}^s) - \nu b^2(6w_1^s + 2bw_2^s - 6w_5^s + 4bw_6^s) = 0 \tag{21}$$

$$a^2(6w_5^s - 2aw_7^s - 6w_9^s - 4aw_{11}^s) - \nu b^2(6w_9^s - 4bw_{10}^s - 6w_{13}^s - 2bw_{14}^s) = 0\,, \tag{22}$$

$$a^2(6w_1^s - 2aw_3^s - 6w_{13}^s - 4aw_{15}^s) + \nu b^2(6w_9^s - 2bw_{10}^s - 6w_{13}^s - 4bw_{14}^s) = 0\,, \tag{23}$$

$$.\, b^2(6w_1^s + 4bw_2^s - 6w_5^s + 2bw_6^s) + \nu a^2(6w_1^s - 4aw_3^s - 6w_{13}^s - 2aw_{15}^s) = 0\,, \tag{24}$$

$$b^2(6w_1^s + 2bw_2^s - 6w_5^s + 4bw_6^s) - \nu a^2(6w_5^s - 4aw_7^s - 6w_9^s - 2aw_{11}^s) = 0\,, \tag{25}$$

$$....\, b^2(6w_9^s - 4bw_{10}^s - 6w_{13}^s - 2bw_{14}^s) - \nu a^2(6w_5^s - 2aw_7^s - 6w_9^s - 4aw_{11}^s) = 0\,, \tag{26}$$

$$b^2(6w_9^s - 2bw_{10}^s - 6w_{13}^s - 4bw_{14}^s) + \nu a^2(6w_1^s - 2aw_3^s - 6w_{13}^s - 4aw_{15}^s) = 0\,. \tag{27}$$

3.3. Free edge.

In this case, on this edge are equal to zero bending moments and shear forces. Here, together with the conditions (19) should take place and the following boundary conditions

$$R_x^s = \frac{\partial^3 w^s}{\partial x^3} + (2-\nu)\frac{\partial^3 w^s}{\partial y^3} = 0 \,|_{x=0,a}\,, \quad R_y^s = \frac{\partial^3 w^s}{\partial y^3} + (2-\nu)\frac{\partial^3 w^s}{\partial x^3} = 0 \,|_{y=0,b}\,. \tag{28}$$

For the nodal points of the contour of the middle plane of the plate boundary conditions (28) can be rewritten in the form

$$R_x^s(0,0) = 0\,, \quad R_x^s(0,b) = 0\,, \quad R_x^s(a,b) = 0\,, \quad R_x^s(a,0) = 0\,, \tag{29}$$

$$R_y^s(0,0) = 0\,, \quad R_y^s(0,b) = 0\,, \quad R_y^s(a,b) = 0\,, \quad R_y^s(a,0) = 0\,. \tag{30}$$

Considering the formula (1), (3) and (28) from (29) and (30), we respectively find

$$b^2(12w_1^s - 6aw_3^s - 12w_{13}^s - 6aw_{15}^s) + (2-\nu)a^3(6w_3^s - 4bw_4^s - 6w_7^s - 2bw_8^s) = 0\,, \tag{31}$$

$$b^2(12w_5^s + 6aw_7^s - 12w_9^s + 6aw_{11}^s) + (2-\nu)a^3(6w_3^s - 2bw_{12}^s - 6w_7^s - 4bw_8^s) = 0\,, \tag{32}$$

$$b^2(12w_5^s + 6aw_7^s - 12w_9^s + 6aw_{11}^s) - (2-\nu)a^3(6w_{11}^s + 4bw_{12}^s - 6w_{15}^s + 2bw_{16}^s) = 0\,, \tag{33}$$

$$b^2(12w_1^s - 6aw_3^s - 12w_{13}^s - 6aw_{15}^s) - (2-\nu)a^3(6w_{11}^s + 2bw_{12}^s - 6w_{15}^s - 4bw_{16}^s) = 0\,, \tag{34}$$

$$a^2(12w_1^s + 6bw_2^s - 12w_5^s + 6bw_6^s) - (2-\nu)b^3(6w_2^s + 4aw_4^s - 6w_{14}^s + 2aw_{16}^s) = 0\,, \tag{35}$$

$$a^2(12w_1^s + 6bw_2^s - 12w_5^s + 6bw_6^s) - (2-\nu)b^3(6w_6^s + 4aw_8^s - 6w_{10}^s + 2aw_{12}^s) = 0\,, \tag{36}$$

$$a^2(12w_9^s - 6bw_{10}^s - 12w_{13}^s - 6bw_{14}^s) - (2-\nu)b^3(6w_6^s + 2aw_8^s - 6w_{10}^s + 4aw_{12}^s) = 0\,, \tag{37}$$

$$a^2(12w_9^s - 6bw_{10}^s - 12w_{13}^s - 6bw_{14}^s) - (2-\nu)b^3(6w_2^s + 2aw_4^s - 6w_{14}^s + 4aw_{16}^s) = 0\,. \tag{38}$$

4. CASE HISTORY

Here we consider three cases and boundary conditions for each case the derivation of these conditions are met for all points of the contour of the middle plane of the plate. We also consider the condition of continuity of bending moments and shear forces in the nodes, etc. Based on the fact that the displacement w^S and rotation angles θ^S, ω^S on the sides s of the rectangular finite element plate change by cubic parabola to satisfy the condition (13) at all points, corresponding to contour lines of the median plane of the plate, we suppose

$$\theta^s(0,0)=0\ ,\ \theta^s(0,b)=0\ ,\ \text{on the line}\ \ x=0\ ;\ \theta^s(a,0)=0\ ,\ \theta^s(a,b)=0\ ,\ \text{on the line}\ \ x=a\ ; \tag{39}$$

$$\omega^s(0,0)=0\ ,\ \omega^s(a,0)=0\ ,\ \text{on the line}\ \ y=0\ ;\ \omega^s(0,b)=0\ ,\ \omega^s(a,b)=0\ ,\ \text{on the line}\ \ y=b\ . \tag{40}$$

On the basis of the relations (39) and (40), we find:

$$w_2^s=0\ ,\ w_6^s=0\ ,\ \text{on the line}\ x=0\ ,\ \ w_{10}^s=0\ ,\ w_{14}^s=0\ ,\ \text{on the line}\ x=a\ , \tag{41}$$

$$w_3^s=0\ ,\ w_{15}^s=0\ ,\ \text{on the line}\ y=0\ ,\ \ w_7^s=0\ ,\ w_{11}^s=0\ ,\ \text{on the line}\ y=b\ , \tag{42}$$

To satisfy the conditions (14) for all points, corresponding to contour lines the median plane of the plate, we suppose

$$\gamma^s(0,0)=0\ ,\ \gamma^s(0,b)=0\ ,\ \text{on the line}\ \ x=0\ ;\ \gamma^s(a,0)=0\ ,\ \gamma^s(a,b)=0\ ,\ \text{on the line}\ \ x=a\ ; \tag{43}$$

$$\gamma^s(0,0)=0\ ,\ \gamma^s(a,0)=0\ ,\ \text{on the line}\ y=0\ ;\ \gamma^s(0,b)=0\ ,\ \gamma^s(a,b)=0\ ,\ \text{on the line}\ y=b\ . \tag{44}$$

On the basis of the relations (43) and (44), we find

$$w_4^s=0\ ,\ \ w_8^s=0\ ,\ \ w_{12}^s=0\ ,\ w_{16}^s=0\ . \tag{45}$$

To satisfy the conditions (19) for all the points corresponding to the contour lines of the plate, we offer

$$M_x^s(0,b/4)=0\ ,\ M_x^s(0,3b/4)=0\ ,\ M_x^s(a,b/4)=0\ ,\ M_x^s(a,3b/4)=0\ , \tag{46}$$

$$M_y^s(a/4,0)=0\ ,\ M_y^s(3a/4,0)=0\ ,\ M_y^s(a/4,b)=0\ ,\ M_y^s(3a/4,b)=0\ . \tag{47}$$

Considering the formula (1), (3) and (11) from (46) and (47) we find the appropriate conditions. To satisfy the boundary conditions (28) for all points, corresponding to contour lines the median plane of the plate, we suppose

$$R_x^s(0,b/4)=0\ ,\ R_x^s(0,3b/4)=0\ ,\ R_x^s(a,b/4)=0\ ,\ R_x^s(a,3b/4)=0\ ,$$

$$R_y^s(a/4,0)=0\ ,\ R_y^s(3a/4,0)=0\ ,\ R_y^s(a/4,b)=0\ ,\ R_y^s(3a/4,b)=0\ ,$$

Where, taking into account the formula (1), (3) and (28) we find the appropriate conditions. Terms of continuity of bending moments M_x , M_y and shear forces R_y , R_x in node (fig. 1. b), we define relations:

$$M_x^s=M_x^{s+1}\ ,\ M_x^{s+2}=M_x^{s+3}\ ,\ M_x^s=M_x^{s+3}\ ,\ M_y^s=M_y^{s+1}\ ,\ M_y^{s+2}=M_y^{s+3}\ ,\ M_y^s=M_y^{s+3}\ , \tag{48}$$

$$R_x^s=R_x^{s+1}\ ,\ R_x^{s+2}=R_x^{s+3}\ ,\ R_x^s=R_x^{s+3}\ ,\ R_y^s=R_y^{s+1}\ ,\ R_y^{s+2}=R_y^{s+3}\ ,\ R_y^s=R_y^{s+3}\ . \tag{49}$$

Taking into account the formulas (14), (15) and (1) and (3) from these conditions we respectively obtain

$$3w_1^j+bw_2^j+4bw_2^i-3w_1^k+bw_2^k=0\ , \tag{50}$$

$$3w_1^{i-1}+aw_3^{i-1}+4aw_3^i-3w_1^{i+1}+aw_3^{i+1}=0\ , \tag{51}$$

$$-3w_3^j+bw_4^j+4bw_4^i+3w_3^k+bw_4^k=0\ , \tag{52}$$

$$3w_2^{i+1}+aw_4^{i+1}+4aw_4^i-3w_2^{i-1}+aw_4^{i-1}=0\ . \tag{53}$$

5. RESULTS

Rewriting all the conditions (50) - (53) in the form of equations, we get:

$$Hq=0\ , \tag{54}$$

where - the order of the matrix, is the number of necessary conditions (52) - (55). With regard to the conditions (54) and the boundary conditions for all the points of the contour of the middle plane of the plate, instead of (10) we obtain

$$\min\left\{\sum_{s=1}^{\overline{n}}(0{,}5(w^s)^T k^s w^s-(w^s)^T P^s)\ |\ H_q=0,\ \text{boundary conditions}\ \right\}. \tag{55}$$

6. CONCLUSIONS

Using the representations (55) considered the test problem of determining the stress-strain state of a square plate, loaded uniformly distributed load. Based on the results of test problems solution, it can be concluded, that taking into account the continuity of bending moments and shear forces at the nodal points and the boundary conditions for all the points of the contour of the middle plane of the plate significantly increases the accuracy of the solution.

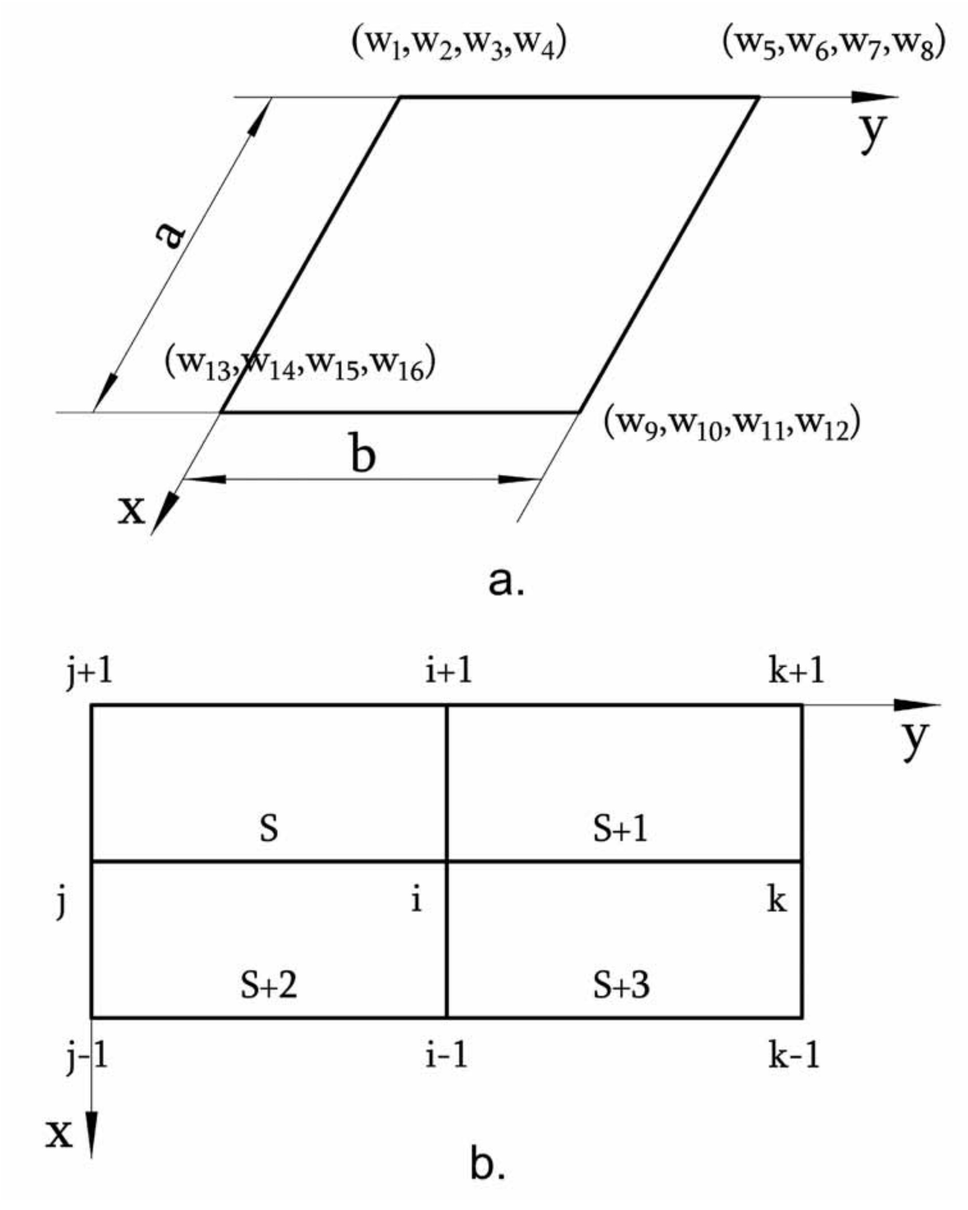

Fig. 1. a - scehmatic representation of rectangular finite element plates
b - ith node. The set of rectangular finite element.

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THE INFLUENCE OF THE BOTTOM ASH FROM BIOMASS BURNING ON THE PROPERTIES OF A CONCRETE MIX AND CONCRETE ITSELF

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Keywords

concrete, bottom ash, biomass

ABSTRACT

The increased interest in renewable energy is mainly due to the continuous depletion of traditional energy sources and excessive pollution of the environment. As a renewable fuel is considered, inter alia biomass, which is co-incineration with coal or lignite. Due to the amount of ash produced, the search for ways of their management is a must. This paper presents an analysis of the effect of the addition of bottom ash resulting from the combustion of biomass on the properties of concrete and hardened concrete. Using the experimental method designed for the concrete mix using cement CEM I 42.5, which is then modified using bottom ash as it is delivered and after mechanical activation (2-fold grinding). For all received series of concrete tests were performed: the consistency of concrete slump method; fresh air content in the concrete mix; compressive strength of concrete after 2, 28 and 56 days aging; frost for 100 cycles of freezing and thawing, water absorption and water penetration depth.

1. INTRODUCTION

Development of the word industry is inseparably connected with the increasing need for energy. Such a state determines new threats concerning its influence on the natural environment. In many countries (including Poland) the main sources of energy are solid fossil fuels (coal and lignite), polluting atmosphere with emission of the harmful gas substances, as well as utilization of side effects of a combustion process (UPS). Therefore, what is highlighted is the use of UPS of fuels as the secondary products for the production of the building materials, or the use of environmentally- friendly processes. As an effect of a long term research conducted in the whole word, the basic directions of utilization of the side effects of combustion of energy sources is its wide use in industry of building and construction materials, underground mining, civil engineering, or agriculture (Rui Barbosa et al. 2011, Zapotoczna-Sytek et al. 2013; Giergiczny 2013).

Power plants implement new systems of gaining energy from the renewable sources. As the renewable fuels they treat e. g. biomass, which is burnt together with coal or lignite. According to the new law from the year 2012 concerning renewable sources of energy it is suggested to limit common burning and turn to burning of pure biomass. Power plants, thanks to production of so called “green energy”, by burning biomass may meet international criteria in the area of emission of CO2 to atmosphere, that were established in Kioto in 1997 (Giergiczny 2013, Iwanek et al. 2008).

According to the directive of the European Union, the use of biomass will allow to reach significant economic benefits. Poland has also declared that until year 2010 the country will be producing 7,5% of energy from renewable resources, and until 2020 – 14 %.

The use of biomass is connected with changing of the chemical composition of the ashes produced in a process of burning. Biomass originates mainly from agricultural crops, waste from the timber industry, or industrial waste. Side effects of the biomass burning are: fly ashes and bottom ashes, the composition of which is variable, because biomass composition is not always the same (Diana Bajare et al. 2013).

The subject for the research discussed in this paper is to determine influence of adding some bottom ash as an effect of biomass burning, on the properties of concrete mixture and hard concrete.

2. BACKGROUND

In order to improve selected properties of concrete, or in order to achieve special properties there are used some special ingredients called additions. They are dozed to the concrete mixtures in the amount greater than 5% of the cement mass. Additions should be taken into account in the calculations of tightness of a concrete mixture. The additions used should meet the requirements of the norm PN-EN 206 -1 Concrete. The requirements should be also met in terms of in properties, production and compatibility:

-maximum amount of fly ash, taken into account in the k value should meet the criterion:

• Fly ash / cement ≤ 0,33 (mass)

In case of greater amount of fly ash the excessive amount should not be taken into account while calculating the coefficient W/C + k * fly ash and minimum amount of cement;

- for concrete including CEM I and CEM II/A (apart from CEM II/A-V) the k value is acceptable:

• CEM 32,5 k=2

• CEM 42,5 i 52,5 k=4

- minimum contents of cement required in a given exposure class, may be lowered maximally to the amount of:

k x (min. contents of cement in a given exposure class– 200) kg/m3

Additionally, amount of cement and ash should be smaller than minimum contents of cement for a given exposure class.

The norm mentioned above does not include any information concerning additions to concrete in a form of bottom ashes being an effect of biomass burning. In this paper the dusts were examined according to the norms typical for fly ashes resulting mainly from burning of the coal.

Bottom ashes used for the research originated from the power plant in Poland, that uses burning of biomass as a renewable source of energy. The sample was taken and delivered by the employees of a power plant. The research results presented in the publication refer to the delivered sample of the bottom ashes. The ashes may have various composition, which is an effect of both the type and quality of burnt fuels, as well as the parameters of the technology used. Mineralogical and organic compositions of ashes as well as their grain size composition determines the possibilities of their economic use (PN-EN 206-1, Rajczyk et al. 2012).

For the tests there was used unground ash and bottom ash double-ground in the disintegrator.

The chemical composition of the bottom ash used in the research is presented in table 1.

CHEMICAL COMPOSITION [% of a mass]									
SiO_2	CaO	K_2O	Al_2O_3	MgO	Fe_2O_3	P_2O_5	Na_2O	MnO	SO_3
89,02	3,82	2,06	1,54	0,58	1,03	0,36	0,18	0,18	0,49
TiO_2	ZnO	BaO	Cl	Cr_2O_3	SrO	ZrO_2	CuO	Rb_2O	NiO
0,11	0,051	0,045	0,064	0,027	0,014	0,026	0,013	0,005	0,01

Table 1. Chemical composition of bottom ash taken from a power plant.

admixture of plasticizer in the amount of 0,8% of the cement mass – series 1. In the next series control sample of concrete was modified in the following relation:

• series 2N – using the bottom ashes in a form as it was delivered, in proportion P/C=0,165 introducing correction of the amount of cement and aggregate,

• series 2M – using bottom ash after mechanical activation (double- ground) with proportion P/C= 0,165 introducing correction of the amount of cement and aggregate,

• series 3N- using bottom ash in the moment as it was supplied in proportion P/C=0,330 introducing correction of the amount of cement and aggregate,

• series 3M – using bottom ash after mechanical activation (double- ground) with proportion P/C=0,330 introducing correction of the amount of concrete and aggregate.

For all the series of concrete there were prepared 15 cubic samples 15 x 15 x 15 cm and 12 cubic samples 10 x 10

3. METHODS

In order to determine the influence of bottom ash on the features of a concrete mixtures and concrete itself, in the Department of Material and Building Processes there was elaborated a research program, including the following designations:

• for concrete mixtures – air content with the use of pressure method and consistency measured by the use of concrete slump test;

• concrete – compressive strength after 2, 28 and 56 days of concrete maturation, absorption, water penetration depth, frost resistance for 100 cycles of freezing and defrosting.

For the tests there were used: cement CEM I 42,5R, sand, gravel aggregate fraction 2-8 mm and 8-16 mm, plasticizer Mapeplast BV 34, bottom ash as a product of burning of a biomass.

There were conducted 5 series of the concrete tests. Control concrete sample with proportion W/C=0,45 and

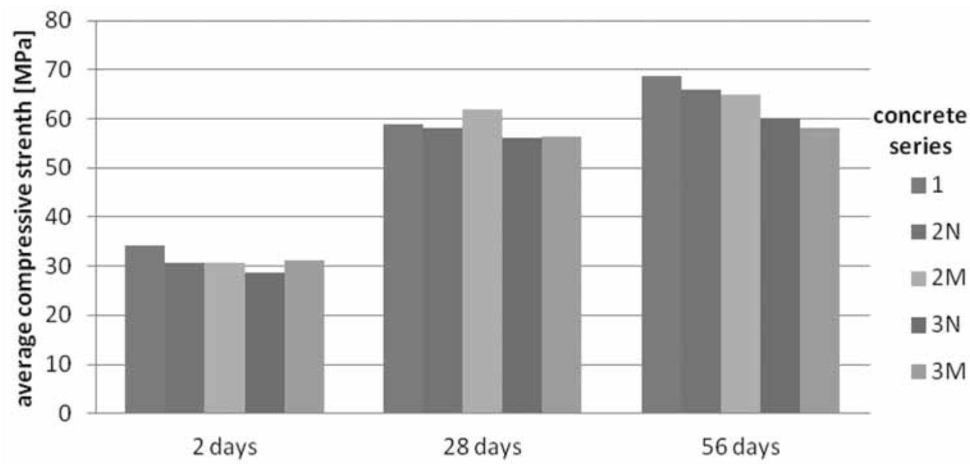

Fig. 1. Compressive strength for particular concrete series.

x 10 cm. After the period of 2 days, 28 days and 56 days of maturation there were conducted compression strength tests. After 28 days of maturation there were also conducted the tests for:

- frost resistance on 12 samples 10 x 10 x10 cm, which were previously weighed and 6 of them were tested after 100 cycles of freezing and defrosting, the remaining six were left in water.
- water penetration depth tested on the three samples 15 x 15 x 15 cm,
- absorption checked on the 3 samples 15 x 15 x 15 cm.

4. RESULTS

Research on the concrete mixtures: consistency and air content, and for concrete: absorption, frost resistance, penetration depth of water under pressure, as well as testing of compression durability, was conducted on the Czestochowa University of Technology, Faculty of Civil Engineering, in the Department of Material and Building Processes. The research results are presented in the tables 3, 4 and there are some interdependencies presented in the Fig. 1.

Concrete series	Cement [kg/m³]	Water [l/m³]	Aggregate [kg/m³]	Plasticizer [l/m³]	Bottom ash [kg/m³]	
					unground	ground
1	436,36	197,70	1704,50	3,5	none	none
2N	412,13	197,70	1643,31	3,5	68,00	none
2M	412,13	197,70	1643,31	3,5	none	68,00
3N	388,10	197,70	1591,48	3,5	128,07	none
3M	388,10	197,70	1591,48	3,5	none	128,07

Table 2. Compositions of the concrete mixtures of particular series in kg/m3.

Concrete series	Consistency – concrete slump test [mm]	Consistency class marked by the concrete slump test S	Air content [%]
1	148	S3	2,5
2N	198	S4	2,35
2M	210	S4	1,8
3N	200	S4	1,8
3M	205	S4	2,3

Table 3. Research results of the concrete mixtures of particular series.

5. CONCLUSIONS

At the stage of the experimental concrete designing the S3 consistency was presumed (result of a concrete slump test between 100 – 150 mm), such consistency was achieved for the concrete mixture of a control series. While adding bottom ash for the further series it was fund that the mixture became more liquid and its initial consistency S3 has changed into S4 (result of a concrete slump test between 160 – 210 mm). For a series of concrete, where the bottom ash was subjected to the mechanical activation (series 2M and 3M) result of a concrete slump test was not much higher than in case of concrete series 2 and 4, in which the bottom ash was introduced in an un-ground form and was equal respectively 210 mm and 205 mm. Bottom ash therefore influences workability and consistency of a concrete mixture.

To the concrete mixtures any aeration agents were added. Air content in the concrete mixture series 1 was equal 2,5%. By adding 16,5% of a bottom ash in an un-ground form with relation to the cement mass (series 2N) insignificantly decreases the air content (2,35 %). On the other hand, adding of the same amount of bottom ash in a ground form would cause decrease of the air content to the level of 1,8%. For series 3N and 3M there was some bottom ash added in the amount of 33% respectively to the mass of the cement, then air content in the concrete mixture was equal respectively 1,8% and 2,3%.

Adding of the bottom ashes to the concrete mixtures caused insignificant loss of the particular concrete durability. Durability test was conducted for each concrete series after 2, 28 and 56 days of the maturation. Average compressive strength of a control sample (series 1), marked after 2 days was equal fcm=34,2MPa. Adding of some bottom ash in the amount of 16,5% in an un-ground form (series 2N) and in a double- ground form (series 2M) caused decrease in the average compressive strength tested after the two days of maturation, in both cases for 10,2 % with respect to the control sample. In case of the series 3N and 3M, in which the maximum amount of bottom ash (33%

Concrete series	Average compressive strength f_{cm} [MPa]			Absorption n_w [% of a mass]	Penetration depth [mm]	Frost resistance	
	after 2 days of maturation	after 28 days of maturation	after 56 days of maturation			Average weight loss ΔG [%]	Average loss of a compressive strength ΔR [%]
1	34,2	58,8	68,7	6,26	82	0,58	36,0
2N	30,7	58,0	65,8	6,66	79	0,63	42,6
2M	30,7	61,8	65,0	7,18	18	0,41	28,0
3N	28,6	56,0	60,1	6,83	68	1,15	27,0
3M	31,2	56,4	58,2	6,89	50	2,0	34,2

Table 4. Results of the tests on concrete of particular series.

with respect to the mass of cement) there may be also observed the loss of an average compressive strength. The loss was equal respectively 16,4% and 8,8%.

Average compressive strength marked after 28 days of concrete maturation, for concrete series 1 was equal fcm=58,8MPa. Adding of the bottom ash caused decrease in the compressive strength almost in all of the series, apart from 2M, in which increase in compressive strength might be noticed for 5,1% comparing to the control sample. Decrease in durability (with reference to the control sample) for remaining concrete series (2N, 3N, 3M) respectively was equal: 1,4%, 4,8% and 4,2%.

Average compressive strength of the concrete tested after 56 days of concrete maturation for series 1 was equal fcm=68,7MPa. For the remaining series, in which bottom ash was added to the components of a mixture, there might be noticed a loss of the average compressive strength, respectively for 4,2%, 5,4%,12,5% and 15,3% comparing to the control sample.

In all the cases introducing of the bottom ash to the concrete mixture caused increase in the concrete absorptivity, with reference to the control sample. The increase was respectively equal 6,4%; 14,7%; 9,11% and 10,0%. According to the norm PN-88/B-06250, concrete directly exposed to the influence of atmospheric factors should have absoprtivity factor not greater that 5%, in case of the other group of concrete type, not exposed to environmental factors, absorptivity should be equal 9%.

Research on the frost- resistance of a concrete was conducted with the standard method, according to norm PN-88/B-05250. The test was conducted on the complex level of frost- resistance

F100. The research procedure was initiated after 28 days of maturation. The test result is considered to be positive, when after a number of n cycles of freezing and defrosting, required in case of a given frost- resistance class, a given decrease in compressive strength is not greater than 20%, average loss in weigh is not greater than 5%, and any of the examined samples was broken or scratched. Decrease in resistance on alternate freezing and defrosting for the controls sample was equal 36%. Introducing of the bottom ash caused that resistance to freezing and defrosting decreased and was respectively equal (2N, 2M, 3N and 3M) 42,6%, 27,9%, 26,9% and 34,2%. It is also worth considering that for any of the series of concrete mixtures there was not used any additional aeration agent, that significantly influences increase in frost-resistance of concrete.

To sum it up, it should be concluded that the use of bottom ashes in the technology of concrete would be pretty difficult, because of the great variability of the physical and chemical properties of this type of ash. This kind of variety is connected with diversity in the type and quality of a fuel. Additional difficulty is lack of regulations influencing knowledge in this area. Bottom waste from the fluidized deposits being an effect of biomass combustion are generally at the same level as waste from the fluidized deposits from the combustion of coal, which means – equally dangerous. Therefore, there is no one existing group singled for these types of ashes.

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THE PROBLEMS OF ACCESSIBILITY OF PUBLIC SERVICES AND TRANSPORT LINKS, CAUSED BY THE GEOGRAPHICAL LOCATION OF THE CITIES IN THE REPUBLIC OF ARMENIA

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Keywords

transport accessibility, settlement system, local center

ABSTRACT

The problems of the availability of public services and transport links between the settlements of the Republic of Armenia, specified by the location of the local centers of the settlement are examined. By the methods of calculation and studies a direct connection between the indicators of the transport accessibility to the nearest town and the population of rural settlements have been revealed. Based on the analysis of the current situation proposals for a polycentric system model formation of settlement in certain regions of the country are presented.

1. INTRODUCTION

The Ljubljana Declaration, adopted in 2003 by the Conference of Ministers responsible for spatial planning of 47 member states of the Council of Europe (CEMAT, formed in Bonn, in 1970.) Specifies that §... for adequate management of the main problems of sustainable spatial development of the European Continent, spatial development policy should be improved in order to:

- reduce inequalities, particularly through the most balanced and effective territorial activities, infrastructure and services in order to enhance their accessibility;

- Support of balanced polycentric development of the European continent, the formation of functional urban regions, including the networks of small and medium-sized cities and rural areas¦ (http://archive.minregion.ru/OpenFile.ashx/6_lublyana.doc?AttachID=2189).

Regional disproportions of territorial development of Armenia and possible mitigation measures found their reflection in territorial planning documents (project resettlement RA) and scientific publications (Safaryan, Yu. A., Muradyan, J.N., Tovmasyan, S.A., Davtyan, M.M. 2011), and in the strategic programs of the State ("The Government of RA Decision No. 1207-N on October 30, 2008 about Approval of Program of the sustainable development"), (http://www.mta.gov.am/hy/conceptions).

In essence, the problem is related with access support for all layers of the population to public services throughout the country, which is a key factor for the formation of a favorable environment and enough quality of life (Aloyan, A. A. and Safaryan, A. Y. 2014).

2. BACKGROUND

Although in era of informational technology the level of availability of many spheres of public services (in particular, forms of involvement in cultural activities, labor market, etc.) are not directly dependent on the geographical location of the settlements, however, the quality of individual services such as health and education, public services, market products, etc., directly caused by the presence of typical for urban infrastructures. It is obvious that both from the point of economic efficiency, as well as the availability of human resources is not only impossible but also pointless accommodation in all rural areas (in the country of 949) the necessary infrastructure of public services. From this point of view, the distance to the nearest city is one of the most important factors affecting the quality of life in rural areas.

3. METHODS , 4. CASE HISTORY

Researches carried out at the level of local authorities in Armenia, show that the provision of minimum services is able to provide the settlement with a population of more than 3,000 people. At the same time, more or less quality and full range of services specific to the local centers of the settlement system, can provide only cities with population of over 5,000 residents (Tovmasyan, S. and Ghazaryan, E., Movsisyan, V. 2011).

It follows that if the settlement is equipped with the necessary infrastructure and even financial resources, the lack of human and professional resources will impede the functioning of (operation, maintenance and development) fully appropriate infrastructures. In other words, to form the center of local settlement system is necessary not only the infrastructure of public services, but also sufficient human resources (Barsegyan, T. 1983).

Fig.1. shows the territorial distribution of settlements with sufficient human resources for the formation of the local center of the settlement system.

It is obvious that most of the populated areas with enough residents are concentrated;

• In western and south-western areas of of Ararat region,

• In the southern and western areas of the Gegharkunik region,

• in the central and adjacent areas to Yerevan, Kotayk and Armavir regions.

There are practically no centers in the northern region of Shirak and Syunik regions of the southern area. Nevertheless, the presence of an appropriate number of residents especially in rural areas (for example, Gegharkunik, Kotayk and Ararat regions) directly does not mean that they can be regarded as local centers of the settlement system, as these settlements need to be supplemented with"missing links" infrastructures required for these centers.

Besides, the solution should be considered from the point of view of the formation of a polycentric territorial organization of the country, as well as in the context of optimization and reform of administrative-territorial structures. On the other hand, the country has a number of urban and rural settlements, where the population is less than 5000, but in Soviet times they had the status of the regional centers, so that in them were created the necessary infrastructures (Meghri Tsaghkahovit, Amasia, Ashotsk).

It is worth noting that over time the criteria for the favorability of access to public services have changed and spatial factor gave way to the temporarily. Moreover, if the last time it was considered favorable access for 30-40 minutes (Belousov, V. (ed.). 1978), but now the indicator is 15 minutes (http://www.mta.gov.am/hy/conceptions).

5. RESULTS

Considering above-mentioned, connection between the number of rural settlements and the distance to the nearest center of a potential settlement system was analyzed. Considering the number of people, some cities (Tumanyan-1797, Akhtala-2408, Shamlugh-735, Ayrum-2395 and Dastakert-301 inhabitants) have not been considered as local centers of the system.

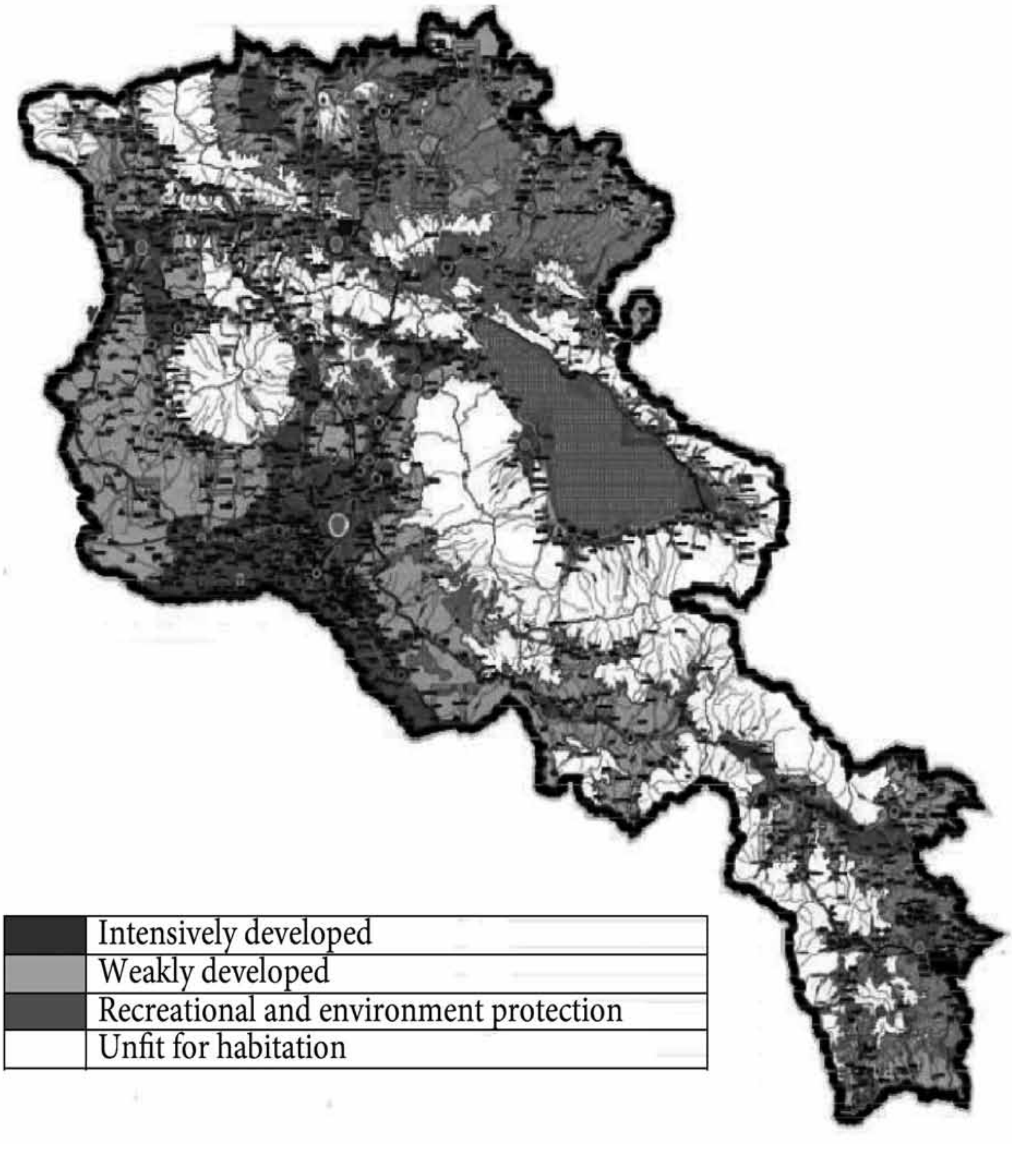

Fig. 1. The scheme of placement of settlements of more than 5,000 residents by regions.

At the same time as such, the city of Meghri is considered, with a population of 4,806 , however, the past status of the district center in the city contributed to the formation of both social and industrial and engineering infrastructures. As favorable to the nearest town is adopted accessibility to 15 minutes, limited favorable 15-30 minutes unfavorable - more than 30 minutes. In the following table (fig.2) information on the number of rural settlements by regions of Armenia due to accessibility are presented. The table shows that the availability of favorable indicators are villages of Armavir, Ararat, Gegharkunik and Kotayk regions partially, and in the worst condition of the village of Vayots Dzor, Syunik and Shirak. Effect of the distance to the nearest town on the average number of rural settlements is shown in the diagram: it is obvious that a direct connection between these factors has a place in all regions of the country. It is also obvious that the average population of the villages of the Syunik region is considerably lower than in other areas. In the scale of the country the average population of the villages, with favorable access is 1698 people, limited-favorable -1002, unfavorable -399. In Syunik region, these figures respectively amount to 593, 348 and 197, which is 2-3 times lower than the average rate of the country. The highest average number of inhabitants of villages in the favorable zone of accessibility, takes place in Gegharkunik region -2461 people, which is about 1.5 times higher than the average of the country. Higher than average index have also villages of Ararat (2370), Kotayk (2303) and Armavir (2280) regions.

6. CONCLUSIONS

Thus, studies lead to the following conclusions:

a. In rural areas the level of accessibility of public services are significantly different in certain regions of the country: in particular, if in Ararat, Armavir and Kotayk regions in the zone of favorable affordability are 80-90% of villages in Vayots Dzor, Syunik and Tavush, the figure is 36-45 %. At the same time, if in Kotayk, Aragatsotn, Gegharkunik, Ararat and Armavir in the areas of an unfavorable accessibility are 1-5 villages in Shirak, Syunik and Vayots Dzor, the indicatores are 37 (29% of all villages), 19 (15%) and 13 (25%).

b. Accessibility of public services and infrastructures in rural areas is directly proportional to the population. The lack of a local center of the settlement, along with other factors, is a major obstacle to improving the demographic situation in the villages and development of rural areas. From this point of view, the most vulnerable are the rural settlements of Syunik region and Vayots Dzor and settlement in the northern regions of Shirak.
Characteris for these regions is not only a low density of population, but even more alarming trend of steady tendency of population decline.

Providing access of public services and infrastructures for the population of rural settlements in some parts of the country involves long-term efforts and tangible investment. To ensure the effectiveness of individual programs and activities, and investments will be, in our opinion, with the following approaches:

• The most vulnerable aspect of the demographic regions, where the town or village, with some potential for the formation of a local center of the settlement system, to implement a policy of “add-ons missing links” of public services and infrastructures (eg the village of Ashotsk and Amasia in Shirak, Aragatsotn Tsaghkahovit) ;

• For regions where local centers are practically absent,taking into account the natural and geographical factors, especially the location of rural settlements and the status of transport links, to develop and implement programs that will in the long run create such centers, such as the village of Tatev in Syunik region, village Shatin and Zaritap in Vayots Dzor, etc.);

• The development of highways a priority to consider the improvement of roads in the vulnerable regions;

• For the villages that have no alternative transport links, to develop a long-term strategy to develop alternative ways.

Implementation of these programs and actions in the long run will allow the country to form a model of polycentric settlement system model, which, in turn, will create conditions for ensuring the availability of the complex of public services in all regions of the country.

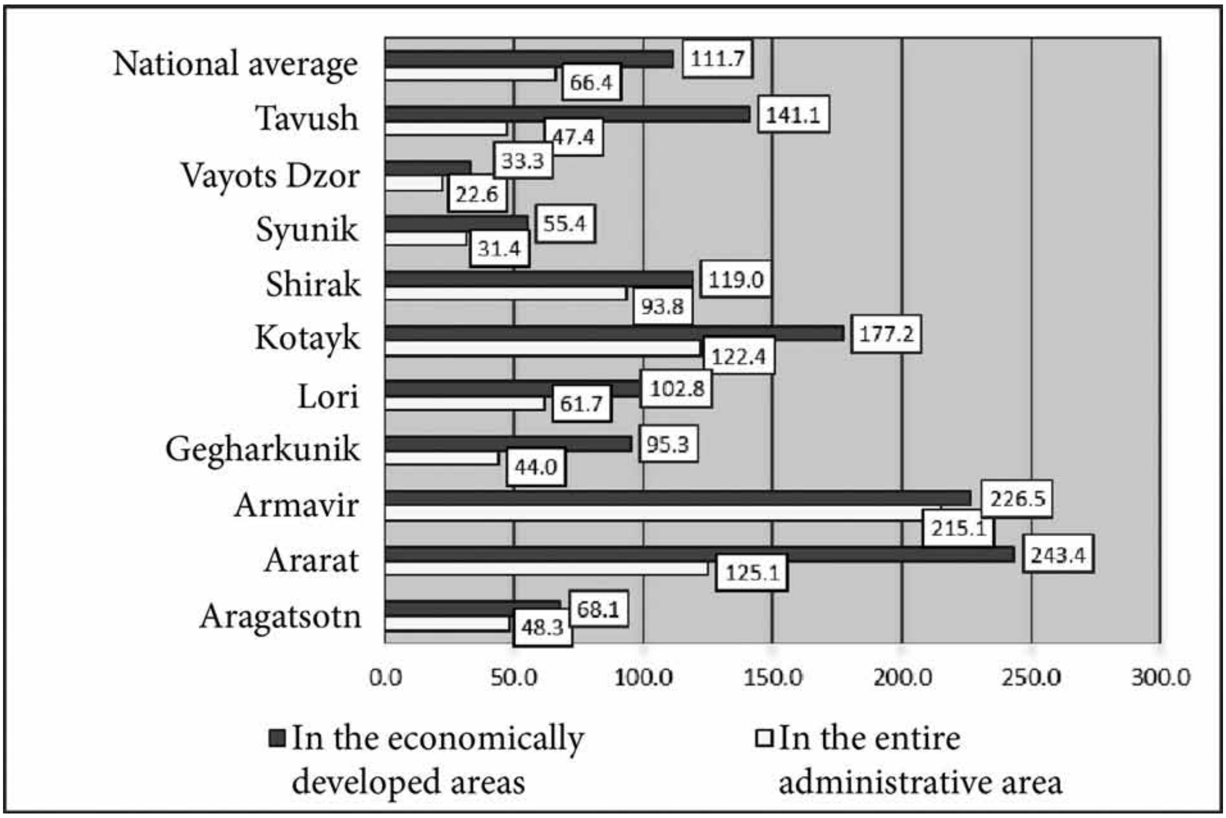

Table. The number of rural settlements, depending on the availability of indicators.

Diagram. The average population of villages depending on the availability of indicators.

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STATISTICAL METHODS OF TRAFFIC SAFETY ASSESSMENT

POSTER

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Keywords

road accident, traffic safety, accidentality

ABSTRACT

The main statistical methods of traffic safety level assessment on highways and city streets are given. Criteria of hazards applicable in various countries are described compared with the factual data. Several common gaps in methods studied on the basis of statistical data calculations and development are summarized.

1. INTRODUCTION

Various methods and approaches for the assessment of safety level are applicable in the research works aimed at traffic safety improvement. All those methods can be conditionally categorized within the following groups:

- Statistical,
- Probable,
- Based on the automobile traffic regime analysis on the assessed location,
- Conflictual points,
- Conflictual situations.

2. CASE HISTORY

Traffic safety level assessment based on statistical records of traffic accidents is done according to facual accidentality data. Statistical methods are used prior to other methods and currently are the most popular ones. Safety level of traffic is usually assessed by the absolute, relative and specific indicators of emergency. Absolute figures enable to evaluate hazardous sections of roads by the total number of accidents in the given period of time. Furthermore, the areas where the number of traffic accidents exceeds a certain number in the given period are considered as dangerous locations.

3. METHODS

Various assessment criteria for highway locations' hazadousness exist in different countries with which the real values can are compared.
For instance, in Great Britain the road section is considered dangerous if one or more road accidents (with injured) occurred on the road of 0.16 km (0.1 mile) length during three years (Jones, V.E. 1981).

Dangerous sections in Hertfordshire demesne are

- black sites - those road sections, with 0.3 km length, where not less than 12 road accidents occured during three years.

- black mile - road section with the length of 1 mile (1.6 km), which is included in those 20 parts of the demesne, that are characterized by a large number of road accidents

- skide side - sections with length of 0.3 km, where every year occur at least 2 road accidents because of slippery pavement in humid weather

- dark site - sections, where a large number of road accidents occur at nihgts, more than in other road sections.

In Rhineland-Palatinate (German: Rheinland-Pfalz) state of Germany the road section is dangerous if one of the below-mentioned conditions exist such as

a) the road area is up to 300 m long and more than 20 accidents of various types or 4 accidents of the same type occurred in one year,

b) the road area is 300-1000 m long and more than 20 accidents of various types or 8 or more accidents of the same type occurred in one year (Vasiliev, A. P. 1989).

In the Czech Republic and Slovakia on the highways of 1000km/h intensity or roads of cities having more than 55.000 population the road sections of 100m length are being classified hazardous if there are being recorded 6 or more road accidents in one year and 5 accidents on the roads of less intensity or smaller number of urban population (Medelskaya, V. A. 1990).

In Bulgaria the traffic section is considered risky where 2 or more accidents happened in one year and the other section of road accidents' accumulation is the area where one or more accident happened on each 100m of its length for the location of accidents in the distance of 100...200m length (Vasiliev, A. P. 1989).

In Serbia the road section of 0.3km is dangerous if the number of accidents in one year exceeds the critical number (Sibenik, T. 1981). Namely,

$$N_{cr} = N_{av} + k\sqrt{N_{av}}\ , \tag{1}$$

where k is the coefficient of repeated level, N_{av} is the average level of accidents on the given section of roads, hence

$$N\ av = \frac{0{,}3\sum\limits_{x} N_x}{L}\ , \tag{2}$$

where $\sum\limits_{x} N_x$ is the total number of road accidents on the highway network in the studied period of time (x =1,2,3,...), and is the length of st udied road network.

In Belgium up to 1 km long location is considered the most dangerous if various types of 10 or more road accidents are recorded during a year (Babkov, V. F. 1993). Similar methods to reveal the hazardous locations are also applicable in other countries. Practically, the absolute indicators of accidentality are applied to identify the scales of emergency as well as to evaluate the material damage of the repercussions of road accidents. However, such methods are not applicable for the comparative studies of different countries due to their diverse number of vehicles, length of road network and local peculiarities that objectively influence accidentality.

Relative indicators of emergency are used for comparative studies such as the number of road accidents, victims and injured people which is for 1.000.000.000 km drive of a vehicle, 100.000 transportation means and 100 million passengers per km.

In Russia the location of accidents' accumulation is revealed by the number of road accidents occurred at least in 3-5 years and by the coefficient of the accident measured by the number of accidents of 1 million aut. km drive (Methodological recommendations on activities aimed at traffic safety development on the road sections of accumulation. 2000).

$$N = \frac{Z \cdot 10^6}{365 \cdot L \cdot N}\ , \tag{3}$$

where Z is the number of accidents in one year, N is the average intensity of traffic, aut/daily, and L is the length of road by km.

For the roads of I-III class the accumulation area is considered the part of the road if 4 or more road accidents occurred in the last 3 years and the value of the accident coefficient exceeds 0.4 road accident/mln.aut.km. That indicator is used for long and relatively similar locations of traffic and for the assessment of traffic safety level. If the road section has local essence where traffic conditions and characteristics of road cover sharply differ in the other sections such as bridges or junctions the coefficient of road accidents is described by the number of road accidents for 1 million automobiles.

$$N = \frac{Z \cdot 10^6}{365 \cdot N}, \tag{4}$$

In the USA and some European countries similar indicators of emergency are being used as well (Renkin, V. U. and Clafi, P. Halbert, S. 1981). For the junctions of roads in the same level

$$R = \frac{2 \cdot 10^6 \cdot A}{T \sum_{i=1}^{n} V_i}, \tag{5}$$

where R is the number of people involved in road accidents among 1 million people, T is the number of days during which the calculations of the accidents were done, A is the number of accident participants during T days, Vi is the i-th approach of intersections with the average daily intensity of traffic, and n is the number of intersection approaches. For separate road locations

$$R_m = \frac{365 \cdot A}{T \cdot L}, \tag{6}$$

$$R_s = \frac{A \cdot 10^6}{T \cdot L \cdot V}, \tag{7}$$

where R_m is the number of road accidents occurred on 1km length road in a year, R_s is the number of road accidents on that road section for 1million km total sum of vehicle's drive in a year, *V* is the average daily intensity on the road section during a year, and *L* is the length of road section.

The method of "pre and post" is popular for the identification of emergency situation that offers the assessment of the accidentality level of the given location based on "pre and post" statistical data of road accidents.
Specific indicators reflect the percentage of one absolute indicator towards another.
They describe the constitution of occurred road accidents and enable the comparison of various locations.
Mostly here are used the

a) specific value of different accidents in the total number (crash, collision, roll over, etc);

b) specific value of traffic accidents occurred by different vehicle types in the total number of collisions;

c) specific value of road accidents' causes (violation of traffic rules, exceeding speed, etc) in the total number of collisions;

d) specific value of the accidents' venue in the total number of collisions, etc.

4. CONCLUSION

Above-mentioned methods of road safety level evaluation are based on statistical data records and development and have several drawbacks. The main demerits are the followings:

• it is necessary to have reliable statistical data on road accidents for a long period of time and no less than for 3-5 years;

• statistical data on road accidents can be considered comparable in the road location only in the case if there were not carried out such works on the road that could considerably affect traffic conditions and safety;

• accountable statistical data on road accidents do not reflect several minor and not recorded accidents as well as the conflictual situations that could cause road accidents (Badalyan, A. M., 2006), (Renkin, V. U. and Clafi, P. Halbert, S. 1981).

• distortions for the real causes of road accidents are possible due to insufficient qualification and interest of a person who makes the reports on road accidents;

• considerable change of indicators of traffic flow is possible in the given period of time (intensity, structure of traffic).

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INVESTIGATION ON THE PERFORMANCE OF SLIT STABILIZED BY BASALT FIBER

POSTER

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Keywords

basalt fiber, silt stabilization, mixing ratio, compactness, shear strength, permeability

ABSTRACT

Chopped basalt fiber was used as additive to reinforce the silt in Beijing. Taking the fiber length, mixing ratio, compactness as the experimental variable, a series of tests which conclude consolidated shear test, compression test, and variable head permeability test were developed, the test results led the conclusions: the properties of the silt in shear strength, compressibility, permeability were improved; when fiber length was set as constant, the improvement in each respects of the basalt fiber-reinforced silt were increasing attenuation when the mixing ratio were less than 4‰,3‰ was the best mixing ratio for shear strength and compressibility, well 2‰ was the best for permeability; as for the fiber length ,when the mixing ratio was constant,3cm was the best length for the shear strength and compressibility, and 2cm was the best for permeability; compactness of basalt fiber-reinforced silt obeyed a quadratic function relationship with compressibility and permeability coefficient under the best mixing scheme, and there was also a quartic function relationship between compressibility coefficient and 3cm fiber's mixing ratio.

1. INTRODUCTION

Texol can limit the deformation of the soil both in lateral and vertical because of the fiber random distributing (Xiong, 1990; Liu, 2011). It can improve the abilities of the soil in many aspects, combine with the convenient for construction, it can be utilized in highway subgrade, soft foundation, retaining wall and other construction projects. And texol draws more and more attention as the development of construction technology, and scholars around the world investigate it there years. Giroud (1977, 1983)put forward the concept of "Geotextile" and "Geomembrane", Shen(2010) did a series of test on properties of texol used in road, and found that there is a significant effect of fiber dosage on the cohesion. Areniez (1988) studied the bearing capacity of reinforced retaining wall by doing a series of model test about retaining wall with random distribution metal fiber. Ghavami.K(1999) investigated the influence of coconut fibers mixing ratio on the tensile and compression tests behaviors, and found coconut fiber could improve the soil on shear strength. Zhang(2014) discussed the influence of fiber length, fitness, toughness, and mixing ratio on the stress-strain curves through the tests about soil reinforced by cotton fiber. Wei (2012) did the triaxial tests on soil reinforced with wheat straws to analysis its deformation-resistant characteristics and mechanism, and found that both the cohesion and deformation-resistant of the soil were enhanced. Basalt fiber is drawn from basalt in high temperature and has following advantages: high strength, well stability, environmental friendly, corrosion resistance. Li(2008)studied the dynamic mechanical properties of concrete reinforced with basalt fiber and found adding basalt can improve energy absorption capacities of concrete. Peng(2009)discussed the applicability of the short-cut basalt fiber in reinforcing the pavement performance of asphalt mixture, And found the short-cut basalt fiber can be used in the road engineering as additive material that enhance the comprehensive performance of asphalt pavement. Sim(2005)studied the applicability of the basalt fiber as a strengthening material in concrete and drew the conclusion that basalt fiber was better than glass fiber in both high temperature resistance and anti-aging.

In this paper, short-cut basalt fiber reinforced soil (BFRS) was studied through tests about strength, compression, and permeability to provide a reference in this field.

2. TEST SCHEME

2.1 Experimental material

The soil used in this study was taken from a construction of expressway project in Da Xing, Beijing, China. The main physico-mechanical parameters of soil show in Table.1, this kind of soil is widely distributed in the flood plain, coastal plain in China. Since it contains little clay and has loose structure and low plasticity index, as consequence, it can lead to the poor water retention, difficult to compaction, suffosion and some other engineering problem when it is used in subgrade engineering. Therefore, the reinforced is done to this kind of soil by basalt fiber (BFRS) to promote the properties of the soil, the fiber used in this study and its basic properties are showed in Fig.1 and Table.2 respectively.

Table.1 Physico-mechanical parameters of soil sample

Optimum moisture content %	Maximum dry density g/cm3	grain composition (%) 0.025~0.055 mm	0.055~0.075 mm	0.075~0.250 mm	>0.250 mm	Plastic limit %	Liquid limit %	specific gravity
14.6	1.74	39.6	25.8	24	3.7	16.7	20.3	2.70

Table.2 Properties indexes of fiber used in test

Filament diameter (μm)	Density	working temperature (℃)	Tensile strength (MPa)	Tensile modulus (GPa)	Elongation at break (%)
10-15	2.7	-270 ~700	3000-4800	90	3.1

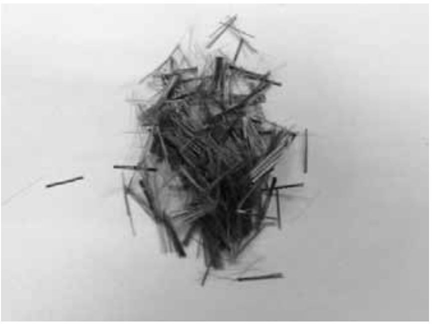

Fig.1 Basalt fiber used in test

2.2 Design of experiment

2.2.1 Samples of BFRS and the pure soil are prepared in accordance with the specification(GB/T50123-1999), fiber are distributed randomly into the soil when preparing the sample, every type of the sample have two groups as controlled trial, and taking the average value of the two groups as the final result.

2.2.2 Consolidated shear test, compression test, and

Variable head permeability test are developed to the different BFRS samples.

2.2.3 Firstly, tests are developed with the sample of different fiber length under the same mixing ratio and compactness.

2.2.4 Then the tests are extended to the samples of different mixing ratio while under the same compactness and the best length.

2.2.5 Finally, tests are developed to the samples of different compactness under the best mixing scheme.

3. STUDY OF SHEAR STRENGTH

3.1 Relationship between strength and fiber length

A series of consolidated shear test to pure soil and BFRS were conducted in different fiber length (1cm, 2cm, 3cm, 4cm) and same mixing ratio(2‰) and compactness(0.96), set the vertical deformation less than 0.005mm per hour as consolidated standards, and the test results are showed in Table.3(0Cm represents the sample of pure soil).

fiber length / cm	water content / %	cohesion / kPa	angle of internal friction / °
0	14.66	11.1	27.6
1	14.38	12.9	28.4
2	14.56	13.5	28.4
3	14.68	16.6	28.9
4	14.59	16.9	28.8

Table 3. Shear strength indexes increment of BFRS under different fiber length

From Table.3 one can see that when the mixing ratio is constant, the cohesion of BFRS increases with the increase of fiber length, and samples with 3cm and 4cm performance better than that with 1cm and 2cm, this can explain that shorter fiber cannot form structure to limit deformation easily and in this study as the fiber length increase to 3cm, there are some fiber at the failure surface of the sample, this phenomenon proves that fiber can provide tensile in a certain length so it can improve the shear strength of the sample; and the reason why the sample with 4cm improves less than sample with 3cm is that when the mixing ratio is low, longer fiber is more difficult to distribute randomly.

On the other hand, the angle of internal friction also experience little increasing as the length increase, but there is no obvious rule of it, and there is a downward trend from 3cm to 4cm. Based on the results, 3cm is selecting as the best length in this study.

3.2 Relationship between strength and mixing ratio

Samples with different mixing ratio at the best length (3cm) and the same compactness 0.96 are tested and the results are showed in Table.4- increasing range comparing with the pure soil in the brackets.

Table 4. Shear strength index increments of BFRS under different mixing ratio

mixing ratio / ‰	water content / %	cohesion / kPa	angle of internal friction / °
0	14.66	11.1	27.6
1	14.47	14.5 (**31%**)	28.5（**3.2%**）
2	14.60	16.6 (**52%**)	28.9（**4.3%**）
3	14.62	19.7 (**77%**)	29.4 (**6.5%**）
4	14.74	20.4 (**84%**)	30 (**8.7%**）

Table.4 shows that cohesion increases with the increase of the mixing ratio, with reaching a 84% improvement at 4‰ mixing ratio, but the improvement is little from 3‰ to 4‰, so 3‰ is the best mixing ratio in this study when considering economic factor; and the angle of internal friction increase little totally, with a largest increase about 9%, so the conclusion can be drawn that basalt fiber improve the shear strength of the soil by increasing cohesion but not angle of internal friction. This is because that after adding the fiber, the interface between soil units and fiber raise; in addition, it can be explained by interleaving mechanism[2] each fiber unit which in the soil interlace with other fibers , once a fiber experiences a displacement tendency by force, there will be an anti-displacement who prevent it, so that any forced deformation of one fiber unit can affect other fibers interleave with it in all directions, and forming a space stress zone as consequence. Comparing with the early study(Song, 2012), the improvement of strength by basalt fiber is similar to it and has a better behavior. Combining with the above mentioned, it can be obtained that the best scheme of fiber to promote strength is 3cm, 3‰.

3.3 Relationship between strength and compactness

Samples with different compactness are conducted under the best scheme (3cm, 3‰)and the results are shown in Table.5.

Table 5. Shear strength indexes increment of BFRS under different compactness

compactness	water content / %	cohesion / kPa	angle of internal friction / °
0.96	14.66	16.6	28.9
0.94	14.88	13.5	28.5
0.92	14.79	12.9	27.1
0.90	14.63	11.1	26.6

It can be seen from the table that both cohesion and angle of internal friction decline with the compactness decrease. For cohesion, the biggest decrease occurs from 0.96 to 0.94; as for angle of internal friction, it occurs from 0.94 to 0.92, this phenomenon indicates that the influences which compactness to the two parameters of BFRS's shear strength are in different intervals.

4. STUDY OF COMPRESSION

4.1 Relationship between compression and fiber length

Taking fiber length as variable, and the mixing ratio (2‰) and compactness (0.96) are constant, this group of test reflects the relationship between fiber length and compression of BFRS, and the results are given in Fig.2. It can be seen that compressibility of BFRS declines with the decrease of fiber length. So it can be deduced that basalt fiber can improve the compression ability of the silt, and longer fiber works better. And the Figure also shows that the compressibility decreases significantly when the length change from 2cm to 3cm, and barely budged from 3cm to 4cm. Taking the uniform distribution as a consideration, 3cm is chosen as the best length to do the further studies.

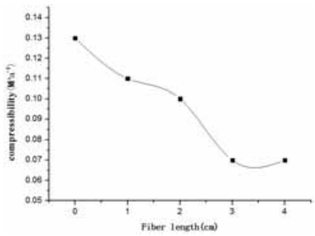

Fig.2 Relationship between compressibility and fiber length

4.2 Relationship between compression and mixing ratio

Taking mixing ratio as variable, fiber and the relationship between it and compressibility can be gotten, while the results shows in Fig.3. It can be found that compressibility presents a downward trend during the mixing ratio from 0 to 4‰, which is similar with the former study(Song, 2012), and has a better result than it. The improvement is owed to two aspects: on the one hand, fiber makes the pores in the soil filled, which make compressible space smaller; on the other hand, Friction contact surface of fiber and soil influence the deformation of the relative movement of soil element in the compression process. In this study, the curves presents as a quartic function, and embodies in□Y =-0.0008 X4+0.01 X3-0.034 X2+0.005 X+0.13. It can also be obtained that the compressibility of BFRS decreases significantly from 0 to 3‰, and slow down the speed of decline from 3‰ to 4‰, so 3‰ can be used as the best scheme.

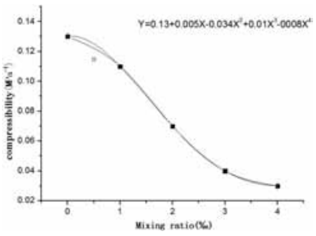

Fig.3 Relationship between compressibility and mixing ratio.

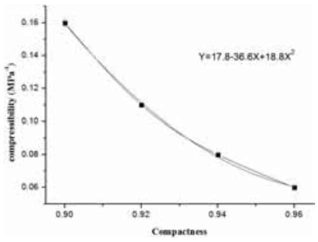

Fig.4 Relationship between compressibility and compactness.

4.3 Relationship between compressibility and compactness

Samples with different compactness under the best scheme(3‰ -3cm) are prepared to do tests which reflect relation between compactness and compressibility, and results are shown in Fig4. It can be seen clearly that with the decrease of the compactness, compressibility of BFRS presents a downward trend, and a quadratic function relation specifically, the fitting result is Y =18.8 X2-36.6 X+17.8, which is similar with the pure silt compression test(Wang, 2003), so the conclusion can be drawn that basalt fiber rarely affect the trend of relation between compactness and compressibility.

5. STUDY OF PERMEABILITY

5.1 Relationship between permeability and fiber length

Variable head permeability test are conducted of samples with different fiber length while the mixing ratio (2‰) and compactness (0.96) are constant, the results are shown in Fig.5. From Fig.5 one can see that the permeability coefficient of BFRS experiences a little change, with the range of 10%. When the fiber length is short (1cm,2cm) , the fiber can fill the pore in the soil which make water difficult to seepage, so the permeability coefficient declines ; when the fiber becomes longer (3cm, 4cm), the permeability coefficient raise again, this is because longer fiber can form a seepage channel which help water flow in the soil. And this is the biggest difference between basalt fiber and other fibers(Liu ,2012)in changing the permeability of the soil. Furthermore, 2 cm is considered as the best length in this study through the results.

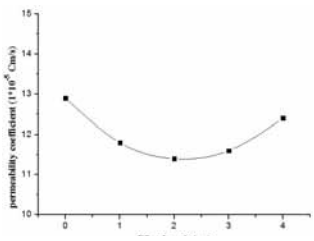

Fig.5 Relationship between permeability and fiber length.

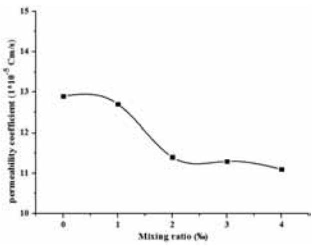

Fig.6 Relationship between permeability and mixing ratio.

4.2 Relationship between permeability and mixing ratio

Samples under best length 2cm and same compactness (0.96)are used in the test and the relation between mixing ratio and permeability can be obtained, the results are given in Fig.6. It can be seen that permeability coefficient changes from 13 to 11 as the mixing ratio raising from 0 to 4.This is similar to the glass fiber test results(Liu ,2012). It is noteworthy that when the mixing ratio changes from1‰ to 2‰, the permeability coefficient falls quickly, and then it remains stable. So the 2‰ is the best mixing ratio for improving the permeability.

4.3 Relationship between permeability and compactness

The best scheme samples are tests under different compactness to explain to relation between permeability coefficient and compactness. Figure.6 shows the results, it can be seen that there is a obvious downward trend of permeability coefficient as the decrease of compactness, which is similar with the rule of pure soil test (Gao, 2010). In addition, the decline of BFRS curves in this study is slower than the pure soil curves , and a quadratic function relation can be calculated as Y =-437 X2+751 X-308 in this study. This is because silt has a honeycomb structure and exist in the form of single particle mostly, so there are some pores among soil units which forms micro channel under pressure, but basalt fiber can fill the pore to prevent the improvement of permeability.

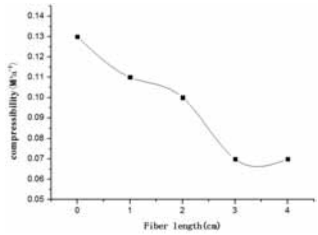

Fig.7 Relationship between permeability and compactness.

5. CONCLUSION

1. Silt reinforced by chopped basalt fiber has a significant increase in its shear strength, compression, and permeability; for the improvement of shear strength, it is mainly manifested as the improvement of cohesion.
2. Fiber length has great influence to the improvement of BFRS; for the shear strength and compression, 3cm fiber has the best behavior. For the permeability, 2cm is considered as the best length.
3. The three aspects of ability improve as the mixing ratio increase, but the growth rate declines in the range of 4‰, in this study, 3‰ is the best ratio for the shear strength; It is a quartic function relation between compressibility and mixing ratio and 3‰ is the best; 2‰ of the BFRS shows best effect for the improvement of permeability.
4. The effect of compactness to the BFRS is similar with the pure soil, and both the compressibility and the permeability has a quadratic function relation with the compactness; And the test results shows that the addition of fiber has little influence on the relationship between compactness and permeability.

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ADVANCE IN INVESTIGATION OF SIZE EFFECT OF QUASI-BRITTLE MATERIAL

POSTER

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Keywords

size effect, strain rate effect, the mechanical behavior

ABSTRACT

In the present paper some aspects of size effect of quasi-brittle materials is reviewed. From the review it is clear that from the time the size effect law based on statistical theory was established by Weibull in 1939 to the present, there are a great deal of achievements on size effect achieved. People came to know the failure mechanism of the size effect. With the help of numerical simulation, such as finite element method, discrete element method, boundary element method, and theoretical analysis, a large number of practical models were proposed and a variety of software programs were developed. The fractal theory, boundary effect, gradient theory were used to explain the size effect. Recent researches reveal that the mechanical behavior of quasi-brittle materials under static and dynamic load is entirely different when the size of structure varies, that there are many differences of the structures with or without a long crack or notch under loading and that there is a close relationship between size effect and strain effect, however the instinct mechanism is still unknown. In a word, size effect is a complex problem and continuous investigation is needed to reveal its nature.

1. INTRODUCTION

Scale is a typical problem in physics theory. Without understanding the scale, you can't understand the theory itself (Bažant 1997). There is a long history for size effects research. In16th century, Leonardo da Vinci had begun to discuss size effects and measure. "In the spinal cord with the same thickness, the longest is the weakest", this is an exaggeration of the size effect. More than a century later, Galileo refuted Leonardo da Vinci's conclusion that if a spinal cord was cut at any point, the remaining ones cannot become stronger, but he thought the size effect is real. Half a century later, Marriott found that a long rope and a short rope can bear same weight, unless there are fracture defects on the longer rope resulting in faster break than a shorter one. Qualitatively speaking, his version is a statistical theory of the size effect, which is two and a half centuries ealier than the Weibull theory. In 1921, after Griffith (1978) established the fracture mechanics, people started to use fracture mechanics theory to explain the size effect. In 1939, Weibull (1939a) established a statistical size effect. His theories on the interpretation of one-dimensional structure are very effective, such as chains and ropes, but when the problem extended to multidimensional structure, this theory cannot show the satisfactory results. Since Weibull (1939a, 1939b, 1951) developed the mathematical theory of statistical size effect, then people tried to use the theory to explain all the observed size effect from the test. From 1984, Bažant and his co-workers (1984, 1990, 1991, 1997, 1998, 2000a,2000b, 2007a, 2007b, 2009) found there existing energy type size effect in quasi-brittle materials, not the statistics type size effect. Then he divided the energy type size effect into type I and type II size effect. Type I size effect is an energy-statistics type size effect, which describes the appearance and development of crack leading to the damage of material. Usually there are no obvious notches and cracks on structures and the structure begins to crack from smooth surface. Type II size effect is a complete energy-size effects, which describes the situation that there has been deeply or stress-free deep cracks existing before the destruction. The cracks of structure develop stably before load reaches the maximum. After Bažant classified the size effect, the research methods of different type size effect are more clearly. This paper mainly discusses the two kinds of size effect.

2. RESEARCH STATUS OF COMPLETE SAMPLES (TYPE I) SIZE EFFECT

2.1 Under static load

For the study of complete samples study (I type) size effect, researchers from abroad started earlier. A lot of achievements were obtained. In 1939, Weibull (1939a) established a relationship between strength and volume when rocks are under uniaxial compression. He thought the strength of rock s decreases when volume increases. Hudson (1972) got the result from uniaxial compression test of the marble samples that rocks' strength varies with ratio of the sample. The result shows there is obvious size effect. Dreyer (1972) regarded that the sample size had nothing to do with rock strength. Later people found that only if the material is sufficiently uniform, the influence of sample size on the strength can be ignored. After energetic size effect was found, Bažant and his co-workers established relationship between nominal stress and size of type I and type II under static load. In recent years, Bažant (2009) developed universal size effect law to unify the type I and type II size effect. It proved that test data accuracy of Bažant's size effect law is authentic.

Researchers in China have also achieved a lot of achievements,though they started start late. In theoretical research, Li Xianwei (1983) and Liu Baochen (1998) are the earliest to study the size effect. Li Xianwei (1983) based on the results of previous tests got the summary of samples' strength under uniaxial compressive: strength of rocks reduce with sample size increasing; strength of rocks increase with the sample size increasing; strength of rocks change ceaselessly with sample size increasing; strength of rocks decrease first then increase with the sample size increases. Lv Zhaoxing (2007) revealed influence of heterogeneity m degree on the material strength size effect through experiments. He thought that heterogeneity is the fundamental reason of strength changing with the sizes .Yang Shengqi (2004) found that the heterogeneity of rock material is not a static variable, but a dynamic parameter, which is closely related to the damage evolution in rock cracks under external loads. The size effect of rock is largely size effect of structural plane. For uniformity strength of the material, in the 1980's, foreign scholars recognize that the nominal size effect structural strength can be attributed to the randomness of material, which is inhomogeneity of material. But later this view is proved only applicable to brittle material, such sa fatigue and brittle metal, fine ceramics.

In addition to fracture mechanics, linear elastic fracture mechanics, plasticity theory, many scholars have attempted to use other theoretical and numerical methods to explain the size effect. After Mandelbort (1982) found that the fractal in 1982, fractal theory is also applied to fracture mechanics. For type I size effect, Carpinteri (1994, 2008) introduced a method of multiplex analysis. He interpreted the size effect as a failure mechanism of damage in localized fractal pattern. Then he got type II Size size effect law trough multi-fractal. Many domestic scholars (Cao Ping, et al. 2011, Gou Peijun 1994,Zhu Zhende, et al. 2006) also tried to study the size effect of rock strength using fractal theory and got a lot of useful conclusions.

2.2 Under dynamic load

Domestic and foreign scholars mainly focus on the complete sample (type I) under static load, Complete samples under dynamic load are just got attention in recent years. Recent studies have found there is an opposite mechanical behavior for complete specimen (type I) under static loads and dynamic loads. Hong Liang and LI Xibing (2008) studied the size effect of rock strength and strain sensitivity under dynamic load. The study results showed that the larger the sample size is, the more obvious the dependence of rock dynamic strength to strain rate. Rock dynamic strength increases with the sample size increases at the same strain rate, which is contrary to the size effect under static load; Size effect of rock dynamic strength decreases with strain rate decreasing, based on which we infer that there must be a critical strain rate, when the strain rate is lower than the critical strain rate, static load size effect station dominance, higher than the critical strain rate, dynamic load size effect dominates.

The relationship between the strength and strain rate can be seen from Figure 1. Material strength increases slowly first with strain rate increases. When strain rate exceeds a certain value, a sharp increase appears. When the strain rate increases to impact explosion strain rate, trend of materials strength becomes slow. For this problem, A.Kumar (1968) analyzed dynamic strength of basalt and granite and got a conclusion that the influence of strain rate increasing to strength is similar to effect when temperature reduce and so we can use the viewpoint of heat activated to describe the mechanism of rock dynamic fracture. Nikolaevsky VN (1990) proposed a model to explain the delay and high dynamic strength. According to his model, crack growth rate is limiter. Value of dynamic strength is decided by overload.

To Hong's test conclusions, Qi Chengzhi (2009, 2011, 2014), revealed mechanism of type I size effect under static and dynamic load through theoretical derivation and got formula of critical dimensions and critical strain rate. Qi Chengzhi using Maxwell model, from the perspective of structure levels, deduced the relationship between material strength under dynamic loading and strain rate and size:

$$\Delta\sigma_I = 3\rho c_s^2 \dot{\varepsilon}_I \frac{l}{v} \tag{1}$$

Where ρ is the density of the material; c_s is elastic shear wave velocity; v is the relaxation rate can be considered to be a single or multiple crack propagation velocity under loads.
When the intensity of the residual stress reaches the strength σ_Y of material, the above formula can be written as

$$\sigma_Y = 3\rho c_s^2 \dot{\varepsilon}_I \frac{D}{v} \tag{2}$$

From the above equation we can get that dynamic loads is proportional to the size and inversely proportional to relaxation rate. So this can reveal mechanisms that the dynamic loads intensity increases with the size increasing and explained why the mechanical behavior of materials under dynamic loading and static is opposite.
For existence of strain rate, Qi Chengzhi verified the correctness of the conclusions by theoretical analysis and gave the critical strain rate prediction formula [37]

$$\dot{\varepsilon}_I = \frac{\sigma_0 v(D)}{3GD(1+D/D_0)^{1/2}} \tag{3}$$

Wherein G is the shear modulus, D_0 and σ_0 can be determined by experiments.

3. RESEARCH STATUS OF NOTCHED SAMPLES (TYPE II) SIZE EFFECT

3.1 Under static load

For the notched samples (type II) size effect, Bažant (1984) established the following formula in 1984

$$\sigma_N = Bf_t^{'}(1+D/D_0)^{-1/2} \tag{4}$$

Among themσN=P/bD or P/D2= The nominal strength of two-dimensional or three-dimensional; P is the maximum applied load or load parameters; D is the characteristics size of structure; B is the thickness of structure; B, D0 is the parameters depending on the structure size.
The above equations rederived later by Bažant, Kazemi (1990) based on equivalent of linear elastic fracture mechanics, using asymptotic approximation of the extended crack energy release function ,so size effect can be revised as

$$\sigma_N = \sqrt{\frac{E^{'}G_f}{g^{'}(\alpha_0)c_f + g(\alpha_0)D}} \tag{5}$$

The parameters are

$$D_0 = c_f \frac{g^{'}(\alpha_0)}{g(\alpha_0)} \quad Bf_t^{'} = \sqrt{\frac{E^{'}G_f}{g^{'}(\alpha_0)c_f}} \tag{6}$$

Where α_0=a_0/D is the initial crack relatively long; cf is the relative length of fracture process zone; g(α□= D (bKI/P)2 is equivalent linear elastic fracture mechanics dimensionless energy release function (KI for stress intensity factor); g'(α) =dg/dα. When α = α0; for plane strain and plane should stress, elastic modulus E' are equal to E / (1 - 2g) and E respectively; gf for is fracture energy.
In order to get the type I size effect when α→0, Bažant expends g (α) on α=0 to third term getting

$$\sigma_N = \sqrt{\frac{E^{'}G_f}{g^{'}(0)\bar{c}_f + g^{''}(0)\bar{c}_f/2D}} = f_r^{\infty}\left(1-\frac{2D_b}{D}\right)^{-1/2} \approx f_r^{\infty}\left(1+\frac{rD_b}{D}\right)^{-1/r} \tag{7}$$

Among them

$$f_r^{\infty} = \sqrt{\frac{E^{'}G_f}{g^{'}(0)\bar{c}_f}} \qquad D = \frac{\langle -g^{''}(0)\rangle}{4g^{'}(0)}\bar{c}_f \qquad \bar{c}_f = \kappa c_f \tag{8}$$

Where R is the geometric similar component parameters; f_r^{∞} is the nominal strength of the large size of the media; D_b is the boundary layer thickness caused by stress redistribution; c_f is effective length (depth) of fracture process zone starting from the smooth surface of the; < . > is Macauley brackets, which means to take the positive part. Bažant the modified (6) according to the cohesive crack model

$$\sigma_N = f_r^{\infty}\left(1+\frac{rD_b}{D+l_p}\right)^{1/r} \tag{9}$$

The lp=characteristic length of material. It represents unit size of quasi brittle materials. For concrete, it is about two to three times the size of aggregate, or it is the direction of parallel crack and effective length of the process zone along the crack propagating.

In the recent ten years, Hu and Duan (2000, 2008, 2010) proposed an alternative explanation. They think what controls quasi-brittle fracture behaviors of concrete is not specimen size, but interaction between fracture process zone (FPZ) with the nearest boundary. They call this boundary effect. They used the boundary effects to explain the size effect of concrete. They think Bažant's size effect law does not give consideration to the fracture process zone (FPZ), and only consider the specimen size D. So they derived formula considering fracture process zone (FPZ)

$$\sigma_N(P_{cri}) = \frac{f_t}{\sqrt{1+a_0/a_{FPZ}}} \tag{10}$$

$$a_{FPZ} = \frac{1}{\pi\times Y^2}\times\left(\frac{K_{IC}}{f_t}\right)^2 = 0.25\times\left(\frac{K_{IC}}{f_t}\right)^2 \propto \text{FPZ} \tag{11}$$

The reference crack length a_{FPZ} is proportional to the length of the complete developed failure process zone (FPZ) in the large structure.While two models are in good agreement with the good experimental data, they are trying to explain the size effect from viewpoint of continuum, which lead to neglect of the structural characteristics and the size of the internal structure of materials. At the same time, two models didn't give consideration to time effect and viscous mechanisms and can't reflect time effect of intensity. In practical engineering, structure is subjected to a wide range of loading rate. From low strain rate under quasi-static to high strain rate under high velocity impact, the mechanical behavior of the structure will varies with the loading rate changing. So to predict the mechanical behavior of the material accurately, people must consider the time effect deformation process.

3.2 Under dynamic load

Research on the mechanical properties under dynamic load is very few and the researches are mainly focused on the fracture toughness. Research (Fen Feng, et al. 2009, Wang Q. Z. 2008) shows that to the geometric similar specimens, the dynamic fracture toughness increases with the size increasing, which is similar to results of Hong on the complete specimen (type I). But for the specimen with fixed diameter and changing size, dynamic fracture toughness increases with the size increasing and then decreases. The curve of toughness and crack is in a convex shape. Papers (Zhang Z.X., et al. 1993, 2000) show that dynamic fracture toughness increases with the loading rate k increasing for gabbro and marble by qualitative analysis. Papers (Zhang Z.X., et al. 2001, Zhou X.P., et al. 2010) shows that dynamic fracture toughness kid can be expressed as the power function and logarithmic function of loading rate k by quantitative analysis re. As we can be seen from the test, there must be a positive correlation between the dynamic fracture toughness and loading rate k for notched specimen (type II), which means there is a positive correlation between dynamic fracture toughness and strain rate. However only few paper concern the relationship between dynamic fracture toughness and strain rate under dynamic load from home and abroad. There are no unified models considering two effects established and the mechanism has not been revealed. Taking strain rate effect into consideration may be a breakthrough to explain the mechanical behavior of notched specimen (type II) under dynamic load.

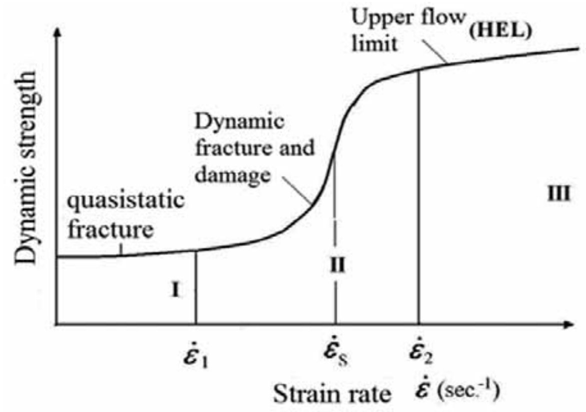

Fig. 1. Fracture mechanism of brittle materials.

4. CONCLUSION

After years of research, people have made a lot of progress to the understanding of the size effect, and with the deepening of the understanding, there are also many new problems appearing, Although the mechanism of complete samples(type I) under static load and static load has been revealed , there are few studies on the notched samples (type II) under dynamic load, the mechanism of which remains to be unknown. There are still many problems need to be solved.:

1. Is there intrinsic link between the size effect and time effect fro the notched specimen (type II)?
What is the theoretical basis of the two linkages?

2. Is there similar relationship between the notched samples (type II) and the complete samples(type I) on size effect and strain rate?

3. what role does the rupture process zone (FPZ) play during the quasi-brittle material failure process?

4. How to decide the critical strain rate of the notched samples(type II) ?

To solve these problems is of great theoretical significance for the understanding of relationship between space and time effect of quasi-brittle materials, structure properties , for the prediction of the strength of different size structu-re under different loading rate. Meanwhile there will be practical significance to improve the design accuracy and improve the safety and reliability of large structures.

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TORSION OF A PRISMATIC COMPOUND ROD MADE OF MATERIALS HAVING DIFFERENT ANISOTROPIC PROPERTIES

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Keywords

torsion, cylindrical anisotropy, logarithmic spiral

ABSTRACT

A problem of a prismatic rod torsion composed of two prismatic parts coupled along the common part of side surfaces is considered. Materials of compound parts of the rod possess different properties of cylindrical anisotropy, and have planes of elastic symmetry, coinciding with the rod's .plane of cross-section. The exact solution of the problem has been obtained when non-rectilinear edges of the resultant part of the rod's cross-section are arcs of logarithmic spirals determined by elastic constants of component parts' materials. While solving the problem a characteristic equation in eigenvalues of the boundary value problem has been derived. If the equation has roots in the interval (0, 1), then the stress at the vertex angle $r = 0$ of the cross-sections of a compound rod has a singularity. The order of singularity is equal to 1- $\lambda 1$ where $\lambda 1$ is the smallest root in the interval (0, 1).

1. INTRODUCTION

In various fields of engineering and construction, isotropic and anisotropic composite structural materials are widely used, which are subjected to diverse force influences. For composite structures, the fact that in case of homogenous isotropic bodies elastic stresses tend to zero, as vertices of outgouing angles are approached, and to infinity for reentrant angles, can be violated for compound bodies.

For the first time (Chobanyan, K.S. 1987) it has been theoretically substantiated that in case of an outgoing angle the strong stress concentration is possible at boundary points of contact surfaces of compound bodies depending on different physical and mechanical characteristics of compound components and their connection geometry and, conversely, weak stress states are possible in case of the reentrant angle.

This situation essentially changes classic ideas about calculation of strength of composite structural elements connections and poses problems for solving which new mathematical methods and approaches are required.

2. BACKGROUND

The problem of torsion of a prismatic elastic rod composed of different isotropic materials was posed and studied by N.I. Muskhelishvili (1954) on the basis of a torsion function. In the work (Vekua, I.N., Rukhadze, A.K. 1933) the problem of torsion and bending of a rod composed of two isotropic materials, limited by confocal ellipses have been considered. In the work (Chobanyan, K.S. 1987) the nature of the stress state at the edges of the contact surface in the loaded compound body was studied. The effect of elastic deformability of the materials of the joined bodies and geometry of the contact surfaces on the nature of stress was studied in detail. In the work (Sargsyan, V.S. 1965) approximate solutions of the torsion problem of prismatic composite anisotropic bodies using small physical or geometrical parameter was obtained. In the works (Gevorgyan, S.Kh. 1968; Aleksanyan, R.K., Chobanyan, K.S. 1977; Aleksanyan, R.K., Melik-Sargsyan, S.A. 1978; Belubekyan, V.M., Belubekyan, M.V., Terzyan, S.H. 2001) the research questions about characteristics of elastic stresses of the corner points of the cross-section, or torsion of prismatic bodies composed of different anisotropic parts was studied. The problem of a torsion of prismatic rods composed of two isotropic and anisotropic parts was solved in the work (Yedoyan, V.A. 2013) and a torsion problem of a prismatic rod composed of two orthotropic materials in the work (Yedoyan, V.A. 2014).

3. METHODS

In the present paper a problem of torsion of a prismatic rod composed of two prismatic parts connected along the entire common part of side surfaces is considered. Materials of component parts possess various properties of cylindrical anisotropy, have planes of elastic symmetry, coinciding with the plane of the rod's cross-section. Axes of anisotropy of the rod parts coincide with the oz axis of a cylindrical coordinate system. The compound rod is subject to torsion by moments Mz, acting on the end sections of the rod.

Let us direct the axis $\theta = 0$ of the polar coordinate system along the common rectilinear boundary of wedge-shaped parts of the rod's cross-section, and the origin of the coordinate system place at the common vertex of wedges (fig.1). Stress functions $F_i(r,\theta)(i=1,2)$ relating to the domains I and II satisfy the following differential equations

$$\alpha_{44}^{(i)}\frac{\partial^2 F_i}{\partial r^2} - 2\alpha_{45}^{(i)}\frac{1}{r}\frac{\partial^2 F_i}{\partial r \partial \theta} + \alpha_{55}^{(i)}\frac{1}{r^2}\frac{\partial^2 F_i}{\partial \theta^2} + \alpha_{44}^{(i)}\frac{1}{r}\frac{\partial F_i}{\partial r} = -2\nu \cdot (i=1,2) \cdot \tag{1}$$

where coefficients $\alpha_{44}^{(i)}, \alpha_{45}^{(i)}, \alpha_{55}^{(i)}\ (i=1,2)$ are elastic constants of materials relevant to I and II parts of the compound wedge and satisfy the following conditions

$$\alpha_{44}^{(i)} > 0, \quad \alpha_{45}^{(i)} > 0, \quad \alpha_{44}^{(i)}\alpha_{55}^{(i)} - \alpha_{45}^{(i)2} > 0, \quad (i=1,2), \tag{2}$$

where *v* is the common relative angle of torsion.

Stresses $\sigma_{rz}^{(i)}$ and $\sigma_{\theta z}^{(i)}$ $(i=1,2)$ by means of stress functions are determined by the following formula

$$\sigma_{rz}^{(i)} = \frac{1}{r}\frac{\partial F_i}{\partial \theta}, \sigma_{\theta z}^{(i)} = -\frac{\partial F_i}{\partial r}, (i=1,2) \cdot \tag{3}$$

Stress functions satisfy the following boundary conditions

$$F_1(r,\theta)\big|_{\theta=\alpha_1} = 0, \; F_2(r,\theta)\big|_{\theta=-\alpha_2} = 0, \tag{4}$$

$$F_1(r,\theta)\big|_{L_1} = 0, \quad F_2(r,\theta)\big|_{L_2} = 0. \tag{5}$$

On the contact line $\theta = 0$ the following conditions of adjacency (Vekua, I.N., Rukhadze, A.K. 1933), (Chobanyan, K.S. 1987) are to be fulfilled

$$F_1(r,\theta)\big|_{\theta=0} = F_2(r,\theta)\big|_{\theta=0}, \quad -\alpha_{45}^{(1)}\frac{\partial F_1}{\partial r} + \alpha_{55}^{(1)}\frac{1}{r}\frac{\partial F_1}{\partial \theta}\Big|_{\theta=0} = -\alpha_{45}^{(2)}\frac{\partial F_2}{\partial r} + \alpha_{55}^{(2)}\frac{1}{r}\frac{\partial F_2}{\partial \theta}\Big|_{\theta=0}. \tag{6}$$

4. CASE HISTORY

Solution of Eqs.(1) can be represented as $F_i(r,\theta) = \overline{F_i}(r,\theta) + F_{i0}(r,\vartheta)$, $(i=1,2)$ where $\overline{F_i}(r,\theta)$ are general solutions of homogeneous equations corresponding to Eq.(1), and $F_{i0}(r,\vartheta)$ are partial solutions of Eq.(1).

Let us represent functions $F_i(r,\theta)$, $(i=1,2)$ in the form of

$$\overline{F}_1(r,\theta) = r^{\lambda}\Phi_1(\theta), \; \overline{F}_2(r,\theta) = r^{\lambda}\Phi_2(\theta). \tag{7}$$

Considering homogeneous equations corresponding to Eq.(1), on the basis of Eqs(7) the following equations are derived relative to $\Phi_i(\theta)$, $(i=1,2)$

.

$$\alpha_{55}^{(i)}\Phi_i'' - 2\lambda\alpha_{45}^{(i)}\Phi_i' + \alpha_{44}^{(i)}\lambda^2\Phi_i = 0 \quad (i = 1,2) \cdot \tag{8}$$

Representing solutions of Eq.(8) in the form of $\Phi_i(\theta) = A_i e^{\theta k^{(i)}}$, we get the following characteristic equation for

$$\alpha_{55}^{(i)}k^{(i)^2} - 2\lambda\alpha_{45}^{(i)}k^{(i)} + \lambda^2\alpha_{44}^{(i)} = 0. \tag{9}$$

Taking into account conditions (2) for solution of Eq.(9), we have $k^{(j)} = \lambda(\sigma_j \pm i\nu_j)$ $(j = 1,2)$, where

,

.

$$\sigma_i = \frac{\alpha_{45}^{(i)}}{\alpha_{55}^{(i)}} \quad \nu_i = \frac{\left(a_{44}^{(i)}a_{55}^{(i)} - a_{45}^{(i)2}\right)^{1/2}}{a_{55}^{(i)}}, \quad (i = 1,2) \tag{10}$$

General solutions of Eqs(8) are represented as

,

$$\Phi_i(\theta) = e^{\lambda\sigma_i\theta}(A_i\cos\lambda\nu_i\theta + B_i\sin\lambda\nu_i\theta), \quad (i = 1,2) \tag{11}$$

and solutions of homogeneous equations corresponding to Eq.(1), $\overline{F}_i(r,\theta)$, $(i = 1,2)$ are represented as

$$\overline{F}_1(r,\theta) = r^\lambda e^{\lambda\sigma_1\theta}(A_1\cos\lambda\nu_1\theta + B_1\sin\lambda\nu_1\theta),\ 0 \le \theta \le \alpha_1, \tag{12}$$

$$\overline{F}_2(r,\theta) = r^\lambda e^{\lambda\sigma_2\theta}(A_2\cos\lambda\nu_2\theta + B_2\sin\lambda\nu_2\theta),\ -\alpha_2 \le \theta \le \alpha_1. \tag{13}$$

Satisfying boundary conditions (4) and contact conditions (6), we have a homogeneous system of equations relative to integration constants A_i, B_i $(i = 1,2)$

,

$$\begin{cases} A_1\cos\lambda\nu_1\alpha_1 + B_1\sin\lambda\nu_1\alpha_1 = 0 \\ A_2\cos\lambda\nu_2\alpha_2 + B_2\sin\lambda\nu_2\alpha_2 = 0, \\ A_1 = A_2 \\ B_2 = \mu B_1 \end{cases} \tag{14}$$

where $\mu = \sqrt{\dfrac{d_1}{d_2}}$, $d_i = a_{44}^{(i)}a_{55}^{(i)} - \left(a_{45}^{(i)}\right)^2$, $(i = 1,2)$.

From condition of existence of a nontrivial solution of the system (16) we get the following equation for

$$(1+\mu)\sin\lambda(\nu_2\alpha_2 + \nu_1\alpha_1) + (1-\mu)\sin\lambda(\nu_1\alpha_1 - \nu_2\alpha_2) = 0. \tag{15}$$

The partial solution of Eqs.(1) can be presented in the form of

$$F_{10}(r,\theta) = r^2 f_{10}(\theta), \quad F_{20}(r,\theta) = r^2 f_{20}(\theta) \tag{16}$$

Functions $f_{i0}(\theta)$ satisfy differential equations

$$\alpha_{55}^{(i)} f_{i0}'' - 4a_{45} f_{i0}' + 4\alpha_{44}^{(i)} f_{i0} = -2\nu. \tag{17}$$

Determining general solutions of Eq.(19) for partial solutions $F_{i0}(r,\theta)$ of Eq.(1) on the basis of (16) we have

,

$$F_{10} = r^2 e^{2\sigma_1\theta}(A_{10}\cos 2\nu_1\theta + B_{10}\sin 2\nu_1\theta) + C_{10}r^2, \tag{18}$$

$$F_{20} = r^2 e^{2\sigma_2\theta}\left(A_{20}\cos 2\nu_2\theta + B_{20}\sin 2\nu_2\theta\right) + C_{20}r^2, \qquad , \tag{19}$$

where A_{i0}, B_{i0}, C_{i0} are constants of integration, and σ_i, ν_i are determined by formulas (10).
Suppose it is required that partial solutions (18) and (19) satisfy Eq.(1), boundary conditions (4) and contact conditions (6). As a result we will obtain a linear algebraic nonhomogeneous system of equations relative to A_{i0}, B_{i0}, C_{i0} and $(i = 1,2)$

$$\begin{cases} 2a_{44}^{(1)}C_{10} = -\nu \\ 2a_{44}^{(2)}C_{20} = -\nu \\ e^{2\sigma_1\alpha_1}\left(A_{10}\cos 2\nu_1\alpha_1 + B_{10}\sin 2\nu_1\alpha_1\right) + C_{10} = 0 \\ e^{2\sigma_2\alpha_2}\left(A_{20}\cos 2\nu_2\alpha_2 + B_{20}\sin 2\nu_2\alpha_2\right) + C_{20} = 0 \\ A_{10} - A_{20} = C_{20} - C_{10} \\ \sqrt{d_1}B_{10} - \sqrt{d_2}B_{20} = a_{45}^{(1)}C_{10} - a_{45}^{(2)}C_{20} \end{cases} \tag{20}$$

General solutions of Eqs.(1) satisfying boundary conditions (4) and contact conditions (6) can be written as

$$F_i(r,\theta) = \sum_{(\lambda_k)} r^{\lambda_\kappa} e^{\lambda_\kappa\sigma_i\theta}\left[A_{i\kappa}\cos\lambda_\kappa\nu_i\theta + B_{i\kappa}\sin\lambda_\kappa\nu_i\theta\right] + F_{i0}(r,\theta) \quad (i = 1,2) \tag{21}$$

where are positive roots of Eqs.(15). The sum is extended to all positive roots of Eqs. (15). This limitation comes from the condition of finiteness of the potential energy of deformation in the vicinity of the point . Solutions of Eq.(21) can be written in a frequently used form

$$F_i(r,\theta) = \sum_{\kappa=1}^{\infty} e^{\lambda_\kappa(\sigma_i\theta + \ln r)}\bar{u}_{i\kappa}(\gamma) + F_{i0}(r,\gamma) \qquad (i = 1,2) \tag{22}$$

where

$$\bar{u}_\kappa(\gamma) = \begin{cases} \bar{u}_{1\kappa}(\gamma) = A_{1\kappa}\cos\lambda_\kappa\gamma + B_{1\kappa}\sin\lambda_\kappa\gamma, & 0 \le \gamma \le \nu_1\alpha_1 = \varphi_1, \\ \bar{u}_{2\kappa}(\gamma) = A_{2\kappa}\cos\lambda_\kappa\gamma + B_{2\kappa}\sin\lambda_\kappa\gamma, & -\nu_2\alpha_2 = -\varphi_2 \le \gamma \le 0, \end{cases} \quad \gamma = \begin{cases} \nu_1\theta, & \text{if} \quad 0 \le \theta \le \alpha, \\ \nu_2\theta, & \text{f} \quad -\alpha_2 \le \theta \le 0, \end{cases} \tag{23}$$

on the basis of (14), we get $A_1 = -Btg\lambda\nu_1\alpha_1,\ A_1 = A_2,\ B_2 = \mu B_1,$ and it is supposed that equation has no common roots with Eq.(15). Therefore, Eq.(23) can be represented in the following form

$$\bar{u}_\kappa(\gamma) = \begin{cases} \bar{u}_{1\kappa} = B_{1\kappa}\left(\sin\lambda_\kappa\gamma - tg\,\lambda_\kappa\varphi_1\cos\lambda_\kappa\gamma\right), & 0 \le \gamma \le \varphi_1, \\ \bar{u}_{2\kappa} = B_{1\kappa}\left(\mu\sin\lambda_\kappa\gamma - tg\,\lambda_\kappa\varphi_1\cos\lambda_\kappa\gamma\right), & -\varphi_2 \le \gamma \le 0. \end{cases} \tag{24}$$

The functions (23) or (24) on the segment are a system of orthogonal functions with piecewise-constant weight

$$d(\gamma) = \begin{cases} d_1 = \left[\alpha_{44}^{(1)}\alpha_{55}^{(1)} - \alpha_{45}^{(1)2}\right]^{1/2}, & \text{when} \quad 0 \le \gamma \le \varphi_1, \\ d_2 = \left[\alpha_{44}^{(2)}\alpha_{55}^{(2)} - \alpha_{45}^{(2)2}\right]^{1/2}, & \text{when} \quad -\varphi_2 \le \gamma \le 0, \end{cases} \tag{25}$$

as the eigenfunctions of differential equation

$$\begin{aligned} &\bar{u}_1'' + \lambda^2\bar{u}_1 = 0 \qquad \text{if} \quad 0 \le \gamma \le \varphi_1, \\ &\bar{u}_2'' + \lambda^2\bar{u}_2 = 0 \qquad \text{if} \quad -\varphi_2 \le \gamma \le 0, \end{aligned} \tag{26}$$

under the following boundary and contact conditions

$$\bar{u}_1\Big|_{\gamma=\varphi_1} = 0 \qquad \bar{u}_2\Big|_{\gamma=-\varphi_2} = 0$$

$$\bar{u}_1\Big|_{\gamma=0} = \bar{u}_2\Big|_{\gamma=0} \qquad \mu\frac{d\bar{u}_1}{d\gamma}\Big|_{\gamma=0} = \frac{d\bar{u}_2}{d\gamma}\Big|_{\gamma=0} \qquad \mu = \frac{d_1}{d_2} \tag{27}$$

Suppose that closing parts and of the contour of the compound rod cross-section domain are determined by the following equations

$$L_1:\ \sigma_1\theta + \ln r = \ln r_0 = c\ 0 \le \theta \le \alpha_1\ \Rightarrow r = r_0 e^{-\sigma_1\theta},$$

$$L_2:\ \sigma_2\theta + \ln r = \ln r_0 = c\ -\alpha_2 \le \theta \le 0 \Rightarrow r = r_0 e^{-\sigma_2\theta}.$$

Satisfying boundary conditions (4) and (5), we have

$$\sum_{\kappa=1}^{\infty} B_{1k} e^{\lambda_\kappa c}\bar{u}_\kappa(\gamma) = g(\gamma), \tag{28}$$

where

$$\bar{u}_k(\gamma) = \begin{cases} \bar{u}_{1k} = \sin\lambda_\kappa\gamma - tg\lambda_\kappa\varphi_1\cos\lambda_\kappa\gamma & 0 \le \gamma \le \varphi_1 \\ \bar{u}_{2k} = \mu\sin\lambda_\kappa\gamma - tg\lambda_\kappa\varphi_1\cos\lambda_\kappa\gamma & -\varphi_2 \le \gamma \le 0 \end{cases},$$

$$g(\gamma) = \begin{cases} g_1(\gamma) = F_{10}\left(r_0 e^{-\frac{\sigma_1}{\nu_1}\gamma}, \gamma\right) & 0 \le \gamma \le \varphi_1 \\ g_2(\gamma) = F_{20}\left(r_0 e^{-\frac{\sigma_2}{\nu_2}\gamma}, \gamma\right) & -\varphi_2 \le \gamma \le 0 \end{cases}.$$

Expanding the function $g(\gamma)$ in series of functions $\bar{u}_n(\gamma)$

,

$$g(\gamma) = \sum_{\kappa=1}^{\infty} B_k \bar{u}_\kappa(\gamma), \tag{29}$$

on the basis of Eq.(29), we get $B_{1k} = b_k e^{-\lambda_\kappa c}$, where

$$b_k = \frac{\int_{-\varphi_2}^{\varphi_1} g(\gamma)d(\gamma)\bar{u}_k(\gamma)d\gamma}{\int_{-\varphi_2}^{\varphi_1} d(\gamma)\bar{u}_k^2(\gamma)d\gamma}. \tag{30}$$

For functions of stresses the following expressions are obtained

$$F_1(r,\theta) = \sum_{\kappa=1}^{\infty} b_k e^{\lambda_\kappa\left(\sigma_1\theta + \ln\frac{r}{r_0}\right)}\left(\sin\lambda_\kappa\gamma - tg\lambda_\kappa\varphi_1\cos\lambda_\kappa\gamma\right) + F_{10}(r,\gamma), \tag{31}$$

$$0 \le \gamma \le \varphi_1, \quad \gamma = \nu_1\theta,\ 0 \le \theta \le \alpha_1,$$

, ,

,

$$F_2(r,\theta) = \sum_{\kappa=1}^{\infty} b_k e^{\lambda_\kappa\left(\sigma_2\theta + \ln\frac{r}{r_0}\right)}\left(\mu\sin\lambda_\kappa\gamma - tg\lambda_\kappa\varphi_1\cos\lambda_\kappa\gamma\right) + F_{20}(r,\gamma), \tag{32}$$

$$-\varphi_2 \le \gamma \le 0, \quad \gamma = \nu_2\theta,\ -\alpha_2 \le \theta \le 0.$$

5. RESULTS

An equation for λ values of the considered boundary value problem has been derived. It was shown that eigenfunctions, which correspond to the different eigenvalues, are orthogonal on the non-rectilinear L_1 and L_2 curves of rod transversal cross-section with piecewise constant weight, where these curves are arcs of logarithmical spirals determined by the corresponding characteristics of anisotropy. The functions of the stresses are represented in the form of the sum of the eigenfunctions corresponding to the positive eigenvalues in I and II domains.

6. CONCLUSIONS

The stresses in the angular point of transversal cross-section of the prismatic rod have singularity when the equation for the eigenvalues has roots in the interval (0; 1). The order of singularity is equal to $1-\lambda_1$, where λ_1 is the smallest of these roots. The formulas for stress functions enable to calculate real values of stresses at each point of the rod cross section. Using the obtained exact solutions to the problem, it is possible to estimate the approximate solutions.

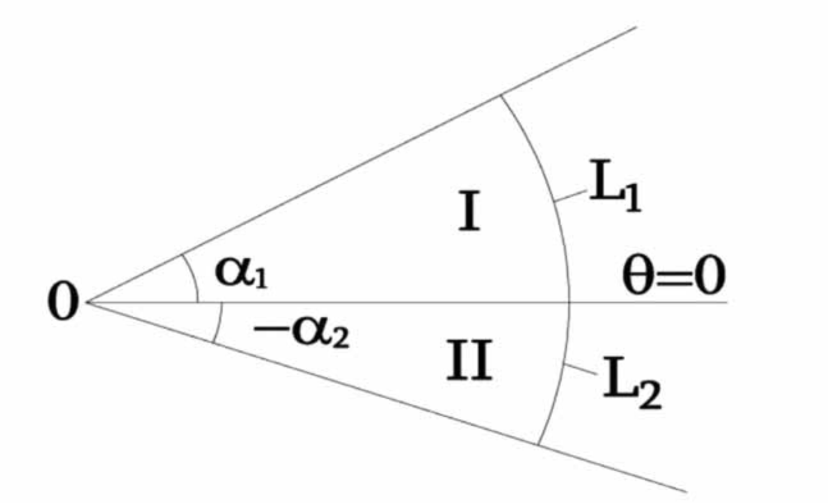

Fig. 1. Let us direct the axis $\theta = 0$ of the polar coordinate system along the common rectilinear boundary of wedge-shaped parts of the rod's cross-section, and the origin of the coordinate system place at the common vertex of wedges.

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FEM MECHANICAL ANALYSIS OF A LARGE-SPAN STEEL TRUSS TRANSFER IN STEEL FRAME STRUCTURE

POSTER

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large-span, reaction spectrum method, steel structure

ABSTRACT

The application of steel structure increasingly widely for its own advantages in the modern architectural of structure design. As for the requirements of architectural changes and fire or other requirements the conversion structure had been a rapidly development. This paper describes the selection of a large span belt truss transfer structure and many advantages in such engineering. By Using software reaction spectrum method calculating and analyzing two structural systems to ensure that if the method which through the lower plus bracing can meet the seismic requirements. Provide guidance for such projects.

INTRODUCTION

With the continuous development of economic and our daily life, people's demand for high-rise buildings continue to improve. In China, Increasing concentration of the urban population, objective factors such as commercial competition prompted the gradual increase in the number of high-rise buildings in the city. With the functional requirements of the high-rise buildings increased, the development direction of modern high-rise buildings show diversity, integrated and comprehensive features. Modern science and technology with the development of tall buildings has both novel and complex and comprehensive diversity becomes an attainable goal. Common layout of modern high-rise buildings are: the upper floor residential middle floors as offices lower floors to open shops, restaurants, and features some recreational and cultural facilities, with the function of each floor of the building. Upper floor walls and open a small mid adequate arrangement of floors wall to ensure that the requirements of the Office of; lower floors requires large axes and column arrangement, ensuring flexible use of space, internal walls as little as possible, meeting space, shops, restaurants and other public facilities requirements. This design contradicted to reasonable arrangement of structure[1].

1. PROJECT OVERVIEW

This project is located in Nanning, Guangxi, structure in this paper belong to the skirt building of project (G zone, after the same), G zone major function for dining, function room. G zone annex 5 floors above ground, the main structure height 29.0M, Because the fire exits required by g area, you need to set channels to meet the needs at the bottom, through the conversion of the structure of, G zone plan shown in Figure 1.

2. STRUCTURE SELECTION

At present, conversion of the common form of transfer is slab, beam transfer, truss type conversion [2]. In the three forms of transformation the beam-type transfer and transfer slab due to convert layer so stiffness that seismic response is strongly. This project conversion belong to the large-span conversion, so weakly seismic response of truss transfer story conducive to the integrity structure stability.
Trussed transfer structure have the advantages of transmitting force clear, forcing transmission route clear. Transfer trusses not only with openings and piping, and their great flexibility in location and size, makes it possible to make full use of building space. Trussed transfer structure weight and lateral force resisting is smaller than transfer beam

,so that the quality and stiffness of high-rise building with truss transfer story becomes relatively moderate. At the same time the seismic response of high-rise building with transfer beam is much smaller.

Because of the G zone skirt building facade of the building complex, multiple large span, cantilever layout(appear more than 20m span and 5m suspension in many places) ,you need to set large span conversion layer, solid-web steel beam and local steel davit arrangement so the structures can be realized. Main entrance of the fire lanes need to be set on underpinning truss (maximum span is 32m), upper underpinning is a 3-layer structure, Simulation analysis on construction system of the above situation is as follows.

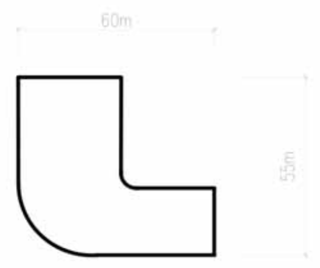

Fig. 1 G zone plan.

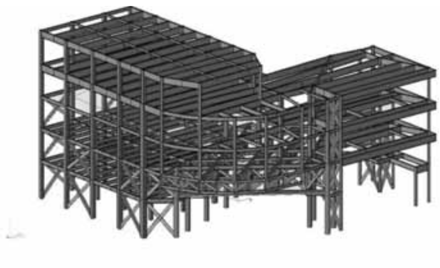

Fig. 2 Structure calculation model.

1) If use of reinforced concrete structures, local steel concrete column can be used to support transition truss. Meanwhile, in consideration of elevator to design shear wall, which formed a frame-shear wall structure system;

2) If used the concrete structural system can not effectively solve the several problems of large and large cantilever(including cantilever end davit Column) structure. Then increasing the encryption column grid has a greater impact on the building's function. (through communication with professional architectural,Column grid have no conditions to Adjust the layout otherwise will impact architectural usage and The facade of the structure.

3) If use the concrete structure system, Underpinning the above 3 layer structure conversion truss part adopts the steel frame structure system connection conversion truss, steel reinforced concrete, trusses conversion Underpinning steel frame and reinforced concrete structures of the body Part node need be designed complexity, it will make it difficult to Construct and additional costs;

4) If use the steel frame structure, it is effectively to achieve and other purposes. Combined with stairs and layout, set a small amount of steel support in the appropriate space in order to control the structure reversed, improve the structures's resist lateral stiffness, balance hogging moment of conversion truss's ends;

5) Brief analysis of column grid of the structure and system selection:

a. Brief analysis of the overall structure of the column and system selection the portion of the span is limited demand, but to use steel structure system;

b. Structure building roof of 2~5 layer, which is Located in the south part of the G zone, is substantially large span system (maximum span of around 24m).Because of the span requirements the steel structure system was taken in.

c. The west side of G zone is Complex structures, layer 2 and 3 floors 8.4m standard column , 4 layer with big openings, 5 layer and roof for large span and large span pick system (over a span of 24m, cantilevering over 5m). Even if the lower floors with concrete structure system, to assurance the big span steel beam constitute a stable framework system, there will be a large number of steel column, which brings great difficulties to construction and cost control;

d. If G zone use concrete and steel frame hybrid structure system in the specification did not have a clear definition, which will make it difficult to define the structure system and control Calculate indicators;

So by comparison of the scheme, G zone skirt building should be used steel frame structure with truss transfer layer.

3. CALCULATION RESULTS OF RESPONSE SPECTRUM METHOD

In order to ensure that the large space structure in the bottom has suitable stiffness, strength, ductility and seismic capacity, we must try to strengthen the conversion layer at the lower part of the main body structure, weaken the conversion layer is arranged on the upper part of the main body structure stiffness . Layer and lower of the transfer body structure's stiffness and deformation characteristics as close as possible. γ (shear stiffness ratio) should be close to 1. When non-seismic design translation γ should not be bigger than 3. The seismic design of the γ should not bigger than 2[3]. Stiffness of the layer structure is small because of the truss conversion layer's strengthen so

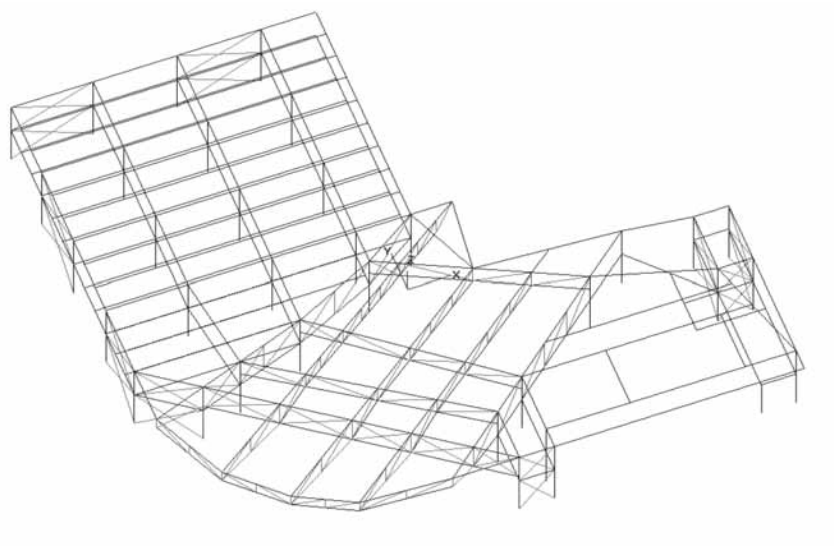

Fig. 3 Truss transfer story plan.

the substructure should be strengthened.

The lower part of this project with bracing to strengthen the computing model is shown in the Figure II. The truss transfer story plan is shown in Figure three. The main structure be analyzed by the YJK1.5.3 as he main calculation software and Gen ver800 Midas as the supplementary software. The calculation of earthquake response spectrum method is shown in the Table I.(Note: Gen ver800 Midas results in the calculation).

The calculation of earthquake response spectrum method is shown in the Table I.(Note: Gen ver800 Midas results in the calculation)

1）Periodic and vibration mode

Periodic（Second）	Vibration mode		Period ratio Tt/T1	Allowed values
T1	0.8286(0.8083)	Y transverse vibration		
T2	0.7189(0.6990)	X transverse vibration	0.67(0.68)	≤0.90
Tt	0.5571(0.5466)	torsion		

2）Maximum displacement under earthquake

Direction	Interlayer displacement angle		Displacement ratio	
	Value of calculation	Permissible value	Value of calculation	Permissible value
X	1/1438(1/1183)	1/250	1.31(1.325)	≤1.5
Y	1/1437(1/1299)		1.37(1.152)	

3）The earthquake force

Direction	Structural bottom shear（kN）	The minimum cut weight ratio	Permissible value
X	3527.44(4488.7)	4.048%(5.282%)	≥1.60%
Y	3227.13(3924.2)	3.704%(4.618%)	≥1.60%

4）Effective mass participation factor

Direction	Value of calculation	Permissible value	mode number
X	97.97%(97.72%)	≥90%	15
Y	98.11%(97.44%)	≥90%	15

4）Effective mass participation factor

Direction	Value of calculation	Permissible value	mode number
X	97.97%(97.72%)	≥90%	15
Y	98.11%(97.44%)	≥90%	15

5）The percentage of underlying framework overturning moment

Direction	Frame column(kN • m)	Percentage	Permissible value
X	32999.0	42.4%	-
Y	35287.9	50.4%	-

6）Checking of Constrained part

Direction	Ratio	Permissible value
X	2.00	≥2.00
Y	2.00	≥2.00

7）Ratio of Shear capacity

X/Minimum Shear capacity	Y/Minimum Shear capacity	Limit of deflection
1.00(0.8471)	1.22(0.88)	≥0.80

8）Ratio of lateral stiffness

X	Y	Limit of deflection
meet requirement	meet requirement	0.7、0.8

Table I The results of the response spectrum method[4][5][6]

4. CONCLUSIONS

1)The results of YJK and Midas Gen basically in a line and the overall dynamic performance index structure are basically the same which effectively verified the validity of the calculation results is correct;

2) G zone skirt building's response of response spectrum method Periodic and vibration mode, Maximum displacement under earthquake, The earthquake force, Effective mass participation factor, Percentage of underlying framework overturning moment, Ratio of Shear capacity, floor Shear Capacity ratio calculation indicators can better meet the regulatory requirements, irregular and vertical planar structure all have better control irregular;

3) The response spectrum method analysis of G District shown that Interlayer displacement angle changed obviously (especially adjacent conversion structure truss floors), but due to set up the effective structure of each Interlayer displacement angle absolute value are far to meet the requirements of the specifications. The overall lateral stiffness surplus to a greater degree so the structure is safety. For large span with truss transfer story steel structure, due to the vertical stiffness changes especially in the conversion layer stiffness is very large, so strength the whole seismic response of especially the lower structure is very favorable, it makes the structure more safe and stable.

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FINITE ELEMENT ANALYSIS OF THE HISTERETIC BEHAVIORS ON LINK-TO-COLUMN CONNECTION USING RIB-STIFFED PLATE FOR D-TYPE ECCENTRICALLY BRACED STEEL FRAMES

POSTER

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Keywords

D-type eccentrically braced frame, rib-stiffened plate link , hysteretic behavior

ABSTRACT

The link-to-column connection of traditional D-type eccentrically braced steel frame is prone to damage under the cyclic loading. Rib-stiffened plates are used to strengthen the link-to-column connection in this paper. By ABAQUS software, hysteretic behaviors have been comparatively analyzed for rib-stiffened plate D-type eccentrically braced steel frame and traditional system. Results indicated that rib-stiffened plate D-type eccentrically braced steel frame, which link buckling first, could effectively prevent premature destruction of the connection. Strength and stiffness was similar to the traditional system, and rotation capacity of the link increased.

INTRODUCTION

With the continuous development of economic and our daily life, people's demand for high-rise buildings conti In traditional D-type eccentrically braced steel frame, cause of link directly connecting to the column, the end of link under large bending moment and shearing force, results in connection prone to damage. Rib-stiffened plates are used to strengthen the link-to-column connection in this paper, making link not directly connecting to the column, can effectively prevent premature destruction of the connection. The link can fully develop plastic deformation, so that more seismic energy could be dissipated, and repair work would be reduced after the earthquake[1]. Traditional system and rib-stiffened plate D-type eccentrically braced steel frame are shown in Fig.1, Fig.2, respectively, e is the length of link. Rib-stiffened plate connection is shown in Fig.3. Using ABAQUS software, hysteretic behaviors were comparatively analyzed for rib-stiffened plate D-type eccentrically braced steel frame and traditional system..

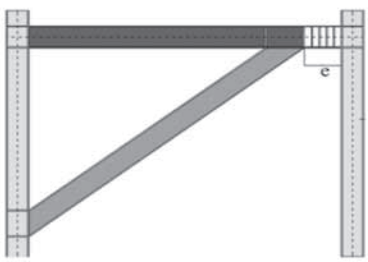


Fig. 1 Traditional D-type eccentrically braced steel frame.

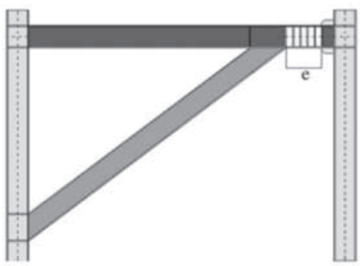
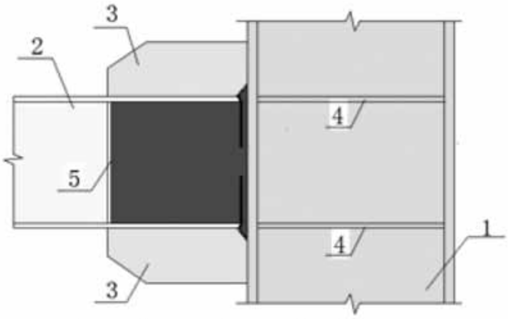


Fig. 2 Rib-stiffened plate D-type eccentrically braced steel frame.



1—column; 2—link; 3—rib-stiffened plate;

4—column stiffeners; 5—beam stiffeners

Fig.3 Rib-stiffened plate connection

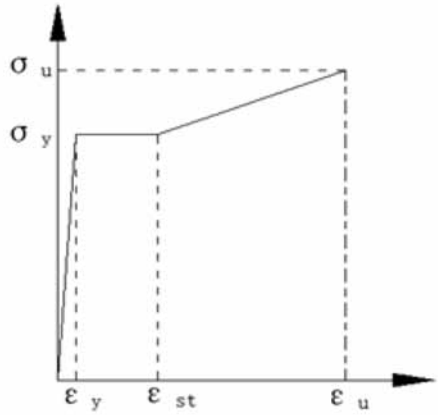


Fig.4 The sketch of constitutive relationship for steel

2. FINITE ELEMENT MODEL

This paper designed two steel frame, which were made of steel grade Q235. Suppose that the distribution of steels is homogenous, stress-strain curve is the same everywhere, regardless of the effect of the rolling on the properties of steels and the steel is isotropic. Shear yielding of link length requirement[2]:

In the formula: ——length of link;

——full plastic moment of link;

——shear strength of link.

Through calculation, the link length was determined to be 630mm. Rib-stiffened plates' size were 210×100 (h) ×10. Link set 10mm thickness transverse stiffeners, spacing of 126mm. Rib-stiffened plate D-type eccentrically braced steel frame (EBF-D2) and the traditional system (EBF-D1) of component sizes are shown in Table 1.

Table 1 Structure members dimensions (unit: mm)

Component	Component section	Component length（mm）
Beam	HM400×150×8×13	4770
Link	HN400×150×8×13	630
Column	HM350×350×12×19	3900
Brace	HN300×150×6.5×9	—
Web stiffener	71×374×10	—

2.1 Constitutive Relationship

Specimens' yield strength σ_y Ultimate strength σ_u Modulus of elasticity E [3] etc, are shown in Fig.4. Poisson's ratio V-0.3. The stress-strain relationship is shown in Fig.4, symbol values in Fig.4 are provided in Table 2.

Table 2 Finite element model material parameters

Component	σ_y (MPa)	σ_u (MPa)	ε_y (%)	ε_{st} (%)	ε_u (%)	E (MPa)
Beam	297.53	483.14	0.162	0.0131	0.1028	1.83364
Column	296.205	502.555	0.1877	0.01488	0.1124	1.57512
Brace	255.916	455.368	0.142	0.01534	0.09519	1.79556

2.2 Meshing

Solid element named C3D8R were used for all components. The grid size of all specimens was 120mm except the link and connections which were 31mm respectively. Finite element meshing of overall structure is shown in Fig.5.

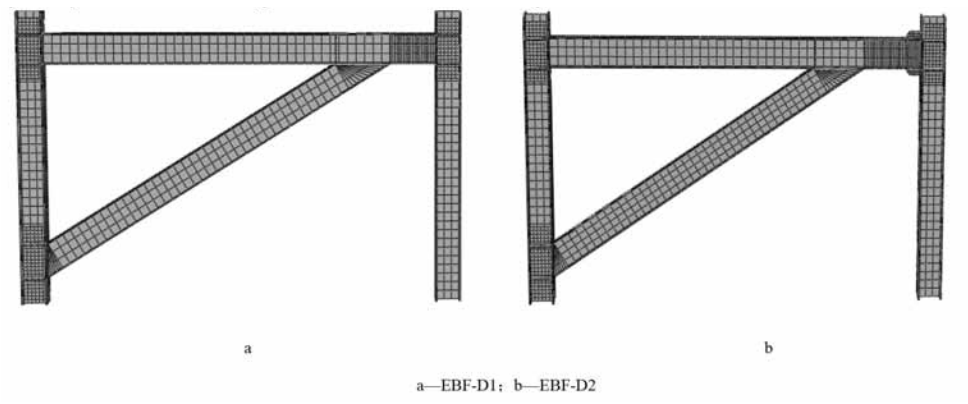


Fig. 5 Finite element meshing of overall structure.

2.3 Contact Definition

Contacts were all tying in this paper, including link-to-column connections, beam-to-column connections, brace-to-column connections, brace-to-beam connections and stiffeners, etc.

2.4 Loading and Boundary Conditions

In the analysis, vertical load of 80N was supposed to each column to simulate axial compression ratio and lateral reciprocating displacement was applied to each column, increasing amplitude of the displacement is 4mm. The analysis was stopped until the displacement amplitude reached 40 mm. The loading diagram of displacement control is shown in Fig.6. In the model, all degrees of freedom were fixed in the bottom end of the column, as shown in Fig.7.

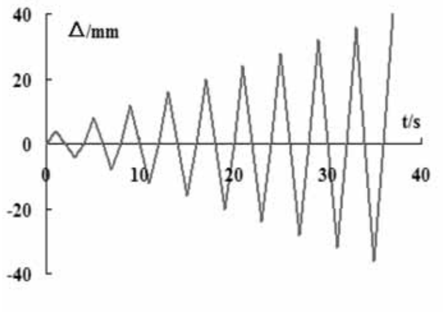


Fig. 6 The loading diagram of displacement control.

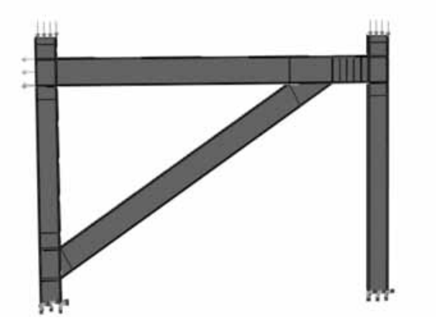


Fig. 7 The diagram of loading and boundary conditions.

2.5 Failure Criterion

In the design of earthquake-resistant, link beam should destroy first, this means that other components remain in the elastic range. Therefore, when the system appears any of the followings, you may conclude its destruction[4] :

(1) When three plastic hinge on the beam or column sections, namely, structure has developed mechanism;

(2) Structural local damage, such as a beam flange buckling.

3. THE ANALYSIS RESULTS OF FINITE ELEMENT MODEL

3.1 Loading Results Analysis

When two steel frames destroyed, the Mises stress of link-to-column connections are shown in Fig.8 respectively. Under the cyclic loading, EBF-D1 link web close to the columns first reached the yield , then the link flanges reached yield. EBF-D2 link web reached the yield almost simultaneously.

As shown in Fig.9, when frames destroyed, EBF-D1 link web formed shear hinge, link flanges formed bend hinge. EBF-D2 link web formed shear hinge, link flanges were out of the yielding phase.

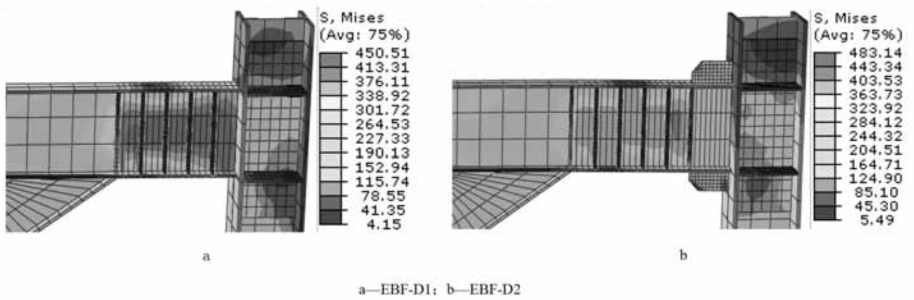


Fig. 8 The Mises stress of link-to-column connections.

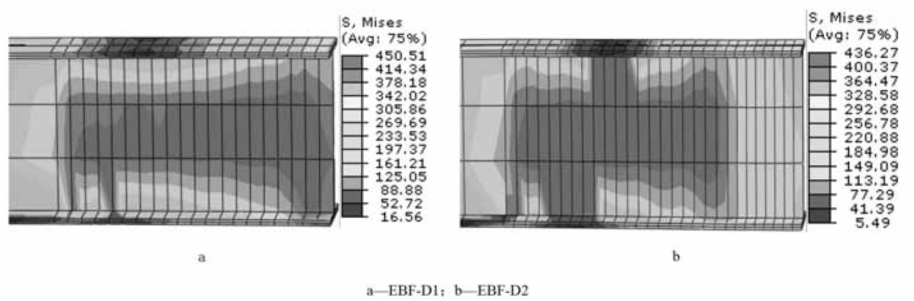


Fig. 9 The Mises stress of link.

As shown in Fig.10, when frames destroyed, the rib-stiffened plates reached the ultimate strength of steel. But the web in strengthened region reached the yielding critical state, the link flanges were out of the yielding phase. In a word, the rib-stiffened plates could fully develop link's shear deformation, dissipate more seismic energy.

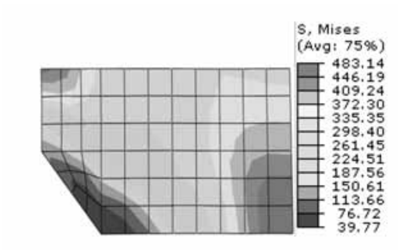


Fig. 10 The Mises stress of rib-stiffened plate.

3.2 Analysis of Hysteretic Behavior

As shown in Table 3, when frames destroyed, EBF-D2 has a larger rotation angle than EBF-D1, so EBF-D2 has better capability of rotation. The bearing capacity is roughly equivalent.

Table 3 Results of two frames under cyclic loading

Specimen	Yield load (kN)	Yield displacement(mm)	Yield rotation angle(rad)
EBF-D1	617.37	6.47	0.0123
EBF-D2	606.33	6.24	0.0119
Specimen	Failure load(kN)	Failure displacement(mm)	Failure rotation angle (rad)
EBF-D1	1812.24	27.2	0.0533
EBF-D2	1889.41	32.0	0.0609

Load-displacement hysteretic curve of two frames under cyclic loading is shown in Fig.11. Can be seen from the diagram that two frame hysteretic curve is rich and stable, spindle, without pinch approach phenomenon. Gave in reverse loading after yield, a softening phenomenon appeared, namely Bauschinger effect. Two frame load-displacement hysteretic curve are very close. As shown in Fig.12, two-frame skeleton curves could also be seen, the bearing capacity is roughly equivalent.

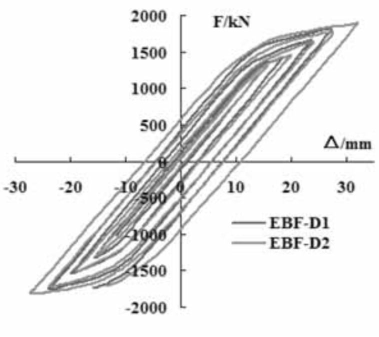


Fig. 11 Load-displacement hysteresis curve.

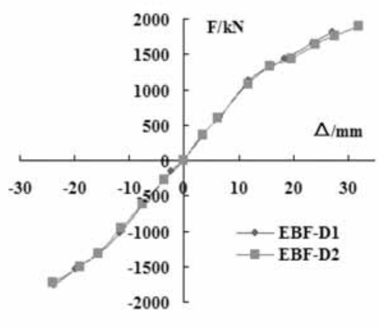


Fig. 12 Skeleton curve.

Shear-angle hysteresis curve of two frame under cyclic loading is shown in Figure 13. Can be seen from the diagram that two hysteresis loop of the frames are fusiforms, EBF-D1 is slightly pinched up than EBF-D2, EBF-D2 is much fuller and steady, without pinch approach. When frames destroyed, EBF-D2 link rotation angle was 0.0609, EBF-D1 was 0.0533, EBF-D2 was higher than EBF-D1 about 14.3%. Obviously, Rib-stiffened plate connection has greater capability of rotation.

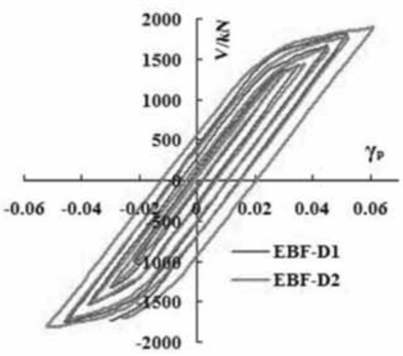


Fig. 13 Shear-angle hysteresis curve.

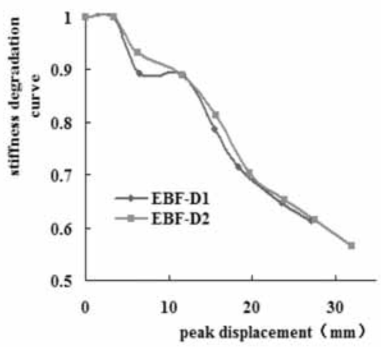


Fig. 14 The curve of the stiffness degradation.

3.3 Stiffness Degradation

The ratio of the equivalent stiffness to the maximum equivalent stiffness is called the equivalent stiffness degradation coefficient. Curve connected by points consisting of peak displacement at various levels and their corresponding equivalent stiffness degradation coefficient[5], is the stiffness degradation curves. It can reflect the stiffness degradation of structure.

Equivalent stiffness degradation curves are shown in Figure 14. The law of two frames' stiffness degradation is similar. The stiffness before the yield remained unchanged, stiffness degenerated obviously after link shear yielding occurred. As reciprocating displacement increased, the rigidity of the structure gradually reduced because of the link beam yield produced large plastic deformation[6]. When destroyed, frames remained very high initial stiffness, it can be seen that frames' lateral capacity are both good.

4. CONCLUSIONS

(1) The rib-stiffened plate D-type eccentrically braced steel frame with link move from the column, avoiding premature destruction of the connection, can fully develop link shear plastic deformation and dissipate more seismic energy.
(2) Compared with the traditional system, hysteretic curve of the rib-stiffened plate D-type eccentrically braced steel frame is fuller, stability, and rotation capacity of the link significantly improves obviously.

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SESSION 6

TECHNOLOGIES AND OPERATIONAL METHODOLOGIES FOR CONSERVATION

AN ANALYSIS OF THE EVOLUTION OF ARCHITECTURAL METRIC SURVEY BY COMPARISION OF TWO SURVEYS OF *PORTA ALL'ARCO* (VOLTERRA, ITALY): FROM 1996 TO 2014

POSTER

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Keywords

survey, Volterra, Porta all'Arco

ABSTRACT

The survey of the Etruscan Porta all'Arco in Volterra was performed in 1996 with traditional direct methodology. In 2014, a new survey of the same monument has been done again with laser scanner and Structure From Motion techniques.

The comparison between these two survey experiences gave cause for wider considerations. It's different the ratio of time spent in situ and the quantity and quality of detectable information. Current techniques allowed, in fact, to obtain an accurate three-dimensional model information with high spatial resolution.

Otherwise, even if this model can be a good aid for the reading of the heritage using virtual navigation software and for the realization of three-dimensional information systems, we still need, as in the past, to interpret the synthetic model of the heritage and realize the two-dimensional representations for specialized analyzes.

1. INTRODUCTION

The Laboratorio Universitario Volterrano (LUV) is an institution of interdisciplinary education and research, working for the study and valorization of the cultural, environmental and historical heritage of Volterra in Italy[1.] The activities that are annually carried out by LUV, involve teachers and students of different disciplines: engineering, architecture, history, sociology, archaeology. LUV was inaugurated in 1996 with a research on the medieval city walls of Volterra. In this context, the survey of Porta all'Arco, one of the main city door, was carried out (fig. 1).

The important role that the door has always played in the past is demonstrated by its historical and architectural values. All its construction phases, in fact, are still recognizable: the Etruscan phase, made by sandstone blocks, dated to the 4th century BC; the later one, presumably dated from the 3rd to the 1st century BC, with the construction of the two arches; the medieval phase, which determined the inclusion of the door in the city wall and its strengthening with the construction of a tower on the top[2]. The architectural survey of the monument was done at that time with traditional direct method. Eighteen years later, always within the activities of LUV, a new survey was carried out with laser scanner and photogrammetric image based modelling methods.

This paper aims to show the results of a comparative analysis of these two survey experiences. The comparison, aimed in the first place to verify the validity of the first survey, gave cause for reflection not only on the methodological and operational aspects, but primarily on what De Simone define "implications", i.e. the relations that may be established between environmental structures and operators, the notions that the survey may highlight as instrument of knowledge of the real (De Simone, M. 1990, p. 221).

2. BACKGROUND

The operational methodology constitutes only a part, although significant, of the architectural survey discipline. The survey is primarily a powerful research tool that allows to understand deeply a work of architecture, taking in all the values, from the constructive to the dimensional ones, from the formal to the spatial ones, making certainly a work of geometric clarification, of measurement, of historical and technology knowledge and, above all, of reading

and graphic transcription of its formal and architectural quality (Docci, M., Maestri, D. 2009, p. 4).
The critical reading of a complex architectural phenomenon involves its discretizing, which occurs since the first inspection, drafting the preliminary sketches; reading that is refined in the measurement phase, planned and integrated in light of the knowledge of the historical and cultural context in which the architecture was made. Therefore, the final drawings, showing the results of the analysis, describe first an experience, in the meaning of "what is acquired in a slow meditative phase on the artefact until reaching a global information" (De Simone, M. 1990, p.235).
Based on the above, it is clear that the concept of 'precision' in a survey drawing has a wider meaning which, beyond the geometric accuracy, it is closely linked to the effectiveness of the drawing to represent and transmit the results of this experience. For these reasons, the precision cannot exclude the codes of the two-dimensional representation, mainly because - as explained by De Rubertis - "it is the structure of the two-dimensional representation to determine the decisive simplification and clarification of the reality", as the simplification of the reality by means of plans derives "from the thought attitude to develop logical constructions in the same two-dimensional shape which characterizes the perception "(De Rubertis, R. 1994, p. 17).
As regards the case of *Porta all'Arco*, on the base of what we say, it is clear that the comparison between these two survey experiences cannot be solved in mere terms of geometric precision, but should primarily aim to define how these two experiences were effective for the critical reading of the monument.

3. METHODS

Noted that the survey is mainly a tool for the critical knowledge of an architectural object, before starting the measurement phase, it is necessary to approach the architecture by means of a careful inspection, aimed at evaluating in situ its dimensional, formal, material and structural aspects. In this first phase, it is necessary to have reached formerly a fair knowledge of the historical-critical notions, aimed to provide an initial documentation. In this phase, also, drawing sketches is very useful for jotting down the first considerations. The preliminary phase is also essential in defining the survey method and in planning all the operational activities.
The method choice usually depends on several factors: the available equipment and resources, the survey purpose, the level of required accuracy, the stereometric complexity of the structure. The new survey technologies make the traditional direct method outdated. However, beyond the instrumental aspects and the operational optimization, the direct method forces the operator to a first critical reading of the object, and to a first simplification of the architectural model in a series of horizontal and vertical plans to which referring all the measures. It leads to the simplification and to the critical recognition of the constructive elements - geometric shapes, structural components, material elements etc. - according to a scale of complexity and importance. For these reasons, the measures taken in the various plans - physical measures, trilaterations etc. - give dimension to a model, which is already partly understood.
On the other hand, the laser scanner and structure from motion methodologies do not require the operator to do the initial phase *in situ* of subjective interpretation and simplification of the architecture, but rather to define the adequate resolution and accuracy for further studies and investigations. These methods record and give back directly the three-dimensionality of the actual state of the architecture, postponing its critical reading in virtual environment. The new survey technologies should not record merely quantitative and extremely specialized information (Guzzo, P.G. 2010). The benefits in which multisensor/information fusion are used can be grouped into two major categories: information augmentation and uncertain management (Blash, E., Hong, L. 1999). The first category refers to cases in which each sensor shall provide only one type of information, for which the integration of multiple sensors increases the knowledge of the object. The second is related to the verification of the quality of the acquired data and its possible improvement (Guidi, G. et al. 2010). The new technologies must therefore not only be preferred for their greater efficiency in the data collection, but for their contribution in the control and improvement of the rigor of the geometric representation, and especially for any additional information that they may give in the reading of an architecture. In fact, despite the schematization of the three-dimensional reality in two-dimensional representations is typical of the human perception, some evaluations could be done only by a three-dimensional visual experience, which allows the operator to navigate virtually in 3D, getting information by the possibility of having an overall view of the object.

Fig. 1. *Porta all'Arco* in Volterra. View of the extra-moenia front (photo: authors).

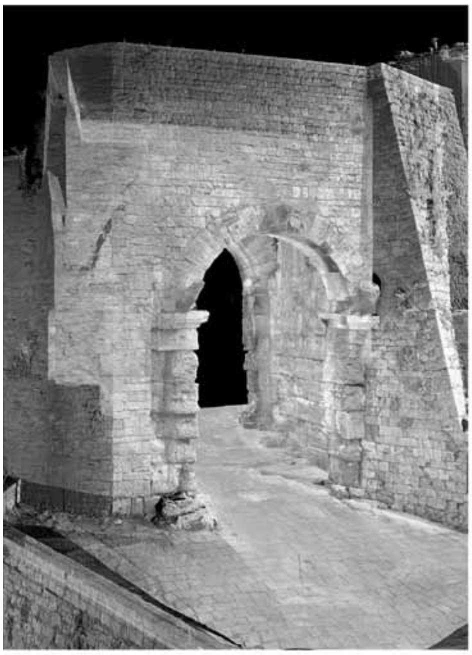

Fig. 3. 3D models of the Porta all'Arco. On the left, laser scanner point cloud model; on the right, model from photogrammetric Structure from Motion survey.

4. CASE HISTORY

As mentioned before, the first survey of *Porta all'Arco* was carried out in spring 1996 with traditional direct methodology. About 20 students in Building Engineering of the University of Pisa attended the survey during a five-day stage. The shape of the door and the degradability of the sandstone - panchina - with which the Etruscan walls are made, required a series of operations aimed at the virtual rebuilding of its geometric profiles. Through a system of vertical and horizontal wires, the original abutments and the edges of the wall surfaces in the inner chamber were reconstructed in situ. These constituted the references for all the general measurements and defined the reference system for detailing each stone block. All the measurements for the description of the plan were referred to a horizontal plane situated at about -2.89 meters from the intra-moenia capital upper side on the right. The measurements in the horizontal plane were referred to a system constituted by a main longitudinal axis and some secondary orthogonal branches (fig. 3). All the vertical dimensions were referred to the horizontal reference plane. The final handmade drawings describes the plan of the door, the intra-moenia and extra-moenia facades, the longitudinal and transversal vertical sections (scale 1:25).

The second survey, carried out in April 2014, was based essentially on two three-dimensional survey methods: laser scanner and image based modelling. As it regards the first methodology, a Leica ScanStation C10 with built-in camera was used. Ten high spatial resolution scans (about 25 points / cm^2) were performed. The rigorous point cloud registration was possible thanks to the survey of the station points coordinates (4 mm registration error). These coordinates were registered both by the laser scanner in its own reference system and through a 3D network by total station measurements. This network defined the common reference system to all the different survey methods. The final point cloud model consisted of approximately 130 million points with associated RGB information resulting from the built-in camera (fig. 2). This goal was obtained thanks to a work in situ of 3 people for about 3 hours and to a phase of post-processing by one person for about 4 hours. The second methodology is based on modelling using Structure From Motion photogrammetric techniques. A Nikon D700 camera with a fixed 50mm lens was used for the acquisition of 54 frames. To ensure a more accurate calculation of the camera orientation parameters and to check the model precision, 30 control points (CP) were placed on the artefacts. The model average error on the CPs was about 3 mm. The final product of this methodology was a TIN textured model (fig. 2). To achieve this, it was necessary: a phase of creation and survey of CPs (2 people for 2 hours), a phase of acquisition of the frames (1 person for 2 hours) and a post-processing (collimation of CPs, image alignment, creation of the point cloud, triangulation, texture application) that took one person for about 4 hours.

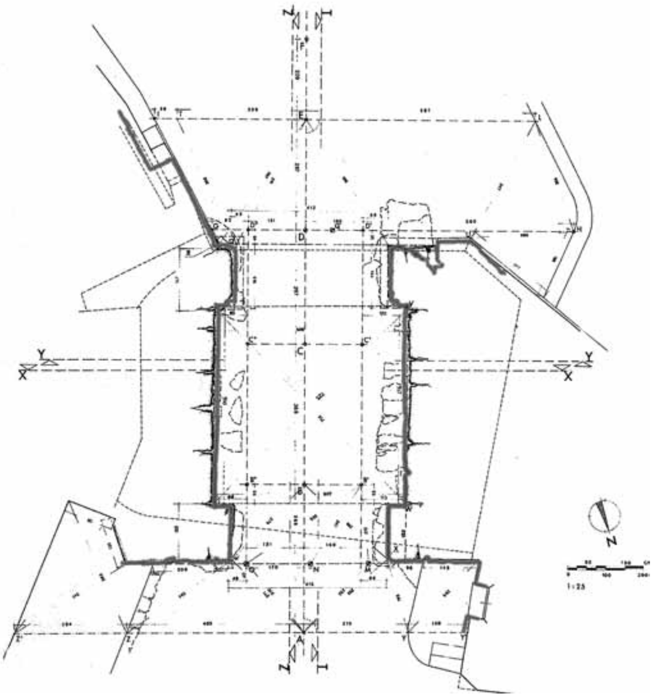

Fig. 3. Superimposition of the horizontal section of the point cloud model (in blue) on the 1996 survey plan drawing.

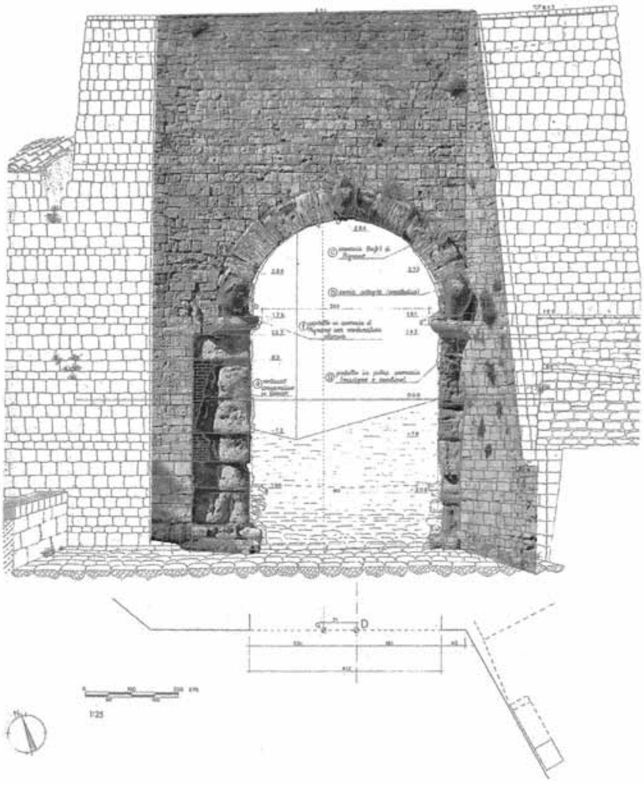

Fig. 4 Superimposition of the 1996 extra-moenia front drawing (in red) on the orthogonal projection of the SFM 3D model.

5. RESULTS

The comparison between the two surveys allows to do some methodological considerations. In terms of accuracy, the comparison between the plan drawing of the 1996 survey and the horizontal section of the 3D model at the same level, showed that the traditional survey has a fair level of precision (errors less than 5÷7 cm) (fig.3).
The alignments of the walls are consistent as well as the measured details (stone blocks, abutments, etc.). The same comparison was performed on the facades and vertical sections drawings. In addition, in this case the overall geometrical accuracy of the traditional survey appears validated, except for some local deviations. A greater error is in the representation of the arch curvature of the external facade, probably due to the measurement of a few control points (only five), that were not sufficient in 1996 to describe the alterations of the arch curvature due to small movements and degradation of the blocks (fig. 4). Obviously, in the original survey, the description of details, considered at the time of lesser importance (micro fractures of the stone, porosity, roughness etc.), is not comparable with that of the 3D model. The elements of free form, not approximable to precise geometry (heads on the external arch, etc.) are also not comparable. On the other hand, the digital model, which has an obvious greater metric accuracy, is in some parts lacking of details to perform an analysis trough an exclusive virtual reality. It should be noted, for example, some gaps in the textures, due to logistical shortcomings in the photographic acquisitions, not identified during the data acquisition. Portions of poor radiometric quality in the images led to the generation of textured models from which significant restoration interventions of the stone walls with bricks are not readable.

6. CONCLUSIONS

The new survey techniques allow to obtain a virtual architectural model, with high geometric resolution, by means of which it is possible to perform critical knowledge analysis. The native three-dimensional survey allows also to obtain useful products for various purposes: BIM models for the management of different nature data archives, virtual realities for the communication to a non-specialized public, etc. For these reasons, a traditional survey appears to be anachronistic, except for difficultly accessible areas. On the other hand, also on the basis of the reported experience, it is essential to recover from tradition the direct contact with the architecture that the digital methodology has often reduced to exclusive operational needs, instead ensured by the traditional methodology in all its phases, from the preliminary inspections to the final drawings elaboration. It is necessary, therefore, to give appropriate importance to the preliminary critical inspection as a phase for getting already a first significant awareness of the architecture in terms of geometry, structure and material in relation of the historical and cultural context in which the architecture was realized. This phase allows also to plan three-dimensional survey operations in a more focused way (levels of detail, geometric resolution, no redundant data collection, etc.) and then to have a greater awareness in the further interpretation of data in virtual environment.

NOTES

[1] The Laboratorio Universitario Volterrano is financed by the University of Pisa, the Province of Pisa, the Municipality of Volterra and the Cassa di Risparmio di Volterra Foundation.

[2] For information about the results of the study on *Porta all'Arco* in Volterra see Caciagli (1997) and Pasquinucci et al. (1997).

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THINKING ON ISSUES OF THE PROTECTIVE ZONING TO THE CONFUCIUS HERITAGE IN QUFU, CHINA

POSTER

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Keywords

protection boundary, restricted construction area, overlapping of protected areas

ABSTRACT

The Temple of Confucius, the Cemetery of Confucius and the Kong Family Mansion (Confucius Heritage in Qufu) in Qufu, Shandong Province were listed among the first key cultural heritages under state protection by the State Council in 1961 and a world cultural heritage by the World Heritage Committee in 1994. To strengthen the protection of Confucius Heritage in Qufu, its protection boundary and restricted construction area was adjusted in 2009, which was consequently different from the heritage zone and buffer zone of Confucius Heritage in Qufu as world heritage marked on the submitted retrospective map. This paper explains the differences and suggests a solution to the overlapping areas.

1. WHAT'S DUAL HERITAGE?

"Confucius Heritage in Qufu" as world heritage refer to one place, but it refers to two places as a key cultural heritage under state protection, so a separate protection plan should be formulated for each according to the Formulation Methods. The two protection levels - world heritage and national key cultural heritage - result in two different delimitations[1] that need to be adjusted and coordinated.

2. BACKGROUND

2.1 Location of the confucius heritages

Sitting in the south toward the north in Qufu, the Temple of Confucius and the Kong Family Mansion are two neighboring and independent courtyards with their own entries and exits. Their enclosed courtyard walls are integrated and surrounded by the Nanmadao Lane, Banbi Street, Houzuo Street, Guloubei Street and Queli Street in a circle. Architecture including the Dacheng Hall and Kuiwen Pavilion, tablet inscriptions, ancient trees and cultural relics is distributed within the wall.

Located outside the northern city wall of the Kingdom of Lu in Qufu, the Cemetery of Confucius is about 1,000 meters from the northern gate of the ancient Ming city. The tombs, mostly facing the south, are located around the graves of the three generations of the Confucian family, with the consecration hall in the south, tombs of various generations and ancient trees around. The outer wall is surrounded by the Linmen Road, former East and West No 104 national highways and the north outer ring road in a circle, making the tombs quite independent and enclosed.

2.2 Current situation of Confucius heritage and its existence

The Temple of Confucius, the Cemetery of Confucius and the Kong Family Mansion are all historical heritages above ground. The temple and the mansion are mainly made up of ancient architecture, and the cemetery consists of tombs of ancient times.

The Temple of Confucius well preserves the style, layout and spatial features of the Ming Dynasty. It has kept its architectural style, layout, scale, rank, number and name unchanged, and is consistent with the pictures contained in the Records of Qufu of the Zhengde Period of the Ming Dynasty and the Qianlong Period of the Qing Dynasty. The 104 buildings that exist today include the Dacheng Hall, sleeping chambers, Kuiwen Pavilion and Apricot Podium. Based on nearly 30 years' protection and maintenance, the Temple of Confucius is kept in good condition today. There are about 1,200 pieces of tablet inscriptions at the temple mainly in the yard between the Dazhong

Gate and the Dacheng Gate as well as in the Pavilion of Imperial Tablets. The 1,833 ancient trees in the temple include junipers, cypresses, Chinese scholar trees and pines, some of which are said to be planted by Confucius himself.

The Kong Family Mansion is mostly consistent with the pictures in Records of Qufu of the Qianlong Period of the Qing Dynasty and with the plot plan drawn in 1940. Covering a total construction area of 14,830 sq m, the 170 extant buildings in the mansion were built in the Ming and Qing dynasties, including the Chongguang Gate, main hall, secondary hall, front and back buildings, and parlor, among others. Architectural relics include the Chenhan Hall and Lan Hall. Restoration of the yards and houses in the central and western part of the Kong Family Mansion has been completed, and that in the eastern part is in process. With a construction area of 3,683 sq m, the Cultural Relics Archives at the mansion gathers cultural relics from Confucius Heritage in Qufu, including more than 100,000 objects and devices for worship ceremonies of the Ming and Qing dynasties, about 60,000 pieces of clothes and adornments, and over 300,000 documents and archives. The 300-plus ancient trees in the mansion are generally in good condition. The land boundary and scale of the Cemetery of Confucius consist with the pictures in the Records of Qufu of the Zhengde Period of the Ming Dynasty and the Qianlong Period of the Qing Dynasty, and the tombs are well kept today with more than 30 extant buildings, including the consecration hall, Si Tang, Temple of the God of Earth, Zhu Bi Pavilion (where emperors used to stand when worshipping Confucius), and Archway of Madame Yu. There are more than 100,000 graves at the cemetery. The graves of Confucius, his son and grandson as well as those of most family celebrities including Kong Shangren, Kong Yuqi and Kong Lingyi are kept in good condition. There are more than 40,000 trees of diverse types, mainly pines, cypresses and Chinese scholar trees, and more than 300 valuable ancient trees standing on both sides of the holy path in the cemetery alone.

3. METHODS

3.1 Protective zoning for the national monument

When the Temple of Confucius, Kong Family Mansion and Cemetery of Confucius were announced as key cultural heritage under state protection by the State Council in 1961, only the name of the protected unit was announced. In 1987, the Qufu Administrative Committee of Cultural Heritages drafted the planned protection boundary and restricted construction area for 14 protected cultural heritages above provincial level, including the Temple of Confucius, Kong Family Mansion and Cemetery of Confucius. The plan was revised in 1989 but wasn’t announced, and the protection boundary and restricted construction area were only officially announced in 1994. (See Table 3-1).

No.	Name of protected unit	Protection boundary	Restricted construction area
1	Temple of Confucius and the Kong Family Mansion	Key protected areas: from the southern end of the holy path to the northern wall of the temple and mansion in the south of Houzuo Street; from western wall of the Temple of Confucius on Banbi Street to the eastern wall on Queli Street (including Queli Archway and the bell tower), with an east turn to the northern wall of the western building and a north turn to the old western wall on Guloubei Street (including one meter from the drum tower), and the area connecting with the northern wall on Houzuo Street; 15.4m on both sides of the central line of the holy path. General protected areas: 56.5m east of Guloubei Street along the southern wall of the current post office, with a north turn to the south of Yanmiao Street and all the way west to the east of Gulou Avenue - this area used to be part of the vegetable garden of the Kong Family Mansion, but now it's divided by roads and turned into a constructed area. It should be managed as Category-2 controlled area. Queli Guesthouse used to be the western building in the Kong Family Mansion, so the status quo shall be strictly observed without increasing the construction area or buildings more than two storeys.	Category-1 controlled area: west of Guloubei Street to the south of Houzuo Street; east of Banbi Street to the southern moat; north of Zhonglou Street to the west of Gulounan Street; 20m on both sides of the protected area of the holy path. Category-2 controlled area: 15m west of the southern section of Gulou Avenue, 15m in the courtyard wall of Queli Guesthouse, and 15m in the wall of Qufu Normal University; north of the moat to 15m west of the northern crossing of Banbi Street, 15m north of Houzuo Street, 50m east of the drum tower, and 30m on both sides from the center of the drum tower; 200m from Category-1 controlled area of the holy path in the Temple of Confucius; the area from Madao to the inner side of east and west ring roads, southern side of northern ring road and greenings within 10m south of the southern moat with the moat as the center, including the front part of the water system in the southwestern corner of the southeastern triangular water area (north of No 327 national highway). Category-3 controlled area: the area inside the moat in the ancient Ming city.
2	Cemetery of Confucius	10 meters south of the outer wall of the cemetery, 5 meters on the west, north and east, part of the Young Ladies' Cemetery (on the east-west extension of the Confucian cemetery's northern wall to 143 meters south of the western side of the No 104 national highway) and forest paths (3 meters on both sides of the wall from Dalin Gate to Erlin Gate and existing road from Dalin Gate to the Northern Gate, including tablet pavilions and ancient trees).	Outside the protected area eastward to the western side of the No 104 national highway, westward to the eastern side of the highway's western branch, northward to its southern side, and southward to the northern side of the road connecting the highway's eastern and western branches in Linqian Village (part of the constructed area in Linqian Village is 60 meters outside the cemetery's southern wall). Areas on both sides of the holy path shall be controlled in the same way as the ancient city wall the Kingdom of Lu.

Table 3-1 Protective zoning for Confucius Heritage in Qufu as cultural heritage under state protection announced by Qufu in 1994.

In 2009, Qufu reiterated the protection boundary and restricted construction areas of the Temple of Confucius, the Kong Family Mansion and the Cemetery of Confucius as a key cultural heritage under state protection. The city began clear-cut management by defining their boundary and used boundary posts to mark their protection boundary and restricted construction areas. (see Figure3-1)

No.	Name of protected unit	Level of protection	Period	Position	Protection boundary	Restricted construction area
1	Temple of Confucius and the Kong Family Mansion	Key cultural heritage under state protection	From the Jin Dynasty to the Qing Dynasty	Lucheng Sub-district Office of Qufu	100 meters outside the southern wall of the temple, 20 meters outside the northern wall of the temple and the mansion, 10 meters outside the western and eastern walls of the temple (including Queli Archway and the bell tower), and 15 meters outside the eastern and southern walls of the mansion; 15.4 meters on both sides of the central line of the holy path; totaling 24.8 hectares in area.	Inner side of the moat in the ancient Ming city and 120 meters on the east and west side of the holy path, 149.4 hectares in area.
2	Cemetery of Confucius	Cultural heritage under state protection	Eastern Zhou Period	Lucheng Sub-district Office of Qufu	Outside the cemetery wall eastward to the east section of the No 104 national highway, westward to its west section, northward to the north outer ring road and southward to Linqian Road, 10 meters on both sides of the path from Dalin Gate to the Northern Gate, totaling 301.9 hectares in area.	100 meters extensions from the outer protection boundary in the east, north and west and to Changchun Road in the south; areas on both sides of the holy path shall be controlled in the same way as the ancient city of the Kingdom of Lu; totaling 150.1 hectares in area.

Table 3-2 Protective zoning for Confucius Heritage in Qufu as cultural heritage under state protection announced by Qufu in 2009.

No.	Name of cultural heritage	City	Cultural heritage (hectare)	Buffer zone (including protection boundary and restricted construction area apart from the cultural heritage) (hectare)	Coordinates of the central point
704-001	Cemetery of Confucius	Qufu, Shandong Province	Existing road inside the cemetery wall and from Dalin Gate (to Shenglin Gate) to Yan'en Gate, including tablet pavilions and ancient trees.	Outside the protection boundary eastward to the western side of No.104 national highway, westward to its western side, northward to 50m outside the cemetery wall and southward to the northern side of the road connecting the highway's eastern and western branches. The constructed area in Linqian Village is 60m outside the cemetery's southern wall. The holy path shall be controlled in the same way as the ancient city of the Kingdom of Lu.	35°37'13.26"N 116°59'10.97"E
704-002	Temple of Confucius and the Kong Family Mansion	Qufu, Shandong Province	Inside the temple and mansion walls, including the holy path (from Wan Ren Gong Qiang to the northern side of No.327 national highway and 15.4m on both sides of the road's central line).	Inner side of the moat in the ancient Ming city and 20m on the east and west side of the holy path.	35°35'49.92"N 116°59'07.33"E
Total			212.1	212.0	

Table 3-3 Explanations of the retrospective map of Confucius Heritage in Qufu submitted by Qufu for world cultural heritage application in 2011.

3.2 Protective zoning for the world cultural heritage

When Confucius Heritage in Qufu applied for the World Cultural Heritage in October 1993, the Chinese application document stated that “the cultural heritage administration and municipal construction authority delimited the protection boundary and restricted construction areas for the Temple of Confucius, the Cemetery of Confucius and the Kong Family Mansion” without any specific data.

In 2011, the then Qufu Bureau of Cultural Heritage and Tourism proposed the delimitation of the heritage zone (212.1 hectares) and buffer zone (212.0 hectares) in the Retrospective Map of the Temple of Confucius, Cemetery of Confucius and Kong Family Mansion for World Cultural Heritage Application (QWLZ [2011] No.109). It also stated in the appendix that the buffer zone included protection boundary and restricted construction area apart from the cultural heritage itself (see Table 3-3 and Figure 3-2).

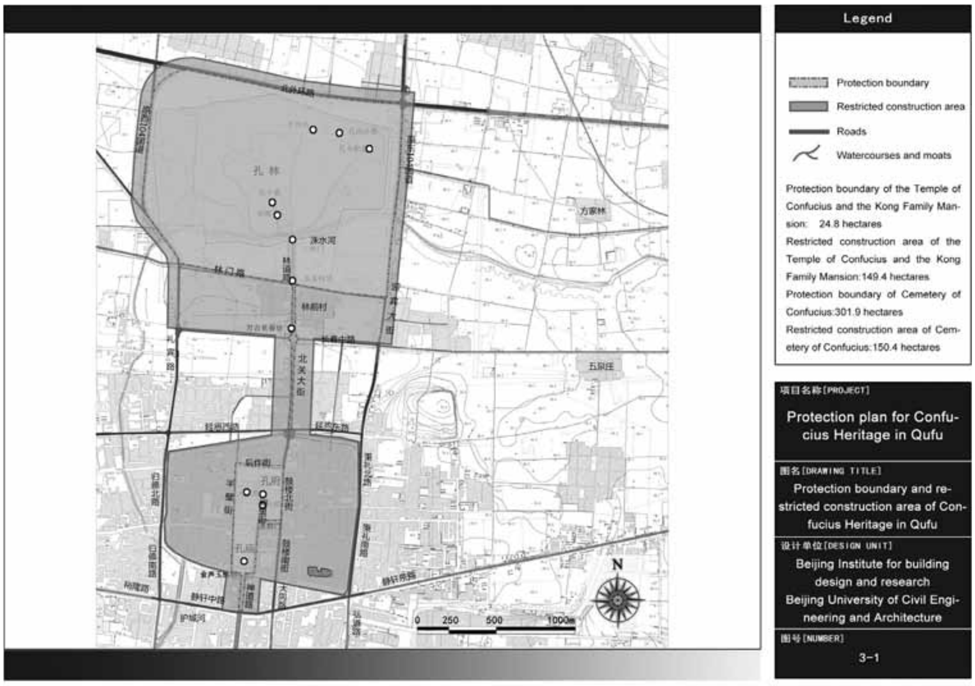

Fig. 3-1 Protection boundary and monitored areas of Confucius Heritage in Qufu as cultural heritage.

4. PROBLEMS IN THE CURRENT PROTECTION PLAN FOR CONFUCIUS HERITAGE IN QUFU

When Confucius Heritage in Qufu applied for World Cultural Heritage in October 1993, the application document only contained the legend of the protection boundary and restricted construction areas without any explanations on the boundary or the concept and scope of the heritage zone and buffer zone. The protection boundary and restricted construction areas of Confucius Heritage in Qufu were only published in August 1994, which was directly used as the heritage zone and buffer zone in the retrospective map of Confucius Heritage in Qufu that was submitted in 2011 for world cultural heritage application. However, to intensify the protection, their protection boundary and restricted construction areas were adjusted in 2009 and were consequently different from the heritage zone and buffer zone in the retrospective map. A comparison would show the following differences.

The protection boundary and restricted construction areas of Confucius Heritage in Qufu as a key cultural heritage under state protection are larger than their heritage zone and buffer zone as a world cultural heritage, which is especially conspicuous in the Cemetery of Confucius.

The delimitation of protected areas for Confucius Heritage in Qufu as a key cultural heritage under state protection is different from the delimitation for it as a world cultural heritage, and such differences are caused by historical reasons.

The delimitation of protected areas for the Temple of Confucius, Cemetery of Confucius and the Kong Family Mansion overlaps with that for the historical site of the ancient Lu city and the walls of the ancient Ming city.

The area on the south of the Temple of Confucius and the Kong Family Mansion overlaps with the delimitation of protected areas for the historical site of the ancient Lu city and the walls of the ancient Ming city, while the area on the south of the Cemetery of Confucius overlaps with the delimitation of protected areas for the historical site of the ancient Lu city.

The overlapping has caused confusion, and the conflict between the delimitation of protected areas of the Cemetery of Confucius and of the historical site of the ancient Lu city is especially conspicuous.

5. SOLUTION TO OVERLAPPING OF PROTECTED AREAS

The overlapping of protected areas refers to the overlapping of the protected areas for Confucius Heritage in Qufu, the historical sites of the ancient Lu city and the walls of the ancient Ming city. According to the published *Overall Plan for Protection of Ancient City of the Kingdom of Lu in Qufu and the Detailed Plan for Protection of the*

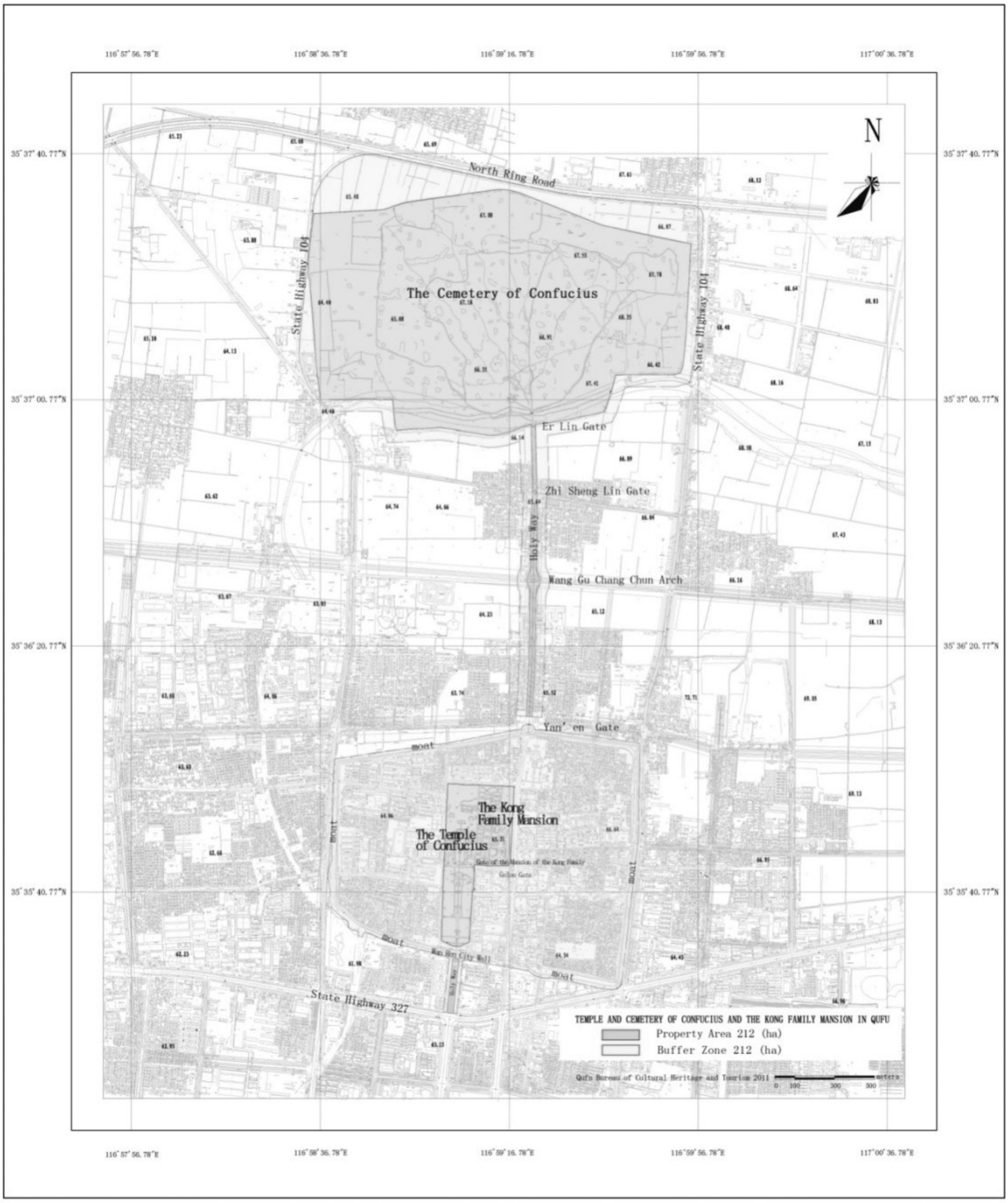

Fig. 3-2 Retrospective Map of Confucius Heritage in Qufu submitted to the World Heritage Center in 2011.

Ancient City of Ming Dynasty in Qufu, the following conclusions can be made:
Temple of Confucius, the Kong Family Mansion, historical sites of ancient Lu city and of ancient Ming city:
The southern wall of the ancient Ming city and the southern wall of the ancient Lu city are overlapped for 1,300 meters, which results in a 150-meter overlap between them and the protection boundary on the south of the Temple of Confucius and the restricted construction area on its eastern and western ends. The protection boundary and restricted construction area of the Temple of Confucius and the Kong Family Mansion should be allocated in the general protected area of the historical site of ancient Lu city and the restricted construction area of the ancient Ming city.
The Cemetery of Confucius and the historical site of ancient Lu city:
The protection boundary of the Cemetery of Confucius should be all allocated in the restricted construction area of the historical site of ancient Lu city. The restricted construction area on the south of the cemetery shall be allocated in the key and general protected areas of the ancient Lu city. The protection boundary on the cemetery's south and the restricted construction areas on its eastern and western ends overlap with the northern wall of the ancient Lu city for 1,600 meters.

6. ACKNOWLEDGMENTS

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MEDITATION TO THE CONFLICTS OF PRESERVATION TO ARCHITECTURAL MORPHOLOGY IN HUI ETHNIC MINORITY OF XI'AN HISTORIC CITY

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Keywords

historical block of ethnic minorities, protection of architectural morphology, conflict and strategy

ABSTRACT

People of the Hui ethnic minority have the religious custom of "living around a mosque and trading by the market", which gives rise to their unique living and architectural culture. However, with the faster pace of city modernization, limited land resources and high population density, people's living and commercial needs can no longer be met. This has led to a series of problems:Demolition of historical architecture has seriously damaged the architectural morphology in historical blocks, some ancient buildings cannot be effectively protected, the living units formed because of the religious custom of living around a mosque are so overlapped that they cause traffic disorder and the living quality of those residents is very poor, among other respects. This paper comprehensively analyzes the living and architectural characteristics in the Hui community of Xi'an and tries to put forth solutions to protecting the architectural morphology there on the premise of respecting ethnic culture, with the aim of striking a balance between the two.

1. INTRODUCTION

This paper focuses on the renewal and conservation of the ethnic historic block with the background of urban modernization. By analyzing the existing status and problems in Hui ethnic community of Xi'an, a certain strategies for conservation are tentatively provided, which makes this research lie in the territory of urban historic block conservation.

2. OVERVIEW OF THE HUI ETHNIC COMMUNITY IN XI'AN

Located in the center of Xi'an city proper next to the drum tower and bell tower, Hui Fang (the Hui ethnic community) features neat and square blocks, chessboard roads, flat terrain and a clear-cut layout. The Hui ethnic community today is home to 12 mosques, multiple historical buildings, and ancient civilian houses, streets and lanes, including six state-level key protected cultural heritages and three provincial and municipal ones. These tangible cultural heritages are of great historical significance. As a typical urban Hui ethnic community, Hui Fang blends traditional Chinese culture with Islamic culture and maintains the traditional layout of Hui ethnic communities, namely "living around a mosque and trading by the market".(Figure 1)This religious tradition has given rise to their unique living features and architectural culture.

Serving both a spatial and a social function, Hui Fang generally refers to areas inhabited by people of the Hui ethnic minority. Existing in the form of a community, it is also a spiritual carrier for Hui society and culture. Upholding the same religion, people living in Hui Fang share the same lifestyle and values, which gives rise to a specific community culture that keeps the Hui people together. On the spiritual level, Hui Fang residents form a powerful cohesion; on the cultural level they share the same cultural system and on the architectural level they feel strongly attached to the living space in Hui Fang.

3. SPATIAL STRUCTURE AND ARCHITECTURAL FEATURES

The old city of Xi'an today inherits the square, symmetrical and chessboard layout of Chang'an in the Tang Dynasty and the layout of Hui Fang complies with that of the city. While associating with the Han people, Hui people have assimilated traditional Chinese culture, which is reflected in their living space through the contractive layout of community - block - neighborhood - courtyard - house and the spatial sequence of public - semi-public - semi-private - private[1].

3.1 Spatial Structure

In addition to the distinct regional culture, the spatial structure and morphology of Hui Fang in Xi'an also features rich and orderly layers. There are mainly three layers.

The first layer is the outermost urban roads, including Beiyuanmen Street and Sajinqiao Avenue, which are main traffic hubs and public space. The second layer refers to block roads such as Beiguangji Street and Daxuexi Lane, which are relatively private spaces for everyday life and traffic and are semi-public. Commercial activities in the Hui community are distributed among roads on those two layers. The third layer refers to closed roads at the end of streets and lanes, which are private space used by surrounding residents.

The architectural layout at Hui Fang has its unique spiritual connotations and its biggest feature is that it is centered on a religious relationship, which is reflected through the fact that the mosque, the center of Hui Fang, plays an indispensable role there. It is not only the venue for regular religious activities, but also the educational, cultural and economic center that is dominant from a spatial perspective. Distributed around the mosque, civilian houses constitute an essential basic element in the spatial morphology of Hui Fang, a morphology that has taken shape while the Hui residents meet their living needs. Business has always been a Hui tradition and an essential social behavior in their lives, so a business street is also an essential architectural form in Hui Fang. If the mosque is considered a spot, civilian houses constitute the surface and the business street is the pervasive line. Buildings of those three different natures create the unique spatial morphology with Hui cultural characteristics.

3.2 Architectural Characteristics

Civilian houses in Xi'an Hui Fang reflect the cultural mixing of different ethnic groups in their plot plan and façade decorations, but there is no denying that they have kept their unique morphology while being assimilated.

Influenced by the Han culture, most civilian houses in Hui Fang have the similar plot plan to traditional civilian houses in Guanzhong, which feature a distinct central axis, multiple vertically-arranged courtyards, usually two or three rows of buildings, and increasing building height courtyard after courtyard, demonstrating a whole set of etiquette and ethical systems. Traditional civilian houses in Guanzhong are known for their multiple rows, narrow courtyards and enclosedness, which has influenced the civilian houses of Hui people. They usually have a rectangular homestead, while the vertically arranged gate house, courtyard, principal room and backyard as well as the single-slope wing rooms on both sides turn the house into a large yard. This architectural sequence fully reflects the perfect evolution of spatial function. Limited by size, the gate is usually set on the left of the central axis, from where a long and narrow paved path leads to other rooms in the yard.

Of all the types of buildings, the one that can best reflect the architectural essence is the civilian house, while the owner, based on long years of "communication" and "running-in" with the house, would eventually turn it into the most suitable one, so we can see the civilian house naturally becomes the best place to reflect ethnic culture. Because Hui people have a long tradition of doing business, the civilian house, which has the most intimate relation with people every day, inevitably also possesses a commercial function. A store in the front and house in the back, or store downstairs and house upstairs is a common feature of Hui civilian houses, which is an inexhaustible source of their architectural vitality.

4. CONFLICT BETWEEN CITY MODERNIZATION AND TRADITIONAL ARCHITECTURAL MORPHOLOGY IN HUI FANG

What with the rapid economic growth and with the flourishing tourism in cities, Hui Fang has attracted large groups of tourists for its unique ethnic outlook, which has driven the development of small businesses there. Today it is without any doubt the most well-known food court in Xi'an and many people go there every single day. While boosting the economy, this has also led to a series of conflicts.

Because of ethnic traditions and religious beliefs, Hui people have lived on this limited land for many generations and their religious custom of living around the mosque makes it hard for them to spread to other areas of the city. As more and more transient residents go to Hui Fang, the population density there has constantly risen and the former spatial layout can no longer meet the residents' living requirements.

In general, streets at Hui Fang have maintained the traditional layout, but the large population has caused traffic congestion and the former streets and lanes cannot be used conveniently any more. In addition businesses are making the best use of every inch of land there, so that residents' living routes and tourists' sightseeing routes

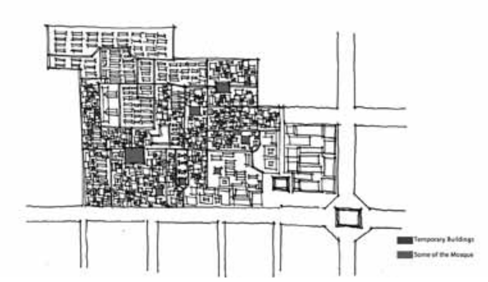

Fig. 1 Current Situation of Hui Ethnic Community (Schematic diagram).

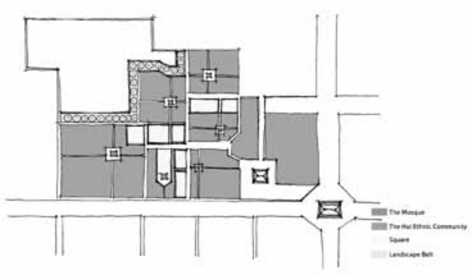

Fig. 2 The Overall Planning Suggest.

overlap significantly, leaving no room for residential privacy. As a result, the once quiet civilian houses are surrounded by around-the-clock businesses, public space is occupied by all kinds of stores and traffic and sunshine and green trees are rare today. The chaotic traffic situation and backward infrastructure at Hui Fang have deprived residents there of the facilities and convenience of modern city life.

In terms of architectural morphology, buildings at Hui Fang are extremely dilapidated because of the lack of systematic maintenance and renovation and the internal architectural structure is unable to support a large population or meet the requirements of modernity. In addition many traditional buildings are on the decline too. Modern life has triggered a surge of self-built houses at Hui Fang. Many people have renovated their original houses by themselves and built a slew of buildings of reinforced concrete structure. In addition, in most courtyards, the residents have set up all types of temporary buildings to increase the area of use, including low asphaltic felt tents and tents made of out-of-place colored steel tiles. It seems that the original courtyards have undergone a series of fission and proliferation. Public space is encroached upon little by little, the public corridor between some buildings is even narrower than one meter and the buildings are of various outlook and quality. As a result, traditional architectural morphology is seriously damaged.

Because of excessive development of Hui Fang in recent years, the material environment that carries its traditional culture is seriously damaged and also traditional architectural morphology is immensely threatened. An ancient saying states:“With the skin gone, to what can the hair attach itself?” If the traditional material environment is damaged, the existence of the traditional culture that is carried and reflected by it comes under question [2].

5. STRATEGIES TO PROTECT THE ARCHITECTURAL MORPHOLOGY OF HUI FANG

Hui Fang needs to meet the requirements on historical blocks imposed by city modernization while protecting its traditional architectural morphology, but it cannot just copy the protection plans for other historical blocks because of its religious custom. On the precondition of respecting ethnic traditions and religious customs, how does one make this historical block not only able to provide the Hui people with a pleasant living environment, but also adapt to city modernization? That’s a question that cannot be ignored, so we hereby provide some tentative strategies.

5.1 Overall planning

We recommend optimizing and renovating the overall planning by respecting the traditional religions and customs of the Hui ethnic minority. With the mosques as the basis for the division, we can divide the Hui Fang into several major districts with each of them containing several mosques. The districts are relatively independent in location, and public spaces can be set at their junctions for the residents to carry out daily activities for exchanges and leisure. (Figure 2)

5.2 Transportation Layout

In terms of transportation layout, the traffic system in Hui Fang needs to be re-planned to avoid too much overlapping between tourism and people’s life, protect residential privacy and respect the residents’ religious custom. To lessen the traffic pressure on Hui Fang, we shall not introduce too much urban traffic into it, and traffic routes for residents, tourists, cargo and emergency shall be planned in an orderly way to prevent interference among each other and form independent and clear-cut streamline systems. Underground space can be developed to build parking lots, so as to alleviate the ground traffic pressure and improve the overall layout of Hui Fang.

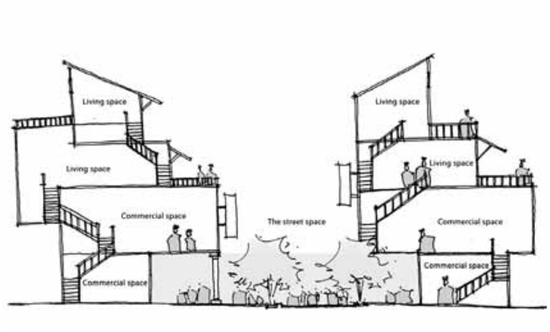

Fig. 3 Transformation Plan of Building Along the Street.

5.3 Spatial Layout

In terms of spatial layout, attention should be paid to protecting the traditional spatial experience at Hui Fang. The courtyard is the basic spatial pattern there, so it must be protected and the disorderly self-built tents should be dismantled. Moreover, streets and lanes are public spaces, marking a transition between civilian houses and nature. They are also the place for exchanges among residents. The space they cover is decided by the height of buildings and width of streets and any change in any of those factors would affect the street morphology. Therefore, explicit limitations and unified requirements should be in place to regulate unauthorized building by residents in order to protect the courtyards, streets and lanes.

5.4 Architectural Morphology

As to architectural morphology, religious custom and ethnic traditions have given rise to Hui Fang's unique architectural morphology. Because the residents are strongly identified with their ethnic culture, new buildings, while being uniform in their façades, should adopt a traditional ethnic style and comply with unified requirements in form, material and decoration. In addition, the architectural form along the streets should be renovated as appropriate. For example, the houses along the street can be changed to the gray space to broaden the usable area of the streets while the second and third storeys remain unaffected. (Figure3) Of course, all these measures need governmental organization and encourage so that the residents have a guideline for the renovation. For existing traditional civilian houses, their façades should be repaired and protected with regard to their original features and the same materials and colors as the original ones should be used. As to their interior layout, it should be properly adjusted and re-divided according to the standards for modern life, while necessary living facilities should be added to improve the residents' quality of life.

5. CONCLUSION

China's urbanization process is speeding up, which makes the renewal and conservation of historic block an important topic. For Hui Fang, a historic block inhabited by Hui ethnic minority, it in particular requires proper renovation and conservation on the premise that the ethnic culture and religious customs are respected, so that it can meet the urban modernization requirements while maintaining the original architectural cultural patterns. This will be a long-term and complicated task and requires the participation of planners, architects, government and residents. We hope, through constant exploration, to achieve effective protection of the ethnic historic block and inherit the valuable architectural cultures.

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EVALUATION CRITERIA OF A STATE OF STONE MATERIALS OF ANCIENT MONUMENTS UNDER RECONSTRUCTION

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natural stones, damages

ABSTRACT

The life of ancient monuments restoration depends on a number of factors of which reliability of results obtained by investigations of the state of stone structures' materials is the most important one.
Qualitative implementation of restoration and reconstruction is ensured on the basis of objectively obtained research data, therefore, for each kind of used stone criteria of the materials' state evaluation should encompass a wide circle of characteristics under observation. The paper presents general principles of evaluation of damaged and defected stone materials. These principles enable by visual inspection and selective laboratory investigation to reveal degree of damage and their reason, as well as make a necessary well grounded decision on curing an "aged" stone or replacing by a "new" stone.

1. INTRODUCTION

Natural stone is considered as the main building material used in ancient monuments of Armenia. To make a well grounded decision about further usefulness of individual stone pieces, as well as their curing and restoring it is necessary to perform visual inspection applying the developed system of basic criteria. Damages and defects should be grouped in accordance with external signs which are characteristic to the specific rock.

2. BACKGROUND

Acquaintance with the object under restoration, from which generally begins all research activities, encompasses gathering and usage of archived photos, drawings and possibly other materials. Then by the scene visual inspection the assortment of materials used in ancient structures, buildings, facilities, and complexes are cleared, and corrected their characteristics and a description of their condition and a preliminary evaluation is given. On the basis of a complex analysis of obtained data the direction of further research is planned, spots of bore pits and kerns cuttings are selected and by heir implementation further thorough research and by the samples' laboratory analysis qualitative actual indices are determined. The effective direction of research depends on volume and mechanical, chemical and biological, thermal and anthropogenic nature of damages and defects observed in materials used in structural components.

Among a good number of factors determining the restoration and reconstruction the choice of "new" available materials is a key factor. In accordance with the principal law on monuments restoration and reconstruction the replacing new materials must be as similar to the initial materials in their external view and technical characteristics as possible, that is be compatible “old” materials of stone structures (MDS 11-17.2004. The observation rules of buildings, constructions and complexes of liturgical and auxiliar purpose). In case of “aged” materials replacement for monuments under reconstruction such a research approach will ensure most possible adecuacy of “new” and “old” materials. In that problems related to stones, in general, are solved with problems related to mortars, for these two materials are masonry components and in structures work jointly. It should be noted that mortar should be compatible with the stone in both of its strength and deformability (modulus of elasticity) indices. It is known that for an effective joint work compatibility of their thermal deformation coefficients is an important condition.

3. METHODS

The visual inspection method gives important information about materials technical state and diagnosis of damages’ supposed reasons. It is considered that damages and defects of stone structures materials except force greatly depend upon influence of water running down from the roof and groundwater surfacing from foundations. Abundant ground damping except possible uneven sinking, on the other hand lack of waterproofing of walls’ horizontal surfaces and lateral surfaces of foundations cause abundant moistening of stone masonry. Steady and abundant moistening of stone covers and walls of monuments is dangerous for natural stones, for it condition physical, chemical, and biological destruction processes. Because of moistening may also occur washout of mortars bonding material and as a result – essential destruction of masonry bonds and fills, development of holes and openings and architectural and construction structures’ skeleton failure. Possible correct information about damages is of great importance to make well grounded decisions. Damages and defects should be grouped in accordance with external signs which are characteristic to the specific rock (fig.1. table 1).

1) Table 1. Damages of natural stone and masonry

External signs of stone physical weathering	External signs of stone chemical weathering	External signs of stone biological weathering	External signs of masonry defects
Moistening	Wall saltpetre	Dark spots – bacterial clumps	Washout of mortar
Holes and dimples	“Self-sputtering” destructions	Multicolour flat formations - lichens	Loss of stones
Sheeted pop-offs	Structural transformations	Multicolour tubers - mosses	Structure skeleton loosening
Lateral and surface cracks		Plants	Linearity failure
Lateral and surface fractures, breaks			Cracks along joints
Lateral wear			Through cracks, fractures, breaks
			Thorough collapse

4. CASE HISTORY

During construction and rehabilitation of TATEV Monastery facility’s stone structures in different periods, stones were used belonging to basalt group which, possibly, were quarried in nearby stone quarries (fig.2. a, b).
Visual and detailed inspection and analyses showed that normal basalts, melanobasalts as well as large porous light andesitebasalts and andesites had been used (fig.3. table 2), (fig.3. table 3).. Damages caused by physical,

2) a - IX century annexe to Tatev Monastry Complex destructed by earthquake
b - The restored in XX century dome of the Blessed Virgin church of the Tatev Monastry Complex
c - “Self-sputtering” destructions and mosses of ancient ornamented stones belonging to basalt group
d - Structural transformations and cut off layers from the stone belonging to basalt group

chemical and biological weathering showed the advantages and defects of used stone groups belonging to this or that kind basalt stones which are naturally conditioned by their initial structure and mineralogical composition. Normal basalts have symmetric granular and sometimes porphyritic structures. There volcanic glass appears only in the form of thin sheets, the plagioclase forms a network system, which is filled with colour ferro-magnesian rock cells. The crystals of plagioclase, as well as pyroxene and rock are intruded in the volcanic glass, thus forming andesite-basalt porphyritic structure. As for andesites they have exclusively porphyritic structure which is formed of plagioclase`s large quantity crystals intruded in the volcanic glass (Acagorcyan, Z.A. 1967). In case in rocks belonging to the basalt group existence of a large amount of plagioclase moisture, as it is known, can develop dangerous consequences. It is conditioned by the fact that plagioclase solved in water can be transformed into basic mineral kaolinite of clay rocks and piled up in the inner surface pores appearing in the form of “self-sputtering” damages.

It is well known that the presence of an essential biological decomposition is a consequence of a group of diverse destructing factors and it, in essence, can be related to the final stage of destruction. Emerging of microorganisms on any surface proves that the material has already been subjected to decomposition by one of destructive factors’ group. Biological Destructions of stone structures of Tatev monastery complex are expressed in irregular spot and lines of different colourful tunes, as well as the stone texture change. For the life of bacteria the most favourable habitats are weathered ancient stones.

Table 2

Kind of stone	Density, Kg/m³	Porosity, %	Strength, MPa	Water absorption, %	$E_0 \cdot 10^{-3}$, MPa
Normal basalt	2110	19	25.6	5.1	4.43
Melanobasalt	2215	12	58.5	3.5	24.34
Andesite	1840	22	29.0	6.9	12.50
Andesite-basalt	1955	27	26.5	5.8	14.26

3) Table 2. Results of stones research belonging to basalt group of Tatev Monastery Complex.

Table 3

Kind of stone	Composition, %					
	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O+Na_2O
Normal basalt	52	20	9	5	9	5
melanobasalt	44	16	11	9	13	4
Andesite-basalt	58	20	7	5	7	6
Andesite	61	18	6	2	5	7

3) Table 3. Results of chemical analysis of stones belonging to Tatev Monastery Complex.

5. RESULTS

During preliminary examination of the Blessed Virgin Church making used of the above mentioned visual observations criteria research and evaluation of more than 1000 stone pieces' conditions were carried out. On the basis of obtained data a decision on restoration or replacement of damaged and defected stones was made. Visual inspections of the structure masonry have shown that in comparison of basalts and andesite-basalts, andesites are more subjected to chemical weathering which is expressed by a number of "self-sputtering" damages and in the form of other structural new formations not only ordinary – out-of quarry stones but, regretfully, also valuable ancient ornamented stones, (fig.2. c, d), (fig.3. table 4).

"Self-sputtering" destructions, density and porosity changes and essential structural transformations of stones are observed. The examined stones to a considerable extent were infected with moss, crust covered epilithic bacterial clumps population of which is different in terms of substrates. Some kinds cover large areas developing a colouring which is seen from a distance and depending on the given kind of bacteria and moss. Thus, surfaces of the Blessed Virgin Church boundary stones are covered by multicolour moss population. Inside, where the ventilation is especially bad, new formations of "Collema mutifidum", "Verrucaria", and "Gasparrinia decipiens" colonies are clearly marked.

Table 4

Section of church under research	Number of stones, pcs	Replaceable stones		Recoverable stones	
		pcs	%	pcs	%
Western facade	165	50	30.3	16	9.7
Eastern facade	190	70	36.8	27	14.2
Southern facade	262	53	20.3	35	13.4
Northern facade	214	44	20.6	33	15.4
All fronts facades	814	217	26.7	111	13.6
Interior western side	111	7	6.3	26	23.4
Interior eastern side	151	21	13.9	96	63.6
Interior southern side	188	46	22.9	73	38.8
Interior northern side	125	8	6.4	89	71.2
Entire interior	575	79	13.7	284	49.4
Entire church	1389	296	21.3	395	28.4

3) Table 4. Results of the Blessed Virgin Church stones research.

6. CONCLUSIONS

According to the principal law on monuments reconstruction among a number of factors determining the quality of reconstruction compatibility of “old” and “new” materials is considered as the most important one. The method of visual inspection and further detailed research provide important information about technical state and diagnosis of supposed reasons of damages. In case of materials replacement such an approach for carrying out research will ensure the maximum possible adecuacy of “new” materials with existing ones.

To get possible correct and overall information by carrying out research of real conditions of “old” stone materials used in components of stone masonry and structures of monuments a system has been developed for classifying their defects and damages in accordance of external signs.

In the course of preliminary investigation of stone structures of the Blessed Virgin Church, applying the developed criteria of visual inspection more than 1000 stones conditions have been performed.

Stones were found having heavy damages in the form of , lateral wear many holes and dimples on their surfaces, laminar tearing, cracks, lateral worn as well as “self-sputtering” destructions, changes of stones density and porosity, essential structural transformations.

The examined stones of the church are to some extent infected with “Collema mutifidum”, “Verrucaria”, and “Gasparrinia decipiens” colonies covering large areas, developing colouring which is seen from a distance and depending on the given kind of bacteria and moss.

During reconstruction work by visual inspection were revealed reasons of existing damages of stones of the monument’s carrying walls, columns, arches and the dome of the cover. It has been found out that the most dangerous reason is steady and abundant atmospheric water running from the roof and percolated through the elements of the structure badly damaging over 20% of stones. The research has shown that condition of stones used both as principal structural component and facing material is decisive in further reliability, seismic stability, and life span of the monument facility.

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THE ADAPTIVE REUSE AND RECONSTRUCTION OF THE HISTORICAL BUILDINGS OF YEREVAN

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ABSTRACT

The current reconstructions of the cultural heritage of Yerevan of the 19th and early 20th century are organized in the wide spectrum of the variations, which do not always guarantee the inviolability of the aesthetical and structural parameters of historical building and correspond to international standards. For the purpose of the substantiation of the rational method that can resolve the permissible limits of intervention in authenticity architecture, analyzed projects in the historical context. On the base of data of materials are made the conclusions about the character of the utilized methods, about Buniatyan'c concept, which was formed in first half of 20th century and found continuation in the contemporary interpretations. The result of a study is the determination of the priority positions, development and canonization of which may contribute to the creation of sustainable national traditions for the reconstruction of buildings in an urban environment.

1. INTRODUCTION

The architectural heritage of Yerevan 19th and early 20th century, have passed since the 1920s a series of adaptive reuse and today they continue to use in the new functions. Fact does not cause doubt, that from the point of view of the retention of authenticity, with the exception of religious, the historical public, habitable and the same type other buildings, which function in the infrastructure of modern city, are the most vulnerable objects of cultural heritage. Problem consists in the presence of a constant conflict of two opposite positions: the criteria of retaining the historical factor require the inviolability of building, but its real life directly depends on valuable functioning. The latter indicates modernization, the correspondence to contemporary technological standards and usually appears the task of an increase in the existing parameters, addition of new volumes and as a result, eventually the existing structure suffers significant modifications.

The practice of radical reconstruction of the building or complex occurred in always and in all countries. Among them are salient objects of the world cultural heritage, which for a time to change the layout, style, architectural and artistic priorities. Analyzing similar historical buildings modern researchers, frequently note innovations as the progressive qualities of architectural work. The contemporary laws of reconstruction are theoretically based on the steadfast positions of authenticity, i.e., rigorously maintaining all components of the object (Likhachev, D.S. 1981). In actuality, not only reconstruction, but also the restoration may violate norms of permissible activities

The contemporary principles of the reconstructions of Yerevan buildings are different. Some are substantiated by scientific preliminary studies, which respectively increase the quality of project. Others are limited "creative intuition", exceed the scope of the permissible measures and as a result it leads to the loss of the aesthetical and historical categories of object.

The purpose and objectives of the paper is to study the features of architectural reconstructions in the historical context, the identification of the traditional school and the regulation of some required positions for the methods of the reconstruction of the old buildings of Yerevan.

2. BACKGROUND

In the Armenian scientific literature on the theme of reconstruction and restoration of cultural heritage principal transactions are dedicated to the objects of the ancient and medieval architecture, mainly including the typological groups of churches, monasteries, palace complexes, bridges, etc., and questions are connected with conservation or restoration of fragments on the basis of the preserved materials or analogies (Harutyunyan, V. 2003). Studies on the identical tasks of urban public and residential buildings of the new time are carried out in the limited quantity (Gasparyan, M.A. 2003), and the problems of reconstruction are examined for the first time.

3. METHODS

The tendencies and features of the reconstruction of the historical buildings of Yerevan are investigated on the base of architectural analyze on site, realized projects and also devised on the same theme the course works and diploma of the students of the National University of Architecture and Construction of Armenia and the Milan Polytechnic Institute.

4. CASE HISTORY

The history of the reconstructions of the buildings of 19th and early 20th century begins already in 19th century. The basic factors, which dictate new construction work, due to the need to increase the existing volume, in this case, it is usual, function remains before or subordinated initial. The expansion of edifices, as Tiflis Commercial Bank, G.Khanzadyan's apartment house, Surb Hripsime girls' gymnasium, Surb Gayane girls' secondary school, occur chiefly by addition of the angular wings, architectural treatment which continue the leitmotif of main volume, preserving its priority position in the composition, taking into account town-planning position, rhythm of articulations, axes, building materials.

Exception from the analogous rules is, for example, the radical reconstruction of the complex of the boys' primary school, which by several decades later was rebuilt into the theater and in which only some load-bearing walls testified about the original structure (Gasparyan, M. 2008).

In the 1920s, the new political authorities nationalized private property. The part of office buildings, educational institutions, plants preserved its typological belonging, but majority was adapted to the new functions. Initially reconstructions were organized inside the construction, but very soon the development of establishments required the expansion of spaces.

The reconstructions of this time performed by the clearly thought-out method, oriented for the retention of the composition integrity of architectural image and harmonious organization of urban environment (Gasparyan, M. 2006). In the constructive plan the solution consisted of the addition of the floor above the crowning cornice, and also wings, those continue the plane of facade, and the use of the traditional building materials, in which was executed the object. Accordingly, in the architectural treatment applied two artistic techniques: horizontal continuation of the original composition and its vertical development with a leitmotif of preserving axial articulation, accents and dominant part, but the reduction in the intensity of architectural sculpture and wall decoration. In this way, it retained the stylistic unity of old and new forms, and at the same time visually identifies their separation. It is exactly such tasks, caused by functional requirements, and was solved by architect N.Buniatyan during the reconstruction of the buildings of the previous historical period –Town council, State bank, Teachers' seminary (fig. 1,2).

Contemporary reconstructions and adaptive reuse are practically oriented to the same category of architectural heritage, i.e., historical buildings of the 19th and the beginning 20th century, but procedure contains the wide potential of the utilized resources, which as a whole, on the ratio of old and new volumes, can be divided into two groups, based on methodology that is accepted: the stylistic unity of the structures and the combination of alternate structures, i.e., the combination of the old and corresponding to time modern forms.

Out of these two concepts is "facade preservation", the essence of which is the dismantling of the historic building and the subsequent assembling of the structurally strengthened main wall, to which is attached new multistory housing, as it is made with the G.Gabrielyan's apartment house in Abovyan Street, Governor's house in Republic Street, etc. A similar practice is beneath criticism and, since the question is the historical and cultural heritage, it is categorically not admitted. In addition, the architectural design of the named constructions is lacking the correct connection between the two composite parts, including the textures and colors of the building materials, axles, apertures and artistic combination of formal components. As the method of reconstruction this way should not be considered, therefore more preferably to go back to the two mentioned above.

The principle of the interpretation of authentic forms in the attached to the historical object new volumes it is used in the different versions. Besides the monotonous repetition how to make the top two floors of P.Sogomonyan's two-story apartment house in Arami Street (reconstruction, 2001), are used in some cases also analogies: the third floor of S.Agadzhanyan's shops at the corner of Abovyan and Arami Street (reconstruction, 1996) are built using the old project, and replaced with the lobby of the new store former open courtyard space. More rarely take advantage a remake matching to historical epoch artistic context; it has been complemented by an administrative building of A.Soghomonyan's Brandy Company in Tumanyan Street (dismantling, assembling and reconstruction in Melik-Adamyan Street, 2002). From the perspective of urban environment, if the buildings are located in a historic district, they fit harmoniously into the surrounding context. The main problem is the complete absence of differentiation of old and new forms and obvious architectural and artistic dominance of the new structure.
Examples of the combination of alternate structures include the reconstruction of the apartment house in Nalbandyan Street (adaptation under Armsberbank, reconstruction and expansion, 1996-2002, fig. 3,4). The main reaching of the design solution consists in the complete retention of authentic structure. New volumes are added to the south-west side and by the garret stepping back from the main facade, their treatment in the contemporary forms makes it possible to clearly separate neoclassical historical facade and the subordination of new fragments to historical means is felt. Furthermore, the monumental new volumes fit perfectly into the urban environment, where before, due to the destruction of the adjacent old buildings, were oriented the open courtyard wooden gallery, architectural solution which is associated with the close space of the atrium.

5. RESULTS

The study of the features of adaptations and reconstructions of Yerevan buildings based on the example of the architecture of the 19th and 20th centuries makes it possible to confirm the known international theoretical positions, which are formulated in the scientific literature and are commented by authoritative architects and art critics.
For all types of the design solutions in the Armenian architecture justification compositional ideas are: interaction between the adaptation and reconstruction; ratio of authentic and new functions, their proximity or antithetical; concrete dating of the time of construction and reconstruction, their stylistic connections or contradiction; political and economic situation, customer. These positions in the historical context characterized by certain regularities in the specific conditions and decisions related to the tasks of adaptation and reconstruction.

The period of the Russian Empire, 1820s -1910s:
• reconstructed object is perceived as an architectural work (it is not considered as an object of cultural heritage),
• in the stylistic determination time frame identical, there are three main architectural trends: national, historic styles and art nouveau,
• need for reconstruction and increase of the building or complex is due to the development function, but function itself is constant or subordinated initial, from which it is clear that the task of reuse usually absent,
• customer and architect, possibly, the same.

The contemporary period, from the 1930s to the present day:
• works of architecture of the 19th and early 20th century are officially included in the list of cultural heritage in 1991, in the complex of the project of preservation and use of historical and cultural monuments of Yerevan. List is annulled in 2000 and again with the changes affirmed in 2004. However, abstracting from the official documents and reference to the opinions and the discussions in the professional circles, that were prevalent during the second half of the 20th century, make it possible to objectively state that precisely from this time the constructions of imperial period are understood as cultural heritage,
• architecture develop in the aesthetics of soviet neoclassicism, constructivism (1930s), modernism (after 1950s),
• reuse rarely preserves the connection with the old function and often antithetical to it,
• customer – the state, after the 1990s also a private person.

Buniatyan'c method, created and approved in the first half of the 20th century, is competent to determine as the origin of the traditional school of the civil building reconstruction in the urban infrastructure. Put in it the concept inherent in the specificity and the mentality of the Armenian architecture, live spontaneously in the best works of local architects. In its conceptual solution the idea of the differentiation of old and new forms is placed. The visual architectural and artistic unity of two structures creates the illusory impression of the use of authentic style in the new volumes, in the sense of the forgery of old style. In actuality, the data is explained by the creative handwriting of the architect, whose professional training had academic nature and who itself worked in the neoclassical style. The absence of the reading of building as the cultural heritage is here obvious, due to the proximity of epochs, as the time difference of the old and the new is not more than 20 years. The tactful approach of the architect to the existing object testifies about the high craftsmanship and, the most essential – professional ethics, piety to the creation of colleague, and in the context of this study – to the cultural heritage.

The specificity of this technique, its basic setting is relevant and can develop today. Its continuation it is possible to consider two following projects, created in the analogous spirit, each with its own original ideas, which are executed by the students of the National University of Architecture and Construction of Armenia and the Milan Polytechnic Institute. The works unite technical dilapidated states of the historical buildings, which by assignment must be reconstructed and adapted.

The object of the first project is P.Esapyan's apartment house in Republic Street, from which was preserved only a wall of main facade (fig. 5). The basic idea of the design solution consists in the task of the revelation of the aesthetical qualities of cultural heritage, that is why the structure is destroyed and the historical factor is lost. The addition of new volumes is substantiated by the need to ensure its functional activity and viability in the urban environment. Wall is considered as the work of plastic skill and maximum visual differentiation and underlining of the artistic value of cultural heritage is the condition of the interpretation of new volumes. Thus, was made attempt by the use the alternative solution to divide wall as fine sculpture and new architectural volume as function. The selection of the function of artistic gallery is dictated by the conditions of urban environment and by the desire to find the worthy correspondence to the artistic values of heritage.

The second project of restoration, reconstruction and reuse includes the fragment of the quarter, where in the transverse boundaries of area, on the lines of the perimeter construction of two parallel streets are located three apartment houses. All buildings are generally in poor condition or ruined and abandoned. For the Museum of Architecture were selected two neighboring edifices in Pavstos Buzand Street, M.Engibaryan's and S.Soghomonyan's, which together serve the purpose of satisfying requirements. First building planned for the temporary and permanent exhibition halls. Second building planned as an administrative part. One of the exhibition halls is located on the basement floor of the left wing. It is solved height of two floors, since there is no overlap cover, so there may be exposed high artifacts. For little intervention and also in order to emphasize the old walls, the new wooden flooring is separated from the historical walls with the crushed stone layer. And a new cover is removed with the surface of glass, allowing light to penetrate inside. As the building itself is a museum exhibit, where wooden beams of the building, which were cut, here show wall girder system of the period. Existing historical stairs, which are partly ruined, should be preserved, and then new stairs from lightweight material can be placed above the old one (fig. 6). The open spaces and backyards of buildings planned as an outdoor museum of architecture, which is part of the public open spaces. There will be displayed exhibits representing 19th and 20th centuries architecture, which are used to decorate of this and surrounding districts, such as building details, stones and balconies parts. Samples are original ones, the main parts are preserved from destroyed buildings in the last few years, and now there are uncared condition in a various places and threatens to abrasion and disappearance. In the third, F.Kalantaryan's apartment house in Arami Street lived the prominent political, military and public figure Aram Manukyan, so there was an idea to create this building as a house-museum. Plan and interior spaces of the structure is preserved and is not transformed. Exhibition hall planed as a row of the room enfilade according to the historical plan.

Fig. 1 Teacher‘s seminary in Astafyan street, 1905, Vasily Mirzoyan.

Fig. 2 Teacher‘s seminary, reconstruction, 1930s, Nikogaes Buniatyan.

Fig. 3 Apartment house in Nalbandyan Street, 1890s-1900s.

Fig. 4 Apartment house, adaptation under Armsberbank, reconstruction and expansion, 1996-2002, Levon Vardanyan.

Fig. 5 Project of the reconstruction of P.Esapyan's house in Republic Street, 2007, National University of Architecture and Construction of Armenia, student Rambod Abdi Fakhrai, supervisor Marietta Gasparyan.

Fig. 6 Restoration and reuse project of the historical and architectural environment of the quarter in the central district of Yerevan city, Museum of the architecture, fragment of the interior, 2014, Milan Polytechnic Institute, students Lilit Vardanyan, Ara Avetisyan, Nanor Nalbandian, supervisors Mariakristina Giambruno, Raffaella Simonelli.

6. CONCLUSIONS

The condition for the longevity and viability of a historic building is its function in the contemporary infrastructure of the city, which requires reuse, rational interpretation of the new functional tasks, introduction of advanced technologies in structure, modern equipment, frequently increases existing volumes. Alternative to the analogous intervention in the structure of the object is the problem of preserving and identifying its aesthetic and stylistic parameters, which can be solved with the observance of two basic formulas: the inviolability of the historic building and differentiation of old and new volumes, with the composition domination of historical building. The analysis of Buniatyan's method and the evaluation of the best examples of reconstructions and reuses of the cultural heritage of Yerevan show that a question can be regulated with the observance of the rules of a correct reconstruction, with the unconditional piety to the formal and structural definitions of architectural heritage. Assertion and development of a similar creative approach, taking into account the architectural specificity of the studied buildings can become the basis to formulate concrete canons, which should be under the strict control of the authorities, to protect the cultural heritage[1].

NOTES

[1] Photographs for the illustrations are made M.Gasparyan, for fig. 1 – from the old postcard, the projects are given by the authors.

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PROBLEM OF PRESERVING AND DEVELOPMENT OF NATIONAL DISTINCTIVE CHARACTER IN CONTEMPORARY ARAB ARCHITECTURE

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Keywords

distinctive character, architectural activity, language of architecture

ABSTRACT

The article deals with the issues of preserving and developing the national distinctive character of architecture in Arab countries in connection with globalization process. When facing distinctive historical and cultural heritage, local natural climatic conditions, religious and spiritual setup and social patterns of life, Western European or Northern American tendencies aggravate the problems of contemporary architecture formation.

The aim of the research is to outline the ways of solving the problems of contemporary Arab architecture directed at the preservation and development of national distinctive character. The problem of preserving the uniqueness of architectural space in Arab countries should be solved, first of all, within the framework of professional activity and education in local schools of architecture aimed at solving regionally specified compositional and ethic questions. An important aspect of such a study is the unveiling of unique specific characteristics of urban space from the point of view of emotionally rich ones, i.e. interesting informative, esthetic, social and functional aspects.

1. INTRODUCTION

In the age of thorough globalization process Arab countries face plenty of problems that are typical for contemporary architecture in general. All-pervading modern tendencies, as a rule, Western European or Northern American ones, facing distinctive historical and cultural heritage, local natural climatic conditions, religious and spiritual setup and social patterns of life and thought, aggravate the problems of contemporary architecture formation. These tendencies are demonstrated by new buildings in the centres of Damascus, Cairo and Tunis, site development in Al Kuwait and some UAE cities, etc. The problem of preservation and reconstruction of architectural monuments has become pressing in an Arab city. In this context Arab and Western architects that work in the region try to find new forms and approaches which would suit the distinctive and ancient Arab culture under modern conditions. The Arab specificity, especially in the architecture of public buildings and complexes, has been actively looked for in Arab countries since the second half of the 20th century. At the same time no common strategy of preserving and developing regional uniqueness of Arab architecture under contemporary conditions has been determined. The problem is caused by the underdeveloped professional activity in Arab countries and, first of all, by the weak development of the local schools of architecture as well as by the lack of the developed scientific and research base for designing. All this results in the absence of distinct and clear understanding of how to develop the centuries-old traditions of Arab architecture, which, in its turn, causes insufficient development of the system of national expressive means in the contemporary Arab architecture.

2. BACKGROUND

Some ways to solve this problem are discussed in the research carried out by Arab authors (M. Malla, A. Al Mutlak, B. Najm Ud-Din, S. Nasr, Kh. Uddin Khan, T. Ash-Sharif, etc.), in the works of Western researches and architects (O. Grabar, G. Von Grünebaum, K. Creswell, L. Massignon, E. Diez, J. Marceau, G. Hoag, etc.) The researchers

from Ukraine and other countries of the former USSR have made a great contribution to the studying of Arab architecture (Kh. Benai, S. Bulatov, A. Burov, B. Weimarn, V. Voronina, T. Kaptereva, M. Piotrovskiy, A. Rallev, Sh. Shukurov, etc.).
The existing research examines Arab architecture in the context of creating an artistic form, relevance with the functional as well as natural and climatic peculiarities of the region, in connection with the lifestyle, customs and regional beliefs. At the same time one of the factors defining the development ways of national architecture remains beyond the scope of the research. This factor is the organization and ways of development of compositional and aesthetic means of architectural expressiveness whose purpose is to detect national identity. The objective of the research is to find some ways of solving the problems of the contemporary Arab architecture intended to help preserve and develop national distinctive character.
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3. METHODS

The environmental approach, comparative analysis and field observations are used in the research. The research methods include some features of activity system as well as cultural and historical approaches.

4. CASE HISTORY

The solution of the problem of preserving national distinctive character in architecture depends on the ability of the architect to create viable forms of regional culture, simultaneously connecting them with some outer influences at the level of achievements in science and technology as well as development of society and culture in general. The trends in architecture development that correspond to this approach deal with the issue of developing professional awareness of the architect using the development of regional schools of architecture. The latter in their turn should prefer the concept of education that is oriented towards studying the existing cultural and historical situation in the region, including its social, world outlook, landscape and space components.
When studying architecture, we deal with a sphere of knowledge which, in its essence, is a complicated system. This system includes technical and aesthetic blocks of knowledge. The architect must be aware of the problems in contemporary science and technology, culture and art. For this reason it is important to study not only engineering and technical subjects but also humanitarian ones, for example, history and philosophy, aesthetics and psychology of environment perception. Knowledge and skills of working with an architectural object as a compositional, functional and imaginative unit are also required. One of the problems in formation of such integrity is connected with the issue of the language of architecture which is predominant in the region. It is created by the whole versatility of architectural tricks, various signs, symbols, constructive and tectonic forms as well as numerous options to combine them. The problem of creating a language of architecture that can be understood both by specialists and consumers consists in the fact that this language is constantly changing, evolving, first becoming “partially unclear’, then conventional, and at last it stops conforming modern tastes. Components of ethnical culture form a stabilizing system in this process. Contemporary architectural problems originate mainly from the complicated interaction of regional architectural forms with the world culture. In this situation aesthetic expressiveness of architectural forms is the most contradictive part of regional problems in architectural design. It is directly connected with the issues of preservation, interpretation and transformation of a traditional architectural form. The problem of the language of architecture is a consequence of the issue of studying and interpreting architectural heritage. The problems of preservation of historical and cultural legacy as well as architectural expressiveness of contemporary architecture came to the limelight in practical field in 1960-1990ies, when the active process of city reconstruction took place in plenty of Arab countries. The increasing volume of construction works in historical centres of the cities was explained by the growth of business activity caused by the oil boom. For example, quick development of the Saudi Arabian capital Riyadh has resulted in almost complete destruction of architectural heritage. New office buildings, mosques, palaces, hotels, dwelling areas, water towers and plants here are high-tech buildings, but in the majority of cases, together with the infrastructure of wide avenues, multilayered roads, they are alien to the local culture.
However, a tendency of positive changes has become obvious lately. The trend to use traditions and environmental complex in a thoughtful way can be seen in the project of reconstruction in the centre of Riyadh developed by Rasem Badran (Jordan), one of the most interesting and notable modern Arab architects. Unlike New Brutalism and Post-Modernism masters who enjoy accompanying their designs with a detailed ideological discourse, R. Badran expresses his architectural concept in his buildings themselves. Hasan-Uddin Khan writes that “they use sketches and models, rather than words, to express their ideas and preach intuitive, rather than intellectual approach in architecture. He aspires to develop “Islamic architecture” and contemporary Arab language of architecture, that is reflected in using the local desert vernacular and in references to the historical samples from the past” (Hasan-Uddin Khan, 1995). The development of Qasr Al-Hokm in the old centre of Riyadh has a rich history. The plan of 1979-92 foresaw its restoration. The development plan for the area was made in such a way that the old fragment of the city got another opportunity to regain its historical role as the political, cultural and commercial centre,

finding the right balance between new construction and preservation of traditional elements, reflecting the unique architecture of Riyadh and the characteristic system of interaction among the buildings, squares and streets.
The critics give Badran credit for his good awareness of new technological achievements and their use in his designs. He is also praised for his attention to the urban form and its connection with the identity of the historical Islam city. The project of complex reconstruction was awarded in 1985 at an international contest. Expert of Aga Khan Award for Architecture, Pakistani architect and urban planner professor Mukhtar Husain says that "architect Rasem Badran began his work with the analysis of the environment, climatic and cultural factors, local traditions, standards of public behavior and their influence upon architectural images of the buildings. Both outside and in the interior he recreates the spatial characteristics and peculiar features of the previous building, combining this project skillfully with the surrounding context rather than copying what existed before. The architectural image of the mosque is inspired by the picture of the earlier mosque that was situated at this place, based on an old photo taken in 1930" (Sattarova, D. I.). Qasr Al-Hokm or the Palace of Justice is situated in the central nucleus of Riyadh. The entire complex includes governmental administrative buildings, shopping malls and offices, a great mosque and the Palace of Justice itself. In the construction of the mosque the architect applies some traditional elements: a sakhn (*inner yard*), a riwaq (*arcade, gallery*) and a musallah (*a prayer hall*). At the northern and southern corners of the prayer hall there are two square-base minarets that symbolize qibla, i.e. the direction of the sacred shrine of the Ka'bah in Mecca. The main prayer hall with the columns that are situated according to a square net at the distance of 9 meters resembles an early Islamic hypostyle hall. Typical traditional features of Arab architecture manifest themselves in various ways of surface decoration. For instance, in the interior of the Palace of Justice and in the mosque some local decoration methods have been used, including furnishing, mural painting and cabinet work, triangular crenels in masonry work of various scale and arrangement, as well as patterned floors. The ways and skill of their use relate to the local cultural context. Light as one of the most important elements of expressing an artistic paradigm also has its own interesting solutions. Openings for natural illumination are designed above every capital in the main prayer hall, they resemble the operating principle of ventilation towers in traditional buildings. Natural lighting is supplemented by artificial, with the help of three layers of lamps that create the required level of illumination allowing reading on the floor. The inner yard and square are lit with pole lamps. The buildings by Badran that imitate the architecture of Najd are made of concrete with yellow stone finish. In its southern part Qasr Al-Hokm has six layers in the form of a fortress with thick walls and large towers, whereas its northern part has a dramatic façade with several access points to the inner yard with a garden. The cubistic shape of Qasr Al-Hokm is intentionally overstated. Preservation of national distinctive character has much to do with the understanding of regional specificity, the essence of architecture that reflects the specific understanding of space. Emptiness inside the space in Islamic architecture receives an extremely important spiritual meaning. That is the reason why the spatial design of the complex seems to be crucial. The fact that the design of the Palace of Justice and the mosque provides a series of inner open yards, i.e. a key element of traditional Arab buildings, as well as squares, plays an important role in creating the urban fabric in the centre of Riyadh. In keeping with the best traditions some of the squares have trees planted. It was the yard space that served as a natural oasis with a fountain and a garden. As a rule, it was organized as a symbol of the Garden of Paradise whose description is often met in the Quran. One of the problems of rendering national identity is architectural understanding of space. Contemporary tendencies in Oriental town planning with its system of wide avenues that open into the desert, large squares lit with the southern sun, and huge complexes whose blocks of skyscrapers are set against the traditional "fabric", do not correspond to the traditional notion of space in Arab architecture and town planning. Regarding preservation of the national uniqueness of regional culture the most important task is to show the specific unique spaces in the urban environment. The traditional environment in an Arab city is based on the combination of regular and irregular spaces. Regularity is always a sign of order, logic and management. Rigid regular structures forming the urban frame are to introduce a regulating principle in the complexity of urban life. And the chaotic picturesque fragments (groups of dwellings, yards, blocks, interior forms) create the complexity that makes the environment emotional and interesting. For this reason the solution of the problem of combining urban structures of different aspects into a single compositional and aesthetic unity is essential for the theory and practice of contemporary town planning. This is especially urgent for the process of aesthetic perception of architectural environment. Architecture is supposed to present a sort of paradox, i.e. another kind of information which supports transition from pragmatic logic of habitat perception to the logic of imagination. According to Ya. Golosovker, the supreme instinct of culture manifests itself in the form of the interest aroused by imagination. "It acts as the interest of the whole human spirit and that is why we call it our spiritual interest"(Golosovker Ya. E., 2010). Consequently, the difference between the spaces clear for the person and the ones that do not suit such a definition is, in its essence, definitive for communication. The clear spaces include a straight street, a wide square, a yard with distinct borders, etc. A turn or narrowing of space, immersion into a shadow or a variation of height immediately make the space unclear, in other words, strange, and consequently, such spaces subconsciously receive negative semantics". V.N. Toporov defines semantics of straightness and curvature as a characteristic feature of "culture" (logical clarity) and "nature" (amorphousness, darkness, connection with the "bottom" of the earth and water). However, according to V.N. Toporov, these amorphousness and lack of visibility hide some "elements of the second natural range" which

help overcome depression and lead to liberation, a symbolic exit into cosmic boundlessness (Toporov, V.N. 1995) . Simple geometrically defined spaces are characterized by the fact that when perceived from a certain angle, the geometry of the whole space can be predicted due to its forecastability. These spaces have distinct borders of transition from one to another that are visible to the eye. Often such spaces seem boring because they do not contain at least a simple mystery, i.e. they do not produce information. Complicated geometrically defined spaces must be examined from various angles, they require guessing (assuming). Their connotation structure is active. In this case human creativity can be activated in order to organize the object of observation.

Traditional architectural fabric of a town is based on the interaction of logical, structural and chaotic complicated spaces. A vivid description of space in an Arab town is given in the work of Z. Malla: "The streets are so narrow that the houses almost side with each other. No man's passageways or the notion of a façade to observe an object is absent here. Instead of it there is a monotonous dead wall, all houses are situated facing the inside. Their entire value is hidden in the closed space" (Malla M. Z., 1991). Taking into account the specificity of traditional urban spaces, it can be stated that preservation of the national distinctive character in Arab architecture consists, first of all, in discovery and studying of the spatial essence of regional architecture.

5. RESULTS

The problem of preserving the unique architectural environment of Arab countries must be solved, first of all, within the frame of professional activity and education in local schools of architecture, designed to find answers to the specific regional issues of composition and aesthetics:

- harmonious combination of architecture and natural surroundings, social contents, traditions;
- scientific substantiation of various compositional means and methods of forming integrity in architecture;
- problem of style and search for an architectural plot, language of architecture and speech.

The perspectives of solving the problem of preserving the regional uniqueness of Arab architecture seem to be hidden not in copying the traditional prototypes, space or style methods. The solution can be found, first of all, in the creation of a contemporary language of architecture that cannot remain stable but must be in harmony with contemporary world outlook which is associated with the challenges of time. At the same time the language of architecture must be based on the specific understanding of the essence of architecture and take into account the main traditional features of Arab architectural poetics: specific urbanism resulting from the influence of the dry and hot climate; conceptualization of space in Arab architecture; artistic modulation of the light flow; priority of a decorated surface over sculptural development of shape; its own dictionary of symbolic meanings in space and forms.

6. CONCLUSIONS

These tasks can be fulfilled, first of all, by the development of local schools of architecture based on fundamental professional education. Studying of the historical traditions and regional uniqueness of Arab architecture must become the key element in the contents of education. An important aspect of this studying is attention to the language of the unique urban environment spaces. The peculiar feature of the distinctive oriental language of architecture can be studied from the point of view of emotionally rich spaces that are interesting due to their informative, aesthetic, social and functional aspects, their specific urbanism, light modulation, etc. This can be the starting point for the forms and meanings of contemporary Arab architecture to be formed and understood in the professional environment of architects.

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PROJECT OF REINFORCEMENT AND RESTORATION OF TIGRANAKERT BASILIC CHURCH IN ARTSAKH

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Keywords

tigranakert basilic Church, archaeological excavation, comparative analysis, reconstruction

ABSTRACT

The settlement of Tigranakert in Artsakh was founded and named after Tigran the Great. The town is located in the Askeran region of Nagorno-Karabakh Republic(Artsakh) on the lower current of the Khachenaget river to the south of the river on the one of the comparatively low heights of the slopes of Vankasar mountain and in the depression nearby the slope in the vicinity of the Royal Springs. The place of the settlement was defined and archaeological excavations have already been held for 10 years. At the settlement of Tigranakert there is an Archaeological museum, where a lot of tourists visit from all over the world. Nowadays it is urgent to preserve the discovered monuments and to involve them in tourism. Complex investigation of Tigranakert church enables us to introduce the concept of reconstruction, which is reinforcement and conservation. The remaining ruins, the theoretical and comparative analysis, investigation and comparison of parallels a enable us to give the reconstruction of the newly discovered basilica for the first time.

1. INTRODUCTION

After the excavations of the basilic church of Tigranakert it appeared in the hollow which had became a basin for accumulation surface (especially rain) waters. It is necessary that preventing actions be implemented: partial reconstruction of the monument and drainage, as well as the project for its restoration be implemented.

2. BACKGROUND

The territory of Tigranakert in Artsakh is about 70 hectars. The main construction of the town became visible during excavations: there are fortified area with its citadel, Central area, Antique area, antique and early christian graveyards. During the axcavations in the Central Area of Tigranakert the ruins of an early Christian church (IV-VI centuries) were unearthed.
During the reinforcement of the church it was suggested that such lime mortar be used that ite similar to its medieval properties.
For that analysis of physical-chemichal properties were held .
‘’Yerkir’’ Union of Non-Governmental Organizations for Repatriation and Settlement has initiated and funded the exploration of Tigranakert. The costs of the expedition have been covered partially in 2007 and fully in 2008-2009 by the government of NKR.

3. METHODS

The work was done by the metho d of investigating of the original monument (particularly its measurements) and historical comparative and theoretical analysis.

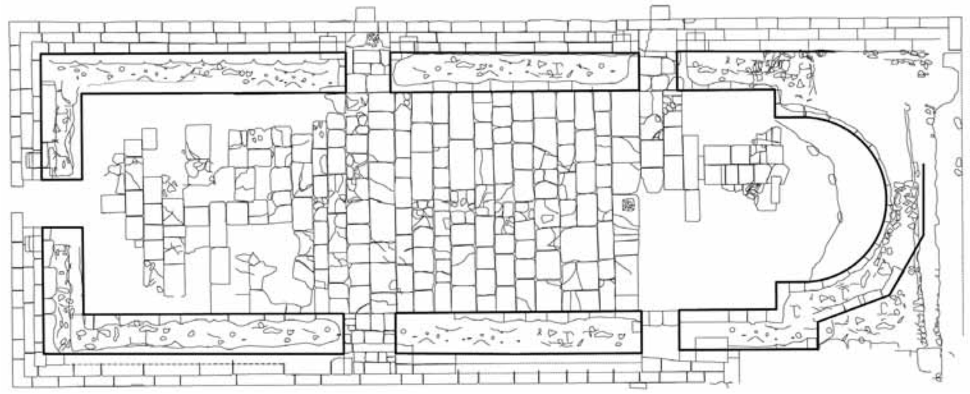

Fig. 1 The plan of the early chistian Basilic church of Tigranakert.

4. CASE HISTORY

The settlement of Tigranakert in Artsakh was founded and named after Tigran the Great (95-55BC). The place of the settlement was defined and archaeological excavations have already been held for 10 years. The town is located in the Askeran region of Nagorno-Karabakh Republic (Artsakh) on the lower current of the Khachenaget river to the south of the river on the one of the comparatively low heights of the slopes of Vankasar mountain and in the depression nearby the slope in the vicinity of the Royal Springs (Shahbulah). The existence of water springs played crucial role for the selection of this particular location, due to this resource the issue of water supply of the city was solved. During the excavations in the Central Area of Tigranakert the ruins of an early Christian church (IV-VI century) were unearthed. Ruins of an early medieval church, as well as remnants of pottery from the same period prove that the settlement has been functional in Middle Ages as well. Before the excavations in the place of the basilic church only large blocks of lime mortar and a hollow with its axis oriented from east to west were found. The plan of the building was completely preserved, the spatial composition (in places the height of the walls is 3,0 meters) is obvious.

Plannig and spatial composition – The whole plan of the church is fully preserved. It is a one-nave hall with a stressed outer apsis. Has a three-stair-step stilobate. The rectangular praying hall (21,4x6,8m) which is oriented from east to west ends in the east with a five-ribbed apsis on the outer part and not so deep (3,4m) semicircular inner apsis. The length of the church excels its width (27,3x9,3m), has a three-stair-step stylobate (28,85x11,25m, with a total space 256,6m2), and five entrances. Besides the apse, the church has a chancel (an area for the choir between the nave and the apse), which stretches 2.5 m to the west and is 0.5 m above the nave level. It is totally covered with limestone tiles and has two stairs going downward towards the nave. This kind of solution is unique among the early Christian basilicas of the southern Caucasus. The floor of the praying hall is cablestone which is mostly preserved. (Petrosyan, H., Kirakosyan L. etc, 2012).

Building technique and engeneering- The church of Tigranakert is built of well polished lime-stone. The walls are reinforced by the mortar of the same limestone. As the church hadn’t a naturally solid rock foundation as there was in the fortified parts an artificial foundation was built for it. After the excavation of the foundation of the eastern part the way that foundation was built became clear. This foundation is a 0,6m high platform reinforced by lime mortar.

The ‘’aboundance’’ of five entrances in the early christian one-nave churches hasn’t been verified. Churches with ribbed absidores have only two entrances (Bayburd, Pemsashen). A stone vault and was covered with a gable tied roof (the roof wasn’t preserved but there were a great number of tiles found during the excavation).

It had a cogged cornice, the capitals which were found during excavations were decorate the capital of the facade. Basilic church has perfect, well-dressed walls and tile floors, and rich architectural decor. This is one of the largest and most magnificent churches of its kind in Transcaucasus. It has analogues in the region (Aykajur-Gyavur kala).

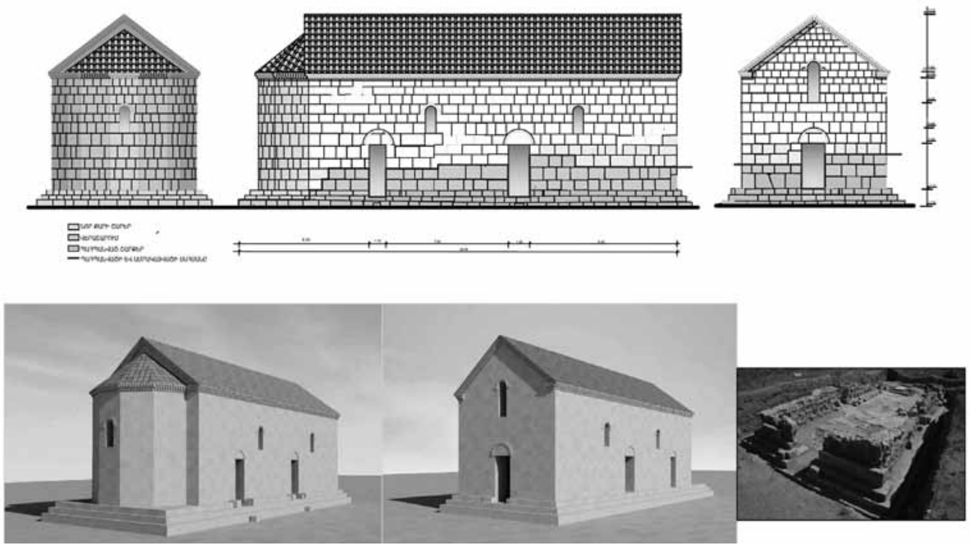

Fig. 2 The view of Tigranakert early chistian church after excavation and project of restoration.

Gyavur kala -(''Fort of Infidels'') was partially studied by Azerbaijani archaeologists during 1960s and 1970s (Vahidov, R. 1965). Today the ruins of an early Christian decorated by vegetal, fruital motives. A composition in the form of crosses and clusters of grapes church are located here. It has parallels in the region and peculiarities of the one-nave churches of the IV-VI century Armenian architecture (Arutyunyan, V. (1950), Cuneo, P. (1973), Hasratyan, M. (1986)). Its peculiarities have been characteristic of the Armenian
architecture ever since its beginnings.

Project of reinforcement and restoration of Tigranakert basilica - Though the basilic church of Tigranakert. is of great scientific and cultural importance it has already caused anxiety concerning preservation, usage and reinterpretation of the monument. Owing to the excavations at the depth about 4,0 meters the ruins of the church were unearthed

Today the church appeared to be in a hollow of about 800m2 and 4,0m deep. The whole space has been lowered to the level of the base. In fact the building is in an artificial basin where not only atmosphere but also subsoil waters are accumulated. The high humidity and the peneteration of waters from te hollow to te stylobates, walls and lime mortar have left visible traces of salt because of moisture.

Rain waters having peneterated in to the blocks have washed out the lime mortar causing damage to the walls. About 2/3 of the three-stair step stylobates have been preseved but some of them were replaced. The mortar of some of the stylobates is destroyed. The walls of the church are preserved to one and in places to two row high. The mortar of the inner part of most walls is also destroyed. In the highest part (about 3m high) only lime mortar is preserved and is rather weatherworn. On almost all parts of the lime mortar the traces of stones are visible.

The cablestone of the church is mostly preserved. About 70% of the cablestone is cracked and broken. They are in their original places though the floor is somehow transformed.

During the excavations about 140 pieces belonging to the monument were found. They are cornerstones, smooth and curved stones of walls, capitals of the entrance, cornices and other parts. Though the excavation is still going on it is suggested that the church should be reinforced to prevent it from different distructive affections of the atmosphere factors. The reinforcement of the church and the reconstruction of some of its parts have mainly one goal-to preserve the monument and present it to the public.

Complex investigation of the of Tigranakert church enables us to introduce the concept of reconstruction i. e. considering the conditions of the preservation of the monument to reinforce and conserve it.

Only factually preserved parts of the monument will be restored. The drainage of the early christian basilica of Tigranakert is of great importance and necessity. The best way of draining the subsoil waters is building a drainage system.

First of all the stylobates of the monument will be reinforced and the missing stones will be placed. The part of the destroyed walls will be restored by preserved blocks and the missing block will be specially built so that they don't differ and look harmonious The cablestone will also be reinforced.

5. RESULTS

Partial reinforcement, preservation and restoration of the early chrisitian basilic church of Tigranakert was available due to the conditien of its preservation and comperatative analysis of other simultaneous monuments. Basilic church of Tigranakert as a hitorical monument is included in guided tours of Nagorno Karabakh.

6. CONCLUSION

As a result of excavations of Tigranakert of Artsakh in its Central Area an early chrisitian basilic church was escavated. Along with planning and spatial composition similar to that period it has differences. The one nave hall has large scale measures, five entrances, peculiar architectural details.The spatial composition of the building is typical to the medival, Armenian and international churchbuilding techniques preservation of the building allows to condu et partial reinforcement and preservation. The comparison of the monument with Transcaucasian and particularly Armenian early chrisitian similar complexes, its theoretical and comperative analysis, studies of the parallels allows to present the project of restoration of the newly excavated basilic church which respresents a tiled gabled, prolonged building. Such planning and spatial composition of the building is typical to the early medival Armenian and world church building.

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STUDY ON TYPICAL DEPENDENT STRUCTURE OF 400 YEARS OLD THE SHIBAOZHAI TIMBER TOWER

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Keywords

shibaozhai tower, dependent structure, protection and restoration

ABSTRACT

The Shibaozhai historic tower, being boasted the sole dependent wooden structure of 400 years old, has being erected at the bank of the Yangtze River in Chongqing. The tower was built up by a special technique called Chuandou structural system that was once prevalent in the region of southeastern China. Nowadays the Chuandou structure system is identified as one of the timber construction technique of the intangible heritage of China. The structural features and carpentry skills of the wooden tower are intensively described, following the analysis of the dependent structure how to subtly combine it with the cliff and finally realized the unique building is discussed in this paper. Finally the protective measures and technical key points of restoration of the timber tower are also stated.

The Shibaozhai tower, located on the north bank of the Yangtze River and 45km away from Zhongxian Town of Chongqing, is a unique dependent timber structure with over 400 years of history. The tower was built up and leaned against on the Yuyin hill, during the Wanli Period (1573-1620) of the Ming Dynasty, and looks like an isolated hill with steep cliff. By virtue of its unique architectural form, the tower is entitled as "a Jewel on the Yangtze River".

1. HISTORY OF THE SHIBAOZHAI TOWER

According to Local Records of Zhongzhou State in 1826, the Hall of Prince atop the Yuyin hill was built between 1572 and 1619 and was the earliest building having existed up to today in the Shibaozhai area. The tower was built in 1819, more 200 years later than the Hall of Prince. The group of buildings in Shibaozhai had been matured its architectural form from 1796 to 1820. In 2001, the State Council of China declared the group of buildings in Shibaozhai to be one of the fifth batch of the National Historic Monuments.

There are few high-rise timber buildings preserved in China, so the dependent nine-floor tower is full of the most important value of historical and architectural artistic. The ingenious site selection of the tower was perfectly combined the Yuyin Hill with the dependent timber structure, showing the superb techniques presented by ancient carpenters who took advantage of local geography and topography. The tower erects as the highest dependent timber building in China and is identified as a genius cultural heritage with outstanding value. Moreover, it also stands for an irreplaceable supplement and evidence to the development of Chinese timber constructions.

The nine-floor tower was built up leaning against the Yuyin hill, with multi-overhanging eaves, and boasts as a splendid landmark building. On the ninth floor of tower there has a narrow stair leading to the floor of the Kuixing Pavilion, a square building with triple eaves and pyramid-like curve roof. The profile of tower and pavilion merging into a twelve-floor building of 56 meters high if it is being viewed from southeastern direction. The building was elaborately shaped according to the ups and downs of hill, and became a harmonious and grandiose structure in the Shibaozhai area.

The Shibaozhai tower is located on the Yuyin Hill which faces the upper reaches of the Yangtze River, actually acts a beacon-like landmark along the river course running its way from the southwest to the northeast.

Fig. 1 The photo of the Sakyamuni Pagoda and the Shibaozhai Tower.

2. FEATURES OF DEPENDENT TIMBER BUILDING

Timber structure is a major type of the ancient Chinese architecture; the vast majority of timberwork building is composed of beams and pillars to form an independent structure system.

The Sakyamuni Pagoda (commonly called the wooden pagoda) of Fogong Temple in Yingxian Town, Shanxi, is more than 900 years old. The pagoda exists in today as the highest independent timber structure in the world. The pagoda has an octagonal plan, with five visible floors outside and nine concealed floors inside. The wooden structure was built with double circles of pillars, each outside and another inside on every floor, creating an octagonal tube frame from bottom to top. The close-set diagonal bracing of tangential direction and radial direction between pillars enhances the plane rigidity greatly. The fully closed wooden frame composed of lintels on the pillar serves as a huge ring beam, and makes the wooden pagoda just like a rigid octagonal tube. The octagonal wooden tube, somewhat similar to modern tube structure, has good anti-seismic performance, which makes the Sakyamuni Pagoda survived from several historic earthquake strikes.

The independent timber structure of the Sakyamuni Pagoda adopted the technique authorized by the imperial government, which was entitled the official mode. Otherwise the dependent timber structure of the Shibaozhai tower was built with local technique commonly known as the folk mode. In addition, the Sakyamuni Pagoda erected its big volume from the plain earth with prominent silhouette, while the Shibaozhai tower was built up leaning against the steep cliff, with setting of rocky hill and dense woods, showing its silhouette with less strong visual effect.

2.1 Architectural Aesthetics

From the fifth to ninth century, more and more components of building trended to widely adopt curve cut, slight oblique pillar and upward recession to express the softness and elegance. The trend of carpentry made high-rise building present the inward curve line with the retreated pillars at both sides. Those special technical developments effectively ensured the stability of building and gradually became a sort of aesthetic norm followed by carpenters. The retreated pillars of independent structure always happened with its geometrical epicenter. The outside pillars retreated inward with uniform size, like the Sakyamuni Pagoda. Otherwise the pillars of the Shibaozhai tower

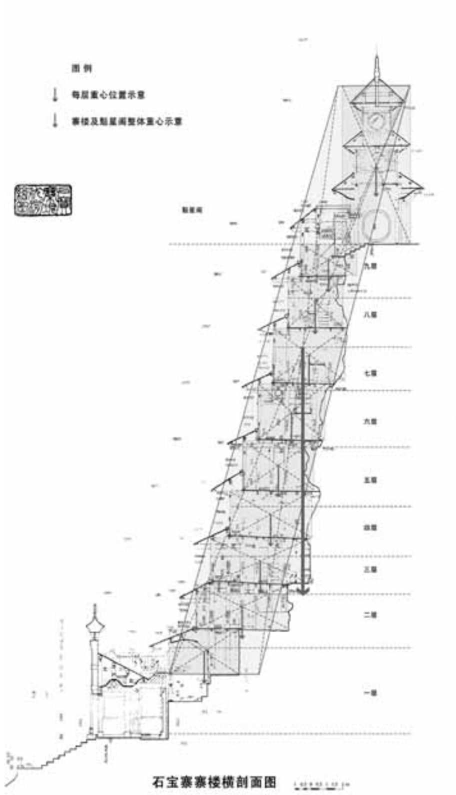

Fig. 2 The Mechanical Features of Shibaozhai Tower.

retreated inward floor by floor according to the shape of hill, different size at each floor. The dependent structure was built up following the steep surface of hill, so the retreated silhouette was often formed by the inward recession of structural pillars stood on every floor.

2.2 Mechanical Features

As tower building developed higher and higher, a technical challenge of structure was how to resist effectively the transverse shear caused by strong wind. An independent high-rise structure requires the gravity centers of every floor to be exactly coincident with that of the whole structure in order to ensure the stability of building.

The whole structure of Shibaozhai tower leans against the Yuyin hill, pillars partly inserted into or bolted with rocks, perfectly combined with natural hill to strengthen the stability of tower. The gravity centers of every floor are not in a line with that of the whole structure. The tower retreated inward floor by floor, and kept its gravity center also moving toward the hill itself. This technique totally ensured the steady and stability of tower.

The group of buildings in Shibaozhai and the Yuyin hill which they built has grown up as an organic entirety. The building and the hill tied tightly each other and became inseparable, perfectly presented the artful combination of what by the man made and by the nature created.

2.3 Chuandou Timber Structural Frame

The dependent timber structure of the Shibaozhai tower was totally built with the Chuandou technique, a local technique widely employed by folk carpenters in the southwestern region of China. The Chuandou structure identified with no wooden bracket, no brick masonry, and the pillars along the width and depth of bays were densely positioned. Those pillars were tied at top and bottom by various cross-through lintels and completely formed the wooden frame system of a high-rise tower. The whole structure by the Chuandou technique shows the mechanical system neatly and steady.

In addition to the pillars were linked by the cross-through lintels, which were also laid beneath the wooden floor to connect the pillars which were positioned at the cross points of axis. The loads on every floor were directly delivered to the pillars via purlins and lintels. Moreover the joists supporting the floors also delivered part load onto the pillars via the tenon-and-mortise work as well as bolsters. All load of the structure was elaborately delivered down following along the timber's texture of most components. Up to the present, despite being dated of 200 hundreds years, the Shibaozhai tower shows no sign of visible deformation or distortion.

3. CHALLENGES AND MEASURES FOR PROTECTING THE TIMBER TOWER

It is advisable and essential to preserve the timber tower in situ. Only in this way, the group of Shibaozhai buildings and the dependent structure could be protected completely to the maximum extent. At the same time, to the extent possible it need to keep the natural and artificial sceneries, fully showcase its historical and cultural value as well as architectural art. Then improve its conservation status, and promote the development of effective protection and inheritance measures for the authenticity and integrity of historic heritage.

3.1 Replacing and Moving Pillars

The decay and transformation of structural carpentry is one of the most popular problems especially for timber constructions. That means the extent of pillars' damage is one of the overriding considerations for protection and repair. At that time, the roof truss won't be lifted away so that it can keep its original wooden structural features and internal settings to reflect the historical precipitation and architectural techniques.

3.2 Chapiter of Beam Frame

If there has some beam frames suffered insect damage or worm-eaten hollow, it should be paid attention to faithfully restoring the original appearance of the building in terms of its figuration, size, decoration and colors in order to restore the new elements as the original ones, instead of changing them based upon groundless supposition.

3.3 Chuandou Timber Structure

The Shibaozhai tower was built with the Chuandou technique and it was built adjoin the mountain side combined wooden structure with stone hill together. The timber then would easily got rotten in addition to the hot and humid weather in Chongqing, which may lead to structural risks. Because of that it is important to enhance the antiseptic property of the wooden parts of the tower. Chongqing is also frequently prone to termites and other insect attacks so the timber here also needs to be treated to prevent damage from insects. In addition, fireproofing and lightning protection should also be taken into consideration. If a fire occurred the result would be disastrous.

4. CONCLUSIONS

The Shibaozhai tower is one of the few high-rise timber pavilions existing in China, and the only one dependent timber building that built with the ancient local Chuandou technique. Because as it is, the variety and regional of ancient timberwork buildings could be proved. Not only a unique case in the architectural heritage it is, but also a most significant landmark along the Yangtze River.

On the issue over protecting the timber tower, both scientific protection and reasonable utilization are mostly needed, at the same time, launching innovative cultural activities is also beneficial to promote the public awareness of protection as well as the social economy. The ultimate goal is to produce an outcome that the tangible historic building and intangible constructive technique will be entirely sustained and handed down generation after generation.

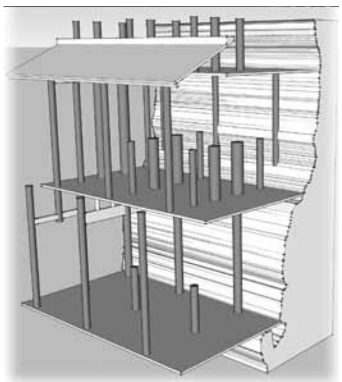

Fig. 3 The Timber Structure.

EMERGENCY INTEGRATED SURVEY OF THE SAN FRANCESCO BASILICA'S ATTICS AND DOMES IN FERRARA (ITALY)

POSTER

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Keywords

structure from motion, laser scanner, emergency survey

ABSTRACT

The recent technological advancements in the field of digital photogrammetry together with the improvement of computational methods for image analysis have been show to aid laser technologies in architectural measurements, yielding high-resolution surveys of unprecedented resolution. In theory (and in many real applications) an integrated survey coming from both laser scanning and photogrammetry is able to meet all the requirements to perform a correct architectural survey, both in terms of the centimeter resolution and for fine aesthetic representations.
The presented study deals a survey of the attic and the top surface of the domes of the left and right naves of the San Francesco Basilica in Ferrara (Italy), in which not all the ideal conditions required for a good quality integrated survey are present. Different practical problems may pose due to a recent earthquake (2012). The present job will be focused on survey planning and performing, in such emergency condition, on the used techniques and the final products. The results of such survey will be used for a future restoration of the Basilica.

1. INTRODUCTION

Latest methodologies for architectural surveying may seem able to model each architectural element with relative ease. By using Structure from Motion (SfM) and laser scanning techniques, either as standalone or as a combination, it is possible to obtain a complete high-quality survey. In some cases, however, peculiar layouts of the working environment may prevent the application of standard methodological procedures.
The present case study refers to San Francesco Basilica in Ferrara, Italy. The basilica has sustained severe damage following a major earthquake in May 2012, including lesions and structural failures, mostly located in the upper portions (attics of aisles).
In order to undertake restoration works, it is necessary to survey the rooms that have sustained more severe damage. A first overview shows that the survey objects have some serious issues, regarding: insufficient lighting, presence of debris and incomplete safety. All of the above causes huge difficulties both for movements and for correct operation of the surveying instrumentation.

2. BACKGROUND

Currently available literature features many examples showing how, by using and integrating laser scanning and SfM techniques, it is comparatively easy to obtain complete models with centimetre accuracy and photorealistic textures (e.g. Caroti, et al., 2015, Fantini et al., 2012, Meschini et al., 2014.), as well as other examples of systematic procedures to correctly perform complete surveys.
For both photogrammetric and laser-scanning data, pipelining splits in two blocks: one in the field, i.e. data collecting, and the other in the lab, i.e. data processing and production of graphical output, both 2D and 3D. These procedures allow analysing the survey object from both geometric and graphical standpoints. However, each one of these blocks has different features based on the methodologies used for surveying.
As for SfM techniques, data collection includes camera calibration and network (planning and picture shooting), while data processing includes (Abdelhafiz, 2009, Manferdini and Remondino 2010): (a) using bundle adjustment

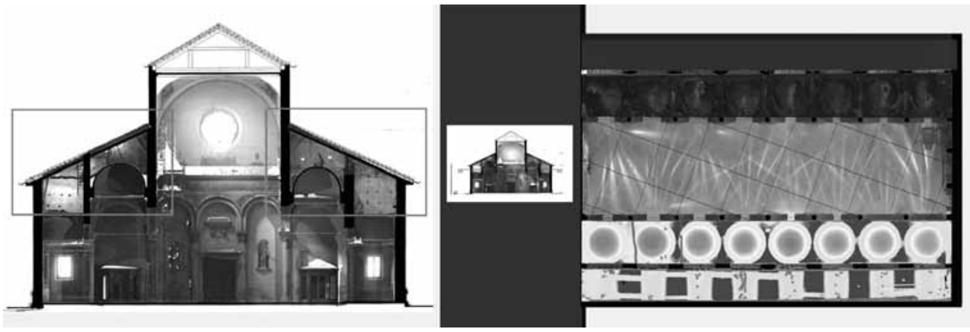

Fig. 1 Cross and horizontal section of the aisles attic.

algorithms, for semiautomatic computation of parameters for external and internal camera orientation; (b) 3D restitution and surface generation; (c) quality analysis of results; (d) texture mapping and visualization.

In laser scanning techniques, data collection only includes the network step, whereas data processing includes alignment, merging and mesh generation, mesh editing, post-processing and generation of photorealistic textures (Apollonio and Remondino, 2010, Guidi, Russo and Beraldin, 2010).

In order to generate models with high chromatic resolution and high geometric accuracy, well-defined conditions must be granted. As regards SfM techniques, lighting must be homogenous, frame overlap must be greater than 70%, an ideal shooting base/range ratio (1/3 – 1/4) would be strongly advisable and both with normal and convergent imaging geometries.

In laser scanning surveys, scans must overlap for at least 20% if using 'matching' scan registration mode, otherwise at least three targets must be visible in each scan. It is also necessary to avoid data loss due to shadowing, and RGB data collection requires homogenous, diffused light.

In the job upon described above, as in most of the surveys performed in areas struck by natural disasters, many of the above-mentioned conditions are not attainable (Fassi, et al., 2015; D'Amico, 2001).

Shallow passageways and/or inaccessible areas decrease the overall ability to effectively use collection points designed for optimal results (Rodríguez-Gonzálvez et al., 2015). On the other hand, total lack of lighting implies use of artificial lighting sources, whose reverberation negatively affects the performance of most of the cameras integrated in laser scanners.

3. CASE HISTORY

San Francesco Basilica, located in the old town of Ferrara, was built in 1494 on a pre-existent building (possibly a XIV century Gothic church), already in use by the Franciscan order, based on a draft of architect Biagio Rossetti, as commissioned by Duke Hercules I as part of an effort to revitalize and modernize the old core of the city. The volume of San Francesco, then, is shaped by Rossetti to streamline a number of road nodes of medieval Ferrara. (Zevi, B., 2006.)

Throughout its history, the basilica has gone through several cycles of damage and recovery: in particular, it suffered damages and structural failures following the May 2012 seismic event. A new plan for recovery and preservation of the main aisles was drafted, focusing in particular on the domes and chapels of the right- and left-hand aisles of the Basilica. The current object of the plan is the three-dimensional survey of the aisles, with particular attention to their attics, and the exterior survey of aisles and bell tower.

The present paper focuses on the survey of the attics of the four side aisles, which, at the time of the surveying operations, showed severe damage (figure 1).The attics of outer aisles measure 46.25 m (length) x 4.42 m (width), while their height varies from 3.95 m to 6.25 m; each one contains the extradoses of eight barrel vaults (radius = 2.8 m), and has been made accessible thanks to narrow wooden walkways that allow longitudinal movement. The attics of inner aisles measure 46.25 m (length) x 5.46 m (width), with height varying from 3.80 m to 5.50 m, and each one contains the extradoses of eight domes(radius = 2.37 m).Their surveying has been particularly challenging, due to presence of obstacles which greatly reduced available operating space; in fact, the imposts of adjacent domes are quite close (about 30 cm) and merge into the perimeter walls, effectively precluding movement

AREA	Aisle	Wall	N. scans	N. Photograms	Mesh	Texture
Aisle LX	Aisle outer Vault	wall 1	20	165	Laser scanner	Photoscan
		wall 2		24	Laser scanner	Photoscan
		wall 3		217	Laser scanner	Photoscan
		wall 4		26	Laser scanner	Photoscan
	Aisle inner Domes	wall A	26	14	Laser scanner + Photograms	Photoscan + Laser scanner
		wall B		57	Photograms	Photoscan
		wall C		1061	Laser scanner	Photoscan
		wall D		45	Photograms	Photoscan
Aisle RX	Aisle inner Domes	wall B	19	46	Photograms	Photoscan
		wall C		299	Laser scanner	Photoscan
		wall D		33	Laser scanner	Photoscan

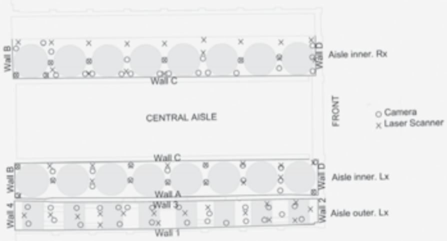

Fig. 2 Scheme of distribution of instruments and the elaborate.

of persons and gear.

At the time of the survey, the inner right-hand aisle was safe, with raised wooden walkways to allow movement. On the other hand, the outer right-hand aisle was inaccessible and therefore it was not surveyed.

Left-hand aisles were accessible, although lacking any intervention for debris removal or installation of wooden walkways. The extradoses of the domes are quite often broken, with entire rows of bricks missing in the worst cases.

The attics featured slanted beams along with horizontal, lower ones, both original and replaced during recovery interventions, which cause major shadowing issues as regards installation of artificial lighting sources. In order to overcome the problem, achieving a diffused light, a very high number of light points should be used, at least one every impost. Besides economic issues (generally a major limiting factor in the planning of a network), this solution further limits the available operating space, so that localized lighting was chosen instead, moving the floodlights together with surveying instrumentation. Floodlights used in this survey are of the controllable colour temperature type, which was set at 5400°K.

4. METHODS

Surveying (3D data collection)

The attics of the aisles of the Basilica were surveyed with a Trimble TX5 laser scanner, fitted with a built-in camera. The resolution of the survey was set at 4 mm at 10 m, the merging resulting in a very dense point cloud (on average 100 pts/cm2). In order to simplify the model where surfaces were smooth, a decimation of the points was performed, preserving in any case the geometrical information.

In order to texture the derived model with more faithful colours, optimised for subsequent three-dimensional modelling via SfM methodologies, a dedicated photographic campaign was performed using a Nikon D800 camera fitted with fixed 50 mm and 24 mm lens.

Image collection

A theoretical photo-shooting plan requires compliance with well-defined parameters. In the present survey, movements are allowed at best only along narrow wooden walkways, which define the direction along which the base to range ratio can be granted as correct. As regards vertical shootings, the presence of beams and the operating difficulties preclude raising or lowering the shooting point. In the most inaccessible or unsafe areas, it has been sought to collect as many images as possible, dropping the optimal shooting design and leaving check and eventual deletion of unfitting photograms to the subsequent processing step.

Generally, for each room, photograms did not follow a fixed shooting plan, exploiting the interpretive abilities of SfM software (figure 4, left). Many images have been correctly oriented (with crosschecks versus laser scanning data) only thanks to smart points automatically detected by the software. In other cases, it has been necessary to

Fig. 3 Deviation maps of the wall respect to a vertical middle plane.

manually enter the coordinates of several control points detected in the point cloud. The geometrical precision obtained is the order of 1 cm. On the other hand, the graphic resolution of the applied texture is higher and coincides with the linear dimension of the pixel, in the order of 1 mm. This allows reading of very small elements (e.g. rifts, cracks, deformations, etc.). In order to reduce shadowing issues, great care was
taken to place the camera in the midpoint of the lighting sources covering the mid-upper and mid-lower portion of each photogram, respectively.

Laser scanning collection

Laser scanning resolution was set in drafting phase at 4 mm/10 m; each room was covered on average with 10 scans, each one requiring about 9 minutes. It was linked to a pre-existent topographical network via use of a total station.
Laser scans of the attics have also used artificial lighting, aiming to place the scanner in the midpoint between two floodlights.

Data processing

Data processing workflow generally includes processing of laser point cloud, which is used as a geometric reference for surface generation and image projection on the mesh for high-resolution texturing.
Subsequently, photographic data is processed, computing shooting geometry for the cameras and reconstructing the point cloud via SfM algorithms. The survey is then framed in the laser scanning reference system, through well-identifiable control points on the walls. Anyway, when the reference laser mesh shows obvious problems, photogrammetry data is checked and therefore used for surface generation (Figure 2).
In some cases, laser scanning point clouds are very noisy due to high concentration of dust in the attics, which requires frequent breaks to blow the scanner mirror clean. In other cases, meshes show obvious geometric issues. In some scans problems due to vibration were noticed. The wooden walkways installed for security purposes turned out to be unstable and sensitive to any movement.
In fact, the short sides had so little operating space that the scanner could not be properly positioned and the distance between scanner and wall is less than the minimum operating distance (about 60cm). In these cases, laser derived meshes have holes that hinder their usability. On the other hand, issues in photo shooting result in poor overlap in some areas, which effectively prevents the generation of a point cloud with verifiable accuracy.
In order to overcome the absence of data in the laser mesh, a procedure which integrates photogrammetry and laser-scanning data has been followed. Whenever a hole in the laser point cloud was detected, the surrounding area was extracted and locally compared with same area in the photogrammetric cloud, which is already framed in the same reference system. The clouds are subsequently aligned by means of the Iterative Closest Points (ICP)

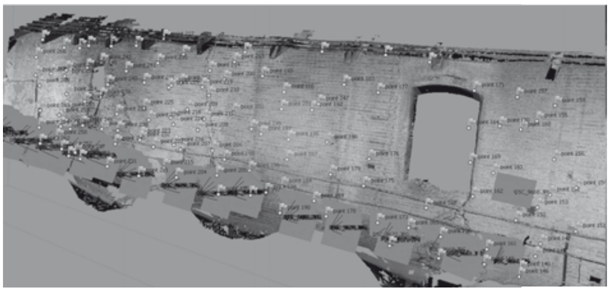

Fig. 4 Imaging geometries .

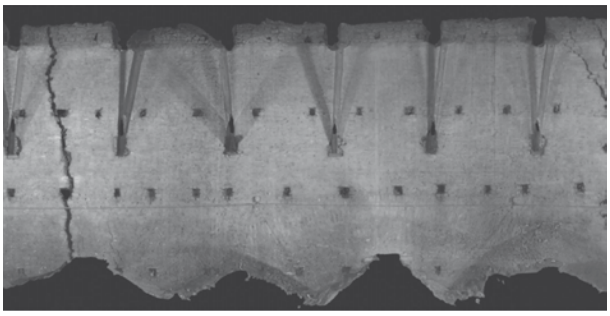

Fig. 5 Example of damage wall portion.

algorithm, and if the iterative procedure yields a sub-centimetre Root Mean Square (RMS), photogrammetric reconstruction is accepted and the data sets are integrated.
After correct integration of the point clouds, the next step includes orthoprojection of photograms on the laser mesh, except for the noted cases.
Point clouds derived from laser scans have been instead used for extraction of 2D graphical output.

5. RESULTS

The methodology used allowed us to obtain a complete textured model of the survey object, with few gaps. This has been used to derive several outputs: verticality maps and horizontal and vertical sections.
Verticality maps
The Integration of laser scanner and SfM surveys allow us to create complete verticality maps. The analysis of these allows the identification of areas out of alignment, cave-ins and fractures on the walls due to earthquakes. In Respect to middle planes of the respective walls, in the figure 3 in the left, an outward displacement of the top part of the wall is evident, while on the right there is evidence of swelling of the wall in the central area.
Horizontal and vertical sections
Starting from a model that is a product of both procedures, vertical and horizontal sections of the church were created, useful for creating the entire project of restoration. In the sections that are a result of the sum of partial processing, it’s possible to analyze the fractures, the gaps, the ceiling beams, the changes of position etc. For example, in fig.4 (right) we can analyze the fractures on the wall. This information is very useful for the planning of the restoration project. From the completed model, the technician can have a complete vision which would not be possible even visiting the site.

6. CONCLUSIONS

Integration between terrestrial laser scanning and photogrammetry is a well-established surveying practice. The present paper analysed a case in which the single methodologies are aimed at the final product, rather than aesthetic purposes. In this case, integration of laser scanning with photogrammetry has proved useful, beyond improvement of graphical quality, to make up for missing data in the laser survey. Possible future developments for the present work could include the definition of a methodology enabling validation of the integration as proposed, in terms of expected and attainable precision.

NOTES

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THE ORIGINS OF THE ORNAMENTS APPLIED IN EARLY MEDIEVAL ARMENIAN ARCHITECTURE

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Keywords

architectural ornaments, early medieval Armenian architecture, chapiters

ABSTRACT

The ornamentation of artistic decoration applied in early medieval religious buildings, prerequisites of their formation, their national and international sources are observed. For centuries, the Armenian masters, using the ancestors experience, taking the progressive changes from outside and preserving national spirit, enriched Armenian architectural treasury. Faithful to the principle of succession, they created new ones, based on previous achievements, improving and breathing new life into them.
Early medieval Armenian architecture monuments of artistic expression in a variety of ornamentation have been chosen for the study. In the trims of the observed structures, geometric and plant ornaments such as combine acanthus, palm leaves, grape clusters, spiral and leaf, pomegranate fruit and branches, grills, as well as secular and religious images with rich ornaments have been applied.

1. INTRODUCTION

The main feature of Armenian architecture of early medieval period (4-7th cent.) is the magnificence of the structures' architectural compositions, balance, clarity of tectonic structure, as well as the modest and restrained use of artistic expressions in exterior design. The primary methods of artistic decoration of religious buildings of this period were portals, window openings arches, cornices, vaulting, vault bows and the styling ornamentation.
Vegetal ornaments were mostly used: acanthus palm decor, leaves and bunches of grapes, pomegranate fruit and leaves. We can also see cornices and window vaulting decorated by geometric motives (teeth, arches, circles, balls, lattice, etc.), as well as ornaments rich with secular and religious images, in which, along with national peculiarities, the Hellenistic, Byzantine and Syrian cultures influence is obvious.

2. BACKGROUND

Vegetal ornaments (grape and pomegranate, palm ornaments, ornaments of chapiter) used in Religious structures in the early Middle Ages (4-7th cent.), their national origin and global interactions are considered.

3. CASE HISTORY

Grape and pomegranate ornaments. The grape and pomegranate motives stand out in vegetal decorative engravings and have been widely used in early medieval, ancient eastern and Hellenistic monuments. They were mostly widespread in countries where there was viticulture, and wine-making industry was developed. There are a number of Bronze Age objects of decorative and applied arts, that symbolize grapes and pomegranates. Ceramic pots decorated with images of vine leaves and clusters, as well as various toiletry items (luxury brow jewelry, earrings, etc.) made of precious metals in a shape of pomegranate and cluster have been found (Harutyunyan, S. and Qalantaryan, A., Avetisyan P. 2005).
After the adoption of Christianity, this decoration, receiving a symbolic value, becomes the main motive of religious buildings. It has been found in the Caucasus, Syria, the Byzantine Christian religious buildings' trims of the same era.
Whereas in early medieval architecture the pomegranate as a vegetal decoration appears for the first time after three centuries since Christianity adoption (7th cent.) in the decoration belt of Zvartnots, then the vine ornaments were

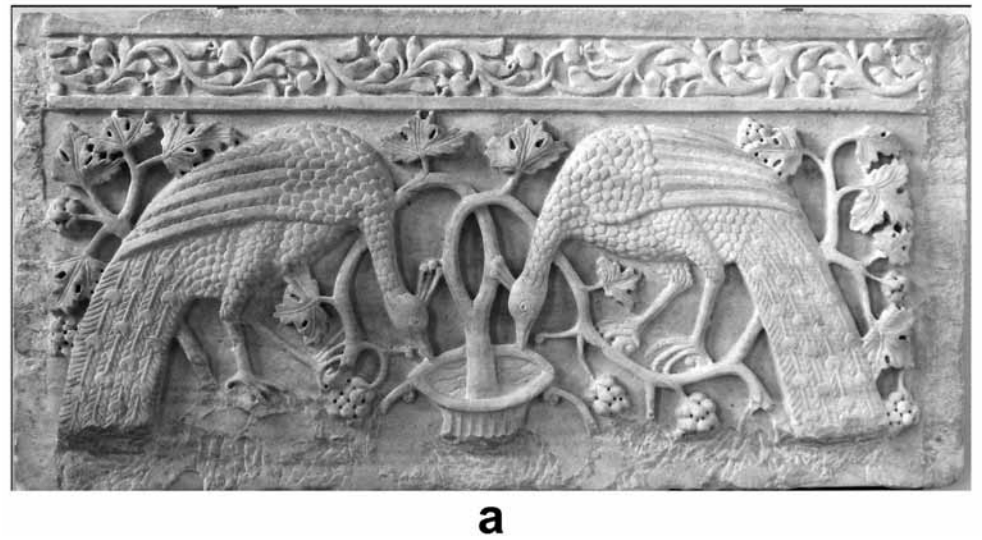


Fig. 1 Grape and pomegranate ornaments in the Armenian and Byzantine architecture.
a - Ravenna. Church St. Apolinare (6 century)

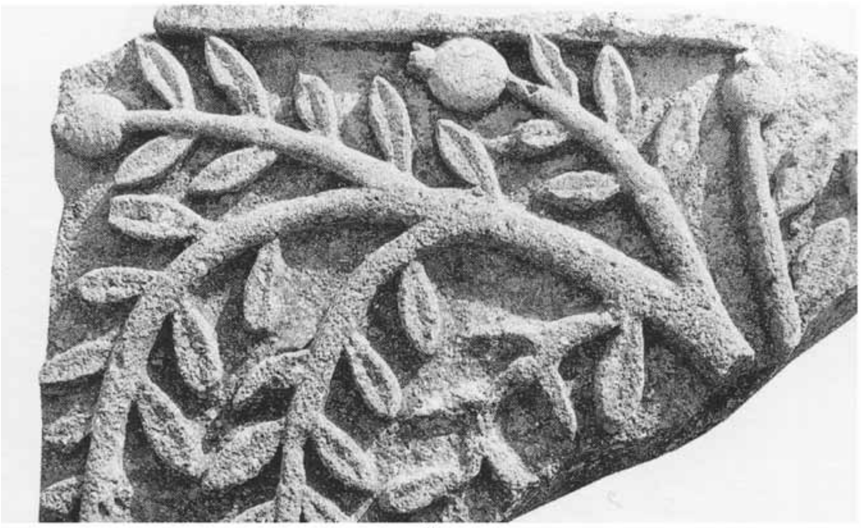
the main decorative motives of the first Christian structures. They appeared in Aghts royal tombs (4-5th cent.) and in the first Christian religious buildings: Qasakh basilica (5th cent.), Tekor Cathedral (5th century), etc. The grape is symbolizing Christ and his teaching. “I am the real vine, and my Father is the gardener. […] No branch can bear fruit by itself, but only if it remains united with the vine; no more can you bear fruit, unless you remain united with me. I am the vine, and you are the branches” (Jn. 15, 1-5) (Harutyunyan, S. and Qalantaryan A., Avetisyan P. 2005). Grape ornament has an important place among the Byzantine decorative motivess. Of course, in the ancient Greek decorative art, the grapevine was the symbol of viticulture and pagan god of Wine Bacchus, in the Byzantine period in Armenian decorations this ornament bear the idea of Savior and the tree of life. For example, in the center of symmetrical composition of decorative engravings of Ravenna Church (6th century), the grapevine rises symbolizing the tree of life, above which the cross is located, and on both sides there are peacocks (fig. 1, a).

Such compositions are also found in Armenian architecture, especially in cross compositions. A cross is located in the center of the casings trim compositional axis of Qasakh basilica entries. Its two sides are worked out by grape bunches and palm decor. The ornaments on the lintel of church Koghb (5-6th cent.), Ashtarak Tsiranavor Church (5th cent.) and village Ptghni are also surrounded by clusters of vine. This ornament later developed in compositions of khachkars.

Thus, during the Christianity period the vine cluster had the meaning of tree of life and the Paradise Park. Vine was also identified with the blood of Christ, “... Jesus Christ as the true grapevine, vine as divine blood, the Judgment Day as the harvesting and crushing of grape bunches/souls in God’s own winepress. In Christ’s liking, Armenian saints and martyrs are the vines and the grapes that are crushed and transformed” (Petrosyan H. L. 2008).

In early medieval Armenian ornaments the motive of wave-shaped grape clusters and leaves of the various options and styles were on the rise. Wavelike motives in different structures have very similar and at the same time very different treatments (churches Hripsime, Mreni, Odzoun, Talin, Artik, Mastara, Bagaran, Ptghni, Aruch, Sisavan) (fig. 2, c).

This motive achieved perfection in the outer decoration of Zvartnots Temple (7th cent.), the distinctive features



b

Fig. 1 Grape and pomegranate ornaments in the Armenian and Byzantine architecture.
b - The pomegranate ornament in temple Zvartnots (7 century)

of which are the ornaments of the arcature's archivolts of the first tier. Nonuniform arches are crowned with consistently repeating clusters and vine leafs. Arch decorations of Zvartnots temple are simple and truthful (fig. 2, d).

Such ornamental motives are also found in Byzantine architecture, which indicates the Armenian-Byzantine cultural relations.

Pomegranate traditionally holds a special place in Armenian culture. Undoubtedly, it is the main motive in Armenia in all areas of the fine arts – as the most common ornamental composition it is found in architecture, painting, book graphics, ceramics, metalwork, woodcarving and embroidery. It should be noted that pomegranate as an architectural ornament appears for the first time in the 7th century in Zvartnots.

Meanwhile, in the same centuries, there are plenty of images of pomegranate in the countries neighboring Armenia (Byzantium, Persia).

In Armenian architecture a pomegranate fruit and branch had an important significance in the pagan period. The reason for this might be that in ancient times in Armenia the pomegranate was connected to worship of pagan goddess, and therefore, during the dissemination of the Christianity the pagan temples dedicated to Anahit were destroyed and on the same places Christian churches dedicated to Blessed Virgin were erected, the images of pomegranate, as fruit connected with cult of Anahit, were also shattered and their places in the church ritual, architecture, etc. were replaced with grape.

As mentioned above, pomegranate as an architectural ornament appears for the first time in Zvartnots. In addition, Christian doctrine has inherited the ancient symbolism of the pomegranate as a tree of life or Paradise Park (fig. 1, b). It has the same value in the ornament of Zvartnots. The master carver of temple has depicted the Garden of Eden in full harmony with the cathedral rising on the background of Mount Ararat and surrounded by vineyards.

In the Paradise Park there are reliefs of animals, and it is interesting that the bear image is also remarkably present in the ornamental belts encircling the cathedrals in Zvartnots and Talin, where it is a logical association with the motives of vines and bunches. The bear is the custodian of Paradise Park.

Later the pomegranate motive appears in the second half of the 7th century in other monuments (Yeghvard, Artik, Talin churches). In ornaments of these monuments the influence of Zvartnots's pomegranate is obvious.
In the ornaments of khachkars in parallel with the grape appears the ornament of pomegranate, which has been rooted for centuries as symbols in Armenian spiritual and secular life, acquired a new significance with the advance of Christianity: "As a sweet fruit is hidden under the bitter peel of pomegranate, so in the words of the prophets in the Old Testament the symbol of the Christ, as well as the events of the New Testament are hidden" (Ghazaryan V. 1995).
One of the vegetal ornaments in early Christian architecture is the palm ornament in various combinations, that has been used in Armenian and Hellenistic monuments. Later, various options were used in medieval monuments (churches Zoravor, Sisian, Byurakan, Ptghni, Aruch, etc.).
In first half of the 7th century in the external decoration of facades and drums of several monuments a decorative arcade with double pilasters has been applied (Zvartnots, Artik, Talin, Voskepar, Sisavan, etc.).
Ornaments of chapiter of external decorative arcades' pilasters of Zvartnots temple have the pairs of flowers motive adopted in decorative art. This motive, having deep roots in miniatures, symbolizes the meaning of parent-couple. In the decoration of Zvartnots it is also symbolic and stands as a symbol of new life and fertility (Mnacakanyan A. Sh. 1955).
In the external decoration of early medieval Armenian churches the most important place occupied by the unique chapiters of the columns with basket weave spherical forms covered by spiral elements.
A striking examples are the chapiters of the columns of Zvartnots temple's apses. Observing the chapiters of Byzantine churches St. Sophia, St. Sergius and Bacchus, which also have a spherical shape and angular spiral elements, we can see interaction and decoration similarities of Zvartnots and Byzantine chapiters. This type of chapiters has been applied in Yereruyk Basilica and without any proportional changes appeared both in the early Christian and medieval architecture developed in Armenia (Arzni, Oshakan Irind, Banak, Gagkashen, etc.) (Mnacakanyan S. Kh. 1971).
There is also a similarity between the Armenian, Syrian and pre-hellenistic architectural styles (Toramanyan T. 1984).

4. RESULTS

• Plant carvings in various forms are widely used to successively repeat grape cluster and leaf hooks motives. In all structures grapevine and leaf developments are very similar to each other, at the same time have very different solutions. After the adoption of Christianity, getting the symbolic value, this ornament form becomes the main motive of religious buildings.

• Pomegranate as an ornament for the first time appears in the first half of 7th century in Zvartnots temple. In ancient times it was connected with the death and the underworld (in the cornice of Garni temple). Further, according to the Christian understanding the pomegranate tree stands as a symbol of new life, the "Paradise Park".

• Repeatedly encountered palm leaves ornaments in different styles have been applied in the Hellenistic, Greco-Roman periods, as well as in Armenian early medieval monuments.

• Columns, pillars and chapiters were an important part of early medieval Armenian churches. Chapiters are quite unique volumetric compositions consisting of ornamental motives of basket capped spherical volume and a pair of scroll patterns. Similar chapiters have been formed under different cultures (Hellenistic, Byzantine, Syrian) influence. At the same time they are complete and consistent, which is typical for the national and local traditions.

5. CONCLUSIONS

Thus, the study of ornaments used in cult buildings of medieval Armenian architecture (4-7th cent.) shows that the Armenian mason masters, bringing to perfection the art of stone processing, and transmitting their experience from generation to generation, left a valuable samples of Armenian art.
These ornaments, having external influences, are the uniqueness of national thinking, that became the cornerstone of architecture and got its high art incarnation in Armenian masters' stone works.

c

Fig. 2 **The grape ornament on the archs.**

c - Sisavan (7 century)

d - Zvartnots (7 century)

d

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SOCIAL USE OF WOODEN ARCHITECTURE IN TOMSK-METHOD OF PRESERVATION OF THE UNIQUE PHENOMENON OF WORLD CULTURE

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Keywords

wooden architecture, preservation, tourism

ABSTRACT

The article is devoted to the town wooden building structures of the second half of XIX - early XX centuries, showing Russian national architecture. The author focuses on the relevance of its preservation and argues that science-based contemporary (present day) usage is crucial in preserving the wooden buildings. Wherein historical experience and the needs of modern society are important components when assigning functions of the wooden houses of the XIX - XX centuries. Various options of inclusion the ancient buildings in modern life are considered as an example in projects of future Architects and Restorers – students of the Chair of Restoration and Reconstruction of Architectural Heritage of Tomsk State University of Architecture and Building, which were carried out for the ancient Siberian city under the leadership of the author.*

1. INTRODUCTION

Tomsk, old Siberian town, was celebrated 410-year anniversary in October 2014. The wooden architecture, represented the style of “classicism”,
“tradition” and “modern” has been preserved here. The holistic arrays of urban wooden buildings of the second half of XIX - early XX centuries, are a vivid embodiment of Russian national architecture. Such situation is a rare phenomenon in major Russian cities. In the best case, there are isolated islands of wooden buildings among modern buildings. And in Tomsk, where we have such quantity and variety of the city preserved wooden architecture, it is constantly in loss of this unique phenomenon of world culture. As a result of research findings, carried out by the author, we can say that 1035 wooden buildings and structures in the historic center of Tomsk (sheds for coaches, granaries, etc.) had been lost from 1985 to 2003. They were replaced by high-rise modern buildings made of concrete and bricks. In 2003 here were preserved 1805 wooden buildings and structures. By now this figure is decreased. The issue of the value of Russian wooden architecture, particularly in Tomsk, of the need for measures to preserve it, has been repeatedly raised by the author at the international conferences, seminars and in the media [3, 4, 5]. How can we save today the historic wooden architecture in major cities, embodied the folk traditions and professionalism of architects? One of the tools to ensure its preservation, is obligatory use of the wooden historical building by a modern society.

2. BACKGROUND

The purpose of this research is to share experiences, to consider the various aspects of using of wooden historic buildings in Tomsk, taking into account its value, the needs of modern society and the investment attractiveness.
Considering the modern functional use as a way of preserving the historical wooden buildings it is essential that its adaptation, proposed to the ancient wooden monument of history and architecture, promotes preservation of its architectural and design features and at the same time does not worsen the technical condition. The same rules should apply to other wooden objects forming the ordinary, but valuable wooden city’s structures. After all, it is these buildings which form the historical fabric of the city, its unique architectural and artistic appearance and constitute a background of historical and architectural monuments. There are a lot of such buildings, more than

wooden objects with the official status of monuments of history and architecture. Therefore, scientifically based method of choosing the architectural monument's adaptation plays a key role in the preservation of both individual wooden buildings and the architectural and artistic originality of the historical center of Tomsk. Large research and project work is being done at the Chair of Restoration and Reconstruction of Architectural Heritage of Tomsk State University of Architecture and Building (the Chair of R&RAH of TSUAB).

3. METHODS

One of the criteria of scientifically based method of choosing the ancient wooden buildings adaptation is a compulsory consideration of each structure as an element of urban system – manor, quarter, group of quarters and etc. A comprehensive solution of the functional purpose of holistic urban fragments of the Tomsk's historical center is considered at the Chair of R&RAH of TSUAB as the most effective way to preserve historic wooden architecture [2]. This approach allows us to offer the modern functional use taking into account the real needs of the urban area. At this stage social and design diagnostics is a significant project tool and an integral part of pre-project studies. Preserved manor system of wooden houses in Tomsk creates good conditions for using of historic buildings for luxury housing. 1-3 houses in the estate make it possible to place here "family nest" which older, middle and younger generations can live together. This coexistence of generations is typical of the Russian tradition. The opportunity of living in the historic center of the city in a separate estate with a large yard, with the garage and other outbuildings, arbors, flower beds, places for children to play – is unique to the big city. Accommodation in a house made of wood (eco-friendly material) in large spacious apartments with high ceilings, which include dining room, living room, library, office, bedroom, children's room, room for servants and so on, best corresponds to the concept of "luxury housing". Such approach to the modern use of historic wooden buildings automatically solves the problem of caring for ancient buildings, removing the financial burden from the municipal budget. The use of historical wooden buildings as residential should prevail, as they are a major percentage of housing in the historic center of the city. Undoubtedly, it takes a series of measures to improve the comfort of living in a historic building (decompression, remodeling, installation of engineering equipment and so on). The yard in the estate promotes real communication, which in modern society is increasingly replaced by a virtual one. In addition to luxury housing the apartments for young professionals and scientists, college campuses and so on can be placed here. Tomsk is a university town where every fifth person – a student and every tenth person has a higher education. The knowledge of the building's value features helps to eliminate such modern functional use which can distort its construction idea, planning, architectural and artistic and design features. The system of values proposed by O.I. Prutsyn, in our view, most fully and objectively describes the ancient buildings [1]. The presence or absence of historical, town planning, architectural and artistic, emotional and scientific restoration and functional values determine its significance. The revival of national traditions is increasingly becoming a fundamental idea in choosing a new function for a number of objects of wooden architecture in the course and diploma designing. Small hotels are particularly relevant to Tomsk, scientific and cultural center. With the help of proper authority's politics a group of investors can be interested in arrangement of small hotels of wooden buildings in the historic city center. It is also one of the measures of the preservation of ancient wooden architecture.

Among the wooden buildings in Tomsk there are houses, which planning structure is well suitable for a variety of museums, clubs, hotels and other public functions. It allows demonstrating the beauty and uniqueness of historic wooden architecture to a large number of people, expanding their knowledge of the native city's history, and increasing the interest in preserving its unique features.

4. CASE HISTORY

As examples there are two variants of the one-storied wooden house's adaptation, the architectural monument of the late XIX century on Sovetskaya st., 20 in Tomsk, suggested the 5th year students of the Chair of R&RAH of TSUAB. We should note that students carried out the course project of the architectural monument's adaptation based on the previously developed their restoration project of the same building. Such approach allows studying well the town planning situation, all values and characteristics of the designed object. The compulsory step in the adaptation project is to write a script. It allows students to answer a series of questions: why is this feature best suited for the building?; how will a visitor feel here?; what does this facility differ from the others like this?; what is commercial component?; and etc. All it makes the design process deliberated. The interior of one of the rooms (student's choice) is compulsory part in student conceptual design. Alena Mikheev adapted the wooden

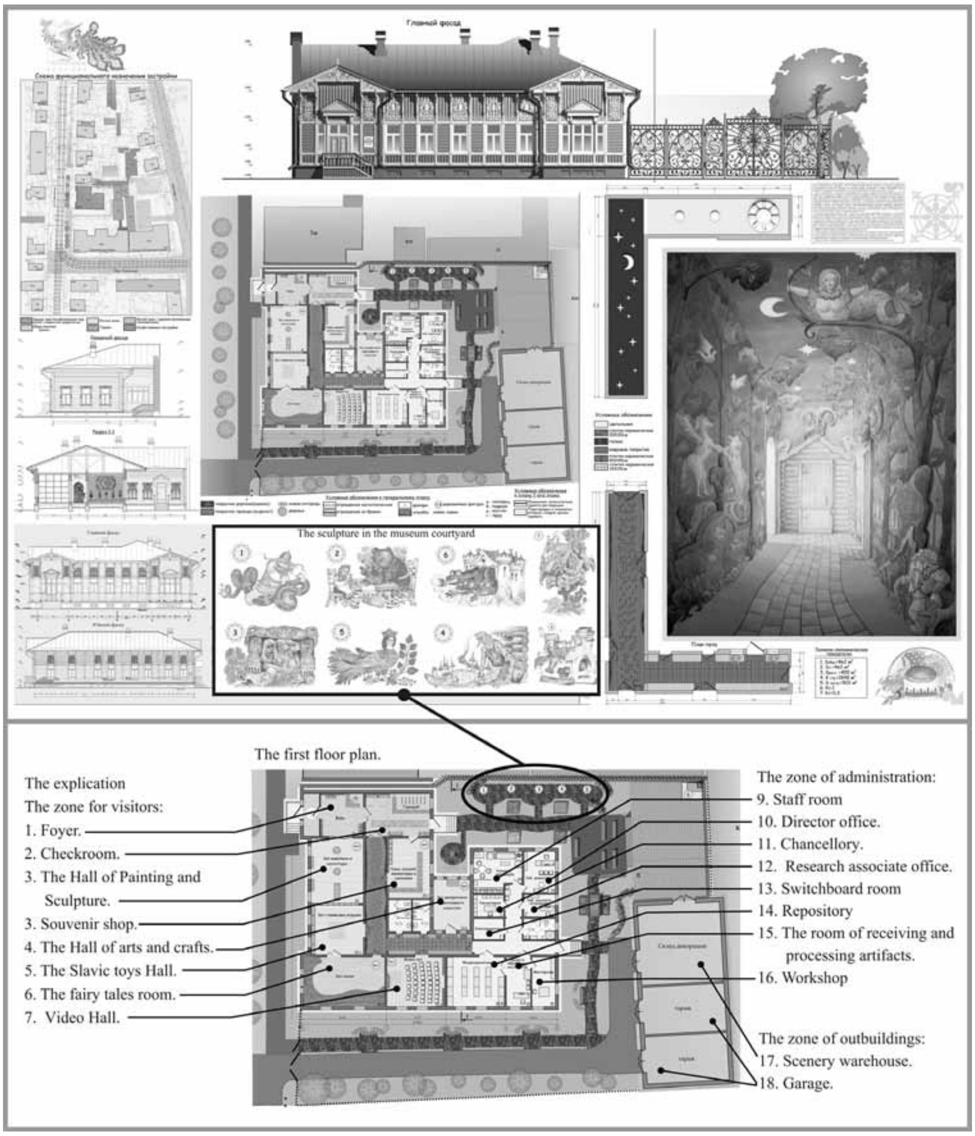

Fig. 1 Fragment of conceptual design of the architectural monument's adaptation as the Museum of Slavic mythology, 20, Sovetskaya st., Tomsk, Russia.Student – Mikheeva A.N. Supervisor – Romanova L.S. The Chair of Restoration and Reconstruction of Architectural Heritage of Tomsk State University of Architecture and Building (the Chair of R&RAH of TSUAB)

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architecture monument as the museum of Slavic mythology in her project (Fig. 1). Such museum had already been in Tomsk, but there weren't enough places for its accommodation. Therefore the administration of the museum made an assignment for design and contacted us to study the possibility of placing the Museum in the wooden architecture monument on 20, Sovetskaya st., Tomsk, being empty after the fire. Planning structure of the house where he used to live a medical practitioner Lomovitsky, is well suited to accommodate the museum. We were allowed to separate areas for visitors and museum administration because of the house had the front and back doors. The original interiors

were loss and the author should show the imagination. Bright memorable feature of the Museum of Slavic mythology developed by the student is a road to the fairy tales room. It is a corridor which walls are painted with fantastic creatures. The mermaid is cozily nestled on the branches, the devil welcomes the visitors going to a wooden hut at the end of the corridor, and behind its door the fairy tales' room is. There are twinkling stars and moon shine over the road of the corridor. And the sun shines around the corner. This is the project decision of decoration and lighting of the ceiling. The knowledge of Slavic mythology allows the author to use the symbols of Slavic in interior design, in the pattern of metal fencing, gates and small architectural forms at the Museum area.

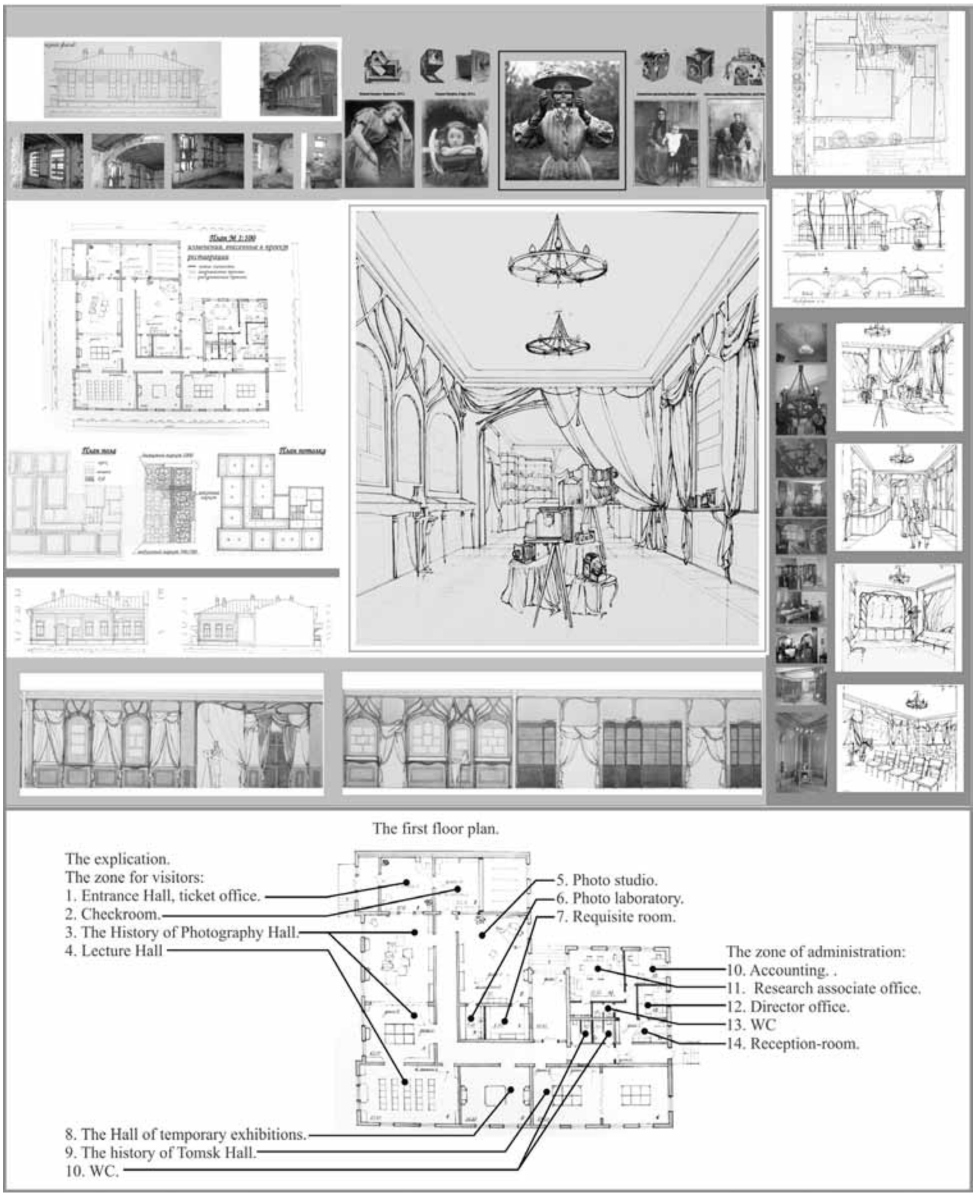

Fig. 2 Fragment of conceptual design of the architectural monument's adaptation as the Museum of Photography, 20, Sovetskaya st., Tomsk, Russia. Student – Stoyak U.A. Supervisor – Romanova L.S. The Chair of Restoration and Reconstruction of Architectural Heritage of Tomsk State University of Architecture and Building (the Chair of R&RAH of TSUAB).

Yulia Stoyak suggested to adapt the architectural monument on 20, Sovetskaya st. in Tomsk, as the Museum of Photography (Fig. 2.). In the museum, visitors can find out more about the history of photography and the camera of beginning of XX century; see photos of famous Tomsk's photographers, pictures of old city, of Tomsk merchants, of scientists, of city dwellers, and have lectures; attend master classes. Photolaboratory will attract the visitors' attention, where everyone can make a photo the way we did it a few decades ago. In the courtyard a visitor can get a photograph in dresses of early XX century against the backdrop of large pictures with the views of the old Tomsk. In her project the author illustrated the main facade, the courtyard, the interior of the exhibition hall and other rooms of the Museum.

The project of Karina Manilo illustrated the adaptation of object of the historical environment for luxury housing (Fig. 3). Two-story wooden house on 8, Vershinin st., built in the late XIX century is situated at a comfortable place in the historic center of Tomsk near the Buff-garden. The house is designed for a family of 6 persons. A couple of

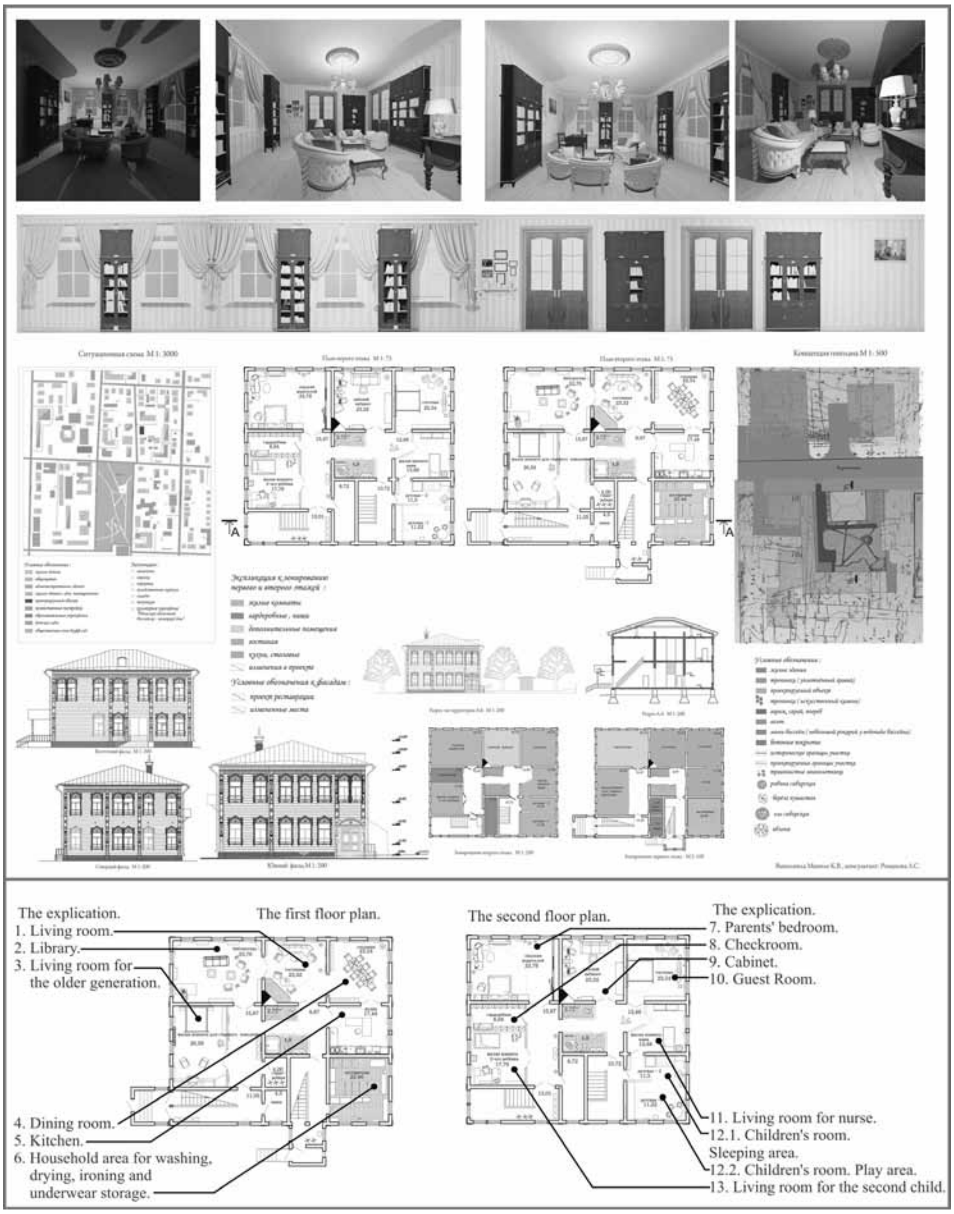

Fig. 3 Fragment of conceptual design of the architectural monument's adaptation as the Museum of Photography, 8, Vershynin st., Tomsk, Russia. Student – Manilo K.V. Supervisor – Romanova L.S. The Chair of Restoration and Reconstruction of Architectural Heritage of Tomsk State University of Architecture and Building (the Chair of R&RAH of TSUAB).

the older generation lives on the first floor, with all convenience and exit to the garden. Library, living room with fireplace, dining room, kitchen, room for washing, drying, ironing and linen storage is located also here.

On the second floor there is a room for a small child with playing and sleeping area, babysitter room, guest room, study, parents' bedroom, dressing room, older child room, a toilet and a bathroom. There are also garage, household building, cellar on the territory of estate.

5. RESULTS

These examples clearly illustrate the possibility of variety using of wooden historical buildings in Tomsk. By

now the course and diploma projects on the chair of R&RAH are made for more than 70 objects of wooden architecture – monuments of history, architecture and environmental development. Projects exhibites at the international, national, regional and city exhibitions, always drawing visitor's attention. For some of people the opportunity of the second life of the ancient wooden buildings is a sensational discovery. Therefore, educational activities, promotion of historic wooden architecture, restoration projects and contemporary usage is a necessary and important component for its preservation in Tomsk and Russia. Timely scientific based adaptation of historic wooden buildings to the modern needs of the society is an effective method of saving them. And the decisive role in the implementation of this method belongs to the government.

6. CONCLUSION

All above said makes it possible to preserve the spirit and uniqueness of Tomsk, which was granted by the status of historical settlement in 2010. It is very important for the preservation of historical roots of national culture and identity, and also to attract domestic and foreign tourists.

Everybody knows the tourism all over the world is one of the most stable and significant source of income that could be used to preserve architectural heritage. These materials are based on studies carried out at the Chair of Restoration and Reconstruction of Architectural Heritage, which were not published earlier.

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METHODOLOGIES AND TECHNIQUES FOR THE CONSERVATION OF CULTURAL HERITAGE IN EMERGENCY CONDITIONS

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Keywords

safeguarding cultural heritage, emergency conditions of cultural heritage, conservation of cultural heritage

ABSTRACT

Emergency conditions frequently pose risks for Cultural Heritage.
These conditions have diverse causes: some are brought about by natural disasters or war, others by political and economic decisions. The measures taken to contrast and respond to these conditions will vary, depending on the context and the short-term risks.
Three sample cases taken from countries with different socio-cultural backgrounds, illustrate the methods and the solutions adopted for conserving Cultural Heritage threatened by emergency conditions.

1. INTRODUCTION

Cultural Heritage all over the world is often threatened by emergencies, be they natural disasters or man-made events. All too often damage to heritage is due to inadequate or inexistent preventative measures. All too often emergency measures are needed to address problems of deterioration brought about by bad management of the Cultural Heritage. Many natural disasters are predictable and could be prevented but political, social and economic factors ensure that prevention and damage containment work is never carried out. Cultural Heritage is the historic testimony of the civilizations that have followed one another over millennia, shaping the world.

2. BACKGROUND

Cultural Heritage bears witness to our past: it is the materialization of our virtues but also our vices. All too frequently Cultural Heritage is sacrificed in order to obtain temporary cultural, racial or religious supremacy: destroying or standing by whilst others destroy Cultural Heritage is considered advantageous. This is wrong. History teaches us that Cultural Heritage (both material and immaterial) is the only means to acquiring a little immortality, testifying as it does to the existence and the thoughts of both communities and individuals. In recent years some testimonials have been destroyed because of the ideologies they represent. This has been the work of religious and political extremists wishing to annihilate testimonials of other religions or civilizations considered unworthy. Emulation of this idealogical destruction has also brought about damage. World history offers plenty of examples of man destroying all traces of that which he considers undesirable.

3. METHODS

Researching how to conserve Cultural Heritage threatened by emergency conditions poses difficult issues. Damage caused by direct action (war, vandalism, destructive theft) has to be taken into account as do the risks Cultural Heritage is exposed to as a consequence of abandonment and neglect1. The causes of these destructive actions are as varied as the methods and techniques used to combat them: these last take into consideration the environment where the conservation work takes place as well as the prerogatives and resources of the local communities. The feasibility of rapidly ensuring the safety of the Cultural Heritage (both moveable objects and building structures) is to a great extent determined by the properties of the component materials and the size and location of the Heritage item. These factors determine the vulnerability of the Heritage item.

4. CASE HISTORY

We describe below three examples of diverse approaches to conservation undertaken in: A Pakistan, B Lebanon, C Italy.

- A. (Pakistan) The SWAT Valley

The Swat Valley lies within Khyber-Pakhtunkhwa Province (formerly North-West Frontier Province, NWFP), in the foothills of the Hindukhush-Karakorum mountain ranges. “Swat, known as Suvastu in the RigVeda and as Soastene in Greek sources, is mentioned in classical texts because of its role in Alexander the Great’s Indian campaign in 327 b.C. Late Antique Chinese and Tibetan sources refer to Swat as Uddiyana, the homeland of Padmasanbhava, Guru Rimpoche, who brought Buddhism to Tibet” (Olivieri, L. M. 2014, p.57).
In 1992-93 I was one of a group of archaeologists and architects sent by Is.MEO cos’è?? to work with the Missione Archeologica Italiana (MAI) in Pakistan: we studied archaeological findings in the city of Barikot and some Buddhist monuments of the Ghandarica period (stupa) in the Swat valley2. In 2012 following the request of the Director of the Mission, Doctor Luca M. Olivieri, an agreement between the Archaeology, Community, Tourism - Field School (PIDSA) (ACT) and DiDA, Università degli Studi di Firenze made it possible for me to return to Pakistan to study conservation work undertaken on some large stupas in Swat.

- B.(Lebanon) The Chamaa Mosque

After the most recent Israeli attack upon Lebanon “the world” rallied to provide appropriate reconstruction: Stockholm Conference, August 31st 2006. The post-war socio-political situation in Lebanon is far from clear: the country is divided and the South is certainly one of the areas that does not recognize the Governing Authority. This disavowal has to be taken into consideration when taking measures to protect the cultural heritage of these areas. Chamaa is a small village situated on the top of a hill, about 20 Km from Tyre. It owes its importance to the presence of a mosque whose original nucleus, probably belonging to the Fatimid period (10th century), is situated inside a castle built at the time of the Crusades. There are structural remains dating from the following periods: Fatimid (10th - 12th century), Crusader (12th–13th century), Mameluke (13th–16th century), Ottoman (16th–20th century) and Modern (20th – 21st century). Within the ancient towered walls of the castle there are private civil edifices and buildings of “public” interest such as a small mosque, an olive press and a cistern for collecting water. This nucleus was badly damaged by the last bomb attacks of the July-August 2006 war. According to tradition the village was named after the prophet Chamoun Al-Safa, (called Nabi Sh’ma in Arab), who preached in this area in the 1st century A.D. and whose remains it would seem are preserved inside the mosque. The bombings of the July-August 2006 conflict caused serious damage to the entire fortified village complex: parts of the wall were reduced to rubble, the housing was made uninhabitable and the sacred area also suffered damage; the minaret and one of the bays to the entrance portico collapsed and the keystone of one of the four domes was dislodged. While the survey operations on the mosque structure were in progress a local building firm started rebuilding the minaret and restoring the mosque: this work was carried out with the Mayor’s permission and was paid for with the financial aid provided by Qatar.

- C. (Italy) The Palazzo Vecchio in Florence

Any trial designed to protect Cultural Heritage requires the preparation of an archive with information gathered by compiling forms which provide the information required for preparing an emergency plan for each individual component of the Cultural Heritage. This archive has to facilitate an efficient and rapid adoption of safety measures for heritage items threatened by catastrophic events (flood, fire, earthquake, storm etc.) and terrorist attacks (the risk is proportional to the symbolic importance of the object in question).
A form that was easy to compile and to read was prepared for the pilot project Firenze Tutela3 so as to facilitate the rapid identification of each piece of heritage and to ascertain, on the basis of its specific characteristics, the appropriate measures required for ensuring its safety. These forms were trialled on a significant sample of works inside Palazzo Vecchio. Emergency procedures have to be tested in extreme situations and this explains the choice of the Florence Town Hall whose characteristics of architectural complexity, user diversity and the extremely articulated routes thet have to be used to take heritage items to safety confer a high level of complexity4 (Sabelli, R., 2014, pp. 65-70).

Fig. 1 Saidu Sharif (PAK) conservation work of the main Stupa

Fig. 2 Swat: A rock-carved Buddha partially destroyed during the Taliban (Roberto Sabelli 2012).

Fig. 3 Chama mosque: the collapsed minaret.

Fig. 4 Chama mosque: the ancient cistern (probably dating to the Roman period) about to be filled with reinforced concrete.

5. RESULTS

- A. During the mission in Pakistan I noticed that conservation measures chosen for other monuments involved in the ACT programme took into account the work force and the materials that were available locally. I also observed a tendency to adopt techniques of the past (ashlar e semi-ashlar), sometimes inverting the techniques of their traditional use, sometimes using different sized stone blocks, always ensuring the integrated parts were undercut to further differentiate them from the original parts. It was possible to adopt these techniques because of the manual skills of the workforce deployed whose leaders have been trained in accordance with precepts laid down by G. Tucci and D. Faccenna in the 1960s5. The restoration work undertaken by the Missione Archeologica Italiana and its successors is praiseworthy if we consider that SWAT, on the border with Afganistan, was controlled by the Taleban for several years and even now only the constant presence of the Pakistan army makes it reasonably safe to work there. The Taleban were responsible for destroying some non-Muslim Cultural Heritage6 (figg. 1, 2)

- B. While the survey operations on the mosque structure were in progress a local building firm started rebuilding the minaret and restoring the mosque: the work was carried out with the Mayor’s permission and paid for with the financial aid provided by Qatar. The symbolic value of religious buildings and the fact that they are an element for aggregation means they are the first to be rebuilt with contributions from Arab countries and in particular Qatar. Unfortunately the Chamaa mosque was rebuilt with such speed that it was impossible to negotiate with the authorities in charge regarding the procedures for rebuilding the monument. The foundations of the minaret, rebuilt in reinforced concrete, rest inside an ancient cistern (probably dating to the Roman period) which as a result is now filled with reinforced concrete; rooms, vaults and walls have been rebuilt without the slightest documentation of the work carried out. The only documentation used for rebuilding the mosque at Chamaa was a sketch with a plan showing how the rooms were distributed (figg. 3, 4).

- C. The form was tested on a significant sample of works inside Palazzo Vecchio. Emergency procedures have to be tested in extreme situations so Florence Town Hall was chosen as an experimental site because its architectural complexity, user diversity and well articulated walking routes make it a highly complex site. In order to prepare an appropriate survey form we studied national research projects co-ordinated by the National Department of Civil Defence and the Civil Defence Service of the Municipality of Florence, especially the ICCD (Istituto Centrale per il Catalogo e la Documentazione) catalogue system of MiBACT (Ministero dei beni e delle attività culturali e del turismo).

The Florentine Civil Defence Service had already started surveying and cataloging the Cultural Heritage of the Municipality of Florence and this made it possible to trial an integrated system for heritage protection using an information database that was already at a well advanced stage. We defined a survey form that was divided into three sections: “anagraphical”, juridical and descriptive. The installation of a geo-referenced instrument to control and monitor Palazzo Vecchio’s Cultural Heritage was also included in the trial. In the event of an emergency this instrument will make it possible to ascertain the area impacted by the calamity, identify the heritage items potentially at risk and immediately decide, on the basis of the characteristics of each heritage item, the appropriate measures and the human and technical resources required for their immediate safe-keeping (figg. 5, 6).

6. CONCLUSIONS

The three examples cited here highlight the fact that emergencies affecting Cultural Heritage can be resolved using a variety of different techniques, materials and time-frames. The problem of conserving endangered Cultural Heritage is more socio-anthropologic than economic. The perception of Cultural Heritage varies considerably in different parts of the world. The population’s educational level is an important factor as are the priorities chosen by political systems. All too often the material Cultural Heritage is traded, usually to obtain immediate political consensus or financial gain. The fate of much of the Iraqi and Syrian Cultural Heritage is emblematic: the items that are saved from destruction during the fighting are sold to finance further destruction as are many of the objects from the sacked museums. Some solutions are inappropriate, undertaken with inadequate skills and information, others, even in extremely difficult areas, if well organized and directed can generate an awareness that the heritage belongs to that cultural area and should therefore be protected.

Fig. 5 Florence, Palazzo Vecchio: Judith and Holofernes.

livello-	*numero ambiente*	*giacitura*	*ID*	*ambito*	*sito culturale*	*numero identificativo*	*colore livello*
P3	71	pav	7	PAL01	QUARTIERI MONUMENTALI	U01022	

nome ambiente	*destinazione uso ambiente*	*corpo di fabbrica*	*codice ICCD*	*numero inventario1*	*numero inventario 2*	*numero inventario 3*
SALA DEI GIGLI	MUSEALE	01				

numero inventario 4	*numero inventario 5*	*categoria elemento culturale*	*tipologia oggetto*	*descrizione oggetto*	*nome*
		mo	scu	GRUPPO SCULTOREO BRONZEO SEC. XV	GIUDITTA E OLOFERNE

scheda collegata	*fotografia giacitura*	*quota oggetto calpestio*	*quota piano calpestio*	*fotografia oggetto*
7	U01022_0064.jpg	3.07		U01022_0066.jpg

materiale/i	*mobile/inamovibile*	*tipo appoggio*	*tipo ancoraggio*	*numero componenti*
Metallo	M	Appoggiato a terra o su superfice piana	MEDIANTE PERNI AL BASAMENTO LAPIDEO	1

dimensione x	*dimensione y*	*dimensione z*	*diametro*	*spessore*	*peso*	*stato conservazione*	*rfid x*	*rfid y*	*prescrizioni*
90	90	236	N		300	B	1681619.86	4848770.86	VERIFICARE LA PRESENZA DI UN PROBABILE ANCORAGGIO AL BASAMENTO LAPIDEO E PREDISPORRE UNA STRUTTURA PROVVISIONALE PER LO SMONTAGGIO

numero addetti	*schedatore*	*competente*	*ref schedatura*	*proprieta generica*	*proprieta specifica*
8				PUBBLICA	COMUNE DI FIRENZE

condizione tutela	*priorita*	*data compilazione*
	ALTA	09/05/2009

Fig. 6 Florence, Palazzo Vecchio: Census schedul.

NOTES

1 Maniscalco 2007, pp. 45-56.

2 "Today the term «G. art» is used to refer to artistic works, mostly stone, clay or «stucco» reliefs, documented in the North-West of the Indian subcontinent (Northern Pakistan) and in Afghanistan from the beginning of the Christian era. These works virtually all depict Buddhist figures (G.'s reliefs were part of Buddhist religious monuments: stūpa, vihāra) and the styles and iconography deployed reveal a mix of elements from diverse traditions: Indian, Iranic, Hellenistic." (Taddei, M. 1994, III, p. 776).

3 National Research Project (2008-2009), Firenze Tutela-Salvaguardia del Patrimonio Culturale fiorentino: elaborazione di un modello di pianificazione per la tutela e la salvaguardia del Patrimonio Culturale di proprietà comunale, undertaken for Florence Municipality with the Civil Defence Taskforce and CESPRO-UNIFI. Various work groups participated in this project: Francesco Ciampinelli and Francesca Malesani collaborated with the writer of this paper.

4 The present-day Palazzo Vecchio was greatly enlarged and modified over the centuries and it houses five museums as well as the municipal administration so there is a constant flow of tourists and residents at most times.

5 Giuseppe Tucci founded the Missione Archeologica Italiana (MAI) in 1955 and Domenico Faccenna directed it until 1995.

6 "The constant presence of the MIA over a long period, the Mission's responsibility for entire archaeological areas on behalf of the Pakistani government, the continuity and training of the work-force over the generations all contributed to the development of a unique work experience. This experience has been transformed into a model for implementing conservation work and used in the ACT project. The first point to be made concerns the relationship between rural communities and archaeological sites. This relationship is vital for safeguarding or "auto-protecting" these sites. Although the sites at first are merely regarded as an indirect source of income, providing work for community members on the archaeological sites (in itself a positive aspect), they are soon perceived as being.

part of the community and as being the responsabilità of the community. It is well known that the archaeological areas controlled by MAI communities were the only ones to escape damage during the tragic period of Taleban rule. These areas and others added after 2011 are the best cared for and the number of visitors has increased by 150% in 12 months in 2013-2014" (Olivieri, L.M. 2014, p. 60).

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RECONSTRUCTION OF HISTORICAL RUINS – RABSZTYN CASTLE APPROACH

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Keywords

Rabsztyn, medieval castle, reconstruction

ABSTRACT

This article discusses the various types of problems considering the chosen methods and decisions dealing with the restoration of the medieval castle in Rabsztyn /Poland/ preserved as a permanent ruin. The conservation of the castle was taking place in stages. The following was considered regarding the problems with the preservation of this castle: foundations and pavements, walls, damage by accumulation of soluble salts, external screening, consolidation, anastylosis, mortars, organic growths, but also reconstructions. The goal is to explore how ruins are elements of this constitutive void of meanings for a visitor and how they relate to what we here call an "archaeological drive." The article presents the works done during the last 10 years and shows the results (also the negative ones) of the restoration works performed by bad professionals for cheap money and the modern tendency in the conservation theory of historical ruins, which does not accept reconstructions.

1. INTRODUCTION

The animated discussions concerning the limits of the reconstruction of medieval castle walls have pushed back a different aspect resulting from the accomplishments of the conservation work performed so far. The pro-economic approach of the investor usually pressures the authors of such restoration projects to not just strengthen and clarify the form of the castle preserved in ruin, but also forces consideration of at least minimum exhibit, sanitary, or social resources. Tourism is demanding and the owner's desire to become popular and gain extra profit ultimately convinces even the most doctrinal monument conservators of at least a partial need for cubic reconstruction of selected elements of the castle protected as permanent historical ruins.

2. BACKGROUND

Historical ruin is full-fledged form of cultural heritage. Its nature is established by the many centuries of material destruction. Its greatest value is the image of a memorable testament to the history of a given location, characteristic enough to establish its personality while serving as an element of a broader cultural landscape. The development and implementation of the spatial policy of a Polish commune is the responsibility of the commune (1). It includes the cultural heritage and monument protection requirements established for the given type of heritage in the Act on Monument Protection and Preservation dated 23rd July 2013. The records of local spatial development plans hold local legislation rank pursuant to the Act on the Local Commune Government dated 8th March 1990. Therefore, monuments and other forms of cultural heritage are not just historical footprints but also
part of mankind's attractive and very individual environment, allowing the people associated with the location to keep their identity and local community bonds. Investment pressure resulting from the adoption of new solutions by local governments in accordance with the rules of sustainable development and a frequent lack of spatial development plans are conducive to investments in the possessed monuments. The communes usually want to sell monuments since this can release them from the obligation to care for them. The strict conservation regulations and the monitoring of the conducted investments in monuments guarantee sufficient monument protection. Additionally, a private investor can usually focus more on the conservation work as they have support in the form of preferential credits. Meanwhile, in the case of a commune, even if it is able to obtain a specific purpose subsidy

for monument protection, it is obliged to contribute money from its budget to cover some of the planned expenses and to make tender offers for all works, where the tender results are obviously determined by the lowest price. The most popular method of historical ruin protection among private investors is reconstruction for commercial purposes. Despite official objections of the conservator, the private owners of castles in ruins are eventually able to convince the local authorities to their investments (the castle in Bobolice, the Tropie castle, or the castle in Korzkiew).

3. METHODS

The “Historical Ruin Protection Charter” (2) passed by the resolution of the General Assembly of PKN ICOMOS on 4th December 2012 is clearly against any construction investments within the area of historical ruins. It indicates that the best form of protection of such ruins is in operations aimed to preserve and protect the historical substance from further deterioration and to make at least part of the ruins accessible to tourists. All other operations in such sites pose the risk of irreversible loss of the value seen in the authenticity of matter. However, according to the Polish standards of conservation protection developed by the scientists of the Monument Preservation Department of the Warsaw University of Technology, such sites can see supplementary restorations implemented through parahistorical complementation and ahistorical sites (Gluszek, C., 2010). According to them, parahistorical sites must have a clearly modern nature and they must take a form which clarifies the historical spatial arrangement of the monument. They are located in the former sites of unpreserved historical structures. The interior of such a site may have a different, no longer historical arrangement, structures, and finish materials. The sites restore or strengthen the lost value of a given historical heritage. Ahistorical complementation sites are modern structures incorporated into a historical site, in free space among the relics of ancient walls. They have no direct relations with the monument but facilitate its presentation and interpretation. The form and construction of such structures are up to the designer. The only conditions set for such objects are that they may not disturb the visual perception of the historical monument. Both restoration methods provide excellent potential for increasing the site’s popularity and both are elements of a broader concept of an appropriate educational policy of the site.

4. CASE HISTORY

The Rabsztyn Castle was built in the late 13th and early 14th century (Dryja, S., Niewalda, W., 2002). In the 15th century and late 16th century, the castle was expanded by adding a middle castle and a lordly residence. The castle was built of irregularly broken local limestone. Over the centuries, it underwent numerous repairs. In 1657, the castle was burnt down by Swedes and since then it fell into ruin. Before World War II, the castle was owned by the State Forests Administration. After the war, it became the property of the Olkusz Commune. The first conservation works started before the war in 1918 under the initiative of the Polish Landscape Association based in Olkusz and they covered initial protection works. In 1982, the Castle was entered in the historical monument register (3). The first conservation work did not start until 1986. Apart from the protection of the crennelation and filling of wall cavities, several window openings in this wall were reconstructed. The works were implemented as intervention and protection works, and there was no complex conservation plan. The initial conservation work plan was not developed until 1990. It included the first inventory and plans to clear the hill from plants. Due to the continuous lack of funds, the work was slow. In 1997, the protection of the castle was guaranteed by its entry into the Study of Land Use Conditions and Directions of the Olkusz Commune and City, and subsequent entry into the Local Spatial Development Plan of the commune in 2005. Finally, the “Rabsztyn Castle Hill” spatial development project concept was developed to provide grounds for establishing the limits for strict protection of the spatial arrangement and display of the castle. According to the concept, the castle was to be preserved in ruin, as a cultural landscape dominant with a potential for slight changes. The protective measures were to cover, for example, the conservation of the castle ruins and the recreation of the past shape of external ground fortifications. In case of the modernisation and reconstruction plans, it was recommended that traditional building forms should be developed with local finishing materials. Recommendations in the scope of improving the tourist and recreation infrastructure included, for example, the introduction of an entrance gate and establishment of the Olkusz Hut Heritage Museum (Głuszek, C., 2010). From 2002 onwards, only cyclical architectural and archaeological surveys were performed, accompanied by various protection works. The decision was also made to reconstruct the entire gate complex and stairs leading to the viewing balcony at the base of the top castle tower.

5. RESULTS

The conservation work performed in the castle for the first 20 years were not sufficiently coordinated. When funds appeared, protection measures were immediately undertaken in various segments of the castle to save successive walls from total demolition. The mandatory tenders for any work imposed upon state owners in every instance of grants are aimed to determine the contractor with the lowest offered service price. A grant is associated with securing a specific amount from the commune's budget. It is only after obtaining the financial support commitment letter that the commune starts to look for funds for castle restoration. The local government elections also serve as an opportunity for many investment plans of the commune. But the will of politicians to realise the campaign promises often disappears after their victory. The years of research keep changing the design concept. All reconstruction works in the castle were aimed to "clarify the initial premise" and appropriately secure the castle. Local conservators are persistent in their efforts to preserve the site as picturesque ruins, but the performed reconstructions have led to not just disputes with the province conservator, but also to critisicm concerning the work from local social groups (4). The disputes with the conservator mostly concerned the roofing of the gate tower and the bridge leading to the castle over the moat. The social criticism was more serious, since it concerned the quality and aesthetics of the performed conservation works. There are diverse causes of the criticism of the restoration effect. The obligation to apply tender regulations, where the price is the determinant, and the lack of appropriate regulations giving preference to experience and reliability create the risk of even losing the cultural heritage. This is a rather big scale problem, which unfortunately continues to grow from year to year. The contractors explain their deficiencies by the laws of the market, where they must make savings by either employing underqualified workers or using cheaper conservation materials and technologies to keep getting contracts. Numerous companies carried out conservation works at the Rabsztyn Castle. The performed works largely differed from the project. All of the contractors stated that they had to adapt their methods and techniques to the various preservation levels of the walls. Every departure from the project requires an extensive analysis concerning the mortar and stone and selection of the best method from the aesthetical standpoint as well (Trochonowicz, M., 2012). In Rabsztyn, the proposed protection of the crennellation with lead sheets was discarded in favour of strengthening the wall with low-absorbing stones and tight mortar, and enforcing the upper areas with a hydrophobic product. In effect, the crennellation received a smoothed-out lump coated with a thin hydrophobic layer, which started to peel after a few years (Mietlicki, P., 2013). As a result, the water can penetrate under the strengthened layer into the original walls and the tight mortar prevents its evaporation. The selection of proper mortar for protection and fillings is not only a technological issue, but an aesthetic problem as well. For technical reasons, mortar should be highly resistant to water, but it should also have parameters similar to the original limestone and sand mortar. In terms of conservation and aesthetic considerations, it should be different from the original but not create an aesthetic dissonance. The application of numerous methods to protect the crennellation should cover a colour retouch of the fillings and putty based on the natural pigments. The filling of wall cavities with materials considerably different from the original in terms of structure, colour, and stone laying methods applied in Rabsztyn (and other places) are controversial due to the poor aesthetics of the entire wall. The reconstruction of the gate junction is among those criticised most frequently. The wall arrangement proposed here is rather typical of brick walls, without the levelling layers characteristic of 14th-century broken stone. The new bricklaying is similar to appareil allongé – thus it may even suggest that the building is younger. The concept of wide joints to replace the original levelling layers is not only unsightly, but may mislead future visitors to believe that this technique was used in the past to build the walls. Such walls could only have resulted from the low skill of its builders. This charge was officially presented to the company's management. Reinforced concrete and bricks were used inside the reconstructed structure. New walls were covered with siding on the outside. To prevent fires, the plans include reinforced concrete ceilings and a staircase, which will then be covered with wood. This seems to convince everyone. However, the decisions on installing modern bars, doors and plastic rectangular windows despite the arched openings raise an outcry. The appearance and fixing of these elements would also be striking in contemporary mansions. The cheap workmanship, no synchronisation on the construction site, no drainage system, and the crooked tower roof should discredit even the most cost-efficient company. The lack of professional knowledge of the subcontractor produced the need fo repeating the same works (e.g. drawbridge, roof structures, or the electrical and water installations). In many cases, one can complain about the quality of works but in case of private investors, there are fewer mistakes because private owners usually adapt the reconstructed space for commercial purposes and count on a quick return of the expenditures. State investors usually aim to complete a certain stage of work as quickly as possible, because they must clear their expenses from the received grants within the current calendar year. Because of rush, insufficient funds and sometimes indolence, the final outcome of restoration works is debatable and this directly affects the loss of credibility and social support for further works.

6. CONCLUSIONS

The pursuit to increase tourism attractiveness of a site has produced the pseudo-historical reconstruction of several elements of the Rabsztyn Castle, which is planned to be preserved as permanent ruins. A badly performed reconstruction may unfortunately create a hazardous situation, which will eventually see the blurring of the differences between what is old and what is reconstructed. In this way, the site can lose its authentic form and matter, just like in case of the results of the reconstruction of the castle ruins in Bobolice. Parahistorical and ahistorical supplements are always architectural creations rather than conservation results. The cubic reconstruction which is to restore the preserved arrangement at least in projection is not an easy thing, because all construction works performed without the support of unambiguous test results transform ruins into fancy buildings, thus leading to permanent loss of value (5). On the other hand, the owners are expected to effectively protect the monuments, provide full access of the community to the heritage, and present properly all of the site's values. However, in the case of permanent ancient ruins, the process of clarifying and exhibiting castle walls demanded by conservation doctrines is dominated by non-conservation operations. We must make sure to provide contemporary conservation creations, especially the pseudo historical ones, with scientific foundations and guarantee that the professionalism of the contractors lives up to the rank of the monument it serves.

Fig. 1 Rabsztyn castle before reconstruction fot.1962, Fotopolska.eu, http://fotopolska.eu/274651,foto.html?o=b3017, obtained 22.05.2015.

Fig. 2 Rabsztyn castle now, foto by author Rabsztyn castle now, foto by author.

Fig. 3 Rabsztyn, entrance gate reconstructed, foto by author.

NOTES

1. (Article 3(1) of the Act on Spatial Planning and Development dated 27th March 2003 – Journal of Laws [Dz. U.] no. 80, item 717 as amended, obtained: 2015-05-30.
2.http://www.icomos-poland.org/images/2012-1204%20Karta%20Ruin%20uchwala%20Walnego%20Zgromadzenia%20PKN%20ICOMOS.pdf, obtained: 2015-05-03.
3. http://bip.malopolska.pl/umigolkusz/Article/get/id,725267.html, obtained: 2015-04-20.
4. http://wodaca.nazwa.pl/stowarzyszenie/rekonstrukcja.php obtained: 2015-04-25.
5. Historical Ruin Protection Charter, op. cit.

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OPTIMIZATION OF THE GEOMETRIC STRUCTURE AND KINEMATICS OF DEVICE FOR CONCRETE SURFACE TREATMENT

POSTER

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Keywords

concrete surface, floating, geometric structure

ABSTRACT

The following paper concerns the subject of defining the optimal time for initiation of the operations of floating with the use of a new geometric form of a processing element. As a result it should provide better properties and operating parameters of the processed concrete surfaces.
Time for initiation of the floating process of a concrete surface was marked with the use of copyright device. With the use of a computer program, there was conducted an analysis of the influence of variable geometric and kinematic parameters of the ring blade on the geometric efficiency. An effect of these calculations was marking of the optimal parameters of the floating with the use of a working ring blade. The parameters were confirmed by means of experiments.
The comparing analysis confirmed the superiority of the processing with the use of ring blade over the processing with the use of full blade, or four blade disc.

1. OPTIMAL TIME FOR INITIATION OF THE FLOATING OPERATION

Defining of the proper time for initioation of the floating operation for the hardening concrete has significant influence on the strength parameters of concrete and its operational features. Too early initiation of this process as well as too late, effects in lowering of the surface quality and decreasing of the durability of the surface layer of concrete.
With the use of a copyright device for designatig the time of initiation of the floating operations (patent application nr UPRPPL 387166) the optimal time for starting the operaton was marked. Determinant of the time for initination of the operation is the value of a drop of the movable part of a device (disc), corresponding to the lowest value of the average surface waviness (F_l).
The research was conducted for the concrete mixture with consistency V3. There were distinguished 10 research fields P_i=(i=1,2,3,…..,10) with measurements 3x3m. Readings of the drop of the device disc was initiated in the first field (P_1) after 20 minutes after the mixture was formed. The further readings were made on the remaining fields every 5 minutes (25,30,…,65). Every single time the measurements were taken in three places, the results were averaged. Directly after making the readings, the research area was floated with the use of floating machine with a ring blade, and the effects of floating were checked by testing the waviness of the surface.
For the analysis of the surface waviness the device RK3 was used constructed in KTPBiM of the Czestochowa University of Technology. The results are presented in table 1.
On the basis of the above mentioned research it may be stated that to the average value of the disc drop marked after 40 minutes (1,32mm) corresponds the lowest waviness F_t=4,36mm.

2. THE THEORETIC ANALYSIS OF THE INFLUENCE OF THE DISC MEASUREMENTS ON THE SMOOTHNESS OF THE PROCESSED SURFACE.

The theoretical analysis was conducted for the floating ring with a constant outer diameter R_z=0,6m, variable inner diameter R_w=0,10;0,13;0,15m, variable forward speed V_p=0,05;0,10;0,15m/s and variable rotational speed of the disc ω=rotations/min (6,28rad/s); rotations/min (7,54 rad/s); rotations/min (8,8 rad/s).
For the calculations there was used a computer program for the effectiveness analysis of the influence of the processed surface for the discs with various construction types, developed and elborated in the institute, as mentioned above.

Research area	Research time	Average value of the subsidence of a measuring plate [mm]	Average waviness
P1	20min	4,29	9,26
P2	25min	3,26	7,53
P3	30min	2,23	6,73
P4	35min	1,67	5,7
P5	40min	1,32	4,36
P6	45min	0,97	6,23
P7	50min	0,56	7,3
P8	55min	0,51	7,4
P9	60min	0,47	8,66
P10	65min	0,39	9,7

Table 1. Average results of the subsidence of the measuring plate.

The floating availability of the device was estimated by its geometric effectiveness S_g [m] of the working element. It expresses the length of the way on which the surface of the working device effects the processed surface.
The numerical results S_g [m] for a disc with R_z = 0,6m, R_w = 0,10 and variable progressives and variable speeds are presented in table nr 2.

	ω		
V_p	**6,28[rad/s]**	**7,57[rad/s]**	**8,8[rad/s]**
0,05[m/s]	11,56	13,84	16,18
0,10[m/s]	5,79	6,94	8,1
0,15[m/s]	3,87	4,64	5,41

Table 2. Geometric effectiveness for R_z = 0,6m, R_w = 0,10 and variable forward and rotational speed.

On the basis of the analysis of table 2 it may be concluded, that geometric effectiveness S_g is dependent on both the forward speed and rotational speed. The data shows that the relationship is linear, thus it is presented in a form of a linear regression equation.
For the fixed rotational speeds ω = 60rotations/min (6,28rad/s); 72totations/min (7,54 rad/s); 84rotations/min (8,8 rad/s) dependency of geometric effectiveness (y) on the forward speed (x) may be described in a form of the functions:

y = 14,76-76,9x

y = 17,67-92x

y = 20,67-107x

The correlation coefficients are at the level of -0,96, coefficient level 0,92.
For the fixed progressive speeds (V_p=0,05;0,10;0,15m/s) depedency of the geometric efficiency (y) on the rotational speed (x) may be described as functions:

y = 0,037+1,83x

y = -0,63 + 0,99x
y = 0,032 + 0,61x
Correlation coefficient at the level of 0,98, coefficient of determination at the level of 0,98.
On the basis of the theoretical analysis it may be concluded that geometric and kinematic parameters of the ring blade are: R_z = 0,6m, R_w = 0,10, V_p = 0,05m/s, ω = 8,8rad/s. For these parameters the average geometric effectiveness reaches its highest possible value.
These dimensions of the blade and parameters of the movement became the basis for conducting the comparative experimental studies of the ring blade with a four blade disc.

3. EXPERIMENTAL VERIFICATON OF THE THEORETICAL STUDIES

Testing of the smoothness of the processed surface depending on the geometry of the working ring elements with various kinematic conditions (such as in the theoretical analysis) was conducted on the 27 research fields with dimensions 3x3m. Smoothness of the surface was tested with the use of the device RK3 testing the waviness (F_l) .
For comparison, additional research field was floated with the use of a traditional solution, which means composing the floating with the use of a full blade and finishing of the surface with the use of a four blade disc. Kinematic parameters taken into account were the same as to which the best geometric efficiency in the theoretical analysis was obtained.
Average waviness (F_l) [mm] for the disc R_z = 0,6m, R_w = 0,10 and variable forward speed and rotational speed are presented in table 3.

	ω		
V_p	**6,28[rad/s]**	**7,57[rad/s]**	**8,8[rad/s]**
0,05[m/s]	6,26mm	5,56mm	4,41mm
0,10[m/s]	5,81mm	6,00mm	5,85mm
0,15[m/s]	6,42mm	5,91mm	5,97mm

Table 3. Average waviness for selected geometric and kinematic parameters.

For the fixed forward speed V_p = 0,05m/s, there was calculated the dependency of average waviness F_l (y) on the rotational speed ω (x) in a form of equation of linear regression:
y = 10,94 - 0,73 x
Correlation coefficient is at the level of -0,99, the coefficient of determination equal 0,98.
For V_p=0,05m/s the dynamics of the improvements in average waviness dependent on the rotational speed was checked. Change in the rotational speed from 6,26rad/s to 5,56rad/s caused improvement in the waviness for 11%, but change in the speed for 8,8rad/s caused improvement in waviness for 20%.
Using the new solution, the lowest average waviness was obtained for the disc R_z = 0,6m, R_w = 0,10, V_p = 0,05m/s i ω = 8,8 rad/s – the waviness is at the level of (F_l) = 4,41mm.
In the comparative research for the four blade disc with the same kinematic parameters the higher average waviness was obtained at the level of (F_l) = 5,52mm.

4. CONCLUSIONS

On the basis of the theoretical analysis and its experimental verification it may be concluded that the use of the concrete processing element in a form of a ring with the outer diameter 0,6 m and inner diameter 0,1 m used in the floating machine allows to reach significantly greater average geometrical effectiveness comparing to the for blade disc. In case of the new construction, average geometrical effectiveness was equal 16,18 m, but in case of traditional construction – 5,01 m.

New geometry of the working device shows significantly higher quality parameter of the worked surface, expressed by the average waviness (F_l) = 4,41mm, for the four blade disc - (F_1) =5,52mm.
To sum it up it may be concluded that the use of a new floating element connected with the fixed optimal time of initiation of the floating operations guarantees increase in the level of the smoothness of the concrete floors for about 27%.

STRATEGIES ON THE PROTECTIVE ZONING OF HISTORIC RUINS AND SUSTAINABILITY IN ECONOMIC DEVELOPED CITY

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Keywords

historic ruins; protective zoning;sustainable development

ABSTRACT

The protective zoning of historic and cultural sites will inevitably affect the city's original regional planning during the development of modern cities. This article, taking the Mudu historic ruins in Suzhou as an example, starts with the sustainable development of the urban economy and focuses on the adaptive and tactical conservation planning of historic sites to cater to the existing planning and the sustainable development of the regional economy. Following field research, the article proposes sustainable development strategies targeting the protective zoning of Mudu historic ruins and further deliberates on ways to exhibit architecture under protection in the ancient-city site in core areas of economically developed towns in an attempt to offer more inclusive solutions and ways to conserve cultural sites within urban development planning.

1 MUDU HISTORIC RUINS

Mudu historic ruins in Suzhou were listed as one of the 10 major archaeological discoveries in China in 2010. The massive scale and rich relics are of important significance in proving the existence of large towns in Wu and Yue cultural areas.

According to China's regulations on the protection and management of cultural relics, the Mudu historic ruins encompass an area of 24 square kilometers that are under protection and control. They basically cover the entire area of Xukou Town and parts of Mudu Town and the Qionglong Mountain Scenic Area. The relics are concentrated in the Wufeng (A), Xinfeng (D), Hefeng (C) and Liaoli (B) areas. In addition, the Qiannian Temple town (E), a small townsite found at the foot of Qingming Mountain to the southwest of the ancient town, covers an area 170 meters in both length and width that is encircled by a nine-meter-wide moat. Two city walls have been found in the Mudu ancient city, located at Wufeng (A) in the north and Xinfeng (D) in the south respectively. The two city walls are about 6,728 meters apart with an ancient riverway in between. The riverway, totaling 855 meters in length, connects Taihu Lake and its east section stretches northward along the city wall. Residence zones in the ancient town feature scattered settlements. In the historic site, there are also 235 dispersed mounds with quite a lot of them surrounded by farmland and buildings today.The webbed urban road systems in the map confirm the maturity of Mudu Town as a modern city with a large number of buildings and production and living facilities, which has brought about many difficulties for the conservation of the ancient sites. It raises the question of how to coordinate the relationship between residents' living, industrial construction and site conservation, forming the kernel for the success of the project.

2. CONFLICT BETWEEN PROTECTIVE ZONING AND SUSTAINABLE URBAN DEVELOPMENT

Mudu Town boasts a developed economy and is located within the Suzhou Chengnan Industrial Belt, Circum-

Taihu Lake Tourism Economic Zone and Wuzhong New City Business Area. As a historic town in southeastern Suzhou, Mudu Town needs to adapt itself into the rapid urban development of Suzhou central downtown while being subject to the protective zoning of historic towns. Mudu agriculture contributes a very low portion toward GNP and its industrial development plays a leading role in the local economy. The town industry is dominated by auto parts, moulds and precision machinery manufacturing. New industrial clusters led by development zones are

Fig. 1.1 Planning Map for the Conservation of Mudu Historic Relics in Suzhou

The relics are concentrated in the Wufeng (A), Xinfeng (D), Hefeng (C) and Liaoli (B) areas. In addition, the Qiannian Temple town (E), a small townsite found at the foot of Qingming Mountain to the southwest of the ancient town, covers an area 170 meters in both length and width that is encircled by a nine-meter-wide moat. Two city walls have been found in the Mudu ancient city, located at Wufeng (A) in the north and Xinfeng (D) in the south respectively. The two city walls are about 6,728 meters apart with an ancient riverway in between. The riverway, totaling 855 meters in length, connects Taihu Lake and its east section stretches northward along the city wall. Residence zones in the ancient town feature scattered settlements.

In the historic site, there are also 235 dispersed mounds with quite a lot of them surrounded by farmland and buildings today.

gradually integrating themselves into the Suzhou High-tech Zone. Suzhou High-tech Zone is a close neighbor to Mudu Town on the town's northeast and possesses a tremendous driving effect on Mudu's economic development. Industrial development is an important impetus for Mudu's economic development. Its planned industrial area covers 813.73 hectares and the planned residential area covers 908.28 hectares, while the protective zoning involves more than half of the total industrial land and more than one third of the residential area. The zoning will inevitably cause a huge impact on Mudu's economy and residence planning. In addition, the protective zone houses a mature developed economy including a wide stretch of industrial land and residential land as well as areas for supporting public facilities, business areas, public greenbelt etc. If all the facilities are moved away in a sweeping approach, a series of contradictions of employment, residence, medical service and traffic in the area will arise and generate a very adverse impact on sustainable urban development.

3 SPATIAL COORDINATION OF PROTECTIVE ZONING AND SUSTAINABLE URBAN DEVELOPMENT

Establishing a reasonable urban ecological system is the long-term solution for sustainable urban development. The city's history and reality, and its past and future, deserve equal attention to correctly balance the site's protection and economic development. To sum up, the key lies in the rational land use and overall landscape improvement in Mudu Town. So we need to focus on the following:

First, we should face up to the problem that some core industrial lands have to give way to site protection and a set of fair and reasonable compensation mechanisms and measures need to be in place. For core industrial land use (industry, warehousing, etc) in the protective zone, high-polluting industries should all be relocated or compensated by the standard of land acquisition, while light-polluting industries and high-tech industries with fewer fixed assets can remain in the protective zone as appropriate after proper renovation.

Second, we should guide the residents in the zone to seek jobs and live outside the zone and intensify living land usage out of the zone. We should make full use of the functions and geographical locations of Mudu Town and Suzhou High-tech Zone and accelerate elevating traditional service sectors while leveraging our own basis for development. Meanwhile, we should speed up developing new tertiary industries such as finance, insurance and real estate to support the development of other related industries while achieving the gradual shift of the employed population between secondary and tertiary industries. We can rely on the existing industrial basis to realize industrial upgrading and create new industrial clusters headed by development zones, taking developing innovative industrial parks as the strategy for industrial transformation, to integrate into the Suzhou High-tech

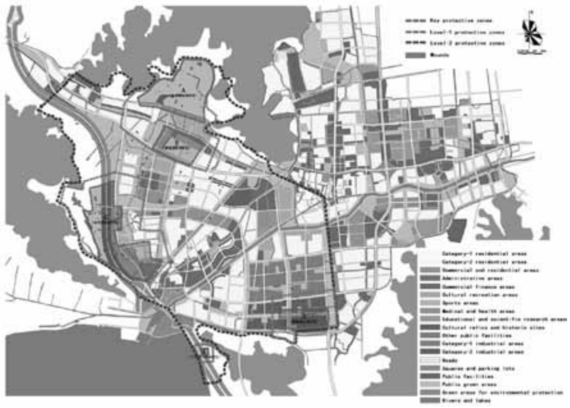

Fig. 2.1 Protective Zoning and Land Use Planning

As shown in Figure 2.1, the planned residential land and business land make up a large share in the protective zoning and are mainly located in the center of the protective zone. In contrast, the planned industrial area and cultural relics cover a smaller area and the former is mainly concentrated in the southeast corner of the entire region. Industrial development is an important impetus for Mudu's economic development. Its planned industrial area covers 813.73 hectares and the planned residential area covers 908.28 hectares, while the protective zoning involves more than half of the total industrial land and more than one third of the residential area. The zoning will inevitably cause a huge impact on Mudu's economy and residence planning.

Zone step by step while highlighting the constellation effect and creating the integration of regional industrial chains.

Third, the government should organize the relocation of residential buildings in the protective zone and actively optimize the allocation in the periphery of the sites to set up comparatively centralized residential areas. Major efforts should focus on residence transformation and improving the quality of life of residents in the zone. In the protective zone residential temporary homes and landscape houses should be erected to show the features of Wu and Yue cultures. During the protection campaign, attention should be paid to the exploitation of tangible cultures of the sites and the settings so that residents in the zone can not only enjoy benefits materially but also experience spiritual contentment.

Finally, we need to integrate and coordinate planning on the landscape resources within the sites. Mudu Town abounds with ancient sites and has a profound cultural foundation in a beautiful natural environment, yet without adequate focus and organizational hierarchies. In terms of cultural exploitation and protection, the sequence of spatial landscapes and structural designs in the town is not very clear cut on the whole and the town lacks a systematic cultural inheritance mechanism. The town should innovate its exploitation of tourism resources and vigorously develop leisure and cultural sectors to expand the presence and influence of Mudu while integrating tourism with leisure and cultural businesses.

4. INTEGRATED EXHIBITION OF SITES PROTECTION IN URBAN DOWNTOWN

Speaking of the specific techniques, the exhibition of architecture under protection in ancient sites in urban downtown should focus on the following:

(1) Restructure the fragmented relics such as city walls and moats and mounds in the periphery of the ancient sites through multiple means to improve their ornamental value.

In view of the scattered settlements of the relics, we can employ multiple layers of demonstration tools including museums and feature displays in the peripheral areas to show the profound cultural deposits of Mudu historic ruins and the internal logic and historical contexts of the ruins of the Spring and Autumn Period with other scenic areas. Wufeng and Xinfeng protection zones house important sites of city walls. Between the two city walls are the ancient riverway that leads out of the mountain to Taihu Lake in the south. It is recommended that the focus is on the city walls and riverway for the exhibition of protective zoning and it is advised that a museum is built in a proper location in the area. The museum can show the struggle for hegemony between the Wu state and the Yue state during the Spring and Autumn Period as its background, with the alternation of Wu, Yue and Chu states as the storyline to illustrate the changes of the relics and dynasties. Some historical allusions such as "Xi Shi on Boating" (Xi Shi is a famous beauty in Chinese history) and "Goujian Stooping to Conquer" can be garnished for an in-depth and three-dimensional cultural interpretation of the historic ruins.

(2) Create a dual system with public ground and underground promenades in Mudu Town to make the protected zone actively involved in the central urban district.

The historic sites exhibition zones on the ground are scattered but interconnected by greenbelts and historic landscapes as well as promenades to form an organic historical gallery in contrast to the circumjacent fast-paced modern cities.

The underground system, by utilizing the underground traffic technologies of modern cities to reproduce another historic space, can be divided into three sections: transportation, pedestrian zones and exhibition zones. Considering the land use and the fact that some sites are buried underground, an underground world can be created with the help of modern technology while building the transportation facilities such as metro lines. The underground pedestrian system can, with the exhibition of important sites, combine the publicity of cultural knowledge, the exploration of relics along with adventures and hiking for exercise.

(3) Strive for diversified exhibitions of architecture. There are intuitive conservation and displays of historic sites, publicity galleries, underground scenery, theme bars on historic cultures and digital cinemas. For example, when passing through a section of a passageway titled "History Corridor", the walls of the passageway will display various 3D historical scenes at random so that people may feel as if they were in a time tunnel and experience the ancient Wu and Yue cultures personally right there. For another example, fans of historic culture and artists can gather together at an underground theme bar to discuss their passions in a unique atmosphere.

5. CONCLUSIONS

The sustainable development of a city is as important as the conservation of historic sites, so it is vital to successfully coordinate the competition for land resources between the two to bring into play the boosting role of the conservation of historic sites for urban economic development.

Meanwhile, as a typical representative of historic cultural relics, Mudu historic ruins should not rest content with a static display of the sites and relics themselves, but should also demonstrate and interpret the cultures and settings they carry through various approaches according to the components and historic cultural deposits. As a result the sites and relics can be more readable, ornamental and interactive and the general public can experience the resonance, which helps to realize the true cultural inheritance.

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SESSION 7

THE FRUITION OF THE HERITAGE: CULTURAL VALUE-BASED TRAVEL, ROUTES AND LANDSCAPE/ NEW USES AND ENHANCEMENT OF MONUMENTS

CREATION OF WORLD CULTURAL HERITAGE BUFFER ZONE UNDER THE INFLUENCE OF A NEW PARADIGM

POSTER

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Keywords

buffer zone, cultural heritage, sustainable development

ABSTRACT

By formulating a valid reason of Creation of World Cultural Heritage Buffer Zone, it is important to notice that historic city centers and other urban territories involve a large number of World Cultural Heritage sites. Monuments, group of monuments and sites take an integral part in the worldwide level acknowledgement of the historic urban value. In fact, each phase of urban development trough the history modifies environmental and structural system, and represents itself as a layer of ages with progressive or radical changing of social and cultural paradigms. Nowadays, cultural heritage protection problems attend with a rapid urbanization and globalization which provide a process of historic urban landscape transformations. An adequate buffer zone has to be defined for proper protection of the property on national, regional or municipal level for the inscribed property on the World Heritage List, but allow of urban development existence with acceptable limit of changes.

1. INTRODUCTION

A large number of the World Cultural Heritage Sites under the protection of UNESCO as monuments, groups of buildings and sites are located in the territories of the cities, including the historic city centers. All properties inscribed on the World Heritage List must have adequate protection and management to ensure their safeguarding expressed by delineated site boundaries and buffer zones for an effective protection of the outstanding universal value and its settings within the cultural heritage property's boundaries against the negative impacts and pressures of urban development.

In fact, the buffer zone has no value itself, but often includes the different typological and morphological territories which cover the historic city centers and other city areas in full or in part to ensure visual integrity of the cultural heritage property and reduction in visible changing of its surrounding. However, a regular structural improvements and modifications of the city and its city center are based on fundamental aspects of human-being and identify the urban development impact by historic, cultural, demographic, social, economic and other permanent factors. Therefore, a confrontation between 'protection' and 'urban development' does exist. These trends are evident with different level of universal or local intensity. Nevertheless, these two positions on protection and development are focused on each statement and do not let to include a new paradigm matter of understanding the integrity and diversity of the past, present and future city forms and structures, and integrate them with a non-stop urban development process (Araoz, G. 2011).

The research suggests a vision on preservation of cultural heritage expressed in Creation of World Cultural Heritage Buffer Zone which is integrated with social and economic interests in preservation and urban development of the historic city centers and other urban territories.

2. BACKGROUND

In May 2015, a total number of inscribed properties on the World Heritage List was 1007 with 161 State Parties. Among the 1007 properties, 779 were cultural heritage. Overview of the cultural heritage properties revealed a large amount of cities and towns, whole or in part, as groups of monuments and sites, and also single monuments which were situated within cities or in the urban territories, were inscribed on the World Heritage List.

Urban heritage becomes vulnerable to the pressures of rapid urbanization process and economic globalization over a period of the second part of the XX century and nowadays in a contrast with the past (Bianca, S. 2010). Indeed, transformations of the existing systems and city structures are continuous processes because of the social demands on new qualitative changes according to requirements of life in each period of time. Parallel threats of the rapid urbanization and globalization to urban heritage represent some tendencies towards of mass tourism and high scaled concentration of new development urban modernization (reconstruction) and within historic cities including city centers. Challenges, produced from socio-economic changes and globalization during the last 15 years, on the one hand are affected in appearance of new needs and new opportunities translated into qualitative changes of urban spaces, but on the other hand a new attitude to the perception of city environment changes and ethical / aesthetic values creates an extra number of variable changes obtaining in the material expression within the city.
In the context of the World Heritage Convention (1972) (futher – WHC), a Global Strategy for Representative, Balanced and Credible World Heritage List focuses on definition of World Heritage and provides a framework on identification and protection of heritage and declares the Outstanding Universal Value (further –OUV) of the heritage and its key role for society and future generations. But the role of cultural heritage in urban context today appears to be more related to city mass tourism strategies than to create a balanced socio-cultural urban environment with cultural heritage and new development management system. However, an excessive tourist exploitation as 'over expansion' and 'gentrification' affect the historic urban environment and landscape with transformations for visual and physical quality of cultural heritage and its surrounding. The growing progress of gentrification, mass tourism and pressure of real estate market within and out of historic city centers lead to results of urban expansion and tendency of excessive high-rise development. It produces inner city functional changes, over capacity of housing density, increasing of new unusual to current place functions, upward spiral in the cost of land and a high rent of property (Krier, L. 1978).

High-rise buildings as well as new aggressive constructions (St Petersburg, Vienna, Dresden, Liverpool, Cologne, Seville and London) in an historic urban context are becoming a regular part of agenda for operational activities and urgent meetings of World Heritage Committee. In 2009 ICOMOS has recommended to remove from the World Heritage List by World Heritage Committee the Dresden Cultural Landscape (Germany) because of the bridge construction across the Elbe River that damaged the OUV. In 2012, once again, ICOMOS recommended to remove another property as Liverpool city centre (UK) to another "In Danger" category on World Heritage List. This time in comparison with Dresden, Liverpool is not delisted but it is still "In Danger". There is an opportunity for Liverpool to stay on the list by solving the problems of lack of overall management system and establishment of maximum heights for new developments, interpretative and visitation facilities. But the most striking example of uncontrolled process by local legislation within the framework of the WHC is a Historic Centre of Vienna (Austria) inscribed on the list in 2001. But one year later during the 26th session in Paris (2002), the World Heritage Committee had debates on delisting Vienna because of the design of four high-rise towers and plan of their construction. Even all factors including a strong protection policy, defined buffer zone or a high status of the World Heritage Site, did not prevent a process of a non-stop urban development.

Thus, only during conferences and sessions in 2005-2011, a confrontation between a necessary "World Cultural Heritage protection" strategy and no less important "Urban Development" was admitted by majority of international experts at the World Heritage Centre and other agencies. The protection paradigm for Cultural Heritage had to be reviewed taking into consideration also the changes that had happen over the last 50 years as (1) protection of monuments and their surrounding, (2) preservation of historic city centres and historic urban landscapes, and (3) preservation of monuments and sites of the 20th century as Modern Heritage. The revision of legal system on World Cultural Heritage conservation and conceptual vision for urban development is related to: (1) crisis of Modernism ideology; (2) mass tourism at cultural heritage sites; (3) tendency of rapid globalization and urbanization process.

In fact, the first relates to the particular meaning of a term of "change" in the theory of cultural heritage preservation were formulated by Alois Riegl in the begining of the XX century. Today, all urban processes and changes as cultural heritage protection and new development should be under monitoring and management. Cultural Heritage Management" understands as process of factors' analysis for protective purposes, control and decrease of damage risk for cultural heritage (Harvey, B. 2011). This approach is based on a new paradigm for preserving heritage places including cultural heritage management and sustainable urban development.

3. METHODS

The case study contains episodes during a working on Cultural Heritage buffer zones' project including preservative and developmental aspects for the historic city centre, entitled "Project of the Preservation Zones of the Cultural Heritage for the Historic Centre of the City of Kazan", Russia (2011) which passed an assessment by State Historical and Cultural Expert Committee and was approved by Ministry of Culture of the Russian Federation in 2011. In 2014, general aspects of new development design and its construction within World Heritage Site were studied in reserch on "Integration issues of contemporary architecture with different level cultural heritage in the historical city centres under the UNESCO protection and its buffer zone" at the University of Florence (Italy) under a supervision of Prof. S. Bertocci and Prof. S. Parrinello (University of Pavia, Italy).
Analysis of the World Cultural Heritage properties (monuments, group of buildings, sites) inscribed on the World Heritage List has been started in 2012. A comprehensive assessment of buffer zones and reasons of their definition were started and completed in 2015, which focused on (1) General Understanding of the evolution process for buffer zones' creation and its necessity, (2) Determining the specific aspects and visions that exert an influence on defining the boundaries of buffer zones by survey, field observation, collecting data, study of documents (World Heritage Convention, official Operational Guidelines and Recommendations), legislative system, Periodic Reports demonstrated by State Parties for Cultural Heritage Management process.

4. CASE HISTORY

In this research, the buffer zone is regarded as a tool refers to the definition of the acceptable limits and scales of quantitative and qualitative changes of the property surroundings.
By understanding the unavoidable changes of the city environment, there were analyzed some official documents and activities involved a sense of urban development within cultural heritage and urban context:
(a) *1987 ICOMOS Charter for the Conservation of Historic Towns and Urban Areas (Washington Charter)* accepts an opportunity to introduce changes into historic buildings and sites;
(b) *2003 The World Heritage Cities Programme* protects cultural heritage and manages urban development;
(c) *2005 Vienna Memorandum of World Heritage and Contemporary Architecture – Managing the Historic Urban Landscape*, where contemporary architecture is considered as 'heritage of tomorrow' integrating with cultural heritage and historic urban landscape;
(d) *2011 UNESCO Recommendation on the Historic Urban Landscape* identifies the dynamic process of urban development in a context of rapid urbanization and determines an opportunity of acceptable limits for historic urban landscape changes.
According to the analysis of the current UNESCO legal framework and official guidelines for the World Heritage protection and conservation, most of the general documents do not consider a buffer zone as a potential common "conservation and development" system that might be adapted to the cultural heritage protection actions and try not to prevent the rapid urban development of nowadays within the buffer zone, which is located in the historic city centers and rest of city territory.
In Operational Guidelines for the Implementation of the World Heritage Convention (further – OGs) that were approved from 1977 till 2013, "buffer zone" was determined to be "provided with adequate protection" (1977, 1978 OGs), defined around a property for "necessary protection" (1980 - 1999 OGs), and ensured "the full expression of outstanding universal value and the integrity and/or authenticity of the property" and include "important views and other areas (…) that are functionally important as a support to the property and its protection" (2005 - 2013 OGs). In 2008, during the International Expert Meeting on World Heritage and Buffer Zones (Switzerland), it was mentioned by UNESCO, ICOMOS and ICCROM that "buffer zone can be a very important management tool in protecting World Heritage sites" and it "may set limits to protect views, settings, land uses, and other aspects, but may also positively encourage developments" (Martin, O., Piatti, G. 2009).
Thus, an ideal model for Cultural Heritage Management consists in cyclic process: (*0) Understanding the category of Cultural Heritage, (1) Understanding the Site, (2) Mapping the Site boundaries, (3) Buffer zone definition, (4) Mapping the buffer zones components with change limits*[1]*, (5) Monitoring & Management System.*
Most of well-known and popular World Cultural Heritage Sites are located in developed regions of the world and in the historic cities, notably in Europe. In this case, the *Analysis of International Experience on Buffer Zones Creation for World Cultural Heritage* was concentrated on urban heritage in the European cities to identify specific characteristics and aspects for buffer zone's definition and improvement. Objects of research were *(1) monuments, (2) group of buildings, (3) sites, and subjects of reserch were (a) World Cultural Heritage buffer zones*. Location of the propeties was chosen within the boundaries of cities in Europe.

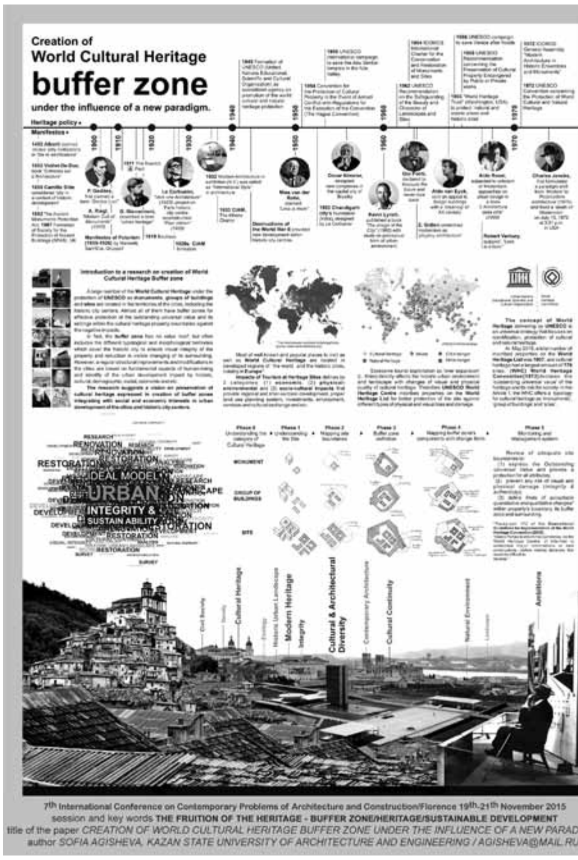
By comprehensive analyzing the properties' buffer zones, 231 properties from 779 Cultural Heritage properties[2] (May 2015) have been defined as urban heritage in the European cities, where:
(a) *174 properties* – buffer zone has been defined;
(b) *41 properties* – no buffer zone, but it is needed;
(c) *16 properties* – no buffer zone and it is not needed.
Comments for analysis of aspect impacted on buffer zone definition or non-definition, and its improvement:
(1) Buffer zone has been defined: A considerable number of buffer zones have been defined without taking into consideration of urban landscape diversity or using an informal approach for creation of buffer zone's boundary as fix circle / free geometry (Amiens Cathedral and Versailles, France; Monastery of Batalha, Porugal; Port of Karlskrona, Sweden; Roros Mining Town, Norway). Also potential danger for properties was determined in incorrect buffer zone's boundary without a prevision of *rapid urban development* (Cologne Cathedral, Germany). Most of buffer zones do not limit the ability to maintain the OUV, but they could be improved in context of detailed review and understanding the sites, and their *geograhic* and *landscape specific aspects* (Amsterdam canals, The Netherlands; Dubovnik, Croatia).
(2) No buffer zone, but it is needed: In 1980s and 1990s the most of the properties were inscribed on the World Heritage List without buffer zones. The pressure of *rapid urban development* demands to define buffer zones because of high-rise building construction (St. Petersburg, Russia) or any risks of mass tourism and new development affected on *visual integrity (panoramas, skylines), historical authenticity, structural and physical integrity (Florence, Italy).*
(3) No buffer zone and its not needed[3]: *Large-scale / new high-rise building complexes* (Tower of London, UK) or existing historic dense of site development (Speyer Cathedral, Germany) are a current context around the property and thus, a buffer zone is not needed because it would be ineffective in dense urban context. Other reasons of declining the buffer zones' definition are *lack of progressive economic development* that leads fixed urban environment with minimal changes (Avignon, France; Segovia, Spain) or properties' localizations with landscape elements as hills, mountains, rivers (Bern, Switzerland).

5. RESULTS

As to analysis of the properties' buffer zones, required parameters to be considered for buffer zone's definition have been formulated: (1) category of cultural heritage; (2) geography/site location; (3) climate/ecology; (4) urban, economic & social development; (5) protection policy; (6) human ambitions & visions; (7) culture; (8) landscape; (9) tourism; (10) diversity of urban environment.
Summery statement for Creation of World Cultural Heritage zone consists of (a) safeguarding of property, its attributes and surrounding, (b) cultural diversity and historic continuity, (c) progress of structural components and elements and (d) possibility of movements and further development.

6. CONCLUSIONS

Definition of buffer zones, where acceptable the limits of urban environmental quantitative and qualitative change would be determined and approved by legal guidelines and protection policy might be a tool for management of protection and development system. Therefore, there is a necessity to elaborate a methodology for Creation of World Cultural Heritage Buffer Zone by taking into consideration not only visual aspect, but others that influence deeply on balanced system with cultural heritage and new development.


Creation of
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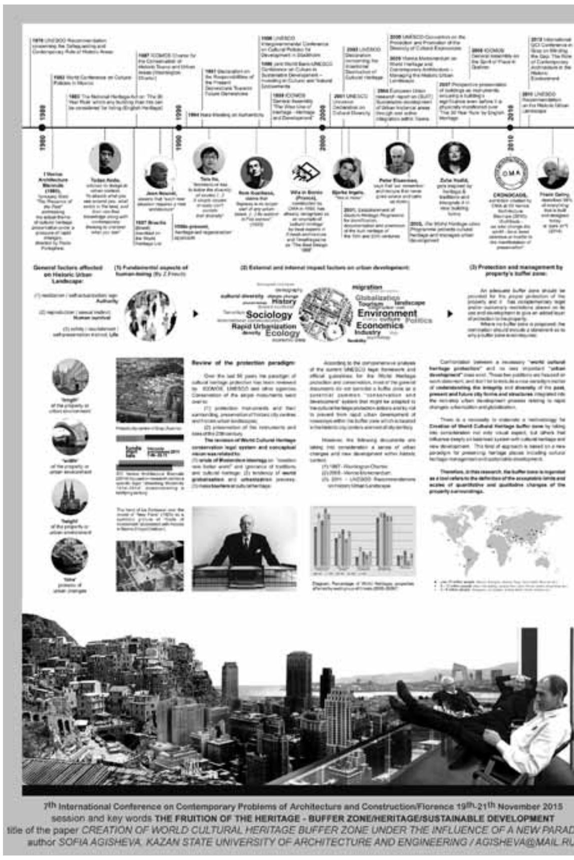
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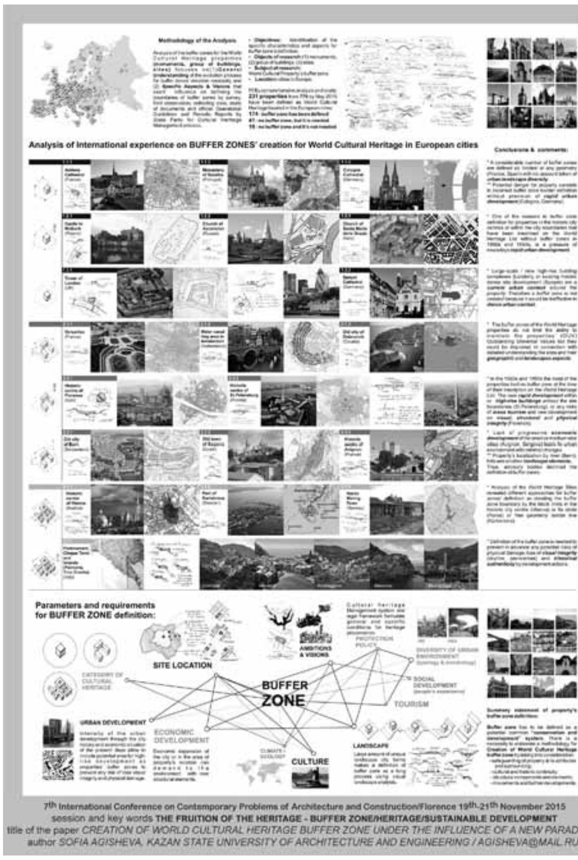
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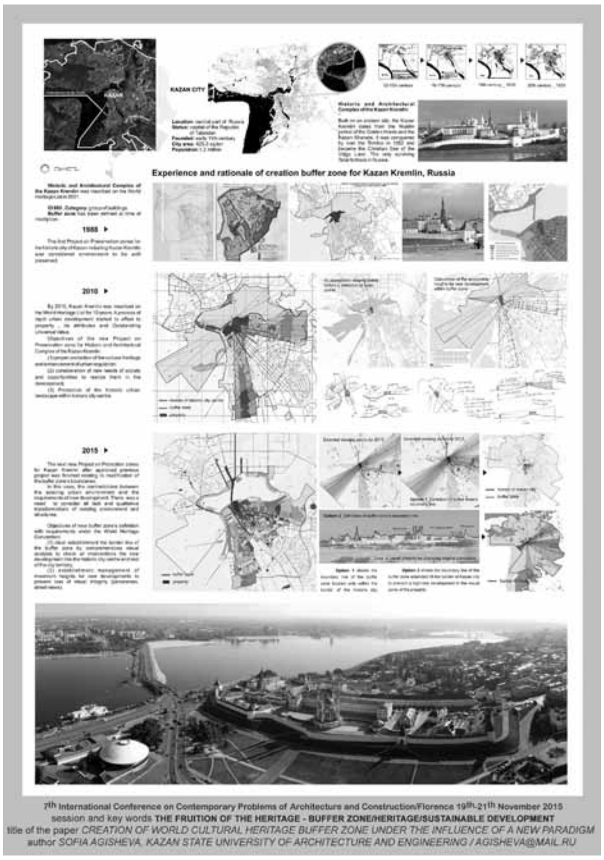
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NOTES

[1] Paragraph 172 of the OGs (2013): "The World Heritage Committee invites the State Parties to inform the Committee (…) of their intention to undertake major restorations or new constructions (…) before making decisions that would be difficult to reverse".

[2] According to the information about number of properties inscribed on the World Heritage List: http://whc.unesco.org/en/list/

[3] Paragraph 106 of the OGs (2013): "Where no buffer zone is proposed, the nomination should include a statement as to why a buffer zone is not required".

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DEVELOPING THE OUV-BASED MANAGEMENT PLANS FOR IRAN HERITAGE SITES IN URBAN AND RURAL AREAS, CASE STUDY: WORLD HERITAGE VISION PLAN FOR THE HISTORICAL SITE OF KHORHEH

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Keywords

khorheh, management, OUV (Outstanding Universal Value)

ABSTRACT

In this article the current challenges in managing Iranian historical sites have been evaluated according to a holistic approach recognizing their potentials as world heritages and resources for sustainable development. Khorheh, an important example of Parthian architecture in central Iran deteriorated due to the lack of conservation and tourism infrastructures was chosen as the case study. Field surveys and comprehensive interviews were done for consolidating its OUVs and codification of proposals for better participation of stakeholders in conservation and interpretation. The strategies to meet these objectives were identified in five phases, i.e. understanding the site, evaluation of the significance, identifying the problems, extension of conservation from the tangible to intangible and developing short term and long term plans according to analyses of the strengths and weaknesses of the built area and the opportunities and threats from the environment, tourism and local economy.

1. INTRODUCTION

Having a vast architectural heritage, Iran has been facing the crisis of conserving this heritage against the disordered industrial and urban development. The contradiction between benefits of the people residing in the lands adjacent to registered historical monuments and the conservation policies leads to the exacerbating destruction of valuable monuments showing the little efficiency of the present conservation planning. The emerging approach in heritage management based on understanding the values of the site and promoting the monument role in the cultural and economic living of its stakeholders can be an appropriate alternative. The uprising registration of Iranian sites as world heritages (WHs) indicates the substantial role of the registration process in controlling the possible threats and the better protection of sites through the awareness and collaboration of the stakeholders, empowering the tourism and use of more scientific updated conservation techniques. Therefore, focusing on outstanding universal values (OUV) can be regarded as an effective strategy for rehabilitation of significant historical sites in urban or rural areas, besides consolidating their potentials for being listed. Historical site of Khorheh at the heart of Iran plateau has a great potential to be considered in such a revised approach. Deteriorated from the uprising development in its vicinity, this site can benefit from some aspects of the local and regional development, i.e. the new research centers and universities, and become in its turn a cultural and financial resource for improving the local residents' lives.

2. BACKGROUND

In 1930, the Iranian Parliament enacted an antiquities law embodying for the first time precise regulations for classification and conservation of monuments and sites (Galdieri, E. and Afsar, K.A. 1992). This law has defined a delicate sequence for protection of each historical site including registration in "The List of National Historical Work (Athar)" and a set of recommendations for better documentation and conservation. Before this period, a number of isolated excavations and restorations were done in the historical sites without any special framework. Since 1930 the process of conservation of Iranian historical sites has changed its direction a lot. Although in the first decades of 20th century conservation of historical sites had been mostly functionalized by the nationalistic historicism supported by the authoritarian modernization, it gradually became more scientific through the cooperation of Iranian and western researchers. Especially the Italian and Iranian cooperation in Persepolis was a reference model for the conservation and restoration works which was done during several later decades. This approach was highly connected to the international movement evolving through policy documents such as the Athens charter (1931) and Venice charter (1964) that mainly emphasized on physical and formal authenticity of the monument and its relation with the adjacent environment. Therefore the management system regarding these texts is referred to as the Convention- based one. Although this management system more or less has been methodologically followed in Iran up to now, it has been encountering more and more with the following problems that are becoming worsen during the recent four decades (after Burra 1979):

1. The increasing number of registered monuments (more than 32000 at present) and the nearly fixed budget allocated by government
2. Destructive urbanization and rural development around the historic sites lead to emerging approach toward registration as a preventive conservation measure.
3. There is little relation between the sites and the local residents and owners of industrial and agricultural neighboring lands.
4. There is no link between tourism and heritage preservation.
5. The lack of long-term management plan is the case with lots of important historical sites and long-term planning is limited in practice just to the sites listed as the WHs.
6. It is observed that the nomination for the World Heritage List would bring unique opportunities to the sites and strengthen the local people’s attention and respect.

Although these problems are generally common with all the Iranian historical monuments, they are more serious in the case of excavated sites. Archeological sites contain different types of cultural relics, tangible (architectural structures) or intangible, which must be conserved through the wide cooperation of government with local and international organizations (ICHAM, 1990). The sites with OUVs belong not only to the contemporary local people but also to those who have a taste of art and architecture in all generations. During the last decade a paradigm shift is observed in the management of Iranian historical sites in order to respect both tangible and intangible aspects of the historical work. It should be noted that there has been always a special attention toward the conservation of the intangible heritages such as the traditional crafts which is now making its path through the conservation of tangible heritage as well (Hodjat, M. 2009). Because there is an unpleasant conflict between the (cultural and natural) heritage conservation and the (industrial and urban) development, more attention is paid to concepts such as monitoring, preventive conservation and sustainability. In this condition a value-based approach which brings more legal, technical and scientific capacities to the site by the social participation will more properly respond to the expanding conservation needs of the sites than the other forms of management that relay only on the limited classical resources.

3. CASE HISTORY

Khorheh historical site located in the borders of the Doudahak and Khorheh villages, in Mahallat city, Markazi province is amongst the first monuments registered in the list of national historical works (5 January 1932). The site covers nearly 3000 m2 area. The ruins of a hypostyle building in its center have attracted visitors through the history. Hasan ibn Qomi wrote that he visited the standing pillars in year 378 AH/ 988 CE (Qomi, H. 1974). One of the first efforts for systematic archeology in Iran was conducted by the order of Naser Al-Din Shah in this site (1859- 1860) (Adl, S. 2000). Visual documentation of this operation is available. During the later periods this site has been excavated several times (Hakemi, A. 1990 and Rahbar, M. 2003). The excavations identified the ruins of a Parthian mansion, accompanying with evidences of the continuity of residence in the area through the following ages, i.e. Sassanid kilns, Ilkhanid graveyards (Ibid) and other monuments from the Islamic period including a mausoleum, cemetery and the ruins of a caravanserai from Safavid era in the vicinity of the site. The natural landscape of the site consists of beautiful views of vegetation and natural ponds and traditional agricultural crops in the foothills. The hypostyle building is the only example of this architecture in Iran which consists of three parts, the portico (ivan), the interior space in the south (andarouni) and outside space in the north (biruni). The unique architectural design of the building is a mix of architectural elements of Greek and Persian design. The main portico has six pillars designed in Ionic form from travertine taken from the mountains of Mhalat. Other parts of the building are made of mud-brick with 14 × 40 × 40 cm dimensions. It was the subject of lots of controversial views among art historians trying to determine its age and use (Rahbar, M. 2003 and Hakemi, A. 1990, Schippmann, K. 1971).

Major material structure is remained intact. The brick walls have been covered with traditional renders, Kahgel which is completely reversible and repaired periodically. Limited application of cement for consolidation of pillars

Fig. 1. Khorheh. The evolution of the northeastward view in the direction of the mausoleum and rural area in
(A) Photograh by Agha Yousof,1892 (B) Photograh by Ahmadinezhad,S., 2013

is reported. Moreover the site area is owned by the Iran Cultural Heritage, Handicraft and Tourism Organization (ICHTO) and any manipulation in the site core zone is prohibited (Hakemi, A. 1990 and Adl, S. 2000). Besides the interventions in the historical design of the mausoleum, only 200 m distant from the site, rural buildings established at the 220 m east of the site are gradually changed without respecting the local architectural methods (image 1). Modern forms of agriculture has also disturbed the natural environment (and topography) of the area. This especially led to destruction of the beauty of natural springs of mineral water in the region (image 2). Inside the borders of the site, brick walls of the outer and inner spaces are eroded by the rainfall due to delays in periodic repairs and maintenance works. Despite this fact that the remains of fallen historical pillars have been retained in the site, the stone pieces are exposed to air pollution and rain without any shelter. The scaffolding holding one of the two standing pillars disturbs the view and integrity of the site as a whole (Karimi, A. 2009). It is a site registered in the national scale, yet it has not respected even comparing with the other national monuments and it needs primarily to take the protective measures at the national level. On the other hand this site with the universal values such as being one of the rare witnesses of the great civilization of Parthian era has a high capacity to be registered as a WH. This can bring new and significant social capital and funding to it. Hence the WH Nomination can be regarded as a serious motivation for its conservation.

4. METHODS

Strategies for managing the site of Khorheh were identified in 5 steps: a) Preparation, data collecting and understanding the site and its stakeholders b) Evaluation of the significance c) Identifying the problems d) Extension of conservation from the tangible to intangible e) Developing strategies.
Consultation with the site stakeholders and relevant authorities was regarded as the first step in preparing a value-based management plan. All the essential elements of the program including resources (human and financial), time and problems were discussed. The potential stakeholders of Khorheh were identified as follows:

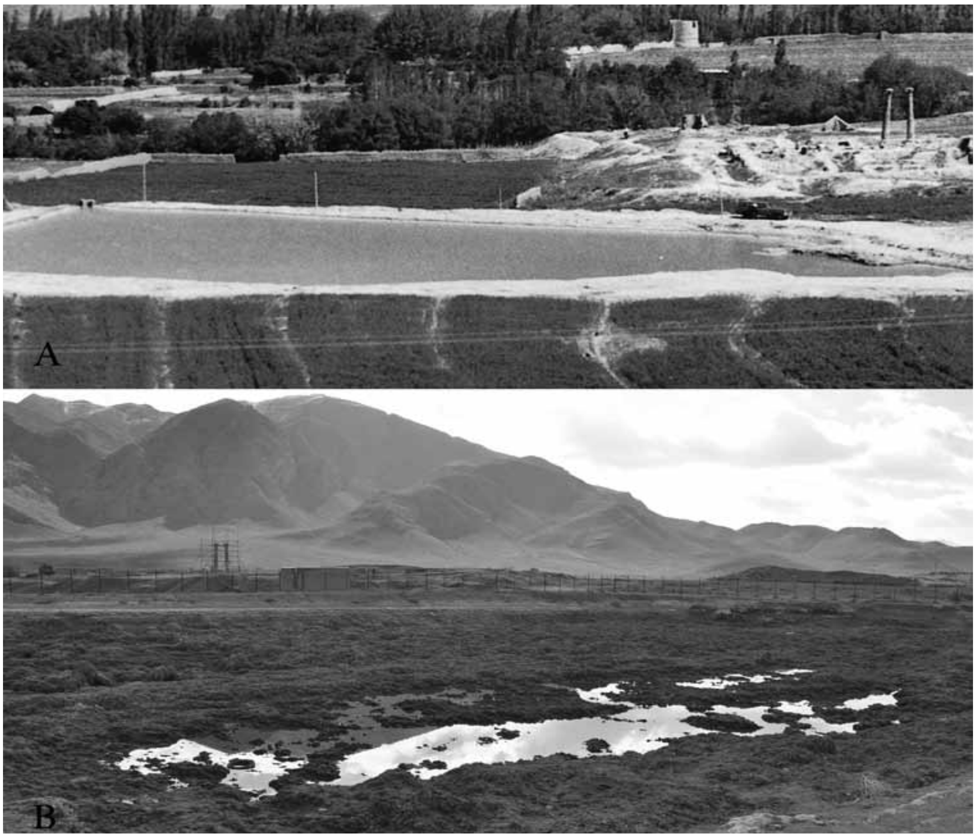

Fig. 2. Khorheh. The evolution of the mineral water lake
(A) Photograh by Rahbar,M., 2000, (B) Photograh by Ahmadinezhad,S., 2013.

• Group 1: ICHTO (Provincial office in Arak and its responsible branch in Mahalat)
• Group 2: Other governmental institutes, i.e. ministry of road and urban development, the Department of Environ ment, Awqaf Organization, Iran Meteorological Organization, and a variety of universities and research centers, providing necessary resources for managing the site through collaborations with ICHTO
• Group 3: Local landowners
• Group 4: Local communities of Khorheh, Mahalat and other social groups interested in the history of ancient Persia

In order to study the experiences of groups 1 and 2, several state archives were surveyed and interviews with officials were done. At present some of the institutions offer good web services, but others still prefer classical technologies for storage and data recovery. Data collection from group 3 was accomplished in the long-term process of public and private dialogues with them in local cultural ceremonies, e.g. in the mausoleum, and sometimes by making direct inquiries and interviews. Due to evaluate the fourth group's opinion diverse methods were used such as preparing questionnaires, interviews with academic experts, etc. Working with stakeholders provided an opportunity to share information and create common responsibility. Their satisfaction and support will ensure the success of the proposed management strategies.
In the second stage, the information necessary to identify OUV of the site was analyzed. The stakeholders' perception of Khorheh was also studied in open dialogues. In the third and fourth stages a statement of OUV was prepared for the site. All the collected data was analyzed to assess the authenticity, integrity and the state of conservation as the main elements of an OUV statement. It was also necessary that other local and national values of Khorheh would be also taken into account. After identifying the values and importance of the site, a comprehensive assessment of the various elements (both positive and negative) that affect the values was accomplished. Using SWOT analysis strategies were defined to reduce the effects of negative factors and to increase the benefit from the positive ones. It should be noted that many of the factors were not essentially malicious, but it is the management

Category	Strategies	The current state of the site management
Material structure (Historical Value)	• Introduction of vernacular architecture and the values of Khorheh architectural design to the residents of neighboring villages through establishing model projects. • Identifying and providing the restoration materials with an emphasis on revival of vernacular methods • Preparing restoration guidelines for stone pillars and adobe structures within the site and neighboring monuments such as the ruined caravanserai according to the regional and international standards	• The vernacular techniques and materials are not available anymore due to limited demand in the public sector • Limited exchange of experiences between ICHTO staff and local people or architects from public sector
Landscape (Cultural and Natural)	• Defining a comprehensive environmental conservation plan in cooperation with local universities and the Department of Environment, Ministry of Agriculture and stakeholders • Interpretation of the site in the context of natural-historical tourism of the region	• limited link between the current management system with the natural conservation and tourism intuitions
Economic Value	• Maximum utilization of tourism infrastructures in the surrounding towns in the short term • Setting facilitations for the visitors in the terminals of the surrounding towns • Equipping accommodation services for residing researchers	• Web Information about the site • No visiting plan in the local travel agencies • No accommodation for researchers or special guests
Social Participation	• Recording the memories of older residents of the area (the legends and beliefs about the site) • Establishing collaboration among the site and universities and research centers throughout the country and region which can support the site as new stakeholders • Encouraging of the establishment of NGOs, public forums and associations for supporting the site • Highlighting the site as a local museum	• NGOs are not linked with the site preservation and interpretation system • Only few public programs are annually held in the capital of the province for interpreting the site

Fig. 3. The main management strategies for Khorheh respecting the various values of the site

due to the lack of proper services in the site and even the whole region.

5. RESULTS

The analysis of internal and external factors facilitated the identification and classification of the key issues in site preservation.
The unique cultural landscape of Khorheh consists of four dimensional levels:

• Level I: The main area of archaeological excavations, including the rich heritage of the Parthian period
• Level II: The Islamic heritages which is linked to the stakeholders' beliefs
• Level III: Respectful use of natural resources, i.e. the old farming systems, indigenous hunting and collection of medicinal plants
• Level IV: Oral traditions that make the sense of identity and social cohesion of the local people.

Internal and external factors affecting the management of these dimensions were evaluated from five different viewpoints including technology and research, social participation, economic value, physical integrity and landscape characteristics. Short-term and long-term management objectives set, as well as a variety of strategies meeting them. Each strategy follows with a series of procedures for the allocation of required resources.
The short-term (focusing at preventive conservation of the architectural elements) and long-term (comprehensive approaches towards restoring the fabric and landscape) objectives targeted for the site are as follows.

Short-term Objectives:
• Reviewing the determined boundaries of the site and revitalization of its true territory by legislation
• Prevention of any further excavation

• Developing drainages to conduct rainwater outside the site and periodic dredging of the drainage system
• Emergency conservation of deteriorated mud-brick structures and stone pillars
• Establishing the security checkpoints
• Establishing the visiting path.

Long-term Objectives:
• Periodic repair of preservative renderings of mud-brick structures
• Feasibility study of establishing a protective coating for the stone pillars
• Restoring the architectural plan
• Reviewing the anastylosis of stone pillars
• Periodic Pest Control
• Establishment of tourism infrastructures
• Mechanization of physical protection facilities
• Encouraging the stakeholders' public participation on the basis of economic profitability and preventive conservation
• Restoring the cultural landscape of Khorheh with the emphasis on vernacular architecture, traditional agriculture and botany and controlling the industrial interventions.

The strategies categorized in different viewpoints of (a) physical and (b) landscape integrity, (c) economic value and (d) social participation were recommended to meet the above objectives. They follow with guidelines to determine the required resources (human, financial, organizational and equipment), the sequence of actions and expected outputs. In image 3) the main preservation strategies for Khorheh and the benefits of selecting the value-based approach against the current state of conservation are presented.

6. CONCLUSIONS

The process of identifying and evaluating the values of a historic site is complex and time consuming. This process may take much more time and intensive interdisciplinary work for Iranian historical sites due to the limited experiences of the stakeholders' participation. However this does not mean that the historical site should be left without a short-term program. Defining a framework of short-term goals is not only an emergency measure during a transition period but it can also act as a prolusion arranging for the long-term plan. Focusing on the universal value of the site can provide new opportunities for its interpretation and support from those stakeholders that were not normally active. The monitoring of accomplished interventions will be important in evaluating the success of management strategies which requires a continuous work inside the site. The final stage of this decision-making process will be the nomination of the site and drafting its management plan that requires a period of three to five years of team working. Until then revising the social and economic development of the region regarding the site as a potentially World Heritage would be a smart approach. It should never be out of mind that a management system and its cycle of planning, implementation and monitoring would be meaningless without considering the broader concepts of sustainability and the stakeholders' contribution.

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THE MEANING OF PARISH HOUSES IN THE VILLAGES AND THE SMALL CITIES IN THE MODERN PERIOD

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Keywords

Parish house, Moravia, Silesia, baroque, type of building, the function of historical building

ABSTRACT

In the past, the parish houses in the countryside or in small cities served various functions in religion, society, and economy. The historical building construction research of the parish houses in Moravia and Silesia indicates that only one specific type of parish houses was built here – with the apartment for the parish priest and with rooms for the chaplains in large parish districts.
Many of the parish houses offered also the accommodation to clergy during their regular visits and thus were rather sumptuous. Fundamental reorganisation of the parish administration in the second half of the 20th century caused that many parish houses have lost their function and were left unused. Since 1990s, the parish houses started to be used for new functions and many of them are being rebuilt.

1. INTRODUCTION

Parish houses, the major baroque architecture monuments of Moravia and Silesia, were researched using methods utilised in examining the history of architecture, history, and sociology. Selected cases examine in detail how their construction approach has evolved in time and their functions in the past and at present.

2. BACKGROUND

Catholic Church baroque parish houses in the region of Northern Moravia and Silesia (Czech Republic) were studied and the obtained knowledge has been compared with the parish houses of similar age in surrounding countries.

3. METHODS

Getting to know the historical parish houses requires knowledge of structure and functioning of the church administration in early modern period. Relevant facts on the church administration were extracted from the literature on the Church history. Historical parish houses, especially the baroque ones, were usually constructed according to certain patterns and often share similar layouts. Such layouts and other rules for construction of parish houses in the past were in modern period included in the building construction textbooks (Joendl, H. P. 1842) that were regularly published and used as far back as in 18th century.
Based on the knowledge of literature and findings from the field, the appearance and current utilisation of larger number of parish houses in the region were compared. Selected cases of historical parish houses then were examined in more detail. Studied were the circumstances of their origination, personality of the builder and constructor, the layout of parish houses, their construction evolution and present utilisation.
Based on the knowledge of baroque parish houses in the region of Northern Moravia and Silesia, the conclusions on their layout and function patterns were formulated and compared with the knowledge on the baroque parish houses in surrounding countries.

4.CASE HISTORY

In baroque period, the Catholic Church gained rather significant position, and in fact the exclusive one in then Habsburg monarchy which included also the territory of today’s Czech Republic. The system of basic territorial entities – parishes, has been applied in the territory of the monarchy as well as in the rest of the Catholic Europe. The church representative of the parish was the parish priest. Depending on the parish size and status, he could use the assistance of various number of chaplains. Parish priests were active in the people count registration; they maintained the parish register since medieval period, which was mandatory after 1563 pursuant to the Council of Trent regulation applicable to the entire territory of Catholic Europe. Moreover, in early modern period, the Habsburg monarchs tasked the parish priests with other responsibilities of the lower level state administration. (Zuber, R. 1987). Therefore, the adequate buildings for parish priests had to be built to meet residential and administration functions.

During early modern period, the rules for building the parish houses were constituted that were modified only slightly during 18th century and 1st half of the 19th century. The layout of parish houses was described by H. P. Joendl in his building construction textbook (Joendl, H. P. 1842). He distinguishes and draws parish houses as “small” or “large” depending on the number of chaplains accommodated there. However, the classification of the accommodation houses for the church administration includes also smaller units than parish houses – accommodation for localists and for exposists in modest single-storey version. Both size types of parish houses show certain identical layout features, namely cross corridor in the centre of the building and separation of rooms of the parish priest apartment and labourer’s premises adjacent to the kitchen. The latrine used to be located next to the staircase. It was the early modern period when many parish houses were established in Northern Moravia and Silesia. As early as in the 2nd half of the 17th century, many parish houses with masonry construction were established or repaired (Rýmařov, Stará Ves nad Ondřejnicí, etc.). The wooden parish houses were replaced in large scale in 18th century with masonry new buildings built following similar layout that were distinguished only by their placement in the surroundings or by the level of decoration.

During 18th century many smaller parish buildings were built without impressive decoration (Petrovice u Karviné, Albrechtičky, etc.). (Gavendová, M., Koubová, M., Levá. P., 1996)
The construction of parish houses was financed by so called patrons, as was usual at that time, who usually were the owners of the manors. They took care also for the maintenance and repairs of churches. The patrons significantly contributed to the appearance of the parish houses. In some cases, the parish houses were designed by major European architects. The parish house in Suchdol nad Odrou has been projected according the design by the Vienna architect Johann Lucas Hildebrandt (1668 - 1845) from 1730. (Mannsbart, C. 2011).

The establishment of the parish house in Bartošovice has been accompanied with the specific circumstances in the manor. The Bartošovice village belonged in 18th century to Podstatští z Prusinovic family. In 1721, the manor as inherited by Jan Josef count Podstatský z Prusinovic, who was the clergyman, the canon of capitular in Olomouc. This priest, who acted here as the patron, ordered to build the opulent parish house as single-storey building in dominant landscape location. The parish house was sumptuously equipped and apart from being the residence of the parish administration, its function was to accommodate not Podstatský himself, i.e. the manor owner, but to accommodate occasionally the church superior during so called canonical visits (regular inspections of the condition and functioning of parishes). The parish house built on unstable subsoil was damaged as early as in 19th century to such extent that it required inserting the ceilings above the top storey and new roof beams at the end of 70s of 19th century. After World War II, the building was used as the school. At the end of 60s of 20th century, it was used for the museum in Nový Jičín. (Augustinková, L. 2015). Since 70s of 20th century, the parish house serves as the seat of the organisation for preservation of free-living animals. The offices were located to the first floor. In the ground floor, the exposition is installed focused on the nature in Poodří region.

The parish house in Životice u Nového Jičína has been built in 50s of 18th century during reign of the Jesuit parish priest Josef Tomanetz. The Society of Jesus (Societas Iesu) acted in Životice u Nového Jičína not only as the parish administrator, but also as the local manorial lords (namely pertaining to the Jesuit College in Olomouc), i.e. the parish house constructor. The utilitarian single-storey building was thus created in the dominant landscape location. Above the front façade is the stone cartouche with the symbol of Society of Jesus. The parish house design author

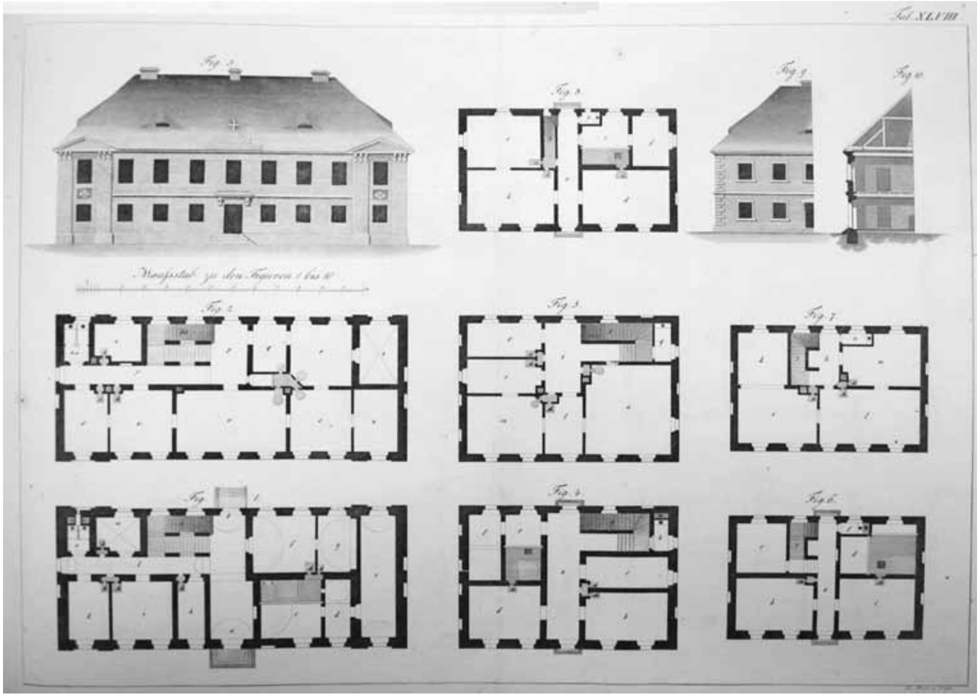

Fig. 1 H. P. Joendl, small and large parish houses and the houses of localists.
Die landwirtschaftliche Baukunst, 1842.

Fig. 2. Parish house in Bartošovice, the exposition of preserving the nature in Poodří,
photo L. Augustinková, 2014.

was the fort constructor from Olomouc known from written records only by his first name Tobias. The object was only barely modified during its existence. In 1898, after the fire, new roof beams were installed in the parish house and in 30s of 20th century, the heating system has been modernized. (Augustinková, L. 2012). Today the building is still in the property of Church which uses it together with Životice u Nového Jičína municipality, which rented the parish house for social and cultural purposes and offers the building also for seasonal accommodation.

The parish house in Dubany existed originally as the wooden building that was very deteriorated in the half of 18th century. Therefore, the parish priest Adolf Hutter often complained to Dubany parish house patron, abbess of Order of St. Clare nuns in Olomouc, Agnes Schreyerin, about the bad parish house condition. After many financial hardships, ultimately the result was achieved and in 1760 a new parish house has been built. It is large, vaulted construction located in the municipality centre across the street from the church. This parish house has usual layout of parish houses of 18th and 19th century. Two-room apartment of the parish priest and labourer’s premises on the opposite end. The layout and construction principles also obviously allow to identify in the ground floor the historical kitchen and adjacent pantry. First floor includes large dining room, three guest rooms and co-operator’s apartment. (Augustinková, L., Orlita, Z. 2009). In the 2nd half of 20th century, the parish house was unused for some time. At the present time, the Vrbátky municipality, on the territory of which the parish house is located, ensures the parish house maintenance with intention to establish the municipality museum here.

The parish house in Kravaře has been built as the single-storey building in 1795 financed by parishioners, patron and from the parish funds. Downstairs were rooms for beneficial, co-operator, labourer’s premises, kitchen and pantry. There was one inhabitable room and in the attic the grain was stored. After the fire in 1862, the building has got the upper floor and new roof beams. Local constructor Josef Seyfried (1865 - 1923) modified the parish house to its present appearance. No significant alteration were made to the layout and mass distribution of the building. His work focused mainly on the modification of the front façade in the neo-gothic style and modernisation of interiors. (Augustinková, L. 2009). Today it serves as the parish house and the community center.

5. RESULTS

Among the parish houses studied, the majority are the realisations or reconstructions made in 18th century. It was a time when Habsburg monarchs closely monitored the actual performance of the administration duties of parish priests and when the Catholic Church was financially sound enough and had such large number of rich patrons that it could allow big construction projects.

Out of 4 closely studied parish houses, three are very sumptuous. Their size was probably one of the reasons why they were left unused in 2nd half of the 20th century. Only recently these objects were modified for cultural purposes.

Such large and representative parish houses have their counterparts for comparison rather locally in the region. In surrounding countries the parish houses are mostly smaller buildings not unlike regular residential houses. (Huyghe, R. 1970)

6. CONCLUSIONS

The parish house is a specific type of historical building. At their time, they were not only intended as the residence for parish priest, or small apartments for chaplains, kitchens, personnel accommodation and storage space, but also the place where parish priests active e.g. in the registration of population, operated their offices.

Among studied parish houses in the region of Northern Moravia and Silesia, the majority are the large, representative and dominantly located objects with hard to find counterparts in Poland, Slovakia or Austria.

At present, the parish houses serve different purposes. Only some of them are used as the residence for parish priests. Majority of these preserved monuments – historical parish houses – are today used most often for cultural purposes – as museums, community centres, etc.

Fig. 3 Parish house in Životice u Nového Jičína, the coat of arms of Jesuits, photo L. Augustinková, 2012.

Fig. 4. Parish house in Dubany, exterior, photo L. Augustinková, 2008.

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DEMOCRATIC EVALUATION OF ARCHITECTURAL HERITAGE RESTORATION AND CONSERVATION PROJECTS

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Keywords

democratic evaluation, architectural heritage, complex decision making

ABSTRACT

The paper is about what kind of evaluation is more suitable for the architectural heritage conservation-restoration projects. Adopting a theoretical-methodological approach, the paper specifically deals with the problem of the complexity of both the concept of architectural heritage and the decision-making of conservation-restoration project, and with the effects it has on the evaluation process. The author argues that the traditional technical-operative approach (efficient and effective use of resources) should be abandoned and replaced by a holistic and strategic one supporting the use of democratic evaluation, which: is based on justifiable and acceptable reasoning, is able to consider the multiplicity of the values and the involved actors' viewpoints, considers preferences' dependence on the development of the deliberation process, and fosters the redefinition of the problems and the invention of new shared solutions.

1. INTRODUCTION

In spite of the complexity of the Architectural Heritage (AH) conservation-restoration projects, their evaluation is mostly developed from an unsatisfactory economic-financial point of view. The most used economic evaluation method is cost-benefit analysis, according to which, the effects of a conservation-restoration project are monetarily measured, the result is determined in terms of economic efficiency, and the decisions mainly depend on the convenience of the investment. This reductive mono-objective evaluation approach is particularly dangerous in conservation and restoration of AH, as it disregards many qualitative socio-cultural values and ignores many intangible effects. This inadequacy may explain the failure of several investments in this field and asks for a more comprehensive, evaluative approach.

The paper will deal with the following items: a) the complexity of AH conservation-restoration project evaluation; b) the limits of the economic approach in evaluating AH conservation-restoration projects and why an integrated inclusive approach is advisable; c) the main features of democratic evaluation; d) a three step procedure to achieve commonly, shared solutions; e) possible conclusions.

2. BACKGROUND

The evaluation of AH is a complex problem due to the complexity of both the concept of AH and the conservation-restoration project decision-making. AH complexity refers to a plurality of values (e.g.: cultural economic, social, artistic, historic, symbolic, identity-oriented, etc.) whose relevance changes over time and space according to different interpretation within anyone culture. AH is a value-loaded concept socially and historically determined, resulting from a subjective selective interpretation of materials and issues, that is, the present selects an inheritance (a building, a historic city center, a monument, etc.), from the infinity of the past, interprets it as resource for current use and decides if it is valuable and should be passed on to the future. Its boundaries are unstable and blurred due to continuous historical additions, and concept enlargement (Benhamou, 2003) (Graham, 2002) (Throsby, 2007).

The AH's values belong to two socio-cultural and economic meta-categories. Socio-cultural values refer to a building, or place value «because it holds meaning for people or social groups due to its age, beauty, artistry, or association with a significant person or event or … contributes to processes of cultural affiliation» (Mason, 2002). They are at the traditional core of conservation. Five main socio-cultural values may be identified: Historical values (educational value, artistic value) referring to the capacity of a building to convey a relation to the past; Cultural values (cultural value, symbolic value, craft-related value), referring to the shared meanings of AH; Social values, referring to the capacity of AH to enable and facilitate social connections: feelings of affiliation, social cohesion, community identity etc. (place attachment); Spiritual/religious values, referring to the capacity of an AH to emanate sacred meanings or to produce wonder, awe, etc.; Aesthetic values, mainly referring to the sense of well-being due to visual qualities of an AH. (Mason, 2002).

Nonetheless, as the Venice Charter (1964) states, «The conservation of monuments is always facilitated by making use of them for some socially useful purpose» that «is achieved by the application of sensitive restoration techniques and the correct choice of appropriate functions» (European Charter of the AH, 1975). As any conservation-restoration project increases the utility of AH, it also is an economic activity (Forte, 1973), and AH can be considered a capital asset, whose different uses and functions, can economically be evaluated. But AH is a peculiar type of capital asset as its market price (as opposed to paintings or sculptures) is not proportional to its cultural value, it can be considered a public good, and it is unique and irreproducible, so that its supply does not increase according to changes in demand. As a consequence AH assessment relies on "total economic value" (Pearce, 1989) whose components are use-value (related to the market price); and non-use value (non-market value) that attempts to grasp the socio-cultural values of AH through the existence value, option value and bequest value, normally quantified by revealed or stated preferences methods. Unfortunately these two methods have limited capacities, or suffer some biases in estimating architectural heritage, so that, economic evaluation, in spite of its pretended analytically sound objectivity, is inappropriate when a multiplicity of socio-cultural values and intangible effects are at stake.

A threefold relational complexity characterizes the decision-making of AH conservation-restoration projects. The first one is the complexity of the decision environment due to the multiplicity of the different actors involved. Restoration-conservation projects take in many kinds of stakeholders: decision-makers, both public (politicians, public administrations etc.) and private (property owners, promoters, investors, etc.); experts (architects, conservators, historians, chemists, sociologists, anthropologists, economists and local experts, etc.); community and other culture groups; ordinary citizens, etc.. All these actors are endowed with different kinds of rationality based on specific logics: politic-institutional logic of public administrations, economic-financial logic of private market decision-makers; technical-scientific logic of the different experts; social logic of the civil society. This kind of complexity causes problems due to conflict among stakeholders (reciprocally denying the legitimacy of their logical paradigms), etc..

The second one is the complexity of decision-making as the conservation and restoration project is the result of a multi-level interaction process among the decision-makers endowed with: different decision-making power, information, technical-scientific knowledge and capacities; a plurality of values, objectives, interests, expectations, preferences, etc.. This kind of complexity causes problems affecting the negotiation process, the incentives to cooperate, etc..

The third one is the complexity of the conservation-restoration design process itself. As the Venice Charter states «The conservation and restoration of monuments must have recourse to all the sciences and techniques which can contribute to the study and safeguarding of the architectural heritage» this requires the involvement of many experts and a synthesis of many different elements belonging from a plurality of disciplines. This kind of complexity causes problems of communication that require the creation of a common knowledge, different approaches to understand reality and to forecast results, effects impacts, etc..

3. METHODS

Starting from the complexity of AH conservation-restoration project the paper aims to outline, from a methodological-theoretical point of view, what evaluation approach is more suitable for AH conservation-restoration projects in complex decision-making environments where many different kinds of values and stakeholders, are involved. Wandering what main roles evaluation plays in decision-making and who sets the values on which the evaluation is performed, the paper presents the recent developments of democratic evaluation (sprung from the participative-deliberative approach in decision-making) as a promising, alternative to the present traditional evaluation approach.

4. CASE HISTORY

According to Bentivegna, evaluation can play two main roles in the decision-making process: to help decision making; to legitimate and justify the decision. Evaluation helps decision-making as it provides specialized critical information and knowledge which allow an informed and rational comparison among the different alternatives, increase the rationality of the decision-making process, reduces the risk and cost of wrong decisions. In complex decisional context, where many values, objectives, expectations, interests and criteria are involved, and no external (the market) or internal (hierarchical control) shared regulators are available, evaluation can play the legitimation and justification role as, being based on scientifically sustainable reasoning, can provide explicit and disputable reasons for the decision, making the process transparent and communicable. In this way, evaluation fosters an active and informed participation, as well as a learning process through the creation and exchange of knowledge.

The evaluation is an operational concept without any absolute semantic value (House, & Howe, 2000): it is a relative and subjective process depending on the specific decisional context in which it is carried out. This means that the judgement changes according to the adopted point of view: the set of values, the system of objectives, the criteria, the interests, and the structure of preference considered. The most relevant actors in AH projects are: community and other culture groups (the general and the organized public interest groups); the market (promoters, banks); the State (politicians, public administrations or institutions); experts (conservators, architects, and other local experts); property owners; ordinary citizens, etc.. As a consequence, in the complex decisional context of the AH conservation-restoration projects, the question of who is in charge to set the values, the objectives, and the preferences, on which the evaluation is developed, is not a trivial question. The matter is especially relevant when, as nowadays, an increasing demand for civil society's participation in the decision-making, as well in evaluation at all stages of the public interventions, arises, requiring that not only the values and the stances of the actors provided with some kind of economic and/or negotiation power, but also the ones of weak social groups (who have no knowledge of the process or in conservation and policy) are considered. The democratic-deliberative evaluation may be a possible solution (Plottu, 2009) because it is able to face strategic problems related to decision-making values and objectives, and to perform a mediation role in the evaluation process recognizing the subjective nature of any value judgement, and considering different, conflicting systems of knowledge (e.g.: scientific vs. tacit). According to House and Howe, deliberative democratic evaluation is based on three main principles: inclusion, dialogue and deliberation. The principle of inclusion requires that all groups with a significant interest (stakeholders) be included in the design and conduct of the evaluation. Of course, not every interest, value or view concerned will have equal weight, only relevant ones should be considered. Dialogue is an evidence-driven cognitive activity in which participants and evaluators collaboratively engage, and from which the most rationally defensible conclusions emerge. Dialogue is mainly a learning process, based on mutually respectful listening and communication of opinions and ideas of all stakeholders. Its main goal is the achievement of commonly shared meanings and solutions, provided that, an attitude of reciprocal understanding and legitimation of the different, interests, objectives and values of the participants are assumed. Deliberation is related to how dialogue is structured and the information is processed. Deliberation is a reflexive, thoughtful reasoning on relevant problems at stake (including preferences and values identification and transformation) by which all the stakeholders reach shared or acceptable solutions.

5. RESULTS

A three stages procedure, encompassing an empowerment process, a deliberative process, and a multi-criteria analysis, is advisable in democratic-deliberative evaluation implementation (Floc'hlay, 1998).

Democratic evaluation is strongly committed to promoting participation: in AH projects some stakeholders are endowed with some kind of decision power, such as public officials, bureaucrats, policy makers, and, to an extent, professionals (architects and other experts) can participate in the process where values are identified, assessed, and ranked and where decisions are made. On the contrary, other legitimate actors, with a stake in the AH in question, but with little or no leverage on the process, and potential stakeholders, who may in the future have some interest in the AH (e.g. future generations or who lives at a distance), generally remain outside (Mason, 2002). The empowerment of those weak stakeholders is the first indispensable stage in the efficient implementation of a Democratic Evaluation as it provides citizens' participation with a minimum amount of organization. It mainly consists of a learning process endowing weak stakeholders with the capacity to understand and consciously influence the complex collective decision-making and to master the knowledge and the techniques which facilitate self-determination in the evaluation experiment and to become able to take charge of themselves and "to speak with a single voice" (Plottu, 2009). The enlargement of participation to all the relevant stakeholders is a crucial point in democratic evaluation that raises a political question about who has the capacity and the power to decide when the technical-scientific aspects are overwhelming. It should be stressed that, even if the empowerment process requires real changes in professional attitudes (experts and evaluators need to be open to laypeople views about AH values and decisions, and embrace alternative ways of understanding values, negotiating differences, etc.), there is no transfer of decision-making power. The traditional decision-makers maintain their power (and the experts' role is not threatened), but they are rather bound (by a pre-commitment) to motivate their decision when it differs from the participation process result (Bobbio, 2002).

The second stage of the implementation procedure is the deliberative process framing. All the stakeholders are involved in a dynamic process of the collective construction of the problem of choice of a shared solution. Such process is based on deliberation and not on a simple confrontation of interests or an aggregation of the preferences of the majority (Plottu, 2009). Deliberation requires that all stakeholders mutually recognize the legitimacy of all the values, preferences, interests and systems of knowledge at stake, and share a common commitment to a mode of reasoning and decision-making based on rational and impartial argumentations (Plottu, 2009). The change in preferences is the trigger that allows to discover innovative common shared meanings and solutions or at least any compromise ones.

This leads us to wonder about which evaluation tools is able to continuously and recurrently reconsider the evaluation objectives, the criteria, and their relative importance. The answer is provided by the third stage of the procedure, that is, the implementation of a multi-criteria analysis. As some relevant operative examples demonstrate (Plottu, 2009; Floc'hlay, 1998; Bobbio, 2002), multi-criteria analysis with multi-decision-maker allows to: consider a plurality of values and criteria, process both quantitative and qualitative data, structure the deliberation process (including a multiplicity of stakeholders, considering different structures of preferences without reducing the multi-dimensionality of value to one sole indicator, considering changes in preferences), produce creative solutions; consider quantitative and qualitative decision criteria. As a matter of fact, multi-criteria analysis helps first, in setting initial goals (through the definition of the evaluation criteria) and in providing suggestions on how to reach them, and secondly, in the delicate step of assigning the relative importance (weight) to the different criteria. The implementation of a multi-criteria analysis with multi-decision-maker (that associates a specific structure of preferences to each participant and develops as many evaluation exercises as the participants are) avoids the risk that the discussion becomes ideological (Bobbio, 2002). As, the evaluation result is a number of alternative's rankings equal to the number of the points of view considered, each actor can realize how the alternatives are ranked, according to both its own structure of preference and other participants' structures of preference. The dialogue shifts from values-comparison level to rankings-comparison one, where both the mutual influence between participants and the transformation of preferences are possible and give room to shared, "creative" solutions (Bobbio, 2002).

6. CONCLUSIONS

Democratic evaluations performed through multi-criteria analysis with multi-decision-maker are particularly useful in complex and uncertain decision-making like AH conservation-restoration projects, and are even more valuable if conducted in the early stage of the project when disagreements and unproductive irreconcilable conflicts between actors can be avoided. In fact, the multi-criteria analysis, structuring the deliberative process, provides the formal framework of the evaluation process and facilitates the decision-making. Therefore, it can 1) facilitate the understanding of the problems and solutions; 2) foster the learning through the exchange and circulation of information and knowledge; 3) increase the awareness of citizens and, in this way, it allows participants to have a clear picture of what they are doing and what tools they can legitimately use to defend their interests and their positions; 4) allow a rational comparison of the different positions, the mutual influence and transformation of the preferences of the actors, so that the creation of new innovative, shared solutions is possible.

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FIGHTING POVERTY THROUGH FORMS OF COMMUNITY BASED TOURISM IN THE TERRITORIES OF CENTRAL KARAKORUM

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Keywords

community based tourism, Karakorum, heritage

ABSTRACT

The paper discusses the outcome of a recent project to develop tourism in the territories of Central Karakorum National Park (CKNP) in northern Pakistan called "PolimiforKarakorum" (Scientific responsible Eleonora Bersani, with Daniele Bocchiola, Barbara Bogoni, Massimiliano Nastri). The project was among the winners of Polisocial Award 2013-2014 and, as such, was funded by the Politecnico of Milan. For nearly a decade, with Ermes Invernizzi and Michele Locatelli I conduct research and planning for the protection and enhancement of the territories of CKNP and its surrounding villages; hence, we were involved in international cooperation projects (in particular, Karakorum Trust and SEED). We are focused on the dynamics through which it is possible to make heritage more known and accessible, in the awareness that tourism is a crucial resource either to preserve cultural resources and to allow a socio-economic development of the population living on the site.

1. INTRODUCTION

UNESCO has undertaken a number of actions within the initiative Eradication of Poverty, Especially Extreme Poverty, in order to foster the Development of Cultural and Ecotourism in the Mountainous Regions of Central and South Asia. "Sustainable tourism" has been found to be one of the most effective tools in activating the social-economical development of extremely poor populations (Pro Poor Tourism P.P.T.). One of the risks of development, when based on tourism, could be that of detriment to the environmental and cultural heritage thus causing a "consumption" of potential sources of income such as the territory, its products and its material culture.

PolimiforKarakorum is a tool to fight poverty with a specific application for the benefit of inhabitants of northern Pakistan villages, in agreement with UNESCO principles and following actions already put forward by stakeholders as Central Karakorum National Park (CKNP). Its originality mainly consists in strengthening the living conditions of an extremely poor population by inserting it within a project for territory enhancement and development of "community tourism". It's a project for social-economical development that allows the containing of social segregation, helps to reduce environmental and cultural decline, facilitates income's allocation and entrepreneurship's development within local communities. By combining the upgrading of poorer populations' living conditions and the valorization of the territory and its heritage, this project also proves its originality in using the "Politecnico" approach to the Community Based Tourism (C.B.T.) theme. As a matter of fact, this approach descends from the thought of C. Cattaneo that has been eventually shaped within our Milan School (C. Boito, A. Annoni, E. N. Rogers, …) and is based on the firm belief that a very strong bond exists among asset management, the places and the culture of the inhabitants.

Introducing forms of socio-economical development, connected with the C.B.T., could start off new projects involving local communities as protagonists in the conservation and enhancement of both their territories and their culture. Community members would not only benefit from the outcomes of the projects, they would also take an active role in the recognition process of their own identity and resources (Bottom-Up Approach).

2. BACKGROUND

The Pro Poor Tourism is considered, by those active in fighting extreme poverty and the dynamics of socio-economic development of local residents, one of the most effective instruments to improve the quality of life of people

most in need and to enhance the environmental, historical and cultural development of the territories involved. The PPT Initiatives, also promoted by UNESCO, are often financed by international organizations. UNESCO itself has taken a number of actions that led to the realization of numerous projects for the economic and social development through the tourist development in some regions of Himalayas (Ladakh, Himachal Pradesh and Sikkim), Iran (Masouleh), in Bhutan (Phobjikha Valley), in Kazakhstan (Northern Tien Shen), Kyrgyzstan (Lake Issyk Kul), Nepal (Humla), in the valleys of Chitral and the Kalash, in Tajikistan (East Pamir). The flow of international and domestic tourism in the territories of the Karakoram and training, currently underway, of the Management Plan of CKNP offers a chance to experience local forms of tourism development managed by local communities and to connect it to the network of actions already initiated by UNESCO to structure the ancient caravan routes silk roads. Pakistan is a poor country and its northern regions, with its arid mountain ranges and Karakorum glaciers, are among the most poor areas of the entire country. The general conditions of degradation of the villages (just think of the problems related to drinking water) are currently a major obstacle to the spread of sustainable tourism managed by local communities. On the other hand, for the high value of its environmental and cultural heritage that territory has significant potential in the application of the forms of Community Based Tourism.
The territories of the Karakoram tell a millenary history of exchanges and meetings, crossed by the silk roads, but also the site of passage of the ancient caravan routes that linked the Indian subcontinent to Central Asia. Karakorum has always been a meeting place of people and a melting pot of cultures, where the reception of the ‘’other” has long been considered as a value. The built heritage is the witness of the stratification of influences of different cultures and civilizations. In the villages of the mountain valleys adjacent to CKNP the living conditions are extreme and one survives thanks to a subsistence economy linked to the minute portions of arable land and few animals that live in symbiosis with men. At the same time, they have an environmental heritage and a cultural-historical one, which requires appropriate measures to protect and use, and are a popular destination for thousands of climbers willing to challenge the highest peaks in the world.

3. METHODS

The project PolimiforKarakorum aims to provide for local communities, to the National Park of Karakorum, to the Ministry of Tourism of Pakistan and to NGOs active on the spot, a concrete tool for the enhancement of local resources and to promote the socio-economic development of the population through its direct involvement in the management of all activities related to sustainable tourism “community”.
The project is divided into two parts: theoretical research and experimentation, closely related from the scientific point of view and interacting at different stages of the study, evaluation and application. Both the theoretical and the applied parts of PolimiforKarakorum must present a multidisciplinary nature and partnership at all levels (Associations, Villages Communities, Park Managing Authority, Governmental Authorities). This multidisciplinary approach in a C.B.T. project is an original aspect of the research: usually the scientific approach is favored, which quite often refers only to economical and social sciences.
Both parts require that methods and tools from each discipline can be ascribed to synthesis and intervention models, that are effective for the achievement of the aims of the project and of the objectives of each task; always keeping in mind that the Bottom-Up Approach principles contribute in varied ways in organizing the research’s different phases.
In the project, the participatory approach is considered a necessary tool to achieve a real and lasting socio-economical development: structural changes can only happen when the inhabitants of the involved villages take part in first person in all the project’s phases, although with different degrees of responsibility. In order to activate an effective interaction with the recipients of the project, it is planned that the experts involved in the working group will undertake the active parts of the project since they are already known in the Northern Areas having previously taken part in similar projects. At the same time, to ensure the effective application of the Bottom-Up dynamics, a number of actions concerning the Top Down processes are implemented through round tables with Local Authorities.
The traditional scientific approach prevails in the theoretical part; the results being systematized in an international publication. Engaging the beneficiaries, during the sharing and dissemination of the results, is both preparatory to the setting of the project’s operating conditions and an assessing tool for the research itself. In particular, in order to achieve the objective of contributing to the advancement of scientific research within the general framework of strategies for enhancing the environmental and cultural heritage, in which the CBT is a tool of social-economical development, a research was carried out on bibliography, cartography, iconography and on projects finalized according to P.P.T. models, in various geographical areas in the last decade, with a specific regard for examples of C.B.T.

Hereafter the research is aimed at finding possible applications of the C.B.T. in the Karakorum area, using the innovative approach as described on the introduction. An evaluation of opportunities, benefits and impact on the area is also carried on through: a) the touristic assessment analysis on the territory under the CKNP; b) the updating of collected data that have been processed during other projects on socio-economical development. More specifically: data collected by the Aga Khan Foundation during the AKHCP program and data already owned by the Politecnico working group active in Pakistan for the last ten years; c) the planning of programs and initiatives to fight extreme poverty so as to make sure that PolimiforKarakorum can be listed among the activities supported and financed by UNESCO or other associations.
In the experimental and practical parts it is required that all the actions are constantly undertaken following the Bottom-Up process, both when planning the Community Based Tourism project, providing a guideline manual, and when planning the feasibility project, roughly defined and applied on four building constructions on the Bagrot, Stak, Hispar and Braldo valleys, to serve as models in the dwelling improvement so as to achieve adequate hygienic levels.

4. CASE HISTORY

According to the data of "World Mortality – 2013 Report", the infant mortality rate in Italy is 3.3 children every 1000. In Pakistan the rate rises to 71 children every 1000. While in the Northern Regions of Pakistan it is 104 every 1000 (2011); 1 child every 3, under the age of 5, has been affected by diarrhea in the last month (Pakistan Millennium Development Goals Report 2013). There are 172.185 people living in villages situated on the Karakorum slopes, organized in 21.138 families (data taken from the 2012 CKNP Management Plan).
In these villages, crossed and photographed by the tourists – since considered quite picturesque – when visiting the Karakorum Park and its beautiful peaks (such as K2, Broad Peak, Gasherbrum), the infant mortality rate is dramatically higher. The main reason for such a high rate is to be found in the condition of extreme poverty and the very poor hygienic situation in which people live. Hence, the tourism development, in which UNESCO has identified one of the most effective tools in fighting against the extreme poverty of the people of the mountainous regions of Asia, finds a concrete limit in this extreme degradation of the villages and of its houses.
PolimiforKarakorum in pursuing a double direction - the upgrading of the life condition of local population and the increasing of the "community tourism" - would allow the interruption of a vicious circle and trigger a virtuous one where the improvement of the sanitary conditions and the social economic development of the population can grow with the valorization of the environmental and the historic and cultural resources.
Our project includes a plan for coordinating tourism promotion activities and interventions aimed at tackling social segregation, to reduce environmental and socio-cultural degradation, to facilitate the distribution of income and the development of entrepreneurship within the local communities. It aims to show how, through the introduction of forms of social and economic development linked to Community Based Tourism, will activate new models of tourist development involving, first, the local communities as protagonists in the project for the protection and enhancement of their territories and their culture not only being beneficiaries of development actions, but also being proactive in the process of recognition of their identity and their resources.

5. RESULTS

Starting from the potential of "sustainable tourism" as a specific tool for the activation of the dynamic of socio-economic development of populations in extreme poverty, we have identified a number of actions to promote the development of a "community tourism" within an overall project of enhancement of areas in northern Pakistan.
The main results of the project are, for the theoretical part, a critical catalog of models of tourist development of poor countries and on the forms of application of CBT, for the experimental part, a project of sustainable tourism development in the Karakorum through training guidelines, evaluation of the benefits and impact on the area and the project of four exemplary interventions at the building that will be a model of adaptation of housing to minimum housing standards (drinking water, sanitation, etc.). It is foreseen that the results obtained from the research are disseminated both in the territory, beneficiary of the project, through the active intervention of CKNP and the continuing involvement of the population, both in the international scientific community through publications and conferences. With more detail we describe actions, results (expected, in progress or on Achieved June 2015) and outcomes, phase by phase. The activities Concerning the theoretical phase are marked with the letter R, Those Concerning the experimental / applied phase with the letter S, even if they are closely related and interacting.

1. Activities : R1.a. Bibliographical research – cataloguing – critical reading; R1.b. Search for case studies with related references to multidisciplinary aspects; R1.c. Search for ongoing programmes and actions supporting and promoting poor countries' socio-economical development, based on the enhancement of the environmental and tourist resources, and directly involving the local communities; R1.d. Comparative reading of R1.a. + R1.b. + R1.c.; R1.e. Production of theoretical models also for the experimental phase; R1.f. Results systematisation for the international scientific publication. Expected/in progress/achieved results: Setting up of the multidisciplinary theoretical scientific apparatus. Output: Research report.

2. Activities: R2.a Definition of the social and economical system for the territory within the CKNP; R2.b Definition of the tourist and infrastructural system. Expected/in progress/achieved results : Definition of a comprehensive picture of the actual socio-economic, infrastructural and tourist system through the use of clear and comparable indicators. Output: Research report; Cartography index in GIS format.

3. Activities: S1.a Evaluation of the theoretical models as defined on R1.e; S1.b Definition of the intervention model; S1.c Social-economic and touristic valorisation project (C.B.T.); S1.d Guidelines definition. Expected / in progress /achieved results: Definition of the project at overall scale; Drawing up of guidelines for the development and strengthening of capacity building. Output: Research report; Project on social, economic and tourist valorisation; Guidelines; Cartography index in GIS format; Infographic.

4. Activities: S2.a Project and guidelines evaluation. Expected/in progress/achieved results: Sharing and approval of the project on tourist enhancement by the beneficiaries. Output: Research report; Project on social, economic and tourist valorisation (final version); Guidelines (final version).

5. Activities: S3.a Project on four targeted case study. Expected/in progress/achieved results: Community Guest House Project; Private House Upgrading Project; Temporary Tourist Accommodation (Camp Site) Project; Community Water Facilities for women Project. Output: Research report; Planning design documents and charts.

6. Activities: R3.a Results dissemination within the international scientific community. Expected/in progress/achieved results: Finding of interest from the international scientific community. Output: Publication; International Conferences/Exhibitions/Seminaries. R3.b Results dissemination among local authorities and commun ities. Expected / in progress /achieved results: Presentation of the project's results with at least two subjects operating in the CKNP territory and sharing of them with the CKNP directorate and local communities. Output: Fliers and promotional material. R3.c Results dissemination among promoters and sponsors for social economic development projects. Expected / in progress /achieved results: Finding of interest from sponsors of social economic development projects. Output: Selection of lines of credit to fund the projects .

6. CONCLUSIONS

The relevance of the proposed theme in the project is connected to the fact that the repercussions of the increased knowledge in the field of tools for the Eradication of Poverty, Especially Extreme Poverty, thanks to a sustainable type of tourism could vocationally involve a large number of countries lacking resources and suffering from endemic poverty. This repercussion isn't only of scientific type, it basically concerns the people, beneficiaries and actors, that could potentially be involved in the processes of Pro Poor tourism (P.P.T.). These processes are raising a growing interest both for the results so far achieved in applying this tool and for its effectiveness as it is constantly proven on the field. Concerning specifically PolimiforKarakorum, the impact of the project on the context is ambivalent. On one hand it is direct, since the implementation of the guidelines and of the artifacts' projects has an effective and immediate impact in the improvement of the habitat and of its attractiveness for tourists, leaving a positive sign on the social economic situation of people. On the other side the impact is induced since CKNP and local people are equipped with a useful tool to coordinate the actions of intervention on the territory, allowing them to increase the ability to attract sponsors and to effectively articulate its use.

Fig. 1 Hispar Village.

Fig. 2 Central Karakorum National Park Surroundings.

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EXPERIENCES OF DOCUMENTATION AND DIGITAL SURVEY OF SOME UNESCO WORLD HERITAGE SITES

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Keywords

UNESCO World Heritage, survey, digital survey

ABSTRACT

The scientific results completed in two decades of experiences even in several sites classified by the UNESCO World Heritage List, from the Joint Laboratory of Landscape Survey & Design and the Laboratory of Survey LRA of the Department of Architecture of the University of Florence, have allowed us to bring together the most advanced technologies in survey knowledge for the digital documentation of the architectural and archaeological heritage. Are presented in this work a brief methodological summary of numerous studies, conducted in Europe, Asia and America, which have found their fullest expression in a more large corpus of studies conducted with international cultural cooperation and collaboration, as well as government institutions, with important cultural administration, universities and technical offices of the Heritage governance.

1. INTRODUCTION

Infographic technologies and digital detection systems, as it tends to show the exposition, can be profitably used in various different studies on the cultural, architectural and environmental heritage. In particular we offer many applications that are related to the management aspects of the extensive digital documentation that accompanies the research taking place in a specific site.

Due to the development and dissemination of innovative IT solutions for cultural heritage, nowadays are also to be taken into consideration, their preservation and maintenance in an environment of digital management. These technologies are essential for the documentation of the life cycle of an opera of the Cultural Heritage these contributions are functional to ensure highly effective for the management and its maintenance, as well as its use conscious. We are moving towards the integration of knowledge and existing structures (for example information systems of public and private institutions for the conservation, research centres and museums) and the role that the sector of digital documentation must cover may become increasingly relevant. The theme of the knowledge of heritage is of primary importance in the legislative framework which frames the UNESCO-protected World Heritage Site; through the numerous experiments developed and the various scientific contributions presented was carried out an initial survey of methodologies for the documentation of sites of interest that, in the context that we propose for the research, as well as becoming a qualified point of reference for researchers could be a meeting place for dealing the themes related to the issues of conservation and eventual recovery or reuse, of many sites, in line with what is prescribed by the Management Plans for UNESCO. In the exhibition are illustrated through digital surveys, virtual models, videos and drawings, the following of the UNESCO World Heritage sites, concerned by studies and surveys conducted by our research laboratory.

2. METHODOLOGIES

During these years we have developed a research group that has involved several specific knowledge of professors and researchers of the University of Florence and Pavia who have been able to consolidate relations with Italian and foreign institutions, on the basis of specific cooperation cultural agreements concerned, and to build relationships with companies interested in the development of technologies and applications specific to the development of research. It is evident that the collection of the experiences of documentation shows the maturation, during more than the last decade, of specific tools and knowledge processing and different results, obtained in post production phase, in relation to the specific needs of the architectural and archaeological heritage UNESCO World Heritage Site. A strategy of promotion of cultural heritage must be up to date in the objectives, strategies and purposes chosen, for these reasons must be based on a strong and modern apparatus of knowledge of the assets studied. Regardless of the type of intervention chosen is clear that a careful analysis of the data acquisition plays a fundamental role for the next address of each decision and an organic strategy on a real project of knowledge is the necessary premise of the project for the preservation and enhancement. The appearance of the documentation becomes even more important when the policy of conservation concerns both the physical object that the immaterial memory of the historical, artistic and cultural artefact that maintains and forward in time.

Years of experience in defining political, scientific and technical protection of cultural heritage in Italy show that is now overcome the phase of single cataloguing and location of the assets to be protected and it seems increasingly necessary to activate systems for the protection of cultural heritage and artistic more integrated and technologically advanced.

RESULTS

The scientific results completed in two decades of experiences in numerous UNESCO World Heritage Sites, before as a researcher and then as founding member of the *Laboratori Congiunto "Landscape Survey & Design"*[1], founded in the Department of Architecture of the University of Florence and recently joined also by the Department of Civil Engineering and Architecture of the University of Pavia, allowed experience the most advanced technologies in the field of survey for digital documentation of the architectural and archaeological heritage. All this knowledge is now involved also in the Laboratory of Survey LRA of the Laboratories of the Department of Architecture of the University of Florence named DIDALABS[2]. Various studies conducted in nine countries (17 campaigns in protected heritage sites) in Europe, Asia and America[3], were carried out especially in the perspective of a cultural international cooperation and in collaboration with government authorities and local administrations, as well as with the state authority of each nation and with the coordination o and administrative offices involved in Architectural Heritage. Through the synthesis of these works and studies, a singular overview can be offered to the scholars of this field, experiences materially built during the research surveys in heritage sites with architectural remains of archaeological interest, that show influences, connections or cultural and compositional models, and that required in depth analysis and, above all, the research of specific tools and knowledge processes and the elaboration of results gathered in relation to the particular context. All pledged to match the traditional and still indispensable direct and 'sight' survey, to the most innovative and sophisticated technologies, to define the relevant procedures, to develop and optimize the appropriate methodologies and specific protocols. Starting from the metric and formal detection of the monument, as first data of consistency of the architectural asset, it is possible for the searchers to reconstruct the thread of its story through the layering of the interventions since founding until today. Further analysis must be related to one another and with the measured shapes, to enrich the knowledge of the architecture. A specific expertise has been configured, unique in the world, based on a wealth of specialist knowledge and skills of the highest level. It is one of the true excellences of the Italian university system and of the entire country, and it was born experimentally working in the field. In the present work we present a number of case studies related with UNESCO heritage protected sites, examples of works produced by highly qualified experts and technology transfer centres that operate through a net of relationships with business enterprises, the Italian and foreign governments and other institutions[3].

HERITAGE AND MANAGEMENT PLANS

The theme of the knowledge of Heritage is of primary importance within the legislative framework relating to the World Heritage Site protected by UNESCO[4]; through the various researches we undertook an initial census of the more proper methodologies for the documentation of the sites architecturally and historically of interest. In this context and for the development of the research, these methods can become a point of reference for scholars, and also be the purpose of the discussion with themes concerning conservation and possible restoration or re-use of many sites, in line with the requirements of UNESCO Management Plans. In order to highlight the importance of a proper management of the Heritage, in 2002, during its 26th session, the World Heritage Committee adopted the "Budapest Declaration".

All partners were exhorted to support the preservation of the World Heritage through some fundamental strategic objectives, trying to ensure a fair balance among conservation, sustainability and development. In this way the World Cultural Heritage can be protected through appropriate activities contributing to the socio-economic development and to the life quality in our communities; moreover through communication programs of actions and education, research, development and awareness strategies; finally, looking for an active involvement by local authorities, for the protection and management of the World Cultural Heritage.

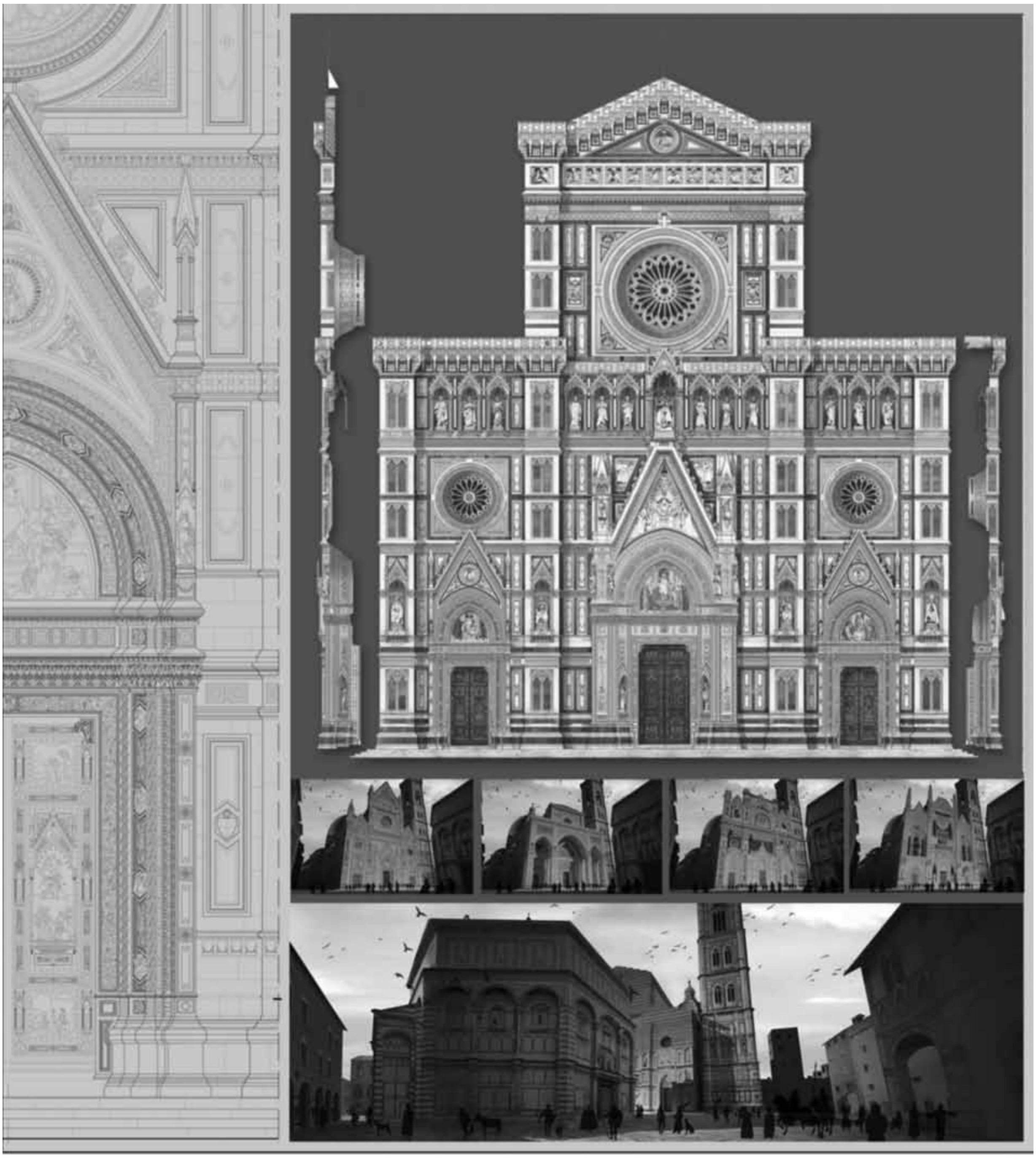

Fig. 1 The survey project for the documentation of the external facades of Santa Maria del Fiore Cathedral in collaboration with the Opera del Duomo in Florence. It allowed the digitization of the entire surface of the exterior stones. Through digital survey systems and digital photogrammetric work, it has possible to store the documented material through G.I.S. systems and to propose, through 3D modelling, a vast interactive scene.

Responsible: Stefano Bertocci, Sandro Parrinello

Participants: Stefano Bertocci, Francesca Picchio, Matteo Ragazzini, Mirco Cantelli, Marco Lastrucci, Sandro Parrinello

Each request for inclusion in the World Heritage List must therefore include a management plan, with a complete description of the way to protect the unique value of the site. The primary objective of the management plan is to ensure an effective protection of the heritage, and to ensure its preservation to future generations. For this reason, the Management Plan should consider the typological differences, the characteristics and peculiarities of the site and of the cultural and/or natural environment where the heritage is located[5].
It should also adopt the existing planning systems and/or other traditional methodologies of territorial organization and management. In the case of serial sites, and/or transnational sites, the Management Plan should ensure the coordination in the management of the single components of the site4. It is clear that the specific activities of our disciplinary field, survey but also drawing, are irreplaceable tools for descriptions analysis of formal, materials and structural features of a building and its context; the results of such activities are essential for the preliminary step of any project or program.
Nowadays, in a general context that considers the specificity and the skills of the surveying specialist useful for the conservation and restoration project, there is an increasingly great interest towards this profession in the field of archaeological researches, insomuch as to become an independent sector. Today the term "context" has cultural, chronological, but also spatial and environmental meanings: the architect, being an expert in describing events in terms of space and environment, can therefore be included with good reason among the scholars who, in the specific field of each archaeological research, have a key role like other professionals: experts in charge of the excavation and of recording the finds work together with archaeologists,
historians, architects, restorers and laboratory technicians.

CONCLUSIONS

Based on the experience carried out in this specific field, operational protocols could be prepared, considering the complexity of the problem to define clearly even at a methodological level, because of continuous innovation offered by digital devices. However it could be important to use a reference methodology at an interdisciplinary level, shared with other fields and approved by UNESCO. Recent developments of legislation for the protection create buffer zones to protect the sites, instead of the past concept to simply define the boundaries of the territories of Heritage List.
These buffer zones are intended to reduce negative environmental or human influences, widening these areas more than before and including natural or cultural territories of minor interest to create an setting of the World Heritage protected.
The importance of buffer zones consists of the necessary protective measures, which define a new concept of preservation for each site, depending on the peculiar aspects of every area. Referential quality standards, concerning both protected complexes and areas included in the lists of heritage, and buffer zones of these sites, are present in the management plans of the sites.
Developments and dissemination of innovative IT solutions for cultural heritage, its preservation and maintenance are used to document works of cultural heritage and ensure its management as well as its aware and proper use.
We are moving towards the integration of knowledge and existing structures (for example, the information systems of public and private preservation institutions, research centres, museums, etc.) and therefore the disciplinary field of Drawing can have a more and more relevant role.

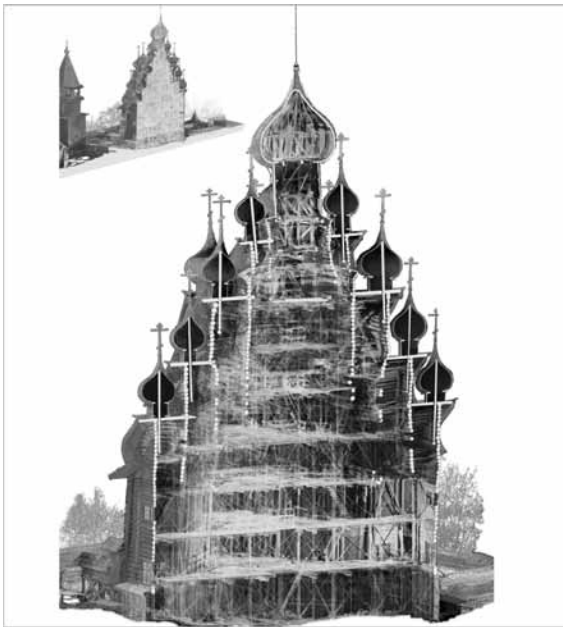

Fig. 2 The project concerns the Pogost complex, with a detailed and accurate analysis of the architectural and static structure of the Church of Trasfiguration for the study of conservative and restorative methodologies. The project focuses on general survey of the object through different methods: laser scanner survey, direct survey, general analysis, realization of a wide photographic campaign and detailed drawings analyzing from the general to the detail. The results consist in 2D and 3D drawings, digital databases, census archive and 3D reconstructions.
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Participants: Stefano Bertocci, Sara Porzilli, Andrea Pagano, Matteo Pasquini, Aurora Sorini, Sandro Parrinello.

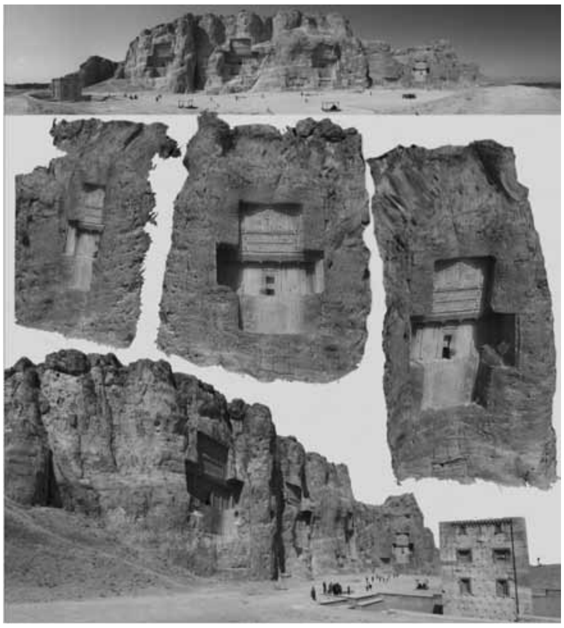

Fig. 3 The research mission in Iran, in the archeological site of Naqsh-e Rostam, provided for the survey of the four tombs of the Achaememid Kings Darius Xerxes I, Artaxerxes and Darius II, carved into the rock. The tombs, all at a considerable height from the ground and know as the "four Persian crosses", were photographed individually and for the entire extension with frontal and panoramic pictures of the plateau in order to obtain a highly reliable model, descriptive of the actual conservation of the site.
Responsible: Stefano Bertocci, Sandro Parrinello
Participants: Stefano Bertocci, Matteo Pasquini, Francesca Picchio, Saeed Aman, Sandro Parrinello

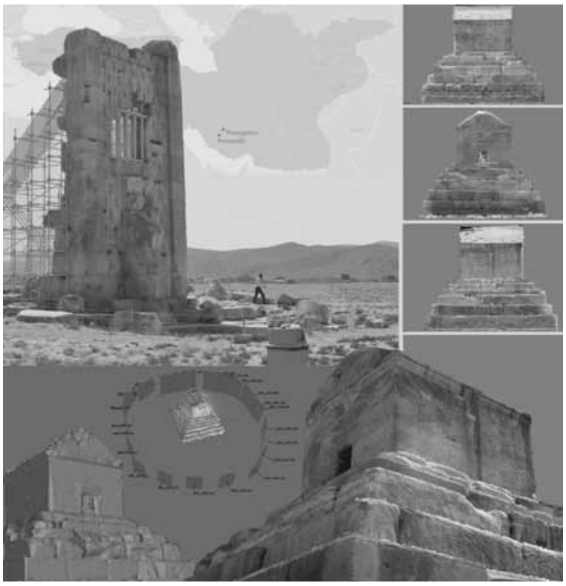

Fig. 4 The fast survey work carried out in the archeological site of Pasagradae aims to the realization of 3D models of the most famous monument of the site, the tomb of Cyrus the Great, using data and pictures acquired during the survey. The monument, with a large square placed on a platform, has been entirely photographed in order to give back the conformation of the stone elements and the actual status of those.
Responsible: Stefano Bertocci, Sandro Parrinello
Participants: Stefano Bertocci, Matteo Pasquini, Francesca Picchio, Saeed Aman, Sandro Parrinello

Fig. 5 The "Barocco Mineiro" expressed it's highest pictorial form in the vault of the church of St. Francis of Assis in Ouro Preto, considered as one of the "sete Maravilhas de Origem Portuguesa no Mundo".
The survey of the celling tested the accuracy of the latest technologies in metric data acquisition through three-dimensional photogrammetry. The 3D model has been necessary base to obtain some scientific considerations about translation of the rules of European Quadraturismo into Portuguese colonies in the late XVIII century.
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Participants: Stefano Bertocci, Silvio Van Riel, Fauzia Farneti, Graziella del Duca, Magno Morales Mello, Susanna Mora Alonso-Munoyerro.

NOTES

[1] The Joint Laboratory of the University of Florence Landscape Survey & Design was founded in 2009 for applications and the development of technology related to the drawing and survey of architecture, landscape and urban areas.

Components, University of Florence: Department of Architecture - DIDA

Department of Agricultural Food Production and the Environment - DiSPAA

Component, University of Pavia: Department of Civil Engineering and Architecture – DiCAr

External partners companies: Piacenti Srl - Restoration Center (PO), Digitarca snc., (BA).

The research group is constituted by professors

Stefano Bertocci (DIDA), Riziero Tiberi (DiSPAA), Sandro Parrinello (Dicar).

[2] Laboratory of Surveying LRA offers students services Surveying the urban scale and architectural; the laboratory is able to offer services on the design of the 3D laser scanner survey, data acquisition and recording of the vector database acquired.

The products supplied will configure as point clouds recorded. The Laboratory of survey is also proposed as teaching structure of

specialist level offering courses aimed at ‘learning methodologies through specific training courses: short courses, seminars, training courses and workshops, aimed at acquiring specific skills in the field of digital survey. Parterships: CyArk (USA); SINECO (ITA), Microgeo srl, (ITA). http://www.dida.unifi.it/vp- 206-laboratorio-di-rilievo-dell-architettura.html

[3] List of UNESCO sites surveyed in 9 countries (17 campaigns in protected sites). Italy: the historical centre of Florence (1982), Piazza del Duomo in Pisa (1987), Hadrian’s Villa in Tivoli (1998), Mantua (2008), Medici Villas and Gardens of Tuscany (2013). Israel: Masada (2001). Jordan: Petra (1985). Cuba: Castle of San Pedro de la Roca in Santiago (1997), Old Havana and its fortifications (1982). China: Great Wall of China. Panama, Portobello and San Lorenzo (1980). Russia: St. Petersburg’s historic centre and its monuments (1990), Pogost of Kizji (1990), Veliky Novgorod (1992), Kazan Kremlin (2000). United States and Puerto Rico: Fortaleza San Juan, Puerto Rico (2011). Iran: Pasargadae (2012).

[4] There are many rules in the field of international legislation preserving cultural and architectural Heritage. International treaty on 16/11/1972; Law n. 184, 6/04/1972; *Convenzione per la Salvaguardia dei Beni Culturali Immateriali*, approved on

17/10/2003; *Convenzione per la protezione e la promozione delle espressioni della Diversità culturale* approved on 20/10/2005. In Italian legislation: Decreto Legislativo n. 42, 22/01/2004 (in particular art. 133 and 143); Law n. 77, 20/02/2006, *Misure speciali di tutela e fruizione dei siti italiani di interesse culturale, paesaggistico e ambientale, inseriti nella lista del patrimonio mondiale, posti sotto la tutela dell’UNESCO.*

[5] A Management Plan for a Unesco Heritage List defines the rules to protect and enhance a protected site. The analysis considers: territorial and city plan legislation, social and touristic development, lists of heritage. The second part consists in the Management

Plan: cultural promotion, planning for preservation, legislation for management (restoration, landscape protection and enhancement).

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HERITAGE SITE MANAGEMENT CONSIDERING SANDETSKY ESTATE AS AN EXAMPLE

POSTER

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Keywords

heritage site management, architectural heritage, management plan, management strategies

ABSTRACT

Art Museum situated in Sandetsky estate in future should be included into touring routes. As a site it must be interactive, clear and understandable, must satisfy the latest scientific and technical requirements and must have recreational area. The Art museum must have an opportunity to enrich and renew exposition. The museum must become available for disabled people. The museum must host international scientific and practical events, round tables. That's why the article presents ways for reaching these goals through creation and implementation of management plan.

1. INTRODUCTION

Nowadays city heritage sites management is a topical issue. Under the influence of world integration great attention is paid to studying cultural features of regions. At the moment it is necessary to consider cultural heritage sites management mechanisms improvement regarding the possibilities of their commercial usage which provides their maintenance and development.

Under condition of globalization architectural heritage complex conservation principle in modern town planning demands to introduce state authorities' initiating, controlling and coordinating functions in partner relationship with local community, private sector and international community. The task of cultural heritage conservation should be solved not only by agencies responsible for monuments conservation but also those authorities which are responsible for town planning and architecture, economy and industrial development, ecology, transportation, providing public services and utilities, property complex, housing and communal services, etc

2. BACKGROUND

Architectural heritage sites nowadays have very important cultural and historical mission. They present not only one of the state cultural policy elements but an important factor of region's social and economical development. That's why the problem of architectural heritage site management lies in several fields and can be research subject for wide range of sciences. For example in the works of such economists as Asaul A.N., Vasileva L.S., Goremykin V.A., Grabovoi P.G., Gryaznova A.G., Ivanova N.V., Maksimov S.N., Mazur I.I., Kuschenko V.V., Lukmanova I.G., Olderogge N.G. and others some aspects of property management in big cities were considered.

Organizational and economical issues of cultural monuments conservation and usage, property management, providing resources for organizations dealing with culture, state expenses effectiveness and state property management improvement, creating and functioning of endowment funds are studied by Abankina T.A., Amunc D.M., Anuprienko V.J., Dymnikova A.I., Zagoskin D.V., Kudryavtseva T.P., Lagutin A.B., Lisitsky A.V., Malinina K.V., Sautin A.D., Starkov A.E. and others.

Historical property influence on urban environment conservation is considered in works of Slavina T.A., Sementsov S.V., Makhrovskaya A.V. and others.

The issues of real property items' conservation processes economics are revealed in works of Ripkem D., Malinina K.V., Kononenko T.V., Kuleshova M.E. However we should highlight that these works give general ideas on the topic and don't reflect special features of the region.

Sandetsky Estate in Kazan as a historical site in different times was described in works of Kazan historians Amirov K., Nikonova S.I., Salikhov R.R., Khairutdinov R.R., Idrisova R.R. and others. These works are usually used as guidebooks around Kazan where Sandetsky Estate is one of the historical and cultural heritage monuments. Besides a great number of photos the works contain serious historical information. Architectural and artistic heritage of Tatarstan Republic and Kazan are studied by such famous scientists as Khalitov N.H., Valeev аюРюб Aidarov S.S., Khudyakov M.G., Valeeva-Suleimanova G.F., Aidarova G.N., Nadyrova H.G., Nugmanova G.S., Aitov R.R., Bikchentaev A.G., Chervonnaya S.M., Dulsky P.M., Krasnobaev I.V., etc. In their works Sandetsky estate is considered as architectural monument in the ensemble of Kazan.

3. METHODS

It is necessary to point out that cultural heritage conservation without proper management of its further exploitation can not be the final objective. It is known that all existing protection documents and regulations of State-Parties of UNESCO Convention are based on its guidelines. The guidelines say that it is necessary to conduct the policy aimed to giving cultural heritage some particular functions in public life and introducing this heritage site into town planning programmes. [Agisheva S.T., Stepanchuk A.V., Cultural heritage management system in the context of rapid changes in urban environment//Izvestiya KGASU, 2014, № 4 (30)]. That's why besides programmes of cultural heritage conservation and integration into modern life of the city, one of the significant parts of town planning system becomes Strategic Heritage Management Plans development. These plans must clearly describe all actions on conservation and development of cultural heritage with Outstanding Universal Value (OUV), i.e. sites from UNESCO World Heritage List or sites from UNESCO Tentative List, which are nominated for joining the main list, also cultural heritage sites of federal, regional or local importance which have Heritage Significance. Cultural heritage management strategy should solve the tasks shown in pic.1.

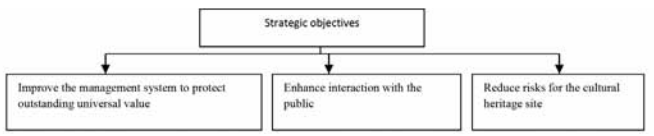

Fig. 1 Cultural heritage site management strategic objectives

While detecting and estimating architectural heritage significance it is necessary to consider criteria which are applied to heritage. Its cultural significance can be based upon tangible attributes including location, arrangement, decoration, structural systems and engineering equipment, aesthetic qualities, application, or/and intangible values such as historical, social, scientific, spiritual associations and creativity.

Any changes or interventions decisions taken must be based on proper research, documentation, and analysis of the monument. Architectural heritage site integrity mustn't be influenced by intervention alien to it. For this it is required to implement careful and thorough assessment of the extent to which the heritage site includes all components necessary for the expression of its significance, as well as to provide a complete identification of the features and processes that make up this value. It is necessary to avoid the negative impact of restructuring and/or neglect, including possible recovery.

It is important to develop a plan of regular preventive measures and provide ongoing care for cultural heritage site. There may also be a need in emergency accident-prevention. Constant and adequate maintenance, as well as periodic inspection is the best conservation practice for architectural heritage, and in the long-term perspective it reduces the cost of repairs. Cultural heritage plan of maintenance can help to solve this problem.

Any intervention should be designed. The scale and extent of changes should be kept to minimum. It is necessary to apply the proven methods of repair and avoid those that could harm the historical materials and cultural significance of the site. Restoration work must be carried out in ways less destructive to cultural heritage. The changes should be as reversible as possible. Over time it will be crucial for cultural heritage site to be energy efficient. However, the cultural significance of the heritage must not be affected by energy efficiency measures. Before exposing heritage site to interventions it is necessary to evaluate its cultural importance, to identify the components and understand their interrelationships. Impact of the changes planned on the heritage cultural significance must be examined thoroughly. It is required to analyze the vulnerability of all the components and qualities of the heritage in relation to changes and take into account the consequences of these changes. To preserve the cultural significance it is necessary to minimize any negative impacts and, where possible to avoid them at all. [Approaches to the conservation of the architectural heritage of the twentieth century. Madrid Document 2011 - http://www.docomomo.ru/en/node/1244]

4. CASE HISTORY

Sandetsky estate was built according to the project of famous architect Karl Mufke in 1906 for the commander of Kazan military district general Sandetsky A.G. in the historical part of the city where the nobility lived. The ensemble is one of the best examples of the beginning of XIX town estate which town-planning expressiveness has totally survived till nowadays. The mansion is the "witness" of hard events in the history of the country at the beginning of XX century. During the October revolution the building stood empty. But since 1924 the building housed T.B. clinic; first for children then for adults.

The building was situated at the outskirt of the city where the air was pure enough for people suffering from this disease. That's why the hospital was opened exactly here. Besides T.B. clinic in Sandetsky estate were placed such organizations as sanitary museum, central school outpatient clinic, malarial post, night sanatorium for 25 patients. So, hospital was situated in the mansion during 40 years, from 1924 till 1964. Then the building stood empty for three years and in 1967 by the 50th anniversary of Soviet government there was opened a museum.

Starting long ago Kazan used to be one of the oldest cultural centres of the country. Kazan State University, opened in 1804, played significant role in establishing and forming scientific and art traditions. In the university taught painters who got their professional education in St. Petersburg Academy of Art, Arzamas Art School and other educational institutions.

Based on the materials of university expeditions archaeological museum, ethnographical museum and museum of antiquities and fine arts were created. Later the department of theory and history of art was opened in the university. This department gave start in life to such outstanding researchers as Likhachev N.P., Ainalov D.V., Malmberg V.K., whose scientific activity won European recognition.

In 1895 on the initiative of the local community and with the support of Academy of Arts Kazan Art School was opened. It became real centre of city's cultural and art life. The school organized annual exhibitions where Mobile art exhibition partnership, Emperor's Academy of Arts, A.I. Kuinji association participated and works of famous Russian artists were presented. Consequently the first public museum with art department was opened in Kazan. Its history goes back to 1895 when Kazan scientist-archaeologist A.F. Likhachev's(1832-1890) collection of pictures, drawings and gravures after his death was given to the city as gift by his brother.

A new stage of museum's acquisition started after revolution of 1917. In 1919 Kazan city scientific and industrial museum was reorganized into Kazan province museum which included such departments as art department, historical and archaeological department and ethnographical department. Museum's collection included pieces of art taken from socialized estates and mansions, closed and ravaged churches and monasteries, given by state museum fund, Kazan University and private owners, bought from private collectors. The museum, also got rich collection of pictures which belonged to O.S. Alexandrova-Geins, who was the heiress of Kazan tea-trader.

Between 1910-1920 the museum bought the collection of graphic and pained works by "World of Art" society exponents Benua A.N., Bilibin I. J., Gaush A.F., Kustodiev B.M., Mitrohin D.I. and others from Kazan painter, publisher and collector Mantel A.F. In 1920 the museum celebrated its twenties anniversary and got the status of the Central museum of Tatar republic. To celebrate the jubilee State museum fond gave to Kazan a big collection of works of end XIX – beginning XX painters. The collection of museum's art fond was increasing. The organizers of the museum's rebuilding and renovation were such famous Kazan museum figures as painter and art historian Dulsky P.M.(1879-1956) and his colleagues Kornilov P.E.(1896-1981), Egerev V.V. (1886-1956), Radimov P.A.(1887-1967). By their efforts art department was transferred into art gallery of the museum.

In 1967 the museum moved to marvellous mansion in the centre of the city – Sandetsky estate.

5. RESULTS

After deep investigation (surveys, seminars, conferences) of social and economical processes in the republic of Tatarstan the authors found out the necessity not only to maintain the cultural heritage site but also to develop museum's activity. The development includes popularization and protection of historical-cultural heritage items, cultural tourism and museum affairs; sponsors and philanthropists attraction to museum's exposition enrichment, small enterprise development which leads to promotion of products connected with the name of the museum.

The strategy on enhancement of interaction with the public is shown in table 1.представлена в таблице 1.

Strategy	Action	Result	Source of verification	Actors	Time frame
Strategic objective 2. To enhance interaction with the public					
Action 2.1	To cooperate with non-state organizations, local authorities and mass media	historical and cultural heritage items protection, popularization of cultural heritage, development of cultural tourism	The increased number of tourists and excursion groups	Ministry of Culture, management team of the Art Museum	Regularly
Action 2.2	To cooperate with travel agencies for including the site into touring routes	Creation of excursion programmes	The increased number of tourists and excursion groups	management team of the Art Museum, transportation team	Annually
Action 2.3	Increasing visitors' awareness about different activities devoted to some particular events and dates in the history of the country and the region.	Strengthening the authority of Jazz festival, developing new programmes responding to the interests of all visitors categories	The increased number of local population, tourists and excursion groups	management team of the Art Museum, mass media, volunteers in social networks.	Regularly
Action 2.4	Museum popularization in schools	Creating favourable conditions for younger generation involvement into cultural values	Increased number of pupils visiting the museum	management team of the Art Museum school administration	Regularly
Action 2.5	Introducing BAR CODE, audio guide, digital information boards	Purchase and installation of the equipments, Wi-Fi connection in the museum halls	Reports and photos	History museum management team	1 year

Table 1.

“Sandetsky Estate”architectural heritage site management action plan

Management system in terms of greater interaction with contact audiences is a new and versatile tool for solving problems of the protection, conservation and utilization of cultural heritage by creating a dialogue between local territorial authorities and museum administration. The development of the management plan and its implementation will enable to set a positive trend in the impact of the cultural heritage to the social and economical development in the region; for example: planning of territorial development, formation of investment attractiveness, the creation of effective incentives innovative types of economic agents behaviour.

7. CONCLUSION

“Sandetstky Estate”is a valuable and outstanding cultural heritage site of the Republic of Tatarstan which has survived almost in initial condition. Protection and popularization of the site is an important task of the state and human rights organizations.

The authors in the article tried to consider all special features of the site and give recommendations for its improvement.

Under conditions of market economy historical monument can fulfil not only educational (cultural) functions, but also has opportunity to earn money for site maintenance in proper condition. For it to look beautiful and be attractive for visitors.

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CULTURAL HERITAGE AND CREATIVE INDUSTRIES: A COMPARATIVE EVALUATION IN CAMPANIA REGION (IT)

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Keywords

cultural heritage, creative industry, local development, evaluation

ABSTRACT

In order of magnitude, the ancient Roman Amphitheater in Santa Maria Capua Vetere (Provence of Caserta in the Campania Region) is the second among this kind of monuments in Italy, following the Coliseum in Rome. However, upon analyzing its use value emerges a disconcerting data: in 2014 records 51.967 visitors, of which 29.857 non payng, while the Colosseum records further 6 million more. Similarly, the Bourbon Royal Palace in Caserta, the biggest royal residence in the world and one of the five Unesco sites in Campania Region, in 2014 records just over 400 thousands visitors, while in France, the Palace of Versailles in 2013 has recorded more than 7 million of visitors. This is one of the many paradoxes which characterizes our exceptional Heritage that, in the persistent absence of effective activities of enhancement – aimed at promoting knowledge and at ensuring the best conditions for the utilization and public enjoyment of the same heritage - still nowadays, is not able to become a "lever" for economic and social development of territories. It is known that to the cultural sector is strictly connected the creative sector and, according with several studies and reports, the Cultural and Creative Industries (CCI) represent now days "the most advanced frontier of the contemporary economic development", constituting one of the most dynamic sector in Europe. In the Italian context, what is the performance of Campania Region? In which way its Cultural Heritage, there understood as the whole of historical heritage and the activities linked to the "material culture" (Industrial Design and Crafts, Fashion, Taste Industry, etc.) can contribute to the local development? Following the methodological approach adopted by Italian Ministry of Cultural Heritage (White Paper on Creativity, 2007) the article presents a first comparative evaluation on the CCI in Campania Region, with the aim to identify the specificity of the different territories (in terms of cultural goods, enterprises, creative capital, etc.).

1. INTRODUCTION

Intending heritage in economic terms – as an asset that can produce richness – it is possible to understand Cultural Heritage as the set of assets which for particular historic, cultural and aesthetic relevance are of public interest and constitute the richness of a territory and its community. As several studies and reports in the field of Cultural Economics have highlighted, the traditional approach that considered this heritage as "immutable" (not renewable and not replaceable because inherited from the past), has been overcome by an approach that recognizes its vitality, or productivity. It is infact already widely shared that the Cultural Heritage is an important "lever for the social and economic development" of the territories, able to produce new goods and services (Greffe, 1998). Cultural Heritage contributes to the identity and branding of territory, and its <<management, including city monument conservation activities, cannot be adequately addressed as an isolated activity that is disjointed from broader urban or regional development policy, programs and projects>> (Nijkamp, 2012). Now days infact one of the resources mainly utilized for promote territorial transformations are cultural resources together with creativeness: both constitute a key element for the development of cities and, in the global competitive scenario, are becoming the drivers for the territorial development (Forte, Fusco Girard, Nijkamp, 2005). As in many studies and reports, the Cultural and Creative Industries (CCI) represent now days "the most advanced frontier of the contemporary economic development" (Fondazione IULM, 2011), constituting one of the most dynamic sector in Europe, with a positive trend in terms of growing and employment, despite the negative economic conjuncture. In the UE the

creative and cultural industries account for 4.2% of the GDP of the Union, nearly 7 million jobs, primarily in small businesses (Schultz, 2014).
According with Union Camere and Fondazione Symbola (2012) the Italian system of CCI values the 5,4% of the GDP, amounting approximately 460,000 enterprises which employ 5,7% of the county's total workforce.
In this context, what is the performance of Campania Region? In which way its Cultural Heritage, there understood as the whole of historical heritage and the activities linked to the "material culture" (Industrial Design and Crafts, Fashion, Taste Industry, etc.) can contribute to the local development?
The paper presents a comparative evaluation on the CCI in Campania Region; it is organized as follows: section 1 offers a concise introduction; section 2 will address an overview on CCI and their role in the Italian context; then, Section 3 describes the approach used in the evaluation, showing in the Section 4 the Case History; the results are presented in Section 4 together with some considerations. The paper ends with some concluding remarks.

2. BACKGROUND

In less than a decade the promotion of the CCI is sustained by many EU policies, projects and documents; in this institutional context several countries have developed reports on the CCI and their impacts on the local economy, giving different interpretation on the definition of the perimeter of the economic sectors. Specifically in Italy the White Paper on Creativity (Santagata, 2007), in outlining the basic profile of an "Italian model" of creativity and cultural production, has adopted an approach that identify three spheres in which creativity is involved in economic processes characterised by the production of culture. Firstly, the sphere of historical-architectural heritage, intended as the product of the creativity of generations, past and future - Cultural Heritage, Music and Entertainment, Architecture, Contemporary Art-; then, the sphere of the production and communication of the contents of cultural industries that provide goods and services with a high symbolic content - Software, Publishing, TV and Radio, Advertising, Cinema-; finally, the sphere of the material culture, expression of the territory and the community - Fashion, Industrial Design and Craft, Taste Industry -. It is essential to underline that Italy is the only country in which the sector of Taste Industry is so relevant from an economic and cultural point of view that it has been inserted among the CCI. The White Paper offers a preliminary assessment of the economic value of the Italian cultural industries, in particular in terms of the value added and jobs. More updated overview is developed in the report of Union Camere and Fondazione Symbola (2014), where the productive cultural system (Historical-Artistic Heritage, Performing Visual Arts, Cultural Industry and Creative Industry) is considered in its three components: enterprises, public institutions and no – profit sector. On territorial scale, the Northwest (29,2%), thanks to the Lombardy Region and the South (27 %), thanks to Campania Region, represent the areas with the highest consistency of the cultural-creative productive system. In particular the Campania Region has a lot of potentialities, though still underestimated (also in terms of studies and researches). In this perspective, the analysis proposed in the paper represents a further step (Forte, 2011; Forte, Rupe, 2015) of a research that aims to identify the specificity of the different territories of Campania Region in terms of social and economic development.

3. METHODS

For the analysis it has been chosen the methodological approach adopted by Walter Santagata in the White Paper on Creativity, with some integration. Among the 12 economic sectors characterised by creativity and the production of culture, the comparative evaluation has been carry out towards the sectors which were considered to be particularly strategic in the context of the cultural-creative productive system in Campania Region: the Cultural Heritage and the Creative Industries (Fashion, Industrial Design and Craft, Taste Industry). In the sector of Cultural Heritage all the activities have been assessed, conducted in entrepreneurial form, connected with the conservation, the enjoyment and the enhancement of cultural heritage (libraries and archives, museums and monuments, gardens, natural parks) and the receptive activities (hotels and hostels in the historical and artistic sites). Regarding the identification of the specific economic activities which compose each sector, it is important to underline that the new Ateco classification (2007) to adopt in the statistical analysis (instead of the 2002 Ateco classification, adopted in the Santagata report) represents the national version of the classification defined at European level aimed to pursuit a unique classification. The category of activities for each sector has been disaggregated in function of the different phases in the generation of the value: conception (invention or conception of products and their protection in terms of intellectual property), production (translates the creative content or a cultural good/activity into commercial goods and services) and marketing (a network for the distribution of products and services). The

Fashion Industry	Avellino		Benevento		Caserta		Napoli		Salerno	
	2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
Conception	20	18	16	21	33	38	174	202	65	78
Textiles	16	18	13	13	61	59	193	189	56	46
Clothing	304	257	165	167	406	423	2.596	2569	687	648
Leather footwear	725	718	42	41	470	512	2.225	2124	196	178
Total	**1.065**	**1.011**	**236**	**242**	**970**	**1.032**	**5.188**	**5.084**	**1.004**	**950**

Table 1: Fashion Industry, n. of enterprises (2010-2014)

Industrial Design and Craft	Avellino		Benevento		Caserta		Napoli		Salerno	
	2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
Conception	20	18	16	21	33	38	174	202	65	78
Production	170	656	287	506	769	1150	3142	3868	1080	1847
Total	**190**	**674**	**303**	**527**	**802**	**1188**	**3316**	**4070**	**1145**	**1925**

Table 2: Industrial Design and Craft, n. of enterprises (2010-2014).

Taste Industry	Avellino		Benevento		Caserta		Napoli		Salerno	
	2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
Conception and Production	805	783	2.594	2.334	161	178	321	304	491	407
	39	32	10	11	8	12	56	55	34	36
	65	73	26	30	295	316	404	392	270	256
	45	45	20	21	18	23	94	90	30	30
Input and auxiliary production	64	67	118	109	116	117	484	525	428	648
	1.030	1.129	758	822	2.216	2.508	7.891	8.557	3.512	3.976
Total	**2048**	**2.129**	**3.526**	**3.327**	**2.814**	**3.154**	**9.250**	**9.923**	**4.765**	**5.353**

Table 3: Taste Industry, n. of enterprises (2010-2014).

comparative evaluation presented in the paper in a synthetic form, only referring to the first two phases, regards the number of business in the five provinces of the Campania Region. The data has been processed on the base of the official data of the Statistical Office of the Chamber of Commerce of Napoli.

4. CASE HISTORY

Campania Region, in Southern Italy, is one of most populated regions, with 5.7 of inhabitants; after Lombardy and Tuscany, it is also the Italian region with the largest number of sites recognized by UNESCO. The region, comprising the provinces of Avellino, Benevento, Caserta, Napoli, and Salerno, is characterized not only by its extraordinary cultural heritage but also for a well structured cultural-creative productive system. The tables 1-2-3 and 4 below show a summary of the data on the number of businesses in the five provinces of Campania and in reference to the two identified sectors: Cultural Heritage and Creative Industries (Fashion, Industrial Design and Craft, Taste Industry).

Cultural Heritage	Avellino		Benevento		Caserta		Napoli		Salerno	
	2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
Conception and production	4	3	3	2	3		7	6	9	8
		2	1	1	2	3	17	12	11	10
	2	2	1	3	3	3	7	8	12	8
Input and auxiliary production	88	93	47	48	127	143	1.529	1.504	531	548
	64	67	118	109	116	117	484	525	428	648
Total	**158**	**167**	**170**	**163**	**251**	**266**	**2.044**	**2.055**	**991**	**1.222**

Table 4: Cultural Heritage, n. of enterprises (2010-2014)

5. RESULTS

The number of enterprises which characterize the cultural-creative productive system in Campania Region achieved, in 2014, the share of 44.462, corresponding to the 7.9 % of the total of the entrepreneurial regional system (564.958). The number of enterprises, in the analyzed period (2010-2014) show a growth rate almost always positive, despite the recession.

With reference to Fashion Industry, Table 1 shows data on the number of enterprises; particularly in the province of Naples, where the sector accounts for 20% of the total manufacturing, the sector of the manufacturing of outerwear, tailoring and made-to-measure (Ateco 14:13) is the most consistent with 1,867 companies that account for 73% on the entire fashion sector. The data confirm the wealth of a business sector, particularly tailoring. This is a healthy production system, in particular thanks to artisanal and branded tailoring (such as the Kiton brand among others), along with ready-to-wear fashion. This consistency emerges also in the Caserta Province characterized by the presence of important industrial districts, specialized in the textile, clothing and footwear sector.

Regarding the Industrial Design and Craft, besides the province of Naples where, among the others, the sector of the production of chairs, sofas and furniture for interior design is particularly consistent, also the province of Caserta emerges for the production of jewelry (there is infact localized the important goldsmith district of Tari). The province of Salerno instead presents a relevant number of enterprises active into the sector of ceramic manufacturing, coherently with a secular tradition.

The Taste Industry is recently recognized as a cultural area, in which converge identity, tradition, territory, history and landscape, along with creativity, research and technological innovation. A growing sector, characterized more than others by a strong integration with local communities and cultures, strongly linked to the territory and its history. Table 3 shows how it is mainly the activity of service to production (farmhouses and restaurants) that have the most important role, confirming that food and wine tourism, quantitatively a niche market compared to traditional segments but declining, such as the sea, has significant growth potential.

In all the five provinces from 2010 to 2014 has been recorded an increment of the number of enterprises. It should also be pointed out that, since 2000, Coldiretti has drawn up a culinary map of the territory by assigning taste flags to those food products obtained according to ancient traditions handed down throughout the territory for at least 25 years. In 2014, a significant 4,813 taste flags were awarded, with Tuscany in first place (463), followed by Campania (429) and Lazio (386), followed by Veneto (371), Emilia-Romagna with 356 products in front of Piemonte with 341 specialties and Liguria with 295 products.

A deeper consideration deserves to be developed for the sector of Cultural Heritage; among the numerous values that have already been attributed to cultural heritage - ‘social surplus value’(Forte C., 1977) vs ‘complex social value’(Fusco Girard, 1997) - there is no doubt that the “use value” is the most easily assessable, especially in reference to the extraordinary synergy that has long been triggered between tourism and culture with cultural tourism having now become a major resources for the economic development of many destinations worldwide (OECD, 2009). Campania is the region, among those of the south, that attracts the highest number of visitors, with it being due to the richness of its cultural heritage. According to the data of MiBACT (Statistical Office), in 2014 it is second in terms of total number of visitors (6.595 after Lazio with 18.515 visitors); among the top 30 most visited sites in the country, with reference to the same year, the archeological site of Pompei continues to remain at second place, with 2.621.803 visitors after the Colosseum in Rome (with 6.181.702 visitors). In the same ranking, there are three more UNESCO sites of the Campania Region.

Despite the positive trend for cultural tourism in Campania, analyzing in detail the most recent statistical data, there are a number of paradoxes that characterize the unique heritage of this region. For example, in order of magnitude, the ancient Roman Amphitheater in Santa Maria Capua Vetere (Provence of Caserta in Campania Region)

is second among this kind of monuments in Italy, following the Coliseum in Rome. But, if we analyze its use value emerges a disconcerting data: in 2014 records 51.967 visitors, of which 29.857 no payers, while the Colosseum records further 6 millions.
Similarly, the Bourbon Royal Palace in Caserta, the biggest royal residence in the world and one of the five Unesco site in Campania Region, in 2014 records just over 400 thousands visitors, while in France, the Palace of Versailles in 2013 has recorded more than 7 millions of visitors. With specific reference to the sector of "additional services" (outsourcing to third parties the management of services, audio guides, gadgets, coffee shops, advance booking, catering, etc.) that, potentially, is a sector with a high earning capacity (Forte, Formisano, 2015) there are several inefficiencies and, until now, their potentiality has remained misunderstood. Only considering the case of the archeological site of Pompei, the "conversion rate" (the number of visitors who made a purchase, expressed as a percentage of the total number of visitors) is very low (1,71%) while the national average is approximately 7 %; in any case, a performance far from that of other international institutions, as the "Supertstar Museums" (16 % at the Louvre or 31 % at the British Museum). Regarding the receipts for visitors (the ratio between the receipts from merchandising and the total number of visitors), the performance of the Pompeii site is very modest (0,17 cents), as the receipts for visitors deriving from all additional services (0,98 cents).

6. CONCLUSIONS

Independently from the emerged critical issues, the article aims at outlining the extraordinary potentialities of development which the Campania Region Cultural Heritage could offer, especially in a perspective of a new productive model where entrepreneurs and institutions are able, synergistically, to enhance the context where they operate. A context composed by "unique and not replicable goods whose value must be transferred on the value of replicable goods" (Granelli, Scanu, 2009). The above analysis represent only a step of an in itinere research program aimed at exploring the culture and creative economy in Campania Region through a deeper evaluation of the performances of the several economic activities in order to identify the specificity of the different territories in terms of social and economic development. Not only that more attractive, because characterized by cultural sites officially recognized by institutions and visitors, but also that minor, characterized by specificity and uniqueness (in terms of cultural goods, enterprises, creative capital, etc.). The particular attention to the sector of Cultural Heritage, Fashion, Industrial Design and Craft and Taste Industry is reflected not only in the field of economics and development policies at European Union level, but also in the field of academic formation and research, as demonstrate the formative supply of the Department of Architecture and Industrial Design "Luigi Vanvitelli", with its several degree courses in architecture, fashion, industrial design.

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JOURNEY IN ETHIOPIA: THE CHURCH OF BETA GIYORGIS IN LALIBELA

POSTER

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Keywords

rupestrian, Lalibela, digital photogrammetry

ABSTRACT

In the past scholars and artists were used a long journey to discover the most important artistic and architectonic richness of Europe, especially in Italy.
The shared aim of those journey, was the deepen their knowledge of ancient artifacts, but also to show their finding and studies to the collegues.
The only instrument to show the results of their direct field experiences , were the sketch books and the drawings made by the travelers during the several steps of their journey.
The collection of that documentation required relatively long time, and represents the first explanatory approach of the artifact. From the XIX century, they were organized survey campaigns which involved many peoples who took measures of the artifact, to obtain an accurate representation of them.
We should compare the representation of the church of Beta Giyorgis and the experiences of the travelers of the past whit the possibilities offered by commons instruments and photographic techniques of contemporary time.

1. INTRODUCTION

Travel has always been considered an opportunity to grow and learn, it permit a direct experience on studied monuments and the discovery of unknown places. Undertaking a trip to study a monument allows to acquire a deep knowledge of the studied object, it offers the possibility to observe all their parts and touch it, but also permits to situate it in the proper environment and socio-cultural context. Those relevant information are often hard to describe and understand through a book page. Travel could also be the occasion to find and produce documents that describe in detail an architecture or landscape, to facilitate the comprehension, study and dissemination. Direct experiences on the monuments attract scholars and artists from everywhere. The destination of those travels were often places rich in history and art, in Europe and especially in Italy , but sometimes they were remote and inaccessible places. This has been our approach to the travel to Ethiopia, up to Lalibela. Since a few years we are focusing our researches on rupestrian architectures, for this reason we decided to move to the small ethiopian city that hosts one of the most interesting and fascinating rupestrian site of the world. The aim of the experience was also that of comparing the materials collected in past travels with the contemporary possibilities offered by technologies for documentation of landscapes, places or buildings.

2. PAST JOURNEY TO LALIBELA (ETHIOPIA)

Lalibela is a small Ethiopian city located at an altitude of 2500mt, on the Asheten Highlands in Amhara region. This city, named Roha in the past, has a very long history and not entirely clear and shared. The settlement rises around an articulated complex composed by eleven churches probably dug in the rock between VIII and XIII centuries. It is believed that the first churches were carved to promote the city as capital after the progressive decay of the Aksumite Empire. Most of the churches are connected with the name of King Lalibela who reigned till the end of XII century and who gave the name to the city. During the reign of King Lalibela was also designed the particular organization of the rupestrian site, it is divided by a canal named Yordanos, taking inspiration from Jerusalem, which, during those years, has been invaded by Salah-ad-Din. Tanks to the presence of the churches,Lalibela became, from ancient time, place of pilgrimage for the followers of Ethiopian Orthodox Church who consider this place a second jerusalem. The complicated history of this city and the place name changes have made difficult to understand the period of the discovery of the churches by Europeans people. One of the first record of Lalibela is probably the map of Fra Mauro da Venezia around 1457-9, who presumably had represented this place basing on the tales of Ethiopian monk who reached Europe. First record of an europen visitor in Lalibela is that of Francisco Alvares, who visited twice beween 1522 and 1525. Alvares published a text containing a description of the city, without illustrations, in Lisbon in 1540. Ten years later Giovan Battista Ramusio referred to Lalibela in his three-volume collection, Delle navigationi et viaggi, which also contains the plans of five churches. Thereafter, no overseas visitors is know to have gone to the Ethiopian city for three hundred years. In 1843 Antoine d Abbadie published mentions of his visit in Lalibela omitting any detailed account of the churches. The city is correctly marked on the map accompanying Douze ans de sojour dans la Haute-Ethiopie, 1868, a publication by his brother Arnauld. In the evnt, further descriptive publication had to await the visit of Gerhard Rohlfs in 1868. Rohlfs was a German geographer, explorer and adventurer. had accompanied, by order of the King of Prussia, the British military expedition to Magdala, his illustration of the Lalibela churches seem to have been engraved on the basis of inadequate sketches or description, they cannot be assumed to give a clear picture of the monuments' appearance at that time. (Phillipson, D. W. 2009) Achille Raffray, the French Vice-Consul at Massawa, went to Lalibela il 1881 with Gabriel Simon and Leon Herbin. They took measurements of the churches while Raffray sketch them, aAnd after his experience to Ethiopia he has published "Les Églises monolithes de Lalibéla, Abyssinie" ,1882. (fig.1 a-b) (Raffray, A., 1882) In 1938 Lino Bianchi Barriviera goes to Ethiopia for study reasons and, in 1939, invited by the Duke of Aosta, he participates, as a drawing artist, in an mission for the study and survey of the archaeological sites of Lalibela. From this expedition he brings back many drawings and, from these, with a commitment lasting for ten years, he creates a portfolio of etchings of the monolithic churches in Llibela. (fig. 1)c-d)

3. JOURNEY TO LALIBELA. THE CHURCH OF BETA GIYORGIS

The travel, departing from Addis Ababa has led us to the northern Ethiopian Highlands, it is occurred in april 2014. Many stops were done during the long itinerary, among the most remarkable: the visits to the ruins of Gondar' s fortress, to the Aksum obelisks in the Tigray region, above all the Wukro area, where hundreds churches were dug. The most fascinating and imbued whit history city in Ethiopia, is certainly Lalibela with its rupestrian site. Among the eleven churches that compose the complex, the most famous and representative is Beta Giyorgis. It is considered that this church was the last one dug and it is carved in a separated area from the other churches. An evident characteristic of Beta Giyorgis is, the squared off court, about 11 metres depth, from which has been made. The roof is therefore at the ground level, following the plateau outline, so the church it is not entirely visible from afar. The church reveals itself in all its splendour going near to the court or observing it from the surrounding little hills. From above, the Greek-cross plan of the church is immediately readable, also highlighted by the concentric crosses carved on the roof. The main body of the church is placed on a base and it is divided in four horizontal strips by a basic cornice running all around the perimeter of the building. In the first strips, on the west side, has been carved three entrances, typical of the sacred Ethiopian buildings. Main entrance, is situated in central position and the access is reserved to priests end deacons during the religious ceremonies. It is flanked by two other doors, respectively for male and female believers. On the others external surfaces of the church were carved blind windows decorated by aksumite frames. Upper strip is simple, unadorned, as opposed to the third strip which is richly decorated by aksumite cornice around the ogeeval windows. The last strip is concluded by a small projecting cornice. The access to the sacred spaces is reached by seven precipitous steps. The plan of the inner spaces follows the external shape and some round arch divided the arms of the cross in four parts. The entrance to the eastern arm of the church is shielded by a curtain passable only by the priests. Also the walls of the court have been dug to obtain additional rooms for the pilgrims accommodations.

4. INSTRUMENTS AND METHOD FOR THE REPRESENTATION OF THE CHURCH

The trip to reach the northern highlands , was characterized by long, and often uncomfortable, transfers by public transport. The buses always crowded, the great difference in height and numerous itinerary on foot, influenced the available dimension and weight of the baggage, reducing it to the minimum required. The used instruments for the representation of these architecture was limited, we can define it "a tourist equipment", it is composed by

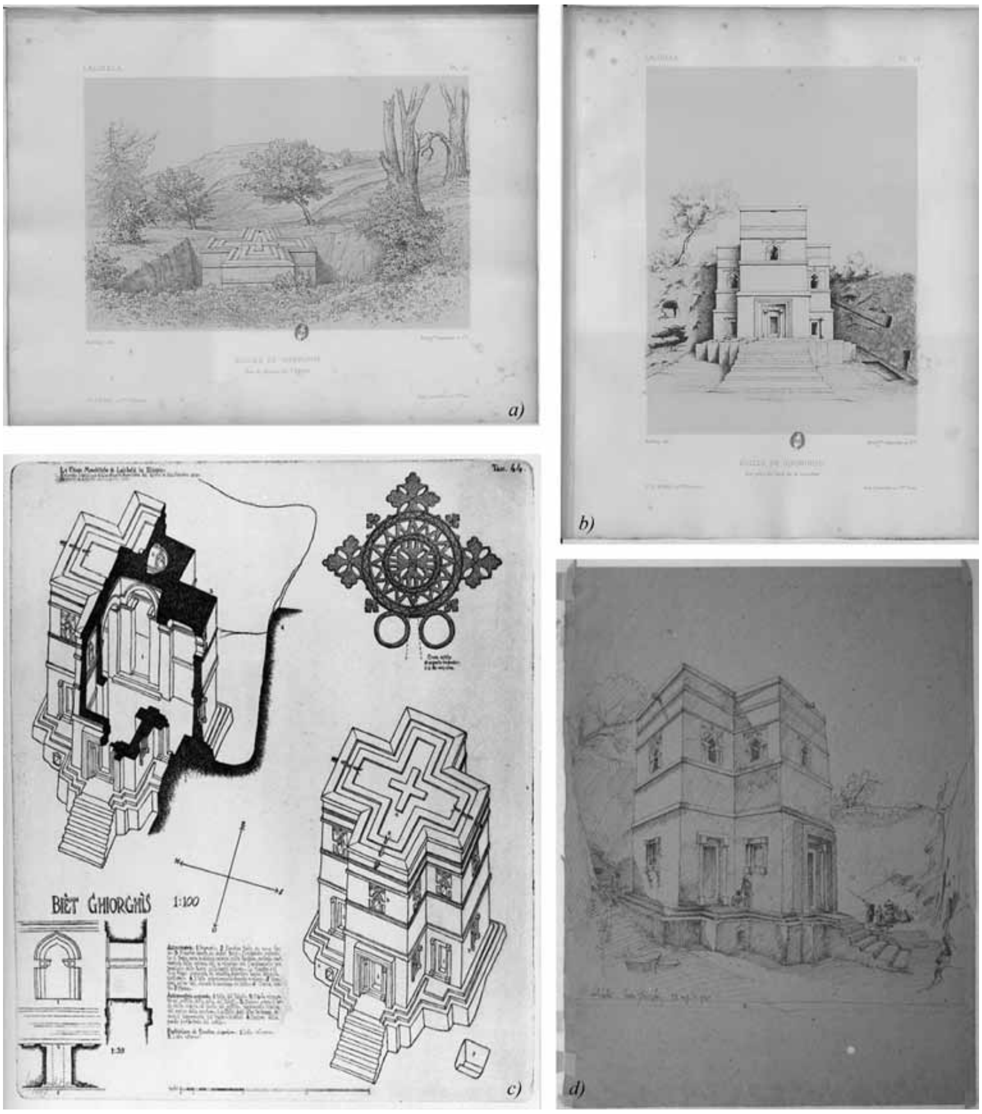

Fig. 1. a) A.Raffray, a page from "Les eglise monolithes de la ville de Lalibela (Abyssinie)", 1882. b) A.Raffray, a page from "Les eglise monolithes de la ville de Lalibela (Abyssinie)", 1882. c) L.Bianchi Barriviera. page from "Le chiese in roccia di Lalibelà e di altri luoghi del Lasta, in «Rassegna di Studi Etiopici»", voll. XVIII (1962) e XIX (1963). d) 4) L.Bianchi Barriviera. view of Bièt Ghiorghis, 28 aprile 1939. sepia ink on light brown paper, mm 505x385.

a digital camera, a tripod and a panoramic head, in addiction to drawing and sketching tools. These commons instruments, in the contemporary society, allowed to obtain various and wide typologies of documents based on photographic techniques, from virtual tour to the construction of three-dimensional models, that are suitable to extract two-dimensional draws, facades, plans and sections, but also animations. To create a virtual tour a panoramic head is essential, because, once assembled with the tripod, it permit to take pictures in every direction, rotating by 360 degrees. The rotation occurs around the focal point of the used lens, preventing parallax errors during the stitching process. Indeed, a series of photographies taken from a single position are then merged, by a software, in a single eqirectangular image. Equirectangular projection is the development of a spherical image. Spherical image could be visualized as a sphere that can rotate in every direction allowing a 360 degrees global view. Making few equirectangular images along a path and linking it by an hotspot, is possible to obtain a virtual tour and to simulate a walk around the studied object. This techique of representation has several benefits, among which, the opportunity to show the object in their environment, but also to be easy to use and to be disclosed online. The

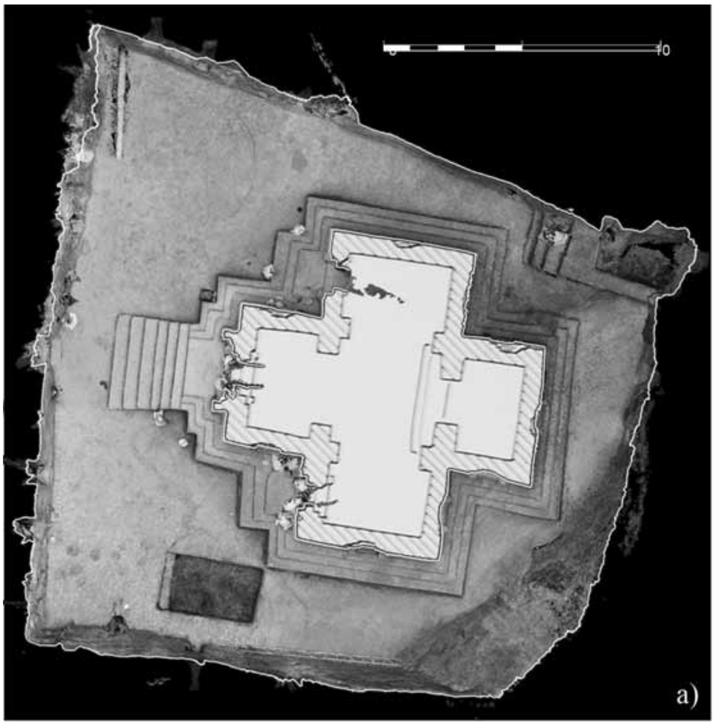

Fig. 2.a Plan of Beta Giyorgis by Points cloud overlay whit a Bianchi Barrivera plan..

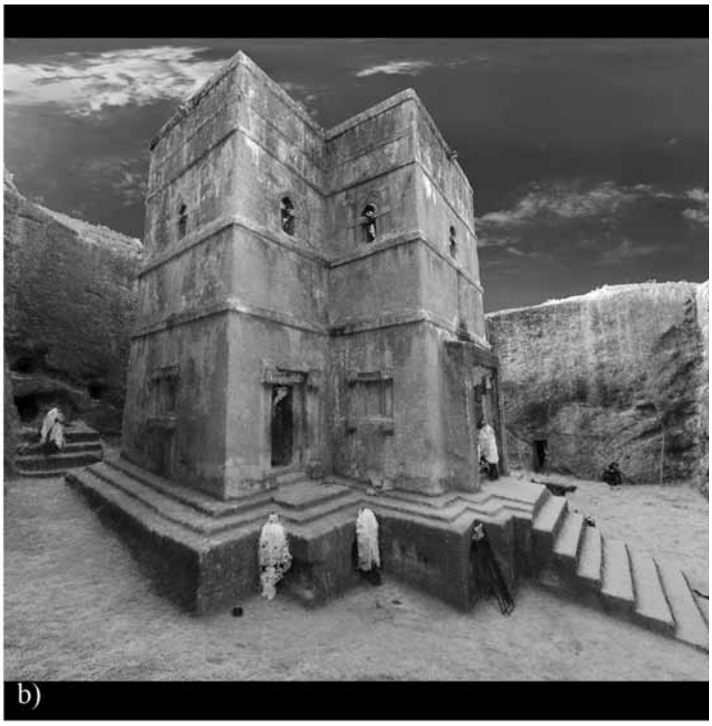

Fig. 2.b perspective view of Beta Giyorgis extracted from points cloud.

principal purposes of virtual tour are disseminate and illustrate the architectural heritage, but, it miss one of the most important factor for complete data, the measure. To obviate to the missing of measure, we thought about the adoption of another technique based on photography, the digital photogrammetry. Photogrammetry allow to obtain point clouds from conveniently taken shots. Points that compose the cloud have position informations as well as colours data, so that permit to draw a truthful representation of the object. The result three-dimensional model is

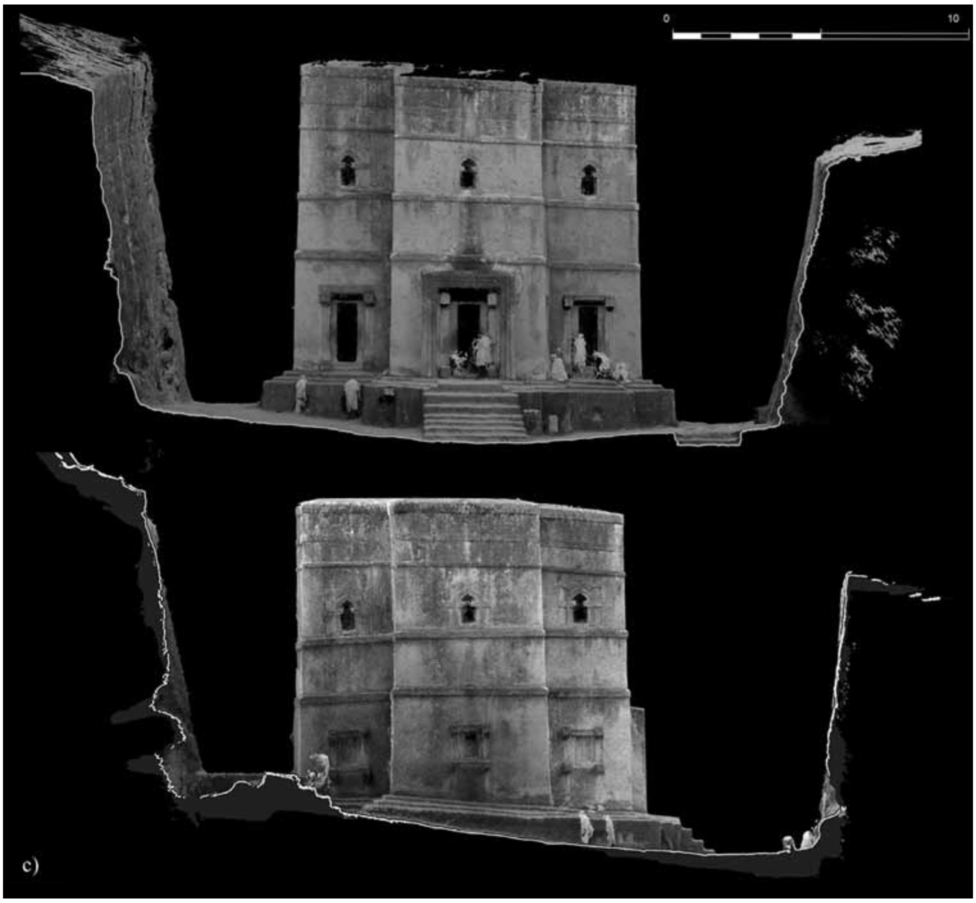

Fig. 2.c Cross section of Beta Giyorgis obtained by points cloud.

not scaled, so to make it measurable, it is necessary to shape again the point cloud. To facilitate this operation we can place in the scene, next to the object, before capturing pictures,some dimensional reference, such as target or a meter stick, to be processed in the points cloud construction.
This technique, in very useful, it permit to visualize a three-dimensional object, and carry out accurate measurement of all the parts directly from it. We can also extract all the plan and sections that can describe completely an artifact. (fig 2). Points cloud could be further elaborated to make a continuous digital model composed by mesh or could be used to create an animation.
The animation is an incisive representation and it is an appropriate instrument to the dissemination to the public of all social and cultural levels. The user of the animation can delve into the landscape, go through the places and move in it. Using these common instruments and in no more then 12 hours, we collected sufficient data to describe completely, employing dynamic and static representation methods, a monument that is worth to be known by the largest part of the people.

5. CONCLUSIONS

The spirit of the study travels is still the The same but all The other factors are change. Technology help us in all involved operations. The trip is simplified by new transport always more fast and comfortable, they reduce the time to cover a distance to few hours, while, in the past it took days or months. Technology make great progress in survey instruments furnishing equipment always more dependable and which permit to do accomplish specific operations. New techniques for measurements allow to complete the measurement process in a relative short time end new instruments for representation simplify the study and understanding of historical buildings. Travel allow to experience new methods and techniques. Travel is today as in the past the best instrument to learn and grow.
In this particular instance, the historical place, the great monuments visited and the pleasant Ethiopian people, made this travel an efficacious instrument for cultural and personal growth. We have been able to study different architectures, try to learn different languages and to understand different cultures.

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DEFINING AN ARCHAEOLOGICAL PARK: THE RESTORING ANCIENT STABIAE FOUNDATION MASTER PLAN 2001, AND WORK SINCE 2007

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Keywords

archaeological park, foundation, urbanism

ABSTRACT

This paper argues that a true archaeological site must have a site with a well-preserved archaeological character, that it have an interest for a broad educated public and that it must have a concentration of activities on the site. It then argues that the execution of such a park must be highly interdisciplinary and that it can be well served by a partnership of the hosting state and a semi-private, semi-public long-term non-profit foundation which can assist the state in coordinating the many disciplines. It concludes by summarizing the joint activities of the Pompei Superintendancy and the Foundation since 2007.

1. INTRODUCTION: WHAT IS AN ARCHAEOLOGICAL PARK?

The term archaeological park is used too casually today. It is often applied to any archaeological ruin with a fence around it. It also seems to imply that being an “archaeological park” will assist in some fashion in the sustainable management and outreach of a site.

It is argued here that a true archaeological park requires more than that. It must be a concatenation of certain features, and only certain archaeological sites should be considered candidates to be developed into true archaeological parks. Others should be left beind the fence, or back underground. (The writer, though trained in architecture, is primarily an archaeologist, as this remark reveals.)

2. BACKGROUND

The concept of an archaeological park began to develop significantly in the 1870’s. The Via Appia Regional Park in Rome, which now extends as a continuous archaeological area from the Forum to well outside the city, was initiated by Pope Pius the IX before unification in 1870, but in its first phase did not initially extend beyond the Baths of Caracalla. In 1931 under Mussolini it was proposed to extend far out into the countryside, creating a “wedge of green” extending into the heard of the city.

Some of the most significant theoretical development of the concept probably came from, oddly enough, America, and for sites which were not actually archaeological sites. The first American National Park (Yellowstone, 1872) set as it goal the preservation of nature untouched by humans as an entire coherent environment, its workings independent of humanity, and even made accessible (to humanity), without modern intrusions.

Somewhat surprisingly, the American Civil War Battlefield parks also may have been key. The American War Department had a thoroughly practical and unromantic reason for preserving great battlefields of the Civil War: the training of officers in battle tactics. When the original terrain with its relation of open and closed areas are preserved, the tactics involved in a battle can be much better understood.

3A. METHODS: DEFINITION OF AN “ARCHAEOLOGICAL PARK”

For the purpose of the RAS-Stabiae Master Plan of 2001 (fig. 2), an archaeological park was defined as:

-a site with a coherent primary character;

-a site which represents a significant phenomenon of history.
-a site with fairly well-preserved remains, which are, or can be made, “legible” to attentive visitors,
-a site which can be maintained with visitors present;
-a number of visitors which is keyed to the volume which the site can manage;
-a site which is largely unencumbered or dominated by modern buildings or other intrusions from outside the main historical period;
-there must be a concentration of activities on or adjacent to the site (e.g., museum, tours, outreach, “ancient” dining, events, concerts, bookstores, primary, secondary and university education, active research, etc.);
-a site which can be integrated with its region, both in terms of modern infrastructure (access), culture and economy, and with, ideally, with other related archaeological sites of the region;
-a site which can be supported in a sustainable manner by a long-term institutional infrastructure.

The critical aspect of this approach is that a successful archaeological park is like any successful urban planning project, it requires a critical mass of interrelated activities on the site before any reaction ignites.
What is also clear is that although archaeology is the critical discipline, this must be a project that goes far beyond archaeology alone.

3B. METHODS: THE JUSTIFICATION FOR NEW EXCAVATIONS AND AN ARCHAEOLOGICAL PARK ON THE STABIAE SITE

The site attracted very little public or scholarly attention before 1998 when the first steps were taken to form the Restoring Ancient Stabiae Foundation. The reason quite simply is that was in the shadow of the world-famous sites of Pompeii (2.5 million visitors a year) and Herculaneum (250,000 visitors a year)(fig. 1). Stabia had c. 1500 visitors a year (now c. 17,000).
In order to justify new excavations in the Pompeii area, where there is already arguably more material than can be successfully preserved, one has to argue that the site of Stabiae is different from the Pompei-Herculaneum town sites.
This is now generally recognized. Villas of this scale represent the environment of most elite levels of Roman society and power. In the last century of the Republic in certain months the villas of the Bay of Naples in fact displaced Rome as the center of political activities of the senatorial elite. Pliny the Elder—not a senator but an equestrian imperial administrator—spent the night of the eruption in A.D. 79 at one of the villas of Stabiae (we don’t now which one) and died on the beach the next morning. These were not “resorts,” but Power Houses, to use Andrew Wallace-Hadrill’s term.
Two great villas of similar scale, Oplontis and the Papyri, can not be excavated to their full extent since are both covered by modern buildings. They are also in deep excavation pits surrounded by degraded urban sprawl, which totally obscures the original relationship to the sea.
Stabiae, on the other hand, is largely unencumbered by modern buildings. Most unusually, the Stabia site still today preserves the panoramic view of the sea and the mountains directly from the villas.
Therefore at Stabiae and only at Stabiae can archaeology recover the total ambience of a major center of Roman power tehso-cvalled “maritime” villas of the Bay of Naples.
It is also a place where archaeology can recover a major center of innovation in Roman arts.
The crucial innovation of the “maritime” Roman villas in the first century B.C. was the integration of architecture with nature and aspects of urbane Greek culture. Statius’ and Pliny’s discussions of their villas at Sorrento and Laurentum make it clear that the artful manipulation of sensations of nature was deeply felt in the generations when the villas were built. Only at Stabiae can archaeology come close to recovering this total environment.
The site has other advantages. The site is not only very well-preserved, like Pompeii, even to the second story of buildings, but has been open to the air only since 1950, and always under roof. The Superintendancy recently (2013) completed an extensive re-roofing project. Also, large-scale excavations in the Pompeii area can be executed rather rapidly since the overburden is volcanic lapilli (cinder) and slow stratigraphic excavation is rarely necessary. Therefore clearing three large complexes relatively rapidly is feasible, if full recording and conservation resources are at hand.
The Stabiae site may offer a high possibility of autonomous financial sustainability, because it is, in effect, an easy site to “sell” to a large public. It should therefore eventually have a high chance of being financially auto-sustainable with visitor fees, much more so than most other sites.
Very few archaeological sites offer this concatenation of features (which argues that most should be protected by reburying).

Fig. 1 Panorama of Stabia, Vesuvius and the Bay of Naples. Photo RAS Foundation/Longobardi.

3C. METHODS: PLANNING APPROACHES

Integrated interdisciplinary approaches: From the outset, it was clear that the creation of an archaeological park on the site of the ancient Roman villas of Stabiae would require a highly integrated interdisciplinary approach.

Archaeology and conservation: The Master Plan calls for only three of the villas to be fully excavated, the three which are already partly excavated: the Villa San Marco, the Villa Arianna and the so-called Second Complex (fig. 2). The others should be left underground. There is some discussion of also including part of the townsite of Stabiae, where a townhouse adjacent to the Villa San Marco was partially excavated in 2009.

Zoning (fig.2): The villas are concentrated on the edge of the hill facing the original shoreline. This is the primary zone and is almost all state land, and it is proposed in the master plan that the entire “front” of the hill be a pedestrian park punctuated by the three excavation areas concentrated in two service “nodes” (entrance and service buildings, parking, fig. 2). There will be no modern constructions in this zone. The service buildings will be in the next zone behind the villas. The rest of the interior of the site will be left in private hands, limited to the current type of agriculture and constructions. It is proposed to grant special concessions to certain landowners who wish to develop their property in ways concomitant with the mission of the park (e.g. raising “ancient” wine).

Access and orientation: The Stabiae site lies directly over the local commuter rail station, the Circumvesuviana, but when one arrives at the station today the site is wholly invisible, and a long walk away. A funicular from the station could make the site accessible to tourists from Pompei in ten minutes with no disorientation (fig. 2). There is also ample open space within the park, and on its perimeter, for extensive parking, privately or state owned.

Visibility from afar: The site is almost invisible in the urban sprawl of the Naples area, but a perimeter of Mediterranean pines could mark it out even from a distance. Evening illumination on buildings and roofing along the top of the cliff could make it the “crown” of Castellammare. This will not “replicate” the ancient villas but suggest the way in which they were highly visible from Pompeii.

The spatial character of the ancient villas should dominate the spatial experience: The brow of the hill would be an open panoramic promenade connecting the two “nodes:” the two excavated villas of Arianna and San Marco (fig. 3). A visit to the site, with its cool breezes and panoramas, would be radically different from a visit to Pompeii, and would be a key to understanding an essential feature of the original designs: the artful manipulation of refreshing environment by skillful architects.

Dual experience of Roman spatial design: The site will offer a dual spatial experience: one which is “observational,” as visitors walk on the unexcavated volcanic cinder and look down 4 m. into the villa floors (fig. 3); and one which is “immersive,” in which visitors are in the villas and have the original experience of the focused cross-axial views created by the upstanding architecture.

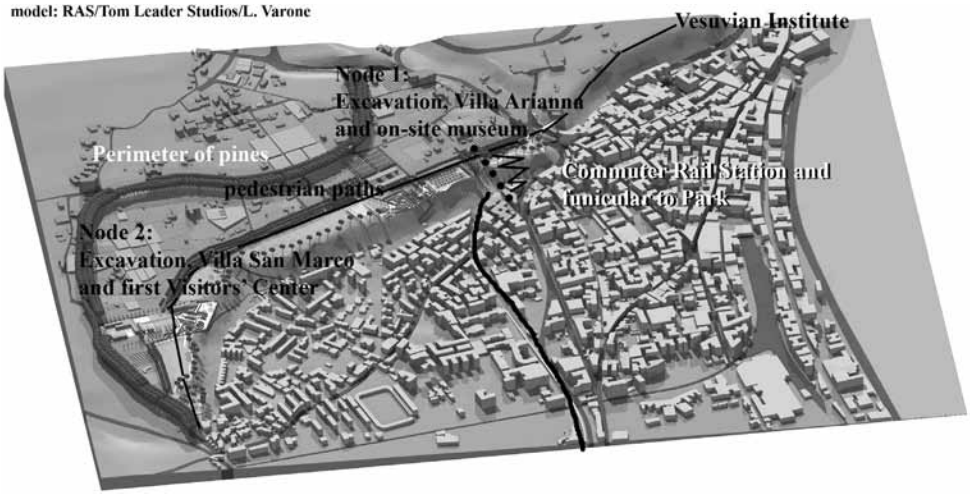

Fig. 2 3D model of the site Master Plan. RAS Foundation/Tom Leader Studio/L. Varone.

Suggestive reconstruction: The roofing should suggest the volumetric massing but not attempt to reconstruct it since this cannot be known with "philological" certainty. RAS has proposed non-invasive suggestive reconstruction of the collapsed terraces at the front of the villas by light scaffolding design, in effect "sketching lightly" on the site.

Integration with modern urban environment: Much of the Park should remain in private hands and in traditional cultivation. The perimeter (fig. 2) can be developed for low-impact archeo-tourism by private investment. The site should be traversed by public paths so that the Park becomes an urban park even when the villas are closed, and connect the city to the area on the plateau, and not be a barrier.

Events: The site has considerable space on the unexcavated areas next to the villas for evening events, and is large enough so that there could be a separate concert at each "node" without interfering with the other.

Regional Integration: A Cultural panorama of early Imperial Rome: Finally the site must function together with the other sites of the Vesuvian area to present a coherent panorama of three levels of early Imperial Roman culture: the small town sites of Pompeii and Herculaneum; the "rustic" farm villas best represented at Boscoreale; and the elite villas represented at Oplontis, the Papyri and best of all at Stabiae.

Catalyst for economic revival: This coordinated cultural panorama offers the justification for a multi-day stay for the serious cultural tourist. By contrast today, for the 2.5 million tourists who visit the Vesuvian area today, the average visit to the area (i.e. Pompeii) is 2.5 hours.

4. CASE HISTORY

The site was first excavated from 1749 to 1782, reburied and forgotten, though excellent plans were published in 1881. It was then rediscovered and partly re-excavated from 1950 by a local high school principal, and in the 1960's excavation passed to the Superintendancy of Pompei. The Italian government made Stabia a protected archaeological zone in 1957. Most of what was excavated earlier is still underground. The site is open to the public. The RAS Foundation was launched in 1998 at the invitation of the Superintendancy to the University of Maryland and the American Academy of Rome, and produced the Master Plan in 2001, and then from 2002 became a new type Italian non-profit foundation with international board representation from the Soprintendenza, the University of Maryland School of Architecture, Preservation and Planning, and a group of local supporters called the Committee of Stabia Reborn. The Foundation is a new type of cultural non-profit ("onlus") in Italy, the first one created under law D.Lgs 368.98 which allows the Foundation to receive and spend both state and private funds

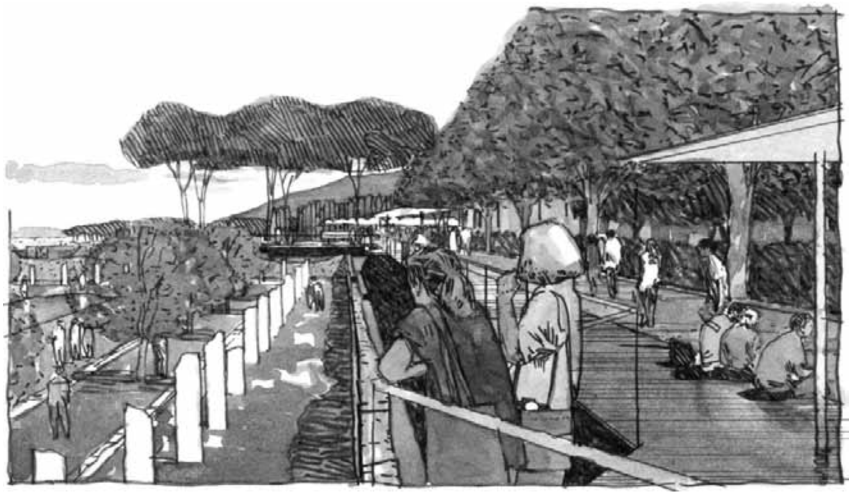

Fig. 3 Rendering of the pedestrian "passeggiata" along the edge of the cliff looking down into the excavation sector of the Great Peristyle of the Villa Arianna. Drawing RAS/Chris Grubbs.

from Italy and abroad, and it was created to assist the Superintendancy in the long term coordination of work and eventual management of certain activities on the park. It was created as a permanent foundation, not a short-term excavation or conservation or construction project alone. Major excavations and construction have been under way since 2006/07, executed both by archaeologists contracted by the Superintendancy, and by the RAS Foundation and its partners.

5. RESULTS

Activity of the RAS Foundation and Superintendancy (SAP, SNAP, SPES) since 2001:
Founded as a non-profit in Italy in 2002, since 2007 the RAS Foundation, together with the Superintendancy Special di Beni Archeologici di Pompei, Ercolano e Stabia (SPES), has:
-master plan 2001).
-geophysical survey in the Vesuvian area, reveals the full extent of the Villa San Marco (22,000 sq.m.)(2002, RAS; demonstration by excavation by sondage, 2006, SANP);
-curated four-year tour of frescoes from Stabia, "In Stabiano" (2004-2009).
-funded and planned and constructed the first phase of the first visitors' center (RAS, 2007-).
-funded and planned the excavation of the entrance courtyard of the Villa San Marco, (2007-2008, planning funding RAS; excavation by SPES contractors).
-excavated townhouse next to villa San Marco (2009, SPES).
-re-roofed most of the Villa San Marco and Villa Arianna (2012-13, SANP/SPES)
-fenced most of the site (2011-13, SANP/SPES).
-conducted geophysical study of the geology of cliff edge (2007, Consortium INNOVA).
-excavated the large formal garden of the Villa Arianna, (2007-2013, SPES, RAS, 12 institutional partner from seven countries. with partners from University of Maryland; Cornell University; U. Tennessee; Univ. Mississippi; U. Birmingham; U. Brock; U. London; CNRS, France, Stockholm,); Southwestern U. The final publication is currently in press with the Quaderni of the Amici di Pompei and publication is expected within 2015.
-re-excavated and conserved the thermal complex of the Villa Arianna (Hermitage, Russia, and RAS, 2010-14).
-opened the first extensive stratigraphic excavations below the A.D. 79 level (RAS/Columbia University, 2011-14).
-executed a three-year study of marble in the Stabiae villas (2013-15, RAS/Univ. Akron).
-3D digital recording of architecture, and LiDAR scanning, (2011-2016, RAS/Maryland, RAS/CyArk Oakland).
-conservation of frescoes in Villa Arianna (RAS/Academy of Fine Arts, Warsaw, 2015-).
Funding Priorities:
-Five priority projects: Five multi-million € large scale excavation.
-comprehensive geotechnical survey and site work to stabilize the cliff edge and control moisture.

-endowment to establish permanent research and archive staff and study abroad center with innovative synchronous distance learning.
-completion of the Visitors' Center begun in 2007.

Institutional support/long term loans of antiquities to institutional partners, permanent foundation:

The RAS Foundation is included in a 2002 Memorandum of Understanding which declares that any institution in the US which supports the RAS Foundation in the study or maintenance of the Stabiae site may earn the right to request long-term loans of antiquities from Italy. US museums and universities may now build collections in a totally innovative way: by rotating collections of antiquities from Italy. The four-year In Stabiano exhibit was the first long-term loan of antiquities from Italy to the U.S.

Study and Research Center:

And very significantly, in 2007, the RAS Foundation took into its management a 90-room modern fully staffed college in Castellammare to serve as an international study abroad and research center (the Vesuvian Institute of Archaeology and Humanities) . This center has hosted over a hundred university and other study groups from numerous countries (Europe, the US, Brazil, Russia, etc.).

CONCLUSION

The project is by no means finished. The archaeology and conservation are well advanced, the bringing and coordination of foreign and other resources, as well as Italian government funding, and the coordination of a wide range of disciplines, is long under way and the creation of a stable foundation with research and educational center has been achieved. Major funding strategy and coordination of various political entities remains elusive but promising. Further more effective types of outreach are being explored. The Foundation therefore has connected archaeology to conservation, urban planning and sustainable cultural properties management.

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INNOVATIVE METHODS TO ORGANIZE CULTURAL TOURISM IN YEREVAN

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Keywords

cultural tourism, monuments, museums

ABSTRACT

Armenia is rich in historical heritage, hence the role of cultural tourism acquires a particular significance here.
Nowadays, museums play leading role in the sphere of developing cultural tourism in Yerevan, moving out of their assigned spaces.
Art centers display their collections in their adjacent areas.
The house-museums of composers and writers carry out musical and poetic performances.
The Museums of visual artists organize events around the city monumens.
Such spectacular measures enhance tourist routes, prioritize the architectural, town-planning and monument preservation issues within the 'urban environment-landscape- national traditions' circle.
Cultural tourism encourages the founding of tour and traveler agencies on the bases of museums.
The goal of this article is to analyze the pivotal role of cultural tourism in Yerevan and to reason the innovative methods for tourism development, which may also prove influential in the sphere of social and economic development.

1. INTRODUCTION

Tourism develops as a complex economic and social-cultural phenomenon, a form of leisure and relaxation.
Tourism is essential for the interaction and rapprochement of the countries around world. International tourism enables people to see with their own eyes the diversity of cultures and the unity of the modern world. Familiarizing themselves and communicating with other nations, tourists are also encouraged to learn more about their own culture and appreciate its uniqueness.
The dynamic introduction of new technologies stimulated the process of globalization of culture, yet today globalization is perceived as a threat to national traditions, local habits, beliefs and values, which moved the issue of preservation of the diversity of cultures to the rank of the world's priorities.

2. BACKGROUND

Cultural tourism is capable of mitigating the negative aspects of globalization, providing the tourists an opportunity to familiarize themselves with the exceptional and unique contribution of every nation to the world culture (Karamasheva, A. 2003).
In our time, tourist and guided routes are developed so as to embrace historical-cultural regions, national parks, historical settlements and urban monuments, which fact is conducive to the intensive development of the tourism industry.
Cultural tourism acts as a pivotal factor for the preservation, use and popularization of the historical cultural legacy. The cultural legacy can play a notable part in the social and economic development. (Gasparyan, M., Safaryan, Yu. 2014).
Cultural tourism produces financial resources deriving from entrance fees, fees for certain services, and some other taxes. These resources may be directed towards environmental protection and education, preservation and restoration of constructions of historical value.

Today's condition of the open-air historical-cultural monuments is worrisome. They are being robbed and destroyed. Under these conditions, the only ways to ensure exploration and restoration of the monuments are development of protection zones and museumization (Drikker, A. S. 1999).

3. METHODS

In the modern world, the immense task of preserving sculpture works and architectural monuments is the responsibility of museums; one of the objectives of museumization is to preserve and popularize monuments. The efficiency of said process depends on the rational and prudent cooperation between the experts in relevant fields. A museum exposition should be designed as a single environment, connecting the items on display with the open-air exhibits. Museumized archaeological monuments bring together archaeologists, museum employees, restorers and the community.

4. CASE HISTORY

The XX century presented the humanity with museums of a new type, which owe their origin to the understanding that not only the items should be preserved and exhibited, but also their own milieu. As a result, open-air reserves-museums came into existence, whose collections, as opposed to conventional exhibits, comprise monuments of architectural and folk arts displayed in their natural environment (Stepanyan, K. 2014).
This trend had started back in the 1950s-60s and continues to date. Armenia's reserve-museums are as follows:
• The "Zvartnots" historical-architectural museum-reserve, founded in 1957 [the museum building was founded in 1973]. Since then, the natural and historical milieu of the VII century has been restored, trees and gardens planted. In the natural-historical park environment of the temple complex, necessary conditions are provided for people with physical disabilities, including blindness. Viva-Cell MTS initiated and placed in the temple area information stands in five languages; for the visually impaired visitors, there is a stand in the Braille alphabet. From 2012 on, nighttime service is also available there: beautifully arranged artistic lighting and sound effects make the monument even more attractive.
• The "Dilijan" Museum of National Architecture [founded in 1983], whose 2266 exhibits showcase Armenian national architecture, household culture, pieces of visual arts and national crafts.
The "Garni" Historical-Cultural Reserve-Museum - one of Armenia's most visited memorial complexes; here, too, crowded cultural events are organized throughout the year (http://hushardzan.am/708/).
Yerevan boasts dozens of museums of all kinds, where the visitors are introduced to the treasures of Armenia's history and culture, the life and career of renowned figures and their contribution to the world culture.
The museums in the Small Center of Yerevan – the Aram Khachaturyan House-Museum, the Cafescjian Center for the Arts, the Ervand Kochar Museum and the Alexander Spendiaryan House-Museum – provide an opportunity for organizing art routes both for groups and individual tourists (Aloyan, A., Safaryan, A. 2014).
As museums reflect the public life, so they are prone to contentual changes consonant with the changing life.

5. RESULTS

The social-cultural significance of museum activity is growing with the increasing role of museums in raising the educational level of the community, preserving and interpreting the cultural legacy, providing cultural identification and organizing leisure.
Nowadays, large museums maneuver between culture and entertainment: marketing strategies are developed to attract more visitors, show-hits are organized, whose tickets are sold out months before Museums strive to comply with the international criteria, which is why they introduce the newest technologies, implement open-air cultural and leisure programs and events, involving tourist organizations and cultural tourist routes. The orientation towards active collaboration with visitors enhances the educational function of museums. The contemporary museum programs pave the way for the transition from the visitors' role as a passive observer to that of a creative associative thinker (Mastenica, E. N. (2006). In front of the Opera and Ballet House in Yerevan, A. Spendiaryan's monument is put up; his tomb is in the nearby park. The A. Spendiaryan House-Museum, taking advantage of this nearness, organizes in the area events, related with the composer's birth and death anniversaries, thus accomplishing two tasks: firstly, the space takes on a new function, and, secondly, the composer's oeuvre is popularized. As a rule, college and school students, admirers of the composer's works and tourists participate in the events (fig.

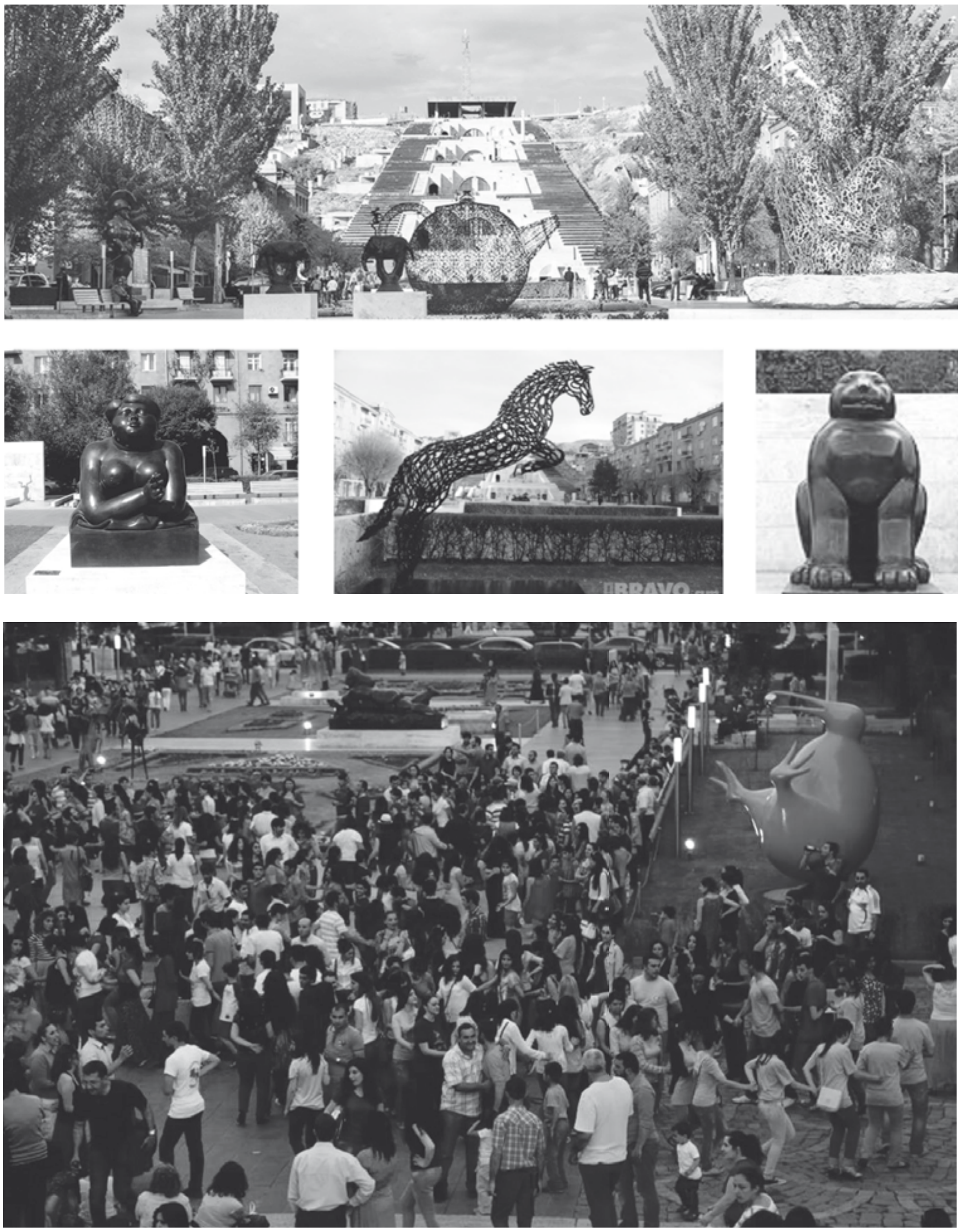

Fig. 1 Annuale event organized by Alexander Spendiaryan House-Museum. 2014.

1).The Cafescjian Center for the Arts [founded in 2009] is located in the “heart” of Yerevan. The mission of the Center is to exhibit the best examples of contemporary art in Armenia, and to introduce Armenian contemporary art to the world. The Center organizes exhibitions of unique modern artworks, movie shows, concerts, educational programs and lectures. The activity of the Museum is planned with the objective of enhancing cultural tourism to the extent possible. One of the world richest collections of monumental sculpture is displayed not only in the Museum halls, but also along the adjoining alley – the so-called Cafescjian Garden of Statues (fig. 2). The specially designed spacious tree and flower arrangements suit best for the sesize able statues. Here exhibited are Fernando Botero’s, Lynn Chadwick’s, Jaume Plensa’s and Barry Flanagan’s works.
Yearly, close to one million visitors attend the Center (http://cmf.am/).

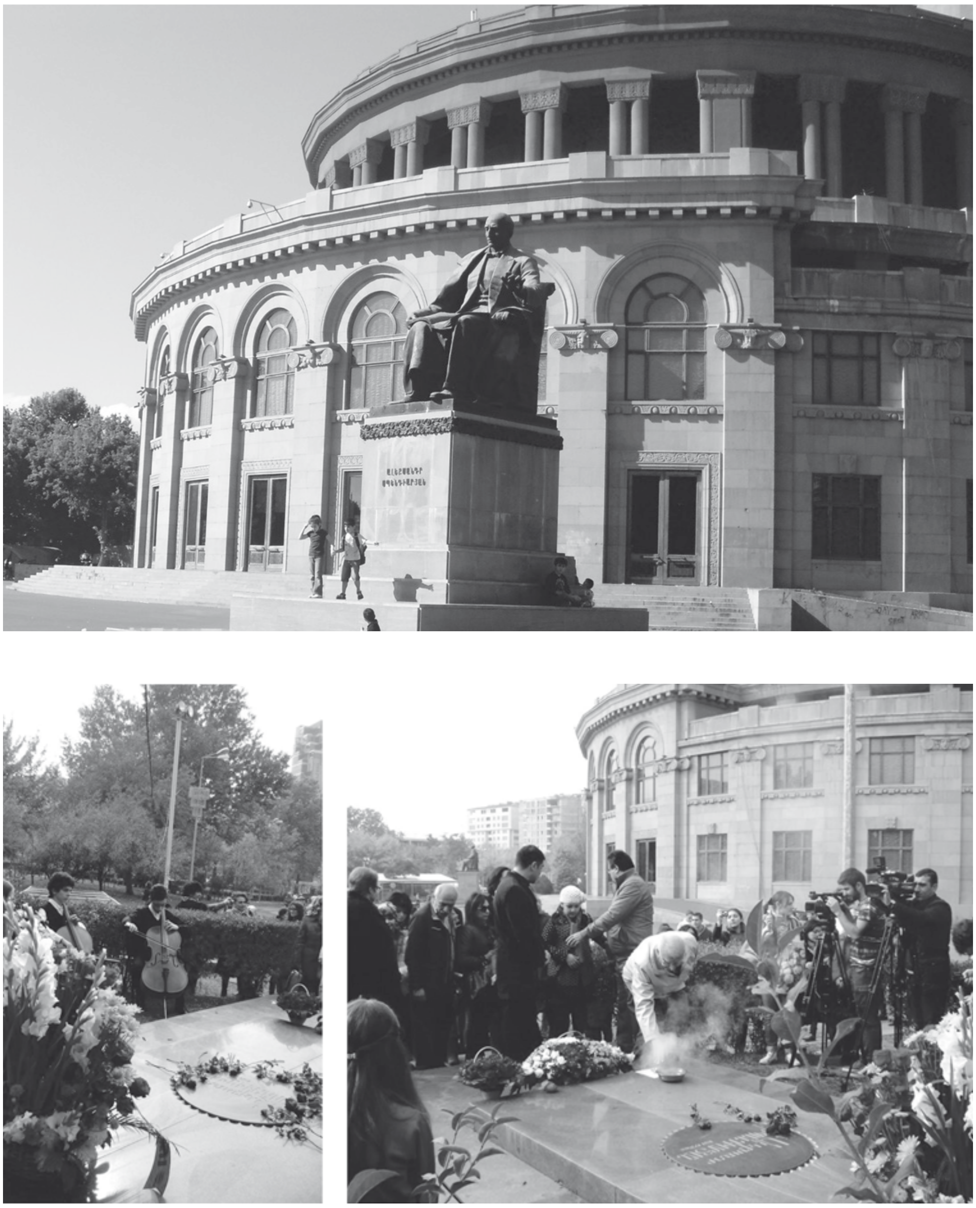

Fig. 2 Cafescjian Garden of Statues and event organized by Cafescjian Center for Arts.

The Museum of painter and sculptor Ervand Kochar [1899-1979], which stands out among the other museums, is adjacent to the Cafescjian Center for the Arts. Kochar's legacy is a most interesting phenomenon of the XX century art.

It is noteworthy that seven monumental statues, created by Kochar, decorate Yerevan, each of them forming a special architectural milieu ["The Eagle of Zvartnots", 1955; "David of Sassoun", 1955; "Komitas", 1971; "The Muse of Cybernetics", 1972; "Vardan Mamikonyan", 1975; "The XX Century Melancholy", 2003; "Biblical David", 2009].

To stimulate cultural tourism, to disseminate information about sculpture monuments, the Kochar Museum[1].

Implements the "Museum on Wheels" project: special events are organized each year around the city's monumental statues with the use of new technologies. School and university students, musicians, actors and tourists are involved in these events (fig. 3).

Fig. 3 Event organizated by E. Kochar Museum at the Monument “David of Sassoun”. 2014.

6. CONCLUSIONS

It is crucial that a monument become a museum exhibit, and the facts and data describing it supplement the display; this adds significance to the museumized item, makes it part of the historical-cultural legacy, endows it with a “second life” - also as an education object.
The very desire to visit a museum serves as a relief from daily concerns (Petrosyan, S. 2011).

The point of prudent tourism management is not only to demonstrate the cultural riches of the country, but, concurrently, to change the tourists’ behavior and views. On the other hand, properly preserved monuments and traditions make the local population take pride in their own culture (http://www.cultshine.ru/cses-307-1.html).

Thus, cultural tourism is a means for the museums to popularize the cultural legacy, enter the latter in the cultural information flows, thus promoting enhancement of relations between international communities (Zeiger, M. 2005).

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SADO ISLAND THE GOLD AND SILVER MINES IN JAPAN. AN INTEGRATED PROJECT BETWEEN ARCHEOLOGY AND CONTEMPORANEITY

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Keywords

urban archeology, industrial archeology, urban restoration

ABSTRACT

This paper analyses the inspection in Sado Island (Japan, September 8-13, 2014) with the scientific staff Niitaga's Prefecture, World Heritage Inscription Promotion Office Cultural Administration Division Niigata Prefectural Board of Education. Since XIV century the Sado Island is famous for the gold and silver mines. The paper intends to analyze three particular aspects of the Japanese island and to illustrate the main activities of the research: urban archeology, industrial archeology and archeology of the natural landscape. All the mines were closed permanently in 1989 and the present project aims to valorize the mines, the natural landscape, the villages of the miners and their productive activities for a correct understanding and knowledgeable use of the territory.

1. INTRODUCTION: WHAT IS AN ARCHAEOLOGICAL PARK?

To northwest of Japan is Sado Island that belongs to Niigata Prefecture. Today in the island of Sado the gold and silver mines are a living cultural heritage and especially culturally active. Here the mining archeology is a very important material resource and it is the cultural value of the island, where the topic mining interacts with three main areas of the archeology contemporary: urban archeology, industrial archeology and archeology of the natural landscape (1, 2). Sado Island has a long mining history which dates back to the days of Konjaku Monogatarishu, compiled about a thousand years ago, and such mining sites have identified now even after such a long period of time. Although mining sites differ by age, the mines on Sado reflect a variety of mining that remains from various periods in history.

2. BACKGROUND

In Japan Sado Island is famous for the gold and silver mines. Studying the history of the island we learn many interesting aspects. The Island is not important only for the mines but also for the main inheritance that are the temples and the shrines. In Edo period (1603-1867) there were almost 300 temples and 272 of them still exist now. There were also 354 shrines 250 years ago, 278 of which still exist.
These temples and these shrines today are an important Cultural Heritage of the island. Another important Heritage is the natural landscape and the ancient villages of miners, alongside to the industrial archeology of the mines (Nishiyama, H. 2013).

3. METHODS

The main topic of this investigation in Sado Island is the relation between the archaeology and the landscape and the relation between the urban archaeology and the industrial archaeology. The archaeology is the study of human activity in the past, primarily through the recovery and analysis of the material culture and environmental data that they have left behind, which includes artifacts , architecture , bio-facts (also known as eco-facts) and cultural landscapes (the archaeological record). Because archaeology employs a wide range of different procedures, it can be considered to be both a science and a humanity and in the United States it is thought of as a branch of anthropology, although in Europe it is viewed as a separate discipline (Niglio, O. 2014a),. In Japan the term National Treasure has been used to denote cultural properties since 1897. The definition and the criteria have changed since

the introduction of the term. These archaeological materials adhere to the current definition, and have been designated national treasures since the Law for the Protection of Cultural Properties came into effect on June 9, 1951 (Nishimura, Y. 2004).
The word archaeology in Sado finds interesting and different connotations. The inspections carried out in September 2014 allowed us to evaluate these different connotations of the island's heritage.
In fact the inspections of the mines (gold and silver) and of the villages have allowed us to reflect on these different meanings of the archeology as a study of the human activities.

4. CASE HISTORY

The archeology of the landscape analyses the land use in different epochs. In Sado Island this study allows to search for traces of ancient mines and to know their configuration. Very interesting the excavations in Nishimikawa area (3).
The urban archeology analyses ancient villages of the miners. Today some of these villages have disappeared but on the territory is still legible traces of these ancient settlements. This study allows us to reconstruct the history of these villages
The archeology of the architecture introduces the stratigraphic study of the constructions. This study allows us to know the different methods and the different construction techniques of the traditional houses. It is possible to know and to analyze also the history of the restoration works (4).
The industrial archeology analyses the human heritage that for four centuries and with different methods has obtained fundamental natural resources that has transformed and distributed throughout Japan. This study allows us to know the ancient methodologies for the extraction and for the processing of the gold and of the silver (5).

5. RESULTS

Today in Sado Island the culture of the gold and silver mines is still alive. The archaeology of the territory is part of the resources that the man has regenerated through new uses. An example are the old millstones; today these millstones are used as ornamental elements of gardens or foundations for the support of lightweight structures (Izawa, E. Nakanishi, T. Oda, Y. 2013). The Architectural reuse processes include adaptive reuse, conservative disassembly, and reusing salvaged materials. This definition is broad and inclusive permitting many different interpretations; however, the underlying objective is that architectural reuse be understood as an evolutionary process occurring over time. Adaptive reuse revises the function of a building while preserving the integrity of architectural space. In order for a building to accommodate change, it must have a functional value as well as a commodity value. Buildings that offer an open arrangement of spaces and a flexible structural frame-work have the best potential for reuse.
This is the case of the Japanese architecture and especially of the traditional architecture in wood and earth where the configuration of the main structure allows to predict compatible reuses with the conservation of the old construction and with the needs of the new functions (Enders, S. Gutschow N., 2002). Then it is interesting to plan, for all ancient villages in Sado Island, a program of Urban Restoration that includes the old miners' houses and the public spaces; an integrated project between archeology and contemporary. This project finds important resources in the historical investigations and in the local analysis that the researchers of the Niigata Prefecture and Sado City are developing since many years. However in this project is important to program activities of training and of information with the local community about the finalities of the urban restoration that includes the landscape, the architecture, the immaterial heritage (knowledge of ancient traditions), the production functions and then the archeology of the human resources (Niglio, O. 2014b).

6. CONCLUSIONS

The analysis of the values of the Cultural Heritage in Sado Island allows us to reflect on future development opportunities. Following are some suggestions:
1. To design archaeological mining parks with cycling routes or special country walks (with maps).These routes allow you to appreciate another important heritage of the island of Sado: large plantations of rice and their terraces.
2. To define the perimeter of the old mining villages and to establish appropriate standards for the restoration of the architecture and of the landscape. It can be interesting to elaborate an Manual in cooperation with the local architects and carpenters with the objective of establishing special rules for Sado Island. This Manual must be

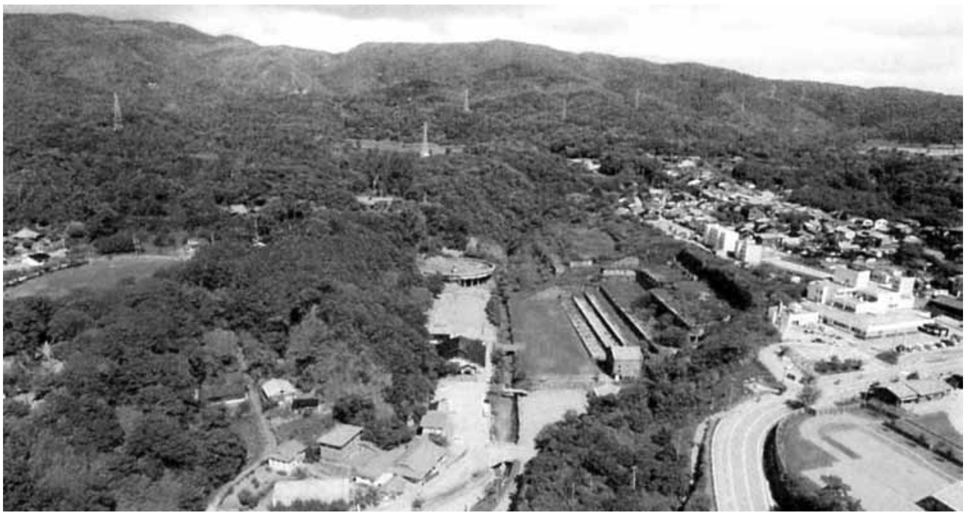

Fig. 1 Aikawa. The mines (the mountains), the industrial archaeology , the ancient village of the miners with the new architectures of the XXI century (Niigata Prefecture, 2011).

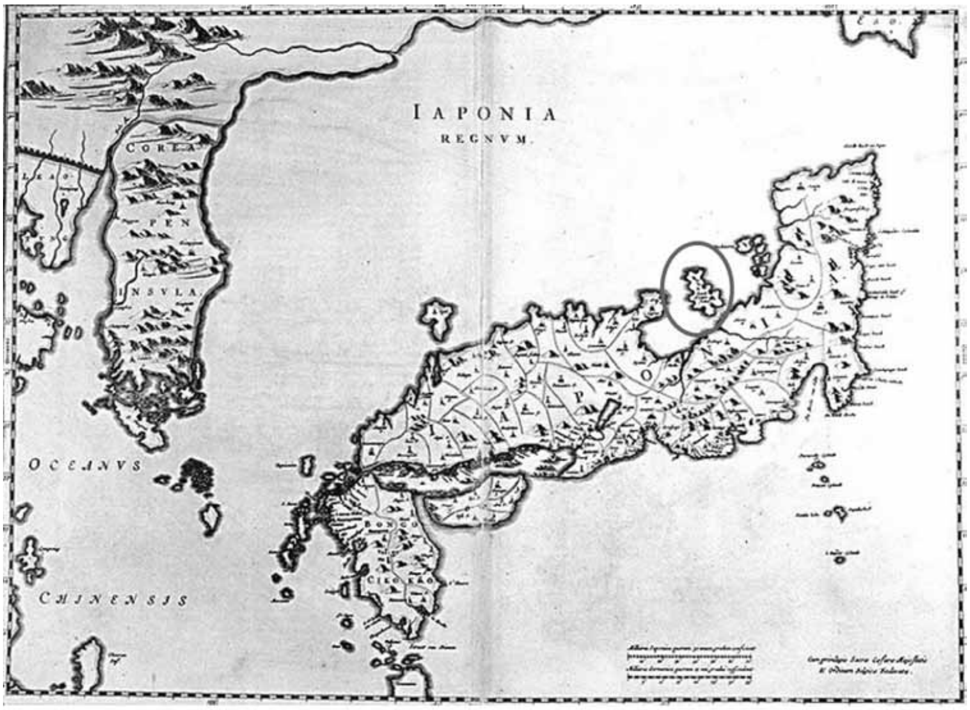

Fig. 2 Japan and Sado Island (circle), XVII century (Yonemoto M., 2003).

supported by historical and archival research, geometric reliefs, study of traditional building techniques, study of natural materials (wood and earth), environmental analysis and by studies of individual architectures for to define objective rules and not general rules.

To organize a local and permanent School for to learn the Architectural Restoration of the traditional houses and for the conservation of the natural and agricultural landscape. This School will be also an opportunity for the local community for to learn as to preserve the Tangible and Intangible Heritage of Sado Island. In the restoration of the villages is also interesting to program small hotels in traditional houses.

3. To design the archaeological park of industrial processes that since the sixteenth century have characterized the extraction of the gold and of the silver. This is a cultural heritage of inestimable value that can also be evaluated by activating training courses to learn and to develop different techniques of mining and processing of precious minerals. With these important assumptions Sado Island is preparing to become a significant World Heritage Site.

Fig. 3 Sado Island. The excavations in Nishimikawa area for to know the ancient surface mines of the gold (O.N. 2014).

Fig. 4 Aikawa. Traditional house realized with wood and earth, a construction method still in use (O.N. 2014).

Fig. 5 Aikawa. The reconstruction of the ancient methodologies for the processing of the gold and of the silver (O.N. 2014).

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COMMON GROUND BETWEEN ARCHITECTURE AND AUDIO-VISUAL LANGUAGE – A NEW TOURIST METHODOLOGY

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Keywords

tourism, heritage, audio-visual

ABSTRACT

The objective of this work is searching for common ground between architecture and audio-visual language (in television), namely: Finding links between contemporary architecture and the audiovisual, analyzing their areas of convergence and intersection. Comparing the evolution of Architecture according to cultural, social and economic movements, and determining influence of audiovisual universe. Developing a historical sequence of past decades regarding architecture as communication and finding common points with the audiovisual. Contextualizing the importance of television in the consumer society as the ideal means of disclosure to a global scale. Considering these results, we also intend to identify the basic concepts of communication which become common denominators, not only for these areas of knowledge but also to other areas.
Use of such concepts as creative and critical support model of study projects, recovery or commercial exploitation of material and immaterial heritage.

1. INTRODUCTION

The study of audiovisual impact on contemporary society is essential to understand society itself. Its influence is global and affects almost all human activities, including architecture. The architecture and the audiovisual naturally develop practices and autonomous and independent theories, however, there are a number of factors that bind them and or intersect. The aim of this study , looking to see if there is a line of continuity in the history of recent architecture , showing the progressive and constant concern in the universe architecture with the image and as a result , find points of connection between contemporary architecture and the language audiovisual identifying these connections and how they manifest themselves. For a general context, there is also the need to establish a relationship with the social environment (the characteristics of the consumer society and information) and the communication universe (in particular the audiovisual).
The social and economic order and the present based on consumption are gradually changing the habits and behavioral characteristics of man, influencing it in their activities. As a direct and indirect result, the practice of architecture has undergone profound changes, so over the past few years we have seen changes in its basic concepts.

2. BACKGROUND

The current concept of communication is inserted in the logic of contemporary social reality essentially based on the information. Communication has been one of the support legs and existence of social media more connected to information. The use of communication and image as selling a product factor has also been an important rule in an increasingly widespread consumerism in contemporary society. For this reason, the communication architecture is assumed increasingly as a process of structural design of the vehicle and excellent transmission concepts.
The issue of audiovisual comes naturally, since the information society, the goal of any vehicle messages, you try to be efficient. Currently, the television the most powerful means of communication and the audiovisual language to its most efficient tool, of course, to seek to establish a relationship with this language. Over time, the architecture has always had a special relationship with the image areas and the new technologies associated with them. Cinema is one of the most recent examples known and studied. A relationship that arises from the very onset of the so-called seventh art, and it develops throughout the century. XX. However, the architecture of the connection with the television is not as clear and obvious. Even in the relationship between television and the cinema, where the existence of television sets was banned by age 50, only the last two decades it was assumed that the strength and efficiency of audiovisual language would be an asset to the film. The study of the audiovisual is essential to understand their integration in contemporary as well as the global influence in many of the activities of man, in

which is included the architecture. The current power of the audiovisual is not only as a result of technological change but also as a result of social and economic development of society.

2. ARCHITECTURE EVOLUTION IN PERSPECTIVE OF COMMUNICATION

The world wars, revolutions, and social movements will end with the aristocratic elites and empires. New political maps are drawn; new countries are formed, and new technological systems, social, economic and cultural rights are developed.

The mass production, the result of industrialization will popularize the products reducing their costs and allowing their sale in bulk. The combination of industrial production with the growth of a new society with purchasing power will generate a middle class that will grow and flourish until the twenty-first century.

It is the mass consumption and the consumption of the masses globally. The masses for the first time in history represent the power, the power to consume and thus the ability to drive the market according to your will or need taking your power for the first time in human history, the so-called “power of masses”.

Television appears as the ideal means of communication. It is something new and efficient. It is something that people invite to your home and is also the means that naturally connects people to the world and each other, but more than that we believe in television.

We believe because television has an odd and powerful handling capacity, its audio features, video, sensory and behavioral (in short for its audiovisual language) Consequently the audiovisual being the language of television becomes the reference and communication handling throughout society and in all areas of knowledge obviously including architecture.

The relationship between architecture and is, therefore, a specific visual and undeveloped area. If the phenomenon of television (audiovisual) is easily accepted its influence in the architecture of the universe implies, for better understanding, a historical context from the end of the nineteen century. The nineteen century was the time of industrialization that culminated later with series production. In the late nineteenth century to the twentieth century the great fairs World are the wonders of the new bourgeois. The locomotive and the car are the icons of an era surrendered to machine. The film develops as a representation of reality, as a storyteller and an advent of a world of illusions and images ‘live’. With the two great world wars are witnessing the end of empires and a whole current aristocratic structure. The society and the economy begin its industrial phase. The structures and principles of the past no longer give answer to these new realities. In 1951, the 8 CIAM (International Congress of Modern Architecture) in Hoddesdon - cold and rational architecture, usually built of blocks and housing estates, was strongly criticized. It was proposed, alternatively, the study of a city that would add meaning and symbols to new public spaces to a study located and custom history and local culture.

In the United States in the 40, 50 and 60 developed a cheerful and upbeat style with a commercial that illustrated another culture is also flourishing in Southern California: the Californian Car Culture: The Googie architecture. This was a humorous classification, but futuristic connotation, vernacular style that developed on par with a commercial concern. The Googie architecture featured a set of cultural trends that were also known as: Jet Age, Pop Luxe, Doo Wop, or Space Age. These movements led to many of the classic conventions were abandoned the attempt in the search for something new and different for architecture.

In 1961, Gordon Cullen, in the book Townscape, attempted to demonstrate the recognition of the needs and requirements of the new city, increasingly focused on the social and consumption.

Other movements, such as the American Robert Venturi begin to develop in the 60s looking for another language that opposed the functionalist and dull rigidity of Bauhaus.

The world evolved and emerged new trends in art and society. The multifaceted and expressive opening of the company opened new horizons to man, particularly in its spirit and its creativity. The experience and the art of everyday life have become the following icons.

In the 50s, the atom, nuclear energy, and the atomic bomb occupied a leading role in popular culture and intellectual debate generating a diversity of movements that hatch in the 60 A time where shaking all areas of society (the Revolution youth, women’s empowerment, anti-racial movements) and appear and / or develop in new economic and technical realities (television, cinema, etc.).

In 1966, Venturi with his book Complexity and Contradiction in Architecture argued that architecture had to find the complexity of modern life. Venturi defends architecture as a reflection of everyday actions and outlines the first ideas of one of the most important objects of contemporary: The construction of the image (Venturi, 1998).

Andy Warhol promotes advertising as an art and breaks the myth of an elitist art. The evolution of advertising provided that Andy Warhol could see your concept be elected as art, architecture influences from the 70s increasingly the image invades the everyday consumer and citizen. Thousands of images and / or visual signals are distributed by our cities along the route our daily lives. Signs advertising, billboards giants, thousands of lights dominate the landscape of the city. Begins a rapid assimilation of a special way of being, that by the end of the century will dominate Western civilization. Increasingly, the image invades the everyday citizen.

The traditional and conventions in architecture began to be called into question. In this perspective starts the policy over the coming decades will be predominant: the consumption strategy.

In fact, it is a time when everything was called into question. On this basis, several architects and workshops investigated different ways of looking at architecture, especially its role as permanent and constructive immobility. Also in the 70s, the American An architecture group Matta-Clark and Austrian Hans- Rucker -Co, were the most far advanced the earliest times, with the experimental creation of architectural spaces in permanent changes (Rucker-Co., 1997). Transform the architecture, adapting it to any social or cultural situation and exploring new concepts as empty, the intervals and the metaphorical spaces (Dornburg, 2002).
In the 70's, the Best Supermarket chain radically broke with the usual design stores. It was designed to an unusual set of buildings with sloping walls that seemed to crumble full of stacked bricks. There was a goal, to draw the attention of potential customers and thus increase sales. The architecture was used as a marketing and advertising tool.
The architect Bernhard Tschumi in the 80s based their studies on the importance of architecture in the materialization of movement in space. One of his most famous works, the redevelopment project La Villette Park in Paris, and concentrated translated these principles: The disintegration of traditional architecture, stable, classical, structural and coherent space fragmentation, making it a route where there is a whole initially noticeable and where the whole is not a direct and logical relationship of all its constituent parts; time, pace and sequence are the foundations of this new structure. The new language of architecture, according to Tschumi, was based on a concept of reactive architecture where space ceases to have a static weight to be dynamic and with a permeable building.
The architecture is no longer seen as a whole in a classic sense, to pass to be formed by a series of live, interactive fragments and experienced by people. People, life, sensations, and society, went to their core values. Two moments were characteristic of that period: The Venice Biennial 1980 and 2000. The first, entitled La Strada Brand new, presented in its scenic street a kind of caricature of its ideals, and symbolically marking the most characteristic movement. The second represents the end of the movement. This biennial, entitled: "More ethics, fewer esthetics", the movement proved its inefficiency and its lack of response to changes in society, new technologies and global movements such as globalization. At the end of the twentieth century, at the height of the image of society, architecture takes its role as a communication process, idealizing their buildings as vehicles of ideas and concepts. Bruno Zevi, in Paisaggistica conference and Linguaggio Grado Zero dell 'Architecture Modern (1997), supports the idea that architecture has to stop being something that is part of the social and economic context in which it operates, to universalize contemporary as a type or concept of general and comprehensive landscape. On another side, there is an explosion in the known artistic territory. The concept of art volatilized up. Authors such as Hans Belting and Arthur Childbirth also advocate the end of the classical concept of architecture. The center architecture as an autonomous discipline ideal representation is giving way to a new and different field.
Duchamp anticipated this idea and argued that an esthetic universe that sets the architecture should be the function and not the substance. Substance which in concept is something more and more undefined and slight nowadays. in this current paradox, we are faced with the dissolution of the classical concept of architecture and its integration into a broader concept of the social landscape. A new concept based on the composition of new languages that mix and intersect art and technique. These new languages are based on concepts such as speed, mergers, globalization and the hybrid, which advocates as Luigi Prestinenza coexist in a theorical meltdown worldwide and are the very reality of contemporary and new worlds of knowledge (Luigi, 2009).

3. CONCEPTS CONTEMPORARY ARCHITECTURE

The connection of architecture with the visual concept is verifiable in a series of principles, concepts, and practices. We may distinguish the following:
a) *New concepts*
In the course of the twentieth century witnessed the development of mass consumption and, therefore, the emergence of new areas such as tourism, shopping centers, the growth of new transport routes such as highways and airports.
Are new and different concepts and in the world of architecture have been designated as 'non-places'. These new "non-places" become for the contemporary man the new living centers, experienced, but not inhabited.
b) *Space as Well Consumption*
The consumption of the engine of contemporary society will influence all areas, including the very concept of space. Spaces are no longer just places where there is consumption from them to be consumable spaces and attraction. The 'non-places' as the shops and shopping areas are imaginary extensions created and generated by what is seen on television and magazines, as such, are part of business logic / audiovisual and their tricks and manipulation strategies must be known and understood in this architecture to be effective.
c) *The audiovisual architect perspective*
In 1983, Gilles Deleuze reference was made to the importance of the image in contemporary society and, consequently, architecture, arguing that the architecture and the image contained common features. Currently, Nouvel compares the architect with a film director. Both play with the concept of space in the magical or conceptual sense. And, because the architecture and space are also things we perceive ourselves and become aware through our senses, are also likely to manipulate in order to achieve the proposed objectives. The architect can, therefore, have

recourse to procedures similar to those of the director to get the desired effects.
d) *The architecture of the imaginary representation*
The audiovisual technologies through the virtual development, allow the man in general and architects, in particular, explore, create and, above all, represent new imaginary worlds, new concepts, new or existing materials have not even invented. Today, with virtual reality, we can not only see these imaginary worlds but also live them and feel them.

4. CONCLUSIONS

It can be concluded that the frontiers between the architecture and the Audiovisual longer rigid and boundaries increasingly expand and intersect and mingle. Generate up common areas with concepts that share and explore as seen in the examples shown. But these concepts are concepts that define contemporaneity. There is a kind of globalization principles that cut across the whole of society and with which modern man is identified, these principles or concepts are interdisciplinary links between the various contemporary activities and the success basis of the market, as they represent the tastes and appetites of the new consumer:
Atmosphere: - It is increasingly important to the ambiance of a place. A qualified space must translate and communicate an intention, be treated with light materials and producing sensations that enhance the senses, taste the experience and where necessary consumer desire.
Consumption: -You want to eat, and you want to be eagerly "led" by marketing to the consumer. The new consumer never seems to be satisfied or satisfied. Expresses its power in a gradual requirement, will want to "here" and "now", "what you want" and "when you want." Consumption has become part of our daily lives.
Speed: -Everything is speed nowadays and wanting to have it all without waiting. Consume up the images, in the same way, to consume the holidays, the food and even life itself, all very fast and without stopping.
Interactivity: -The current television entertainment programs ask what you want and how you want. Play up the games on the net with half the world interacting with us. Architecture is interactive, dynamic and changeable. Today has been a television command to choose channels, but tomorrow will be a pre-computer programmed to choose the ideal program according to our state of mind at the time.
Hybrid: -A space can be a shoe today, but tomorrow it could be a bank counter. The success of a space has to do directly with their ability to adapt to the future, according to the market. The Fashion is increasingly hybrid, and even people of the features seem to change according to the "trend"(Carvalho, 2007).
Entertaining: -Everything is a spectacle. Everything has to be a sight to be excited. The architecture has to make us wonder, the program to be a good show, we have to wonder if love it that surprises us and excites us, is a vacation, a program or a visit to a museum.
Audiovisual language: -Consumption has to manipulate through the audiovisual language to be more efficient. All areas who want to flourish, sell and succeed have to master this language and its manipulation. If we are in a society, then the image of our language is the audiovisual language (Nouvel, 2002).

NOTE

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FROM THE SURVEY TO THE REPRESENTATION OF CULTURAL HERITAGE: NEW SPREADING MODELS FOR KNOWLEDGE AND DISSEMINATION

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Keywords

architectural survey, representation of urban and architectural systems, cultural heritage's communication

ABSTRACT

At the end of the twentieth century, the outbreak of the globalization of trade in Europe was perceived as a problem but, well established phenomenon, can we find positive aspects or even look at globalization as a resource that will globalize also the knowledge and the spreading of the cultural heritage? Changing our communication strategy regarding the cultural heritage, there is maybe the possibility that globalization may indeed become a cultural phenomenon that goes deeper than just the expansion and increasing of tourist markets. As modern society is no longer characterized by categories, but from cultural, economic and social flows that overcome the geographical locations, the contribution of the scientific communities working in the field of the spreading of cultural heritage is called a strong challenge letting the knowledge became more fluent.

1. INTRODUCTION

The cultural heritage have certainly benefited of the wider knowledge of foreign countries and easy and rapid dissemination of information of global society, but together, paradoxically, have been also strengthening local identities and the defence of local cultures: to build the "knowledge economy" will be therefore only possible if, in addition to the growth of purely economic sphere, there will be also real conditions of access, openness and growth of different cultures to a new form of "democracy of knowledge".

2. BACKGROUND

This paper wants to give a brief overview of some experiences of building technology platforms designed to promote more user friendly mode of knowledge of architecture and environment and aimed precisely at an advanced stage of dissemination of cultural heritage that enhances the common value of the Italian urban, archaeological, architectural heritage.

3. METHODS

In the last years we saw how the transition from the traditional operating sequence of architectural survey to methods and procedures with an high technological degree of integration, finally went in the more general dynamic convergence of data in today's multimedia information platforms and device. Based on these considerations, at the beginning of the last decade, the research group led by the author began to experiment with models of aggregation of data from research on the cultural heritage that could convergence in the platforms open and designed to non-traditional mode of use.

4. CASE HISTORY

The study cases that are discussed in following iconography are related to different themes of application of the working methods described above and embrace different scales and dimensional quality, just with the intention of highlighting the cross-disciplinary approach.

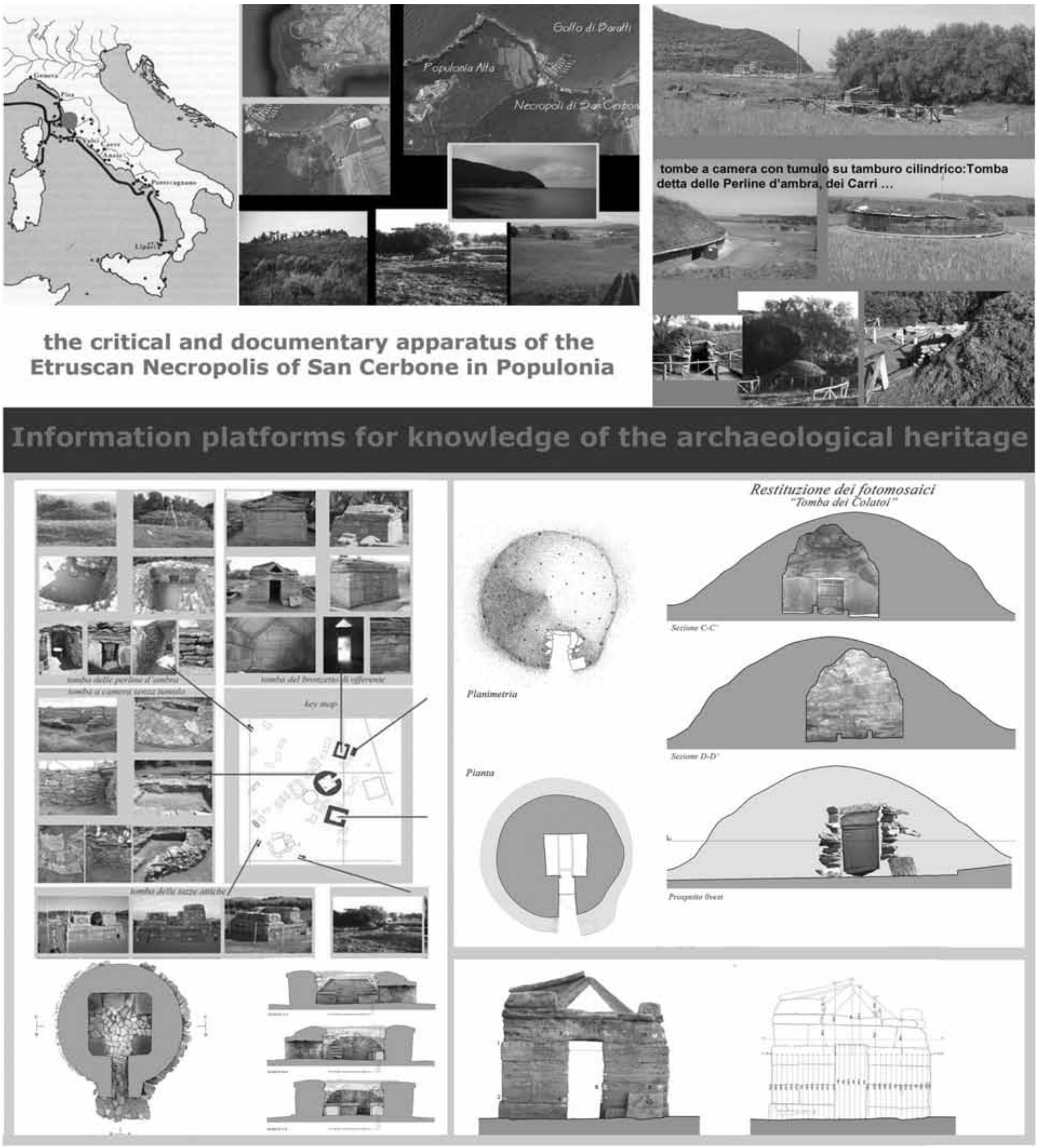

Fig. 1 Populonia project: tombs's measures and surveys in the Etruscan Necropolis.

a) S. Cerbone is the only Etruscan necropolis built near the sea, placed on the spectacular Gulf of Baratti, near the island of Elba. The vocation of Populonia between the VI and IV centuries BC was based on metallurgical processing and represented its source of wealth but also its cause of oblivion until the early XXth century, when the new extraction of iron from slags deposited over the centuries determines its discovery.

b) Emerging only monument of the Roman city of Pisa, the Baths of Nero are located within the medieval walls, near the Piazza dei Miracoli. The artifact (end of I century A.D.) was discovered only in 1548 revealing a cubical building in an octagonal room domed.

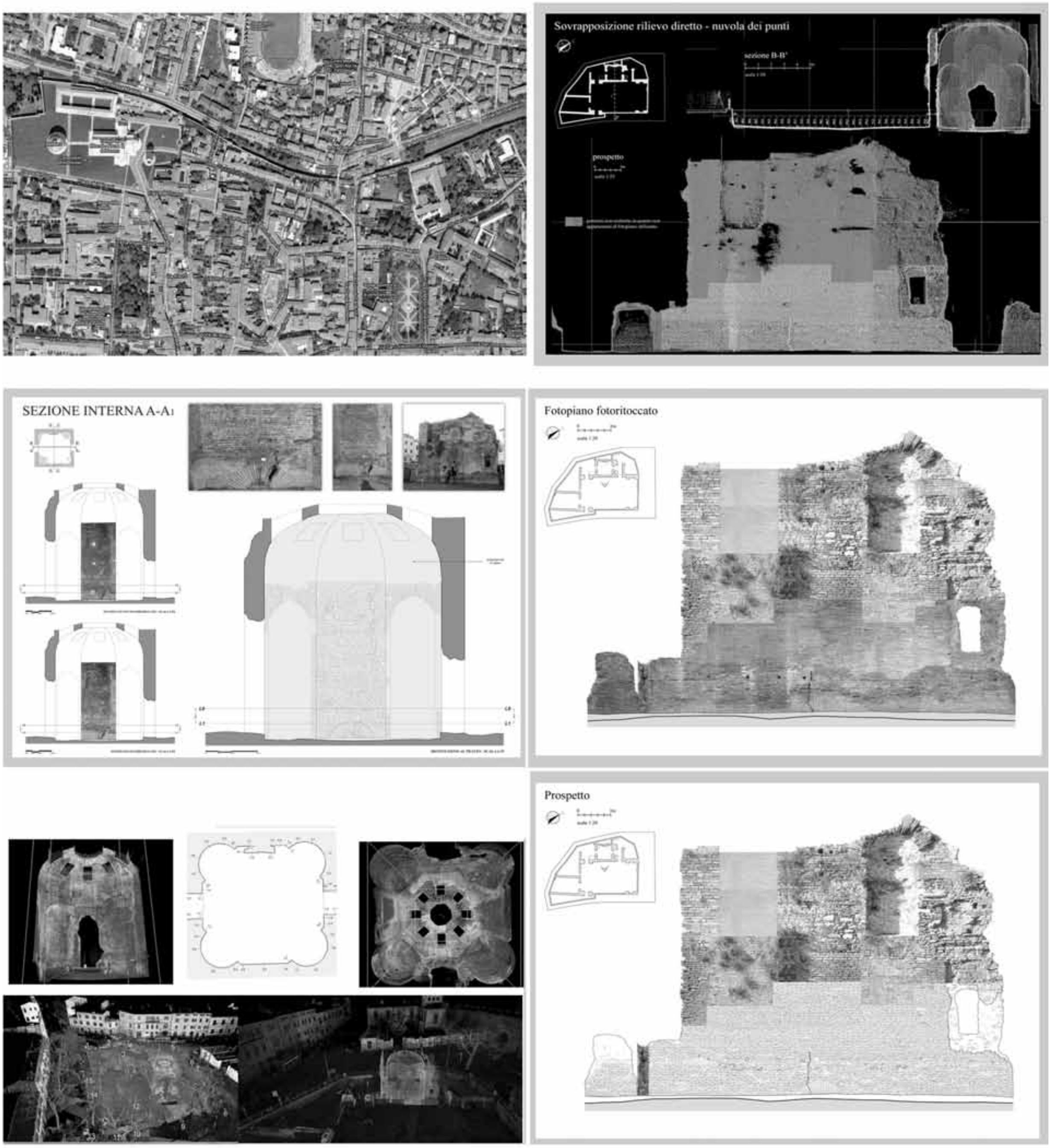

Fig. 2 Nero's thermal baths in Pisa- architecture's surveys and 3D models.

c) The small city of Manciano, situated in the south of Tuscany, is characterized from its ancient historical hill midtown; on the top the big public palace built in XIV century and now in the shapes of a "fortress", overlooks the medieval village encircling the burg.

d) Tbilisi has been for centuries an important crossroads between east and west, where the plot of the story settled an important cultural heritage, which today runs the risk of a too rapid urban modernization and lack of appreciation of the valuable remains of a past so important.

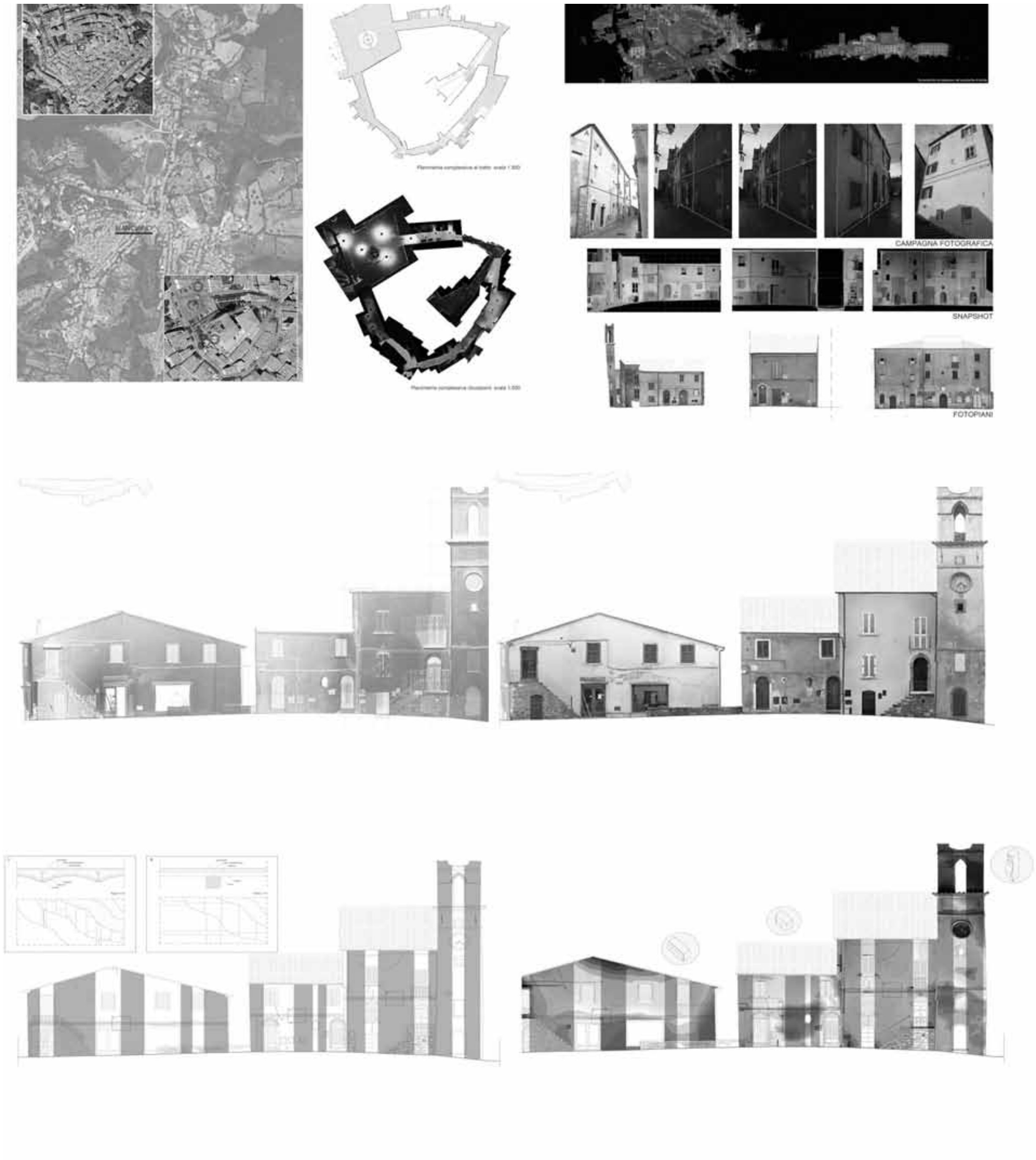

Fig. 3 The urban survey of the Tuscan historical city of Manciano.

5. RESULTS

a) A systematic survey program of 30 graves is conducted since 2007, and documents the precious and layered heritage of funeral constructions[1].

b) After a long succession of problematic restorations and abandonment we participated in the project to re-discover the monument in order to facilitate and improve its conservation and the correct touristic visit of the area by our knowledge/surveys/3D visualization system[2].

Fig. 4 The architecture’s survey of Old Tbilisi .

c) The urban survey of the Tuscan historical city of Manciano was conducted in 2014 in the framework of the didactic activity, developed in multidisciplinary approach with a special focus on the survey and representation of urban qualities and seismic hazard mapping[3].

d) The Tbilisi Project, held in cooperation with the Tbilisi State Academy of Arts, used methodologies of architecture’s survey and representation in Augmented Reality - aimed to the drawing up of the Atlas of Old Tbilisi and of the app Augmented Reality Tbilisi-ARTbilisi[4].

NOTES

[1] *responsible of the research:* Paola Puma *in collaboration with* Andrea Camilli, *research's group:* Arturo Ambrogini, Mariasole Bernicchi, Silvia Burbi, Lorenzo Cantini, Michele Cornieti, Elia Fontani, Matteo Fiorucci, Chiara Iommi, Valentina Madaghiele, Giovanni Pancani, Matteo Pecorari, Lorenzo Pianigiani, Lodovica Pizzetti, Francesco Tioli, Ludovica Vanni, Elettra Vasarri

[2] *responsible of the research:* Paola Puma *in collaboration with* Andrea Camilli, *research's group:* Giovanni Pancani, Lorenzo Cantini, Federico Paoli, Giulio Innocenti Degli, Francesco Tioli

[3] *responsible of the research:* Paola Puma; Stefano Bertocci, Giovanni Pancani, Gianni Minutoli, Andrea Ricci *in collaboration with* Francesco Tioli

[4] *responsible of the research:* Paola Puma, Nana Iashvili; *research's group:* Lorenzo Cantini, Jenny La Greca, Matteo Fiorucci, Pietro Massai, Dima Ajimyan, Azore Gudzavidze (Marchenko Lmtd)

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PREREQUISITES AND PROSPECTS OF FORMATION OF ETHNOGRAPHIC PARKS IN THE REPUBLIC OF ARMENIA

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Keywords

ethnographic park, historical and architectural heritage, Armenian studies

ABSTRACT

Exploring the rich history of Armenia from ancient times to the present day has led to the idea of creating the centralized ethnographic park "Armenia of all times" in the Republic of Armenia with the complex of pan-Armenian center of Armenian Studies as a part of it, where it is possible to present the rich historical and architectural heritage of the Armenian people and make it the property of the world public.
The issue of creating system of 10 provincial ethno-parks on the basis of local museums and the richest heritage of material culture monuments in the Republic of Armenia is raised. We are the first to bring forward this scientific problem by the above-mentioned global issue.

1. INTRODUCTION

Armenian Highland - the cradle of the Armenian people is one of the ancient centers of world civilization. Here Armenian States with their 13 capitals have been formed and flourished. Suffice it to mention the empire of Tigran the Great "Armenia from sea to sea" in the 1st century BC. Armenians were the first in the world, at the state level, to adopt Christianity still in 301 AD.
Being the only Christian nation in the world for a long time, Armenia since the 4th century independently began to develop the types of church buildings that were important for both Christian and Islamic architecture in the subsequent centuries (Alishart Gh. 1881), (Stryzigowski J. 1918), (Burov A.K. 1960). The territory, bounded by the Caspian Sea on the east and the Black Sea in the north-west, has been an important geographic center. Traders could unload goods from China in the shores of the Caspian Sea, where they were transported through Armenia to the Black Sea, from where it was possible to get nearly to any place in Europe. The road from China to Rome in 600 passed through Armenia. In the 4th and 6th centuries the Arab conquests in the south and Vikings in the north favored the flourishing of Armenia, which provided a secure connection between the east and west. Armenians in the past millennium, from the time of birth of the Armenian ethnos in 12th century. BC to the present day, have made and are making a significant contribution to the treasury of world civilization. Armenians gave the world famous ascetics - historians, doctors, architects, poets, philosophers and scientists (Lang, D. 2004). By the will of the fate the Armenian people by restoring statehood today, unfortunately, spread around the world. Armenians live in more than 80 countries around the world, their number is more than 10 million people. The geography of Armenians habitations is vast: Australia, Brazil, Chile, China, Mexico, RF, USA, Japan, etc. While, as in historical homeland in RA lives about 3.5 million people, abroad - twice as much (fig.1.). Today both in Armenia, and abroad there is a significant number of thematic centers of Armenian Studies (History Museum of Armenia, Art Gallery of Armenia, the archaeological museum "Erebuni", repository of ancient manuscripts - Matenadaran, the Museum of Folk Art of Armenia, History Museum of Yerevan, Museum Hov. Aivazovsky, A. Khachatryan, Al.Tamanyana, Parajanov, Saryan, William Saroyan, and many others). However, there is no single "Pan-Armenian Center for Armenian Studies," which would have compiled and permanently send entire activity of the Armenian Studies in monitor mode, on the level of the system -integrated approach. Armenia -- open-air museum, with tens of thousands of architectural monuments of the world, of national and local significance. In light of this, on the agenda is the most important problem of creating a national ethnographic park "Armenia of all times" with the aforementioned international center for Armenian studies. One of the major purposes of this paper is to attract the attention of both government and various layers of the Armenian community throughout the world to this important issue.

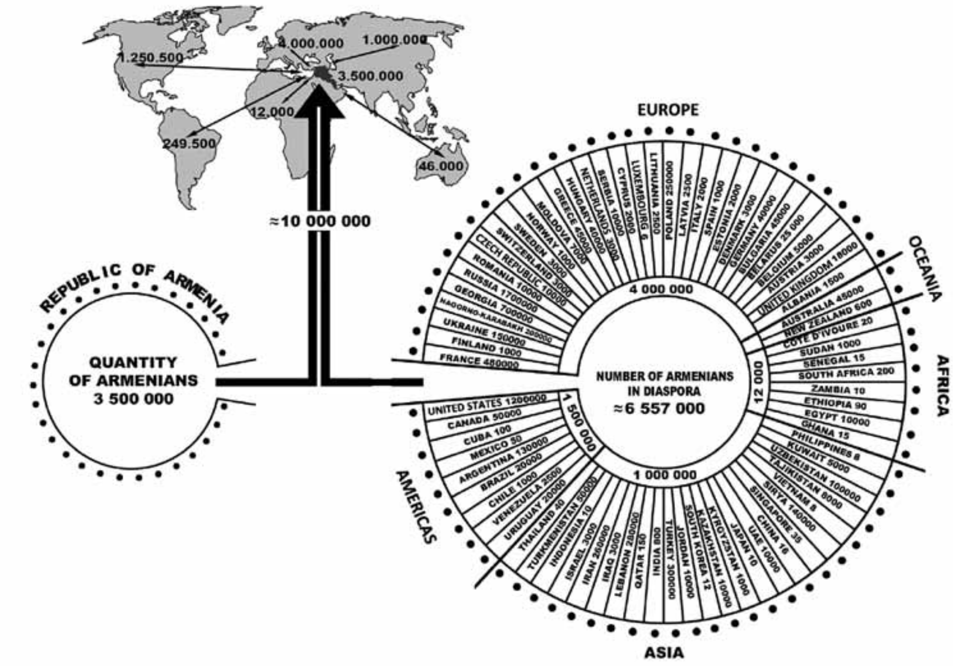

Fig. 1 Settlement of Armenians in the world.

2. BACKGROUND

The extensive scientific material on the history of Armenian architecture in order to identify the most important architectural works and their authors is summarized to record in the database of the Armenian Center for Armenian Studies and further show on the territory of ethno-park:Echmiadzin Cathedral, Zvartnots (temple of Vigil forces), Mastara Church in Ani, Bagaran, khachkars (cross-stones), etc. (Harutunuan V.M. and Safaryan S.A. 1951), (Axasyan A.V., Hakobyan A.A., Asratyan M.M., Xazaryan V.H. 2009), (Francis B.K.Ching, Mark M. Jarzombek and Vikramaditya Prakash. 2007). Creation of a genius Armenian architect - Trdat, the author of the Cathedral of Ani (1001) outgrown in the framework of national architecture. According to the leading theoretician of world architecture Austrian Josef Strzhigovski: "... in his time he (Trdat) was the creator of Gothic designs architecture, ... anyway, he found the way to the Gothic") (Stryzigowski J. 1918); the architects of the Middle Ages Manuel (Akhtamar), Momik (Noravank) and up to now Tamanyan, Safaryan (complex of government buildings in the Republic Square), Israelian (Sardarapat Memorial) Tarkhanyan (Genocide Memorial), Torosyan (Yerevan city hall) and many others (Grigoryan A.G. and Tovmasyan V.L.1986).

3. METHODS

System-integrated approach has been applied, that combines scientific research, project search based on it, and as a result, the introduction of the concept at the level of of specific project proposals. The study includes data collection, analysis and study of literary sources, electronic information and archival materials, field observation, comparative and statistical analyzes, logical and structural models.

4. CASE HISTORY

In RA there is no ethnographic park in the open air and Armenian Center for Armenian Studies, where it would be possible to centralized and extensively present all the rich heritage of the Armenian people, its contribution to the world treasury. At the same time issues of architectural and spatial organization of this type of objects are poorly understood.

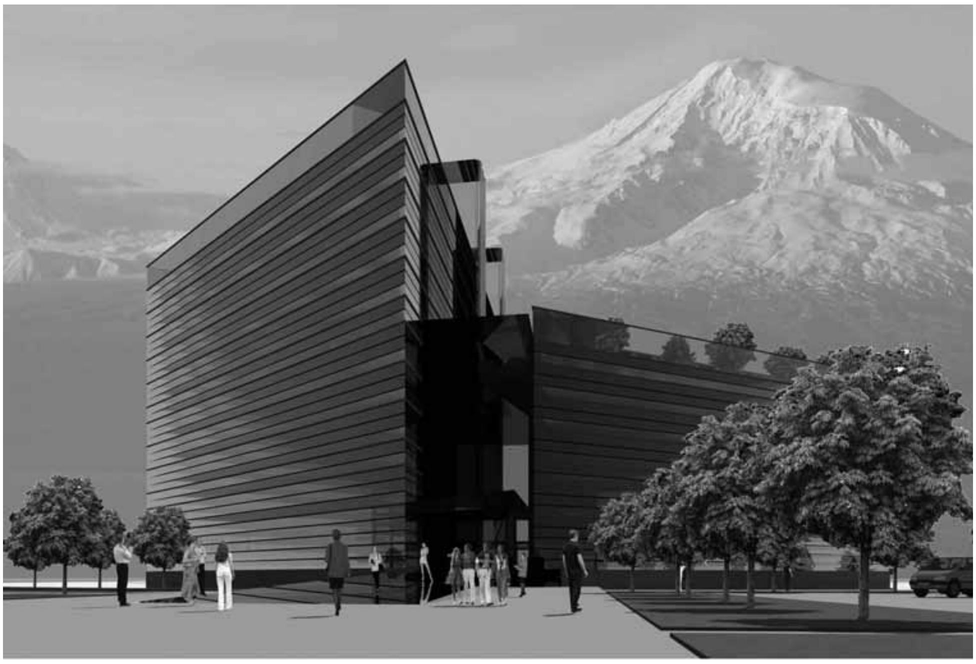

Fig. 2 The centre of Armenian studies.

5. RESULTS

For the first time the problems of architectural formation of ethnographic parks and Pan-Armenian center of Armenian studies have been fully worked out, taking into account the specifics of historical development and the natural features of Armenia and existing building codes[1].
The main tendencies and conditions of their formation are determined.
The main factors, criteria and patterns influencing on their architectural and spatial organization, are reveald.
The scientifically substantiated suggestions on organizing park and center are developed. A careful search for the determination of construction- free of the territory in the RA has been carried out, on which the park can be created. The complex evaluation of the selected territory has been given. The area is selected in Ararat region near Yeraskh and Armash. One of the factors for the choice of territory was orientation of the complex on Mountains of Ararat (**fig.2.**) The territory[2] is free of construction with the relief without significant differences in size 3x3.4km (1400 ha), where will be re-established landscape and the towns of historical and modern Armenia on an appropriate scale and masterpieces of Armenian architecture in a scale of 1:25. Creating a new entity will contribute to the function of uniformly settlement in RA. Simultaneously with the creation of the central and provincial ethnopark would be laid the prospect of further development of tourism in the ancient Armenian land.
On the territory of the national park,bounding with the Mediterranean Sea, Caspian and Black seas, by architectural forms the development of civilization in Armenian Highland will be presented (beginning with 10,000 BC and then - Neolithic 10000-5500 years BC Eneolithic 5500-3500 BC, Iron Age from 2thousand BC-till now, showing the borders, including countries of the Hittites, Assyrians, establishment of the Armenian state and the formation of the Armenian people (by MovsesKhorenatsi), Kingdom of Van (9-7th centuries BC.), Armenian kingdom of Yervanduni(6-3th. BC), the kingdom of Greater Armenia of Artashesyan (2-1st centuries BC), the empire of Tigran the Great (95-69 BC.) and up to the present day Armenia) (fig.3.). The boundaries of the Armenian states will be allocated with bulk masonry of coarse purely hewn natural stone of different breeds and colors. Water spaces of the Mediterranean, Caspian, Black seas, lakes, rivers parts will be shown, where will be placed swimming complexes and boat stations. In the green area of the park is supposed to use green plantings corresponding to historicism. The park itself is seen by public leisure center having both informative and entertaining character. In the ethnographic park in a natural environment will be reproduced masterpieces of Armenian architecture. The 13 capitals

of Armenian countries will be presented. The “Noah’s Ark” will be re-established also. Will be presented: pottery, glass-blowing, carpentry, shoemaker, tanning, binding workshops, shop, bakery, Engraver workshop, oil mill, flour mill, windmill, folk dwelling with tonir for baking lavash, with matsun karas, house of jeweler, tent vendors and many others. Visitors can walk through a beautiful park, eat, dance, listen to a concert, see the artisans at work and buy high-quality products in many souvenir shops and workshops. In the park mini-train will run, committing a leisurely tour of the sights of Armenia of all times. The Pan-Armenian Center for Armenian Studies, as a multifunctional complex will provide the conditions for the visitor center, arriving in Armenia. In the basis of the composition of the center is the idea of two crystals connected by a saddle - the symbol of Armenian biblical mountains - the Mountains of Ararat. Two-part composition of displaced relative to each other in terms of triangular (three-prong) volumes is designed, that are connected by a saddle - communication “street.” In the five-storey volume (symbol of the Small Ararat) is located the exhibition part of the complex, and in the nine-storey volume (symbol of Great Ararat) vestibules, restaurants and offices are concentrated. The upper floors are led under hotel rooms and apartments of flat type. In the buildings the atrium composition, with galleries opened in the inner space, is used. An underground and open parking is planned. Street-corridor symbolically corresponds to the connecting of Greater and Lesser Ararat saddle. Facade solution of the complex is based on the combination of different in the number of floors triangular volumes. Green architecture is widely used on the roof of the complex and around the atrium. The use of renewable energy sources is provided. Complex penetrates the pedestrian esplanade connecting the entrance from the side of the highway, which passes through the street-corridor and finds its continuation in the ethnographic park. The complex is surrounded by a water surface, which reflects the volume-spatial composition of the complex, wherewith its architectural expressiveness is enhanced.

6. CONCLUSIONS

In the Republic of Armenia, on the basis of scientific and design research, for the first time it is to create multifunctional scientific, cultural, entertainment park, focused on the work with visitors and on the commercial component and profit taking.

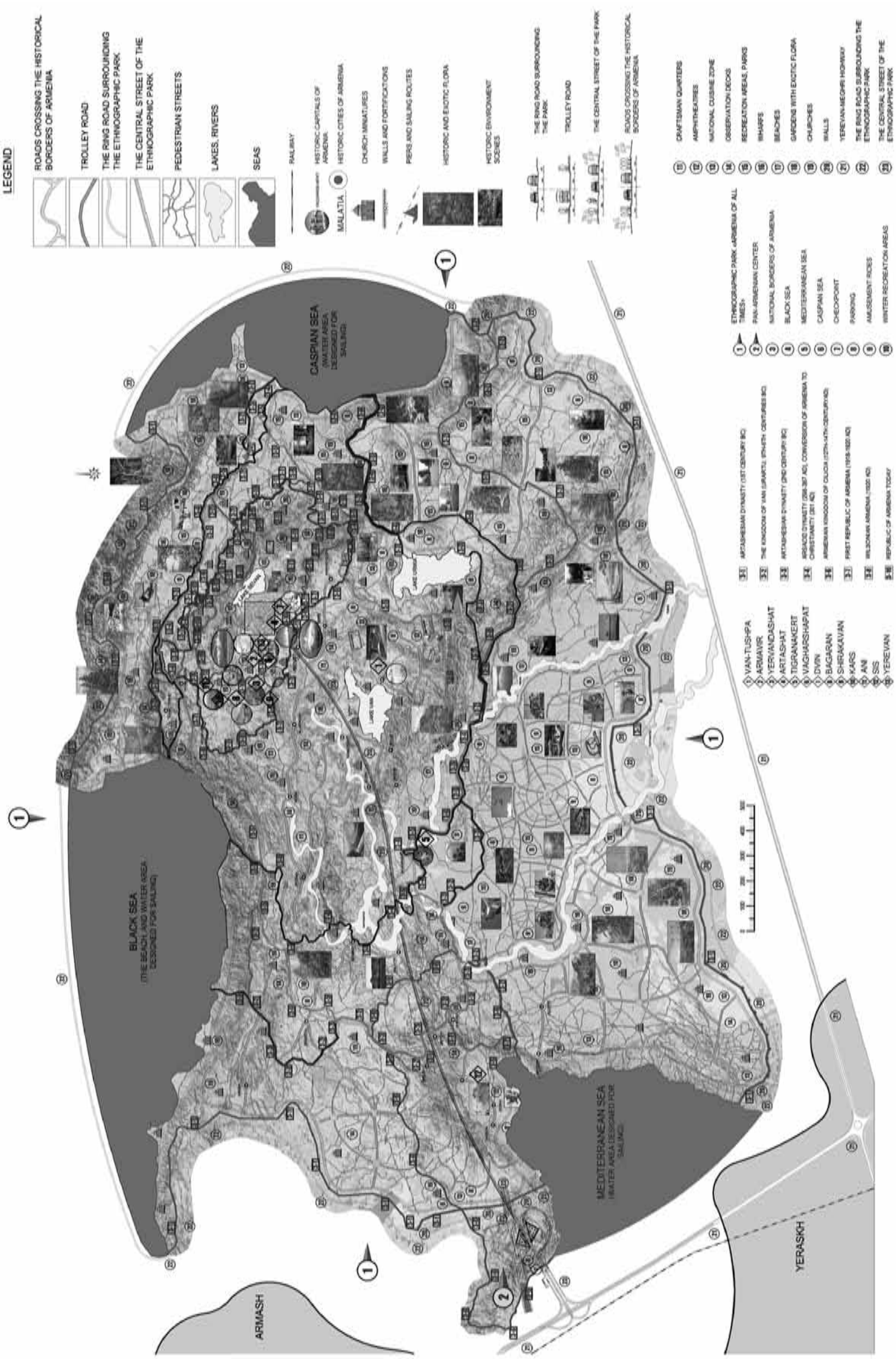

Fig. 3 Ethnographic park “Armenia of all times” with the panarmenian center for Armenian studies.

NOTES

[1] Building codes of RA 2.08.02-89. Public buildings and construction
[2] The territory has been selected due to the data of the National Atlas of Armenia (Centre of geodesy and cartography of RA, Vol.1,2, 2007-2008)

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IMPORTANCE OF REVITALIZATION MANMADE LANDSCAPE OF HRAZDAN GORGE OF YEREVAN AND PRINCIPLES OF FUTURE PRESERVATION

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Keywords

landscape protection, manmade landscape, landscape revitalization

ABSTRACT

In the area that current Yerevan, capital of Armenia, occupies there are several ancient settlements - Shengavit (4-3 millennium BC) and Erebouni fortress, several irrigation canals and Dalma Gardens that date back to 1st millennium BC. The urban area has constantly been inhabited and shaped current urban landscape based on technical prospects of the time. Today's urban landscape and pattern have references from 13th century when central part of the city was shaped. Hrazdan river as a main water source for agriculture was a focal point for economic activities started from ancient times. Based on this; most of the settlements, including Shengavit, were adjunct to the river or with an easy access to it. Dalma Gardens that still is an important piece of land being used for agricultural purposes is connected to Hrazdan river with a canal that in some parts is in use till today. This system was used till 1950's when especially in northern parts of Hrazdan gorge Yerevan inhabitants, immigrants from Diaspora and rural area inhabitants used to cultivate fruit trees and vineyards on terraces dated to ancient times. This raise graveled or sometimes paved terraces, stair-rows and water canals are remaining in some areas of gorge, where the transformation of landscape is visible. These are mostly located in those areas with gentle steepness and water access. It is seen mostly in north-eastern and south eastern (next to Yerevan reservoir) parts. This man-made phenomenon was subject of study during last few years by authors of this paper. They tried to map the area, study the topography, understand typology and consider photo archives and oral histories that will be presented for the first time in this article. It will not only raise awareness on these types of heritage that are new on preservation field. It will also promote revitalization of the whole gorge area as a unique landscape that mixes natural and man-made heritage. It will highlight the importance of restoring this landscape and the need for re-using it with its traditional purposes.

1. INTRODUCTION

Introduction of European Landscape Convention (Florence, 2000) to professionals put the correlation of man-made and natural monuments on a new level. Considering perception of people on character on area resulted of natural human factors that need to be protected, planned and managed. Although after one and a half decade that it is in force still there are cases that this mechanism is not functioning properly (Marin V., Selicato Francesco and others, 2013).

Today the protection, harmonization and association of natural and manmade landscapes with historically evolved identity of 3'000 year old Yerevan with current paradigms of urban planning and architectural innovation is a crucial issue. Hrazdan gorge as a firm example of natural and manmade landscape and also one of the main components of urban structure of Yerevan can be considered as one of the important aspects of this process.

2. BACKGROUND

Hrazdan gorge's climate is continental, with an annual average temperature of 11-12oC. Winter is short with lowest -5-6oC (January) and dry hot in summer 24-25oC (July). Both the cold and hot climate is being mediated by Hrazdan river and ravine topography. Annual precipitation rate is 350-400mm. There are several water springs in the gorge which are connected to sub-lava water supply horizons. They provide humidity on gorge slopes which are vegetated with Ash, Maple, Elm, Acacia and other wild fruit trees (Shahinyan, Aleksanyan, 2014).

For centuries slopes were used for agricultural and habitation purposes in the entire area of Armenian highlands. For that reason slopes were transformed to terraces to improve the efficiency of land and slow down the soil erosion process. One of the examples of this can be considered the slopes that are on the right slopes of Hrazdan gorge between Hrazdan river and Dalma canal, where the steepness of slopes varies from 25% to 400%, in average about 300%. It occupies about 3 km long area with a width of 50 to 120 m, with a total area of 20 hectare (Fig. 1).

At the initial phase retaining wall for shaping terraces are built from falling rocks - basaltic andesite pieces with a height of 1 to 3 m. For reinforcement of the bases sometimes these are put in an angle on bare maternal cliffs. Retaining walls are made of huge irregular basaltic andesite pieces of different sizes. They can vary from 40…80 cm in length, 40…60 cm width and 15…50 cm height. A retaining wall with height of 2 m may have around 15…20 rows of masonry without mortar. In some parts up to 15 terraces were built, for what soil from higher terraces have relocated to lower terraces, with around 40 cm upper hummus layer. The width of terraces varies from 3 to 6 m. Some of them were more enhanced with some adjunct structures – shelters for short stay or winepresses. Terraces are connected through stone stairs again from available rocks of the area. The main water supply source for irrigation was Dalma canal which brought Hrazdan river water for higher elevation. There were secondary ditches that are well preserved in some parts. Although Dalma canal is not preserved in its full and original form, it continues to irrigate Dalma Gardens located in south-west of the city (Shahaziz, 2003). The canal is partly enclosed in pipes and in some parts walls have collapsed but water found its way through the rocks and continues to, flow (Shahinyan Davtyan, 2014) (Fig. 2).

Started from 1950's, after Second World War, the area is left abandoned and agricultural landscape is distorted and fruit horticultural trees have been transformed to decorative wild plantations and trees – Elms, Acacias, etc. In some area retaining's walls were collapsed and land was eroded. During regular site visits some examples of recent activities were discovered, mostly dated to early 1990's, just after the collapse of Soviet Union and during economical rigid period. At that time some of residents from surrounding neighborhoods started cultivate vegetables and fruit trees for family needs.

Architect Gevorg Musheghyan in 1986 writes: *"In very rare cases we see grape yards at artificial terraces of Hrazdan gorge. Here they cultivate mostly oak, apricot, pear, plum trees, rarely premature apple, cherry, sour cherry trees, etc.*" (Musheghyan, 1986).

3. METHODS

Authors studied available archive materials about the area, Yerevan spatial planning plans and other documents, particularly for the last centuries and also available archeological surveys for the surrounding area. A particular area of Hrazdan gorge is selected where terraces, retaining walls, stone stairs and stair-rows, gates and other structures are well preserved and grape yards, apricot and almond trees locations are known. For that specific are a topography update was carried out for future design and policy proposals.

4. RESULTS

During research it became clear that the topic has interested researchers in the past, but there were not any tangible studies and publications. It was also obvious there were not available complete examples of multidisciplinary and integrates studies on landscapes to expose, assess, protect and manage it as a singular heritage system.

There are some other examples in historical areas of Armenia that settlements are located on steep slopes. In particular in southern (Syunik and Vayots Dzor) and northern (Shirak and Lori) regions of current Armenia. Especially in Syunik region there are several well persevered and existing settlements on slopes where more areas with lighter elevation are kept for agricultural purposes. The same technique of transforming steep landscape to terraced agricultural plots is used here also, especially for those cases when gravity irrigation is possible (Papukhyan, 1972).

Although the Hrazdan gorge situation is the opposite and plane areas were inhabited and developed, the gravity irrigation capability and semi-arid climate can be considered the main reasons for using the steep slopes for the agriculture cultivation.

During study it became obvious that constructions on steep slopes in Syunik region, especially Meghri sub-region, was realized by migrants from north Iran region (Papukhyan, 1972).

This fact is interesting as the area of Hrazdan gorge that was considered in this paper neighbors to a district of Yerevan that in early 20th century was inhabited by migrants from the same region of Iran. More specifically the Arabkir and Zaytun districts both with adjacent to Hrazdan gorge built in 1920's for repatriates of Armenian diaspora.
The first master plan of modern Yerevan that envisioned current Yerevan and was developed by the architect Alexandr Tamanyan and was approved in 1924 considered Hrazdan gorge as the main natural component of the city. As a basis for wider green system it was included in the next master plan by the same architects in 1936, and in all further coming spatial planning plans and documents (Safaryan, Gasparyan, Aloyan 2011).
Starting from 1970's some continues actions were taken for protection and development of natural landscape of Hrazdan gorge. In particular the Plan for Organization of Landscape of Yerevan (Authors: Artsvin Grigoryan, Sargis Nazaryan and others) resulted several beautification projects in the gorge area. Although it was landscape oriented plan, it did not consider the historical manmade heritage of the area. In 1980's another initiative put into discussion that was aimed to restore historic Dzoragyugh (Gorge Village) neighborhood on top cliffs of Hrazdan gorge. Even though it has not been approved for realization, some of the buildings later were built based on that approach (Parajanov Museum, Dzorgyugh Restaurant, etc.). This did not revive historical environment, but highlighted the capability of landscape focused projects by involvement of private sector, without any public funding.
Hrazdan gorge continued to draw the attention of planners and policy makers even after Armenia gained its independence. New Master Plan of Yerevan approved in 2005 envisioning the city till 2020 (Authors: Gurgen Musheghyan, Petros Soghomonyan and others) and Zoning Plan for Center of Yerevan (Same Authors) considered Hrazdan gorge important for its biodiversity and "need to define it as a Natural Special Protected Zone" (Musheghyan, Soghomnyan 2004).

5. CONCLUSIONS

As it was mentioned ahead Hrazdan gorge is mostly being considered as a natural landscape and never a unique combination of natural and manmade valuable heritage.
For revival and renewal of the historic agricultural landscape it is needed to restore initial terraces, replace wild vegetation with fruitful trees and plants considering available data's from historical sources.
Authors propose to take inclusive actions and involve local community member for protection and development of this valuable piece of landscape. It will reduce also unemployment rate of that area of the city and will increase small and medium sized entrepreneurial activities. This matter is crucial as for this type of initiatives the best way to make the development a sustainable process and reduce failure risks is to implement multi-component and easy manageable partakers. The restoration process needs to be carried out based on scientific and deep studies and methodologies, in particular highlighting the unique manmade landscape with its hydro-engineering system, terraces for horticultural activities?, pavement and stair-rows connecting them, shelters, storages and winepresses, water fountains and springs. This process has to be done with a special focus on sustainable integrated approach by taking following actions:
• Broad assessment of the area, with a special focus on geomorphological structure and biodiversity;
• Mapping and defining areas suited for protection and development;
• Implementation of Archeological surveys in the needed areas;
• Restoration of historical landscape.
As a result of restoration some examples of local traditional dwellings can be introduced, for example houses with Hazarashen roof (dome shaped wooden structure), winepresses, traditional bakeries (tonratun), cozy wineries, etc. The combination of these amenities in one common infrastructure can bring a new dimension to the area by transforming it to vibrant rural space within urban structure.
In particular last steps have to be anchored on initial research phases. The restoration is to be carried based on scientific approach, resulted concrete and practical planning policies.
Monitoring and supervision of this process is a crucial part of management to avoid distortion and deformation of historical landscape and also reduce commercialization. It can reduce the real value and common interest of the area and its landscape and cause the decline and failure of the project. Especially landscaping ideas, restoration of buildings, illumination, informative and promotional signs, their materials and design solutions has to be controlled and supervised as a high priority.
This has to be addressed as a smart mediation of traditional technics and today's hygiene for kitchenette areas, restrooms and other areas, structures with high hygienic needs.

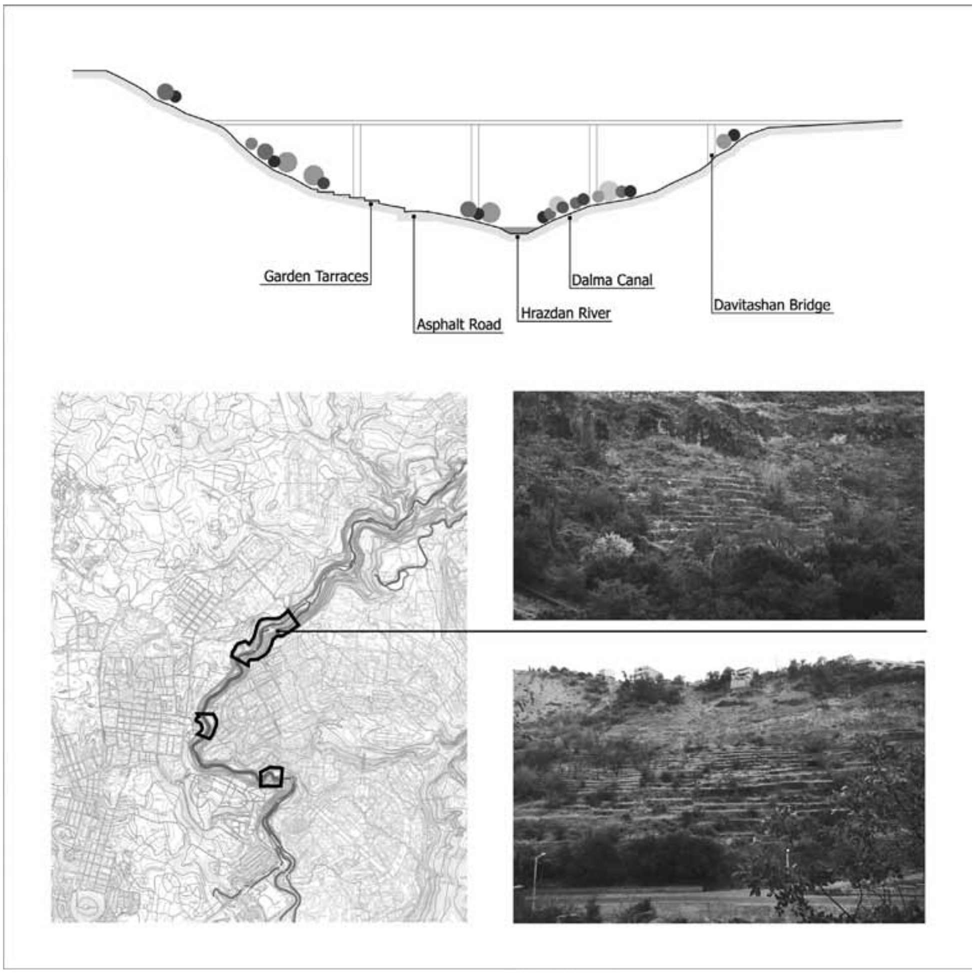

Fig. 1. Elevation of Hrazdan gorge; Situation map of well-preserved terraces and some images, Spring 2015;
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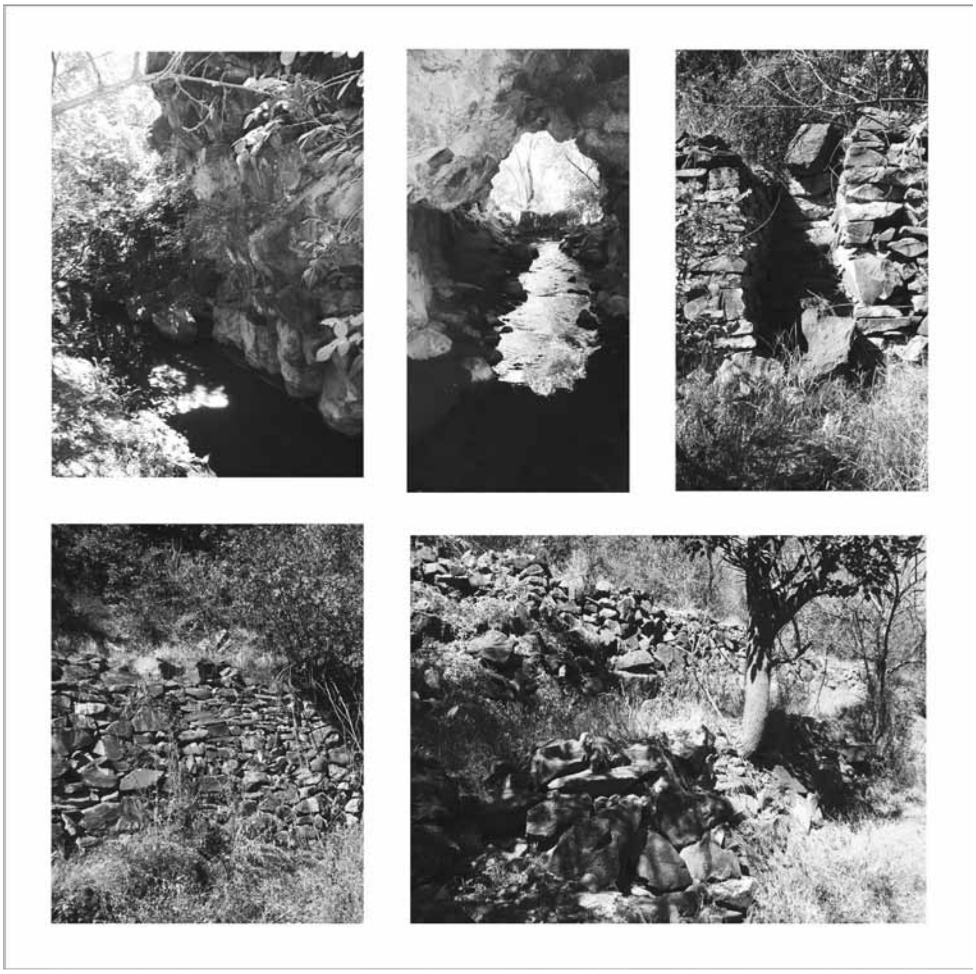

Fig. 2 Images of Dalma canal and remaining terraces, Spring 2014;
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ON SOME ISSUES OF OPERATING OPEN AIR MUSEUMS

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Keywords
education, aerial, open air museum

ABSTRACT

Today there is a vast need for open air museums to be operated in a new way, creating a new interpretation of the environment by means of adapting them for the modern life. There are some ideas that can develop open air museums for additional use. Nowadays there are number of alternative ways of education developed by means of distance learning, public lectures, interactive discussions, master classes, workshops. Open-air museums may be the most important source of information, creating chances to get education in situ of 3D monument environment. Another idea is the use of aerial tramways in open air museum territories, it is a good solution to preserve valuable sites from visitors' traffic, furthermore the aerial trams may give tremendous opportunity to get perception of larger territories of open air museums and finally the harmony of landscape can be preserved without disturbing the integrity of the open air museum.

1. INTRODUCTION

As a matter of fact open air museums prove the human activity in the past, and it's perhaps one of the primary ways to understand the development of human activity, their relations and creations throughout the years and centuries. The role of open air museum is the preservation and transmission of historical memory. Thus, open air museums with their historical, cultural, as well as archaeological heritages are significant part of the true culture. In this regard, Armenia, the history of which dates to thousands of years ago, is of utmost interest with its open air museums cultural heritage, it is a real treasure not only for specialists of the field but also for the entire humanity. Today it is a matter of concern to use this cultural heritage in the open air museums in Armenia more actively and freely for the contemporary culture. A. Safaryan suggested a conceptual project of national ethnographic park in Republic of Armenia (Safaryan A. 2013). Open air museums are considered to vary in types and methods of being presented and accordingly require particular approaches to be operated.

2. BACKGROUND

Every era requires the creation of a special environment to adapt ancient historical layers in modern life, transforming encrypted information for the modern understanding. Today open air museums are reborn and fresh packaging is sought to satisfy and captivate our modern audiences (Zeuner Chr. 1992). This tendency is observed in many countries, for example, during the past decade several museums in Germany and the German-speaking countries have been redesigned and reopened or will do so in the near future. Their exhibition concepts take very diverse approaches; their claim to innovation varies highly (Edenheiser I. 2014). There emerge new ways to present open air museums. This paper observes some ideas about new opportunities to operate them. Over the last two decades, due to information technology development, there is a social and cultural great progress in the field of public education.
As a matter of fact, today the information has become much more available. To provide contemporary education to the new generation, a great number of alternative ways is being developed by means of: distance learning, public lectures, interactive discussions, master classes, workshops. Marie-Paule Jungblut in her paper discusses the challenges where the museum encourages users to learn and participate through hands-on interaction and connects

(online) audiences to exhibition themes and to each other (Jungblut M-P. 2014). Specialized lectures on restoration and conservation held by qualified experts and work in study groups provide an essential introduction to the main areas of open air museum activity. Today we can observe that there are number of museums that organize theoretical and practical classes. It is quite a long period of time “Erebuni” Historical and Archaeological Museum-Reserve in Yerevan, Armenia conducts classes on excavation processes among schoolchildren. The National museum of Belarus started educational program for schoolchildren from 2001. Here it is suggested that schoolchildren become assistants for archaeologists, help them carry out archaeological excavations. The purpose of such training is the formation of historical consciousness and respect for archaeological sites, as well as to stimulate interest in the history and archeology of the country. During the classes the task of the specialists is to introduce the children the work of the archaeologists and gives an idea of how to conduct archaeological excavations by involving them in the process. Only by taking part in it, one can feel how serious, responsible work archaeologists do, to create the impression of his work. But more can be done for future education.

3. METHODS

One of these ideas is to make use of historical site of the open air museums to an educational environment, by means of architectural reorganization of the site for study process, so arising interest among many learners and consequently providing more attendance to the site. This is precisely the case when open-air museums may be the most important source of information, creating the chance for the new generation to get education in situ of 3D monument environment, therefore contributing the functional perspectives of open-air museums. If we choose the open air museums as learning environments in the wider sense of learning it suddenly becomes evident that learning in such particular environments can contribute the process of getting special and additional knowledge. Since, as learners, people are all different and learning process needs also to be developed, to become different over the time, there is of course a vast demand in providing educational processes in a different way. It is possible to create learning situations with an historical atmosphere and historical time in the open air museum surroundings, it could be the type of practice that people can experience another way from what we are used to do now and the learners may create a full picture in the imagination during the study process. New environment will attract the people to learn more, and educational environments directly may turn out to be more efficient for learners in the open air museum.

This special atmosphere may become the strongest factor in shaping the open air museum as a learning environment with specific possibilities. In this regard open air museums can be prepared for providing educational activities; the environment can be adopted for such an occasion. After the analyze of the site, architects can observe the possibility to add some small elements - amphitheater, stage, benches, add some more walking trails if it is required, etc. After all in ancient times Greek and Roman architects experienced the idea of amphitheater and today we can witness the existence of them in many historical sites (eg. Trieste Roman amphitheater). I myself used to have chance to practice this idea; the matter is that the process of excavation in Shengavit settlement in Yerevan, Armenia, is going in a very slow motion. This settlement is one of the most significant archaeological monuments in Armenia dating from the early Bronze Age. It requires some new ideas to be used for continued existence in the future.

The suggestion for that site can be to include an amphitheater in the environment, therefore adapting the site for educational occasions as well[1] (fig. 1). Yet, the most important factor in the process of designing something new in the site is the complete understanding of its landscape context. In order to establish the landscape context for a particular design, there should be a look beyond the boundary of that special area for better understanding the regional patterns that influence the site. Prior to design process it is important to understand how a particular location relates to regional influences, it is essential to distinguish how the new built environment should respond to the site, to ensure that the design will be well integrated into broader patterns of landscape and culture.

The idea of modifying the open air museum to educational content can be fulfilled only in case if all kinds of new developments in the open air museum site are environmentally sensitive and consistent with long-term nature conservation; otherwise, it presents risks to the sustainability of the site itself and more generally the natural environment.

4. CASE HISTORY

Searching for new peculiarities of presentation open air museums it is necessary to mention about one more idea.

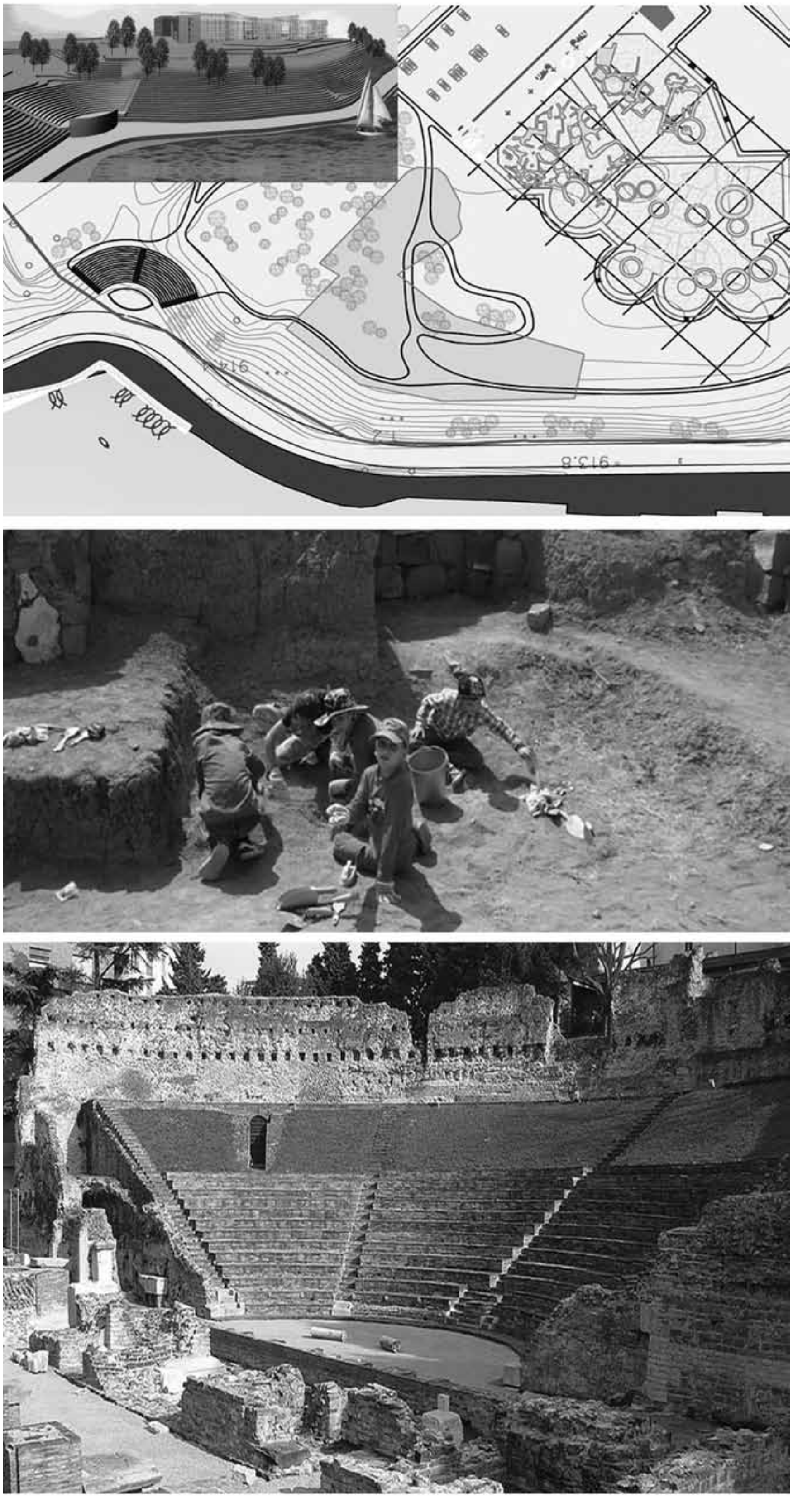

Fig. 1 The open air museum can be adapted to educational processes by means of adding an amphitheater like it is in the project of Shengavit open air archeological museum, considering the experience from ancient times, for example Trieste Roman amphitheater

Indeed, open air museum are considered as irreplaceable cultural richness. Their focal function is to be presented to the visitors, and today they appear to be a part of tourism industry, nevertheless with some negative effect. It is evident that there was always a tension between archeologists and visitors. The excavation activity is a long lasting process that requires more time to examine the historical sites. Furthermore, preservation of historical and cultural heritage is a vital necessity in modern society. Visitors' attendance to these sites is quite risky, there is always a threat to cause harm to the site. Yet to reject the revenue from the tourism industry is not sensible for open air museums, since they are of great benefit for them. They guarantee stable income for the future; it is here when there comes forward a new demand to observe new possibilities to present open air museums combined with these two difficult coexisting concepts – tourism and open air museums. The objective of this new idea that I want to present is to bring open air museum to a new level of perception with excellent possibility to observe it from aerial attractive view. In connection with this, to hold this possibility, now you welcome the idea to use aerial tramways in open air museums. Aerial tramway is not a new phenomenon in our reality. Its prime function is to transmit passengers and load through mountainous and hazardous territories. Yet aerial tramways are often found in tourist landmarks. In the beginning of the 20th century the rise of the middle class and the leisure industry allowed for investment in sight seeing machines. Today there are more than thousand aerial tramways used all over the world. They pass various paths-through the water surface as it is in Barcelona. The aerial tramway crosses Port Vell, Barcelona's old harbor, connecting the Montjuïc hill with the seaside suburb of Barceloneta, the Vallée Blanche aerial tram passes between Courmayeur, Italy and Chamonix, France over the Mont Blanc massif, in the Alps. Another type of aerial path is the Roosevelt Island tramway. It is an aerial tramway in New York City that spans the East River and connects Roosevelt Island to the Upper East Side of Manhattan.

5. RESULTS

In our case my deep consideration is that there can be a good use of aerial tramways directly above the open air museum territories. It can be an ultimate approach of presenting open air museum in a new way; furthermore their use in open air museums can solve some problems mentioned above.

First, the open air museums can get chance to be observed from the most attractive view-top view, without missing a single detail, getting the best view of the museum. This kind of perception gives more complete information about the territory. Besides, there exist sites that are not very much expressive and are required to be presented from a better side. Top view of the site is always an expressive way to be shown. Beyond everything, in case of aerial tram, it appears a tremendous opportunity to pass through territories of open air museums the beauty of which is visible only from top view (fig. 2), such as star shape forts-cities[2] Neuf-Brisach[3] (France), Palmanova (Italy), etc. Such military open air museums are believed to be observed from the top view to get the impression from the entire beauty of these star-cities. Secondly, according to this idea, the aerial trams can pass through larger territories of open air museums taking visitors from one point to another at the same time saving time to get the whole stunning view of the site with minimum effort and maximum satisfaction for that. Examples of such enormous open air museum can be parks of Chantilly, Versailles, France, etc. The features of landscape design in such open air museums, the sizes of which are enormous, could be entirely measured only from top view. Finally, the use of aerial trams can really solve the problem of linking tourism and open air museums, keeping safe the valuable territory from visitors' traffic, especially the archeological sites, where ongoing excavations are in processes, thus saving the relationship of tourists and archeologists.

6. CONCLUSIONS

Analyzing new possibilities of operating open air museums we can come to conclusion that it is important to understand that unfortunately open air museums are often in adversary situation, it is far preferable for the relationship between the open air museums as, in most cases, protected areas to be viewed as an asset offering both positive and productive benefits. The relationship between open air museums, its protection and use is thus highly significant issue, which is in need of much greater research attention if the natural recourses which open air museums so heavily rely upon are not to be degraded or destroyed.

The searches to find new ways to operate open air museums can and will be continued and indeed the possibilities will be different as open air museum themselves are, and new ways to operate open air museums by all means must reserve the harmony of the landscape of the area, without disturbing its integrity.

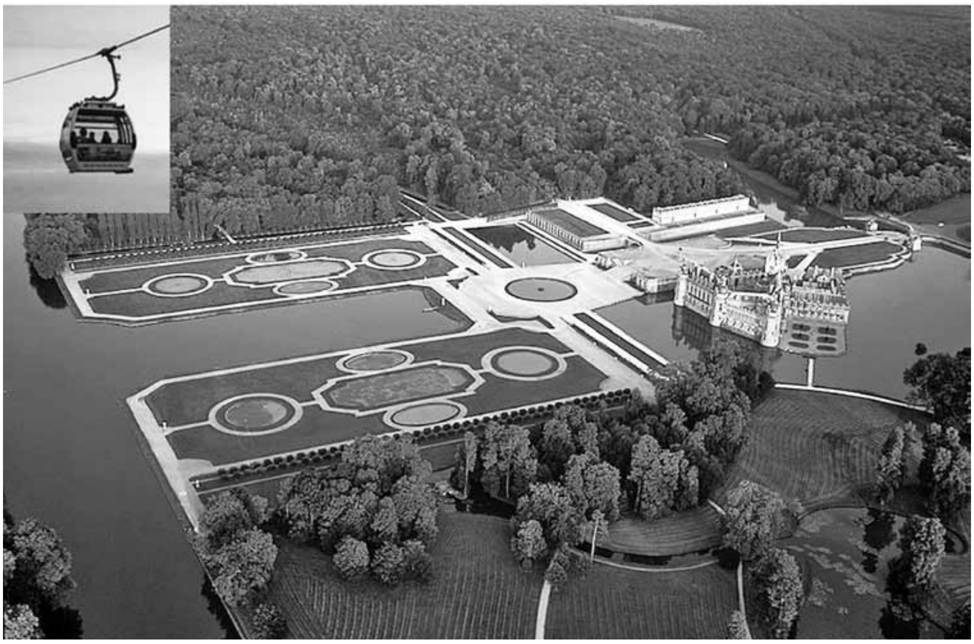

Fig. 2 Using aerial trams is tremendous opportunity to pass through territories of open air museums the beauty of which is visible only from top view (parks of Chantilly in France, Palmanova star-city in Italy)

NOTES

[1]In my final diploma project there was an attempt to improve and recover Shengavit archeological open air museum, and except that conservation project was suggested in the presented work as an additional idea was to add an amphitheater in the environment, therefore adapting the site for educational occasions as well.

[2] Star-shaped forts were a particularly interesting type of fortification. They first appeared around the time that gunpowder became commonly used in warfare; the unusual shape of the forts and the fact that they were made of hard-to-shatter brick (rather than the traditional stone) helped the forts stand up to cannonball fire, Starry Knights: 14 Stellar Star-Shaped Forts & Fortresses, http://weburbanist.com/2010/03/11/starry-knights-14-stellar-star-shaped-fortresses/

[3] Louis XIV himself said of Neuf Brisach: "of all the diamonds in the Crown of France, the most beautiful is the fortress of the Rhine". The Vauban Citadel, http://www.haute-alsacetourisme.com/EN/Discover/Must-sees/The-Vauban-Citadel.html

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ARCHITECTURAL AND SPATIAL DEVELOPMENT OF THE VILLAGE KONY FROM XVI TO XXI CENTURY

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Keywords

preservation of historical and architectural heritage, material and spatial organization of the environment, the northern rural settlement

ABSTRACT

The work analyzes and evaluates the conditions, regularities and peculiarities of formation of the material-spatial environment of one of the unique rural settlements of "Vym land", Republic Komi, – village Kony, the rich cultural heritage of the XIX century. The study revealed the features of life settlements in the period from XVI to XXI century: data analysis of field surveys revealed semantic, informational and aesthetic potential of the material and spatial environment of the settlement; disclosed the relationship and patterns between historical and cultural development of the village Kony and territorial organization of settlements. The obtained results allow finding a reasonable approach to the development of the architectural-ethnographic Museum under the open sky, which will serve as an effective means of transferring relevant to new generations of national historical and cultural specificity.

1. INTRODUCTION

Preserving the historic, cultural and natural heritage is considered in the modern world as one of the key priorities of the cultural policy of any state. The object of protection and research of historical and cultural heritage are key elements, parameters, characteristics of the preserved material and spatial environment, which are carriers of historical, cultural, architectural and artistic value. Identify the conditions and characteristics of historical, architectural and compositional organization of rural settlements of the past, revealing semantic, informational and aesthetic potential of the material and spatial environment, is an important task in the preservation and modern use of heritage monuments (Zueva, I. L. 2013). Territory "Vym land" in the Komi Republic has many historical and architectural sites of conservation significance, study and modern use in the conditions of continuity in development. One of the unique objects "Vym land" is the village Kony, historical and cultural characteristics and spatial potential which is not sufficiently studied to implement the objectives outlined above.

2. BACKGROUND

Questions the necessity and expediency of preservation of historical and cultural heritage of the rural environment have become urgent because of the increasing number of losses of monuments of architecture and urban planning, due to the lack of scientifically based knowledge about the potential and modern use and development of these facilities. Methodological framework the present study is a work dealing with the problems of preservation of historical and cultural heritage of rural settlements; urban studies values of monuments of folk architecture; methods of conservation, restoration and reconstruction of unique ensembles of rural settlements (Sevan, O. G. 2011; Ushakov, Yu. S. 1982; other). A study on "Vym land" is represented by the works of historians, ethnographers and archaeologists, where heritage is seen as a memory of the past (Zherebtsov, I. L. 2000; other). However, a comprehensive study aimed at revealing the historical, cultural and architectural spatial capacity of the village Kony for the purposes of preservation and modern use, are missing, while the buildings of the village are fine examples of wooden architecture of the XIX century.

3. METHODS

The village Kony in the study is seen as historical, cultural and architectural phenomenon "Vym land" and the Komi Republic, as an object for further museumification. The main areas of research that reveal the potential and boundaries of the phenomenon to develop recommendations for museums are as follows: chronological and historical-cultural features (the basis for identifying time periods in the development of the settlement); historical and architectural features (semantic, informational and aesthetic potential of the material and spatial environment of the settlement – the monument of wooden architecture "Vym land"); spatial features (the basis of patterns of spatial development of settlements).

4. CASE HISTORY

The village Kony is currently formed cultural landscape unit – a combination of a village with a surrounding area. Restoring the history of the formation of the settlement was done by the localization of the villages in the area according to the available written sources of different time period (Zherebtsov, I. L. 2000; other). Data sources allowed us to determine the territory of the villages, their location and size, the approximate boundaries. The village Kony is settlement, which appeared in the XI century, and later became the key point of the spatial system of settlements "Vym land". The study area was previously identified as an important item in the geographical and strategic, through which passed the Northern route to the river Ukhta and into the basin of the Pechora river (Pimenova, G. I., & Zueva, I. L. 2005, April).

The study revealed a recurring after 300 years the stages of formation of the settlement, including its formation, development, and death-the desolation, the revival (Fig. 1). Such sustainable existence of the village contributed to: the exclusion of areas from the transport network of the area; the preservation of traditional forms of popular culture; "remoteness from civilization". On the development of the village Kony was influenced by economic factors, socio-political conditions, climatic conditions (Christianization, ancient trips to Siberia along the river, rafting down the Vym, crop failures, famine).

The study identified and disclosed the relationship and patterns between historical and cultural development of the village Kony (in time: the biography of a village development boundaries, XI-XXI centuries) and spatial organization of the settlement (in space: built-up area of the settlement varied from 5 to 100 ha).

The settlement was developed from individual estates. Group of houses freely was located in the landscape, but the original structure of Kony has evolved organically communicating with the relief. A significant number of residential buildings, built in the second half of the XIX century, constructed so as not to block the view of the river. With the increase in the number of buildings has gradually formed the ranks, formed coastal-ordinary type of construction (Fig. 2). The village is dominated by houses with porches on the façade (Fig. 3). Due to climatic conditions in the Northern village was erected constructions so that you almost never leave the house. Vym type of house and its modifications constitute a quarter of the residential area of the village. The remaining mass of huts in its architectural and structural solution is slightly modified version (Fig. 2). In the village Kony survived a variety of huts, with original porches that gives you the opportunity to see how gradually type of north hut is formed. The main and sometimes the only decoration of the house – porch with carved details, columns and arcs (Fig. 3).

The uniqueness of each house in the General model space-planning decision traditional dwellings related to the structural ordering of its elements and decorative details, using the artistic home of a flexible system of proportioning (Zueva, I. L. 2011, Novembre).

The barns housed in a picturesque manner and are not on the ground and on poles. In situ study of the settlement showed that the placement of the new buildings in place previously existed, or close to them, sometimes one of the parts houses was rebuilt again. Therefore, the layout of the development has retained the traditional order.

Each building of the village was perceived in unity with neighboring, that is, as part of the whole. The lack of coverage in the streets gives the uniqueness of the area, gives the impression of purity, naturalness. Placement of household plots randomly, but most houses don't have them. From 1903 to 2001 on the main square of the village stood a steepled Church – vertical which was contrasting horizontal lines coast and houses. The Church, forming the main square of the village, was the compositional center of the settlement; its roof was visible from any place of settlement, and from the river. Additional guidance, emphasis served as a chapel – a monument of architecture of national importance. On the territory of Kony has a small number of trees, which is a tradition for Vym northerners – trees near houses close sun, detain excess moisture and vain is needed for planting the ground.

The basis of visual perception, which in folk architecture has received considerable attention (Ushakov, Yu. S. 1982), based on the degree of disclosure of the settlement to the main navigation (water and land). The village Kony, is located on the banks of the river, and at a time when the Vym river was a transportation route, the composi-

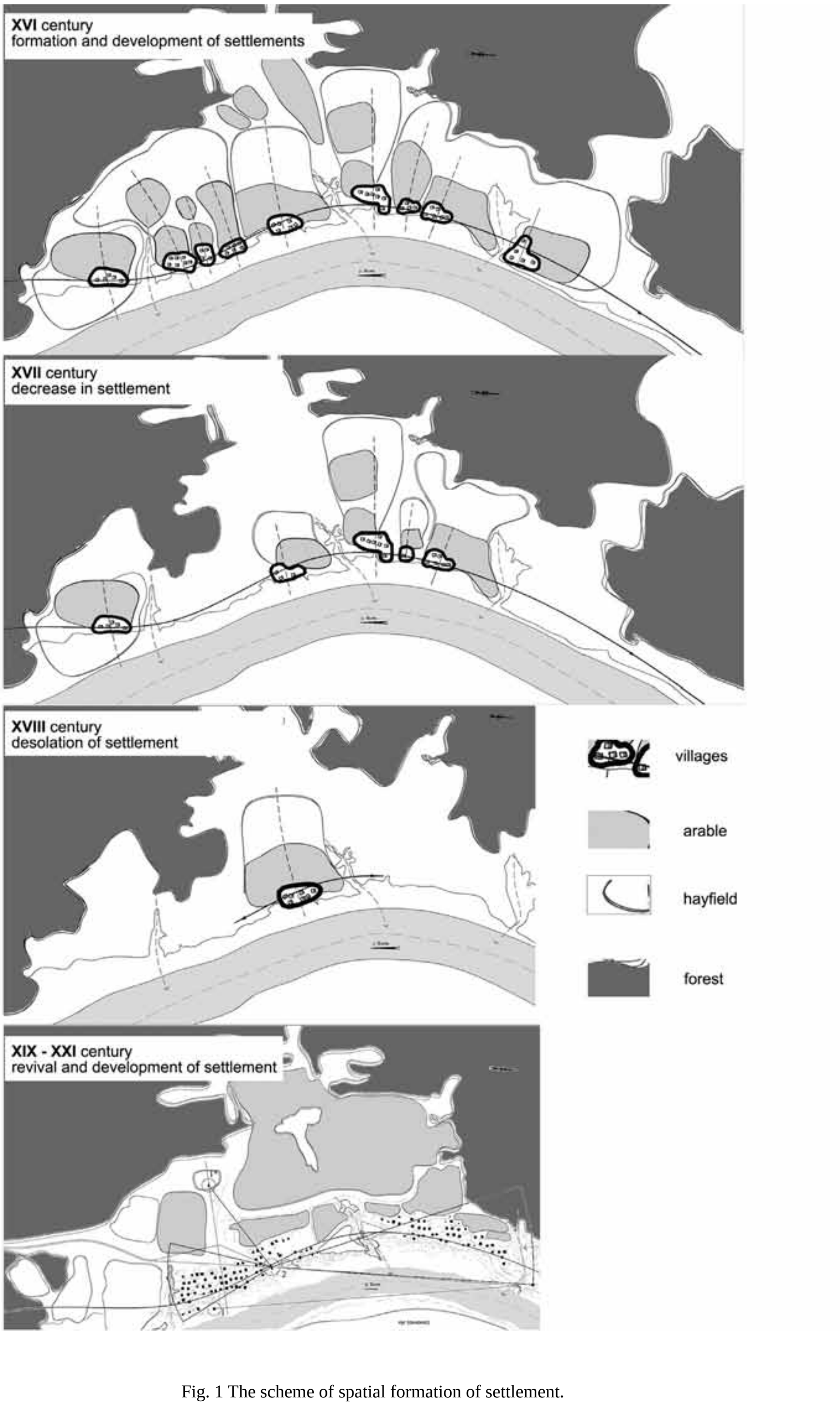

Fig. 1 The scheme of spatial formation of settlement.

tion of the village can seem like centric: the semi-circle perception of the settlement is dominated. Currently, when the river was low, lost its original meaning, and the village was cut off from other settlements of “Vym land”, Kony are perceived mainly from two sides – linear type of composition with predominantly bilateral perception (Fig. 2). Architectural space of the village is diverse, and by this is confirmed its harmonious relationship with the natural elements and high visual quality of the environment. These features of the organization of the historical and architectural environment of the settlement led to the formation of original compositions and architectural solutions of the village Kony. Therefore, the studied settlement as a whole is a unique monument of wooden architecture of “Vym land” with high semantic, informational and aesthetic potential of the material and spatial environment.

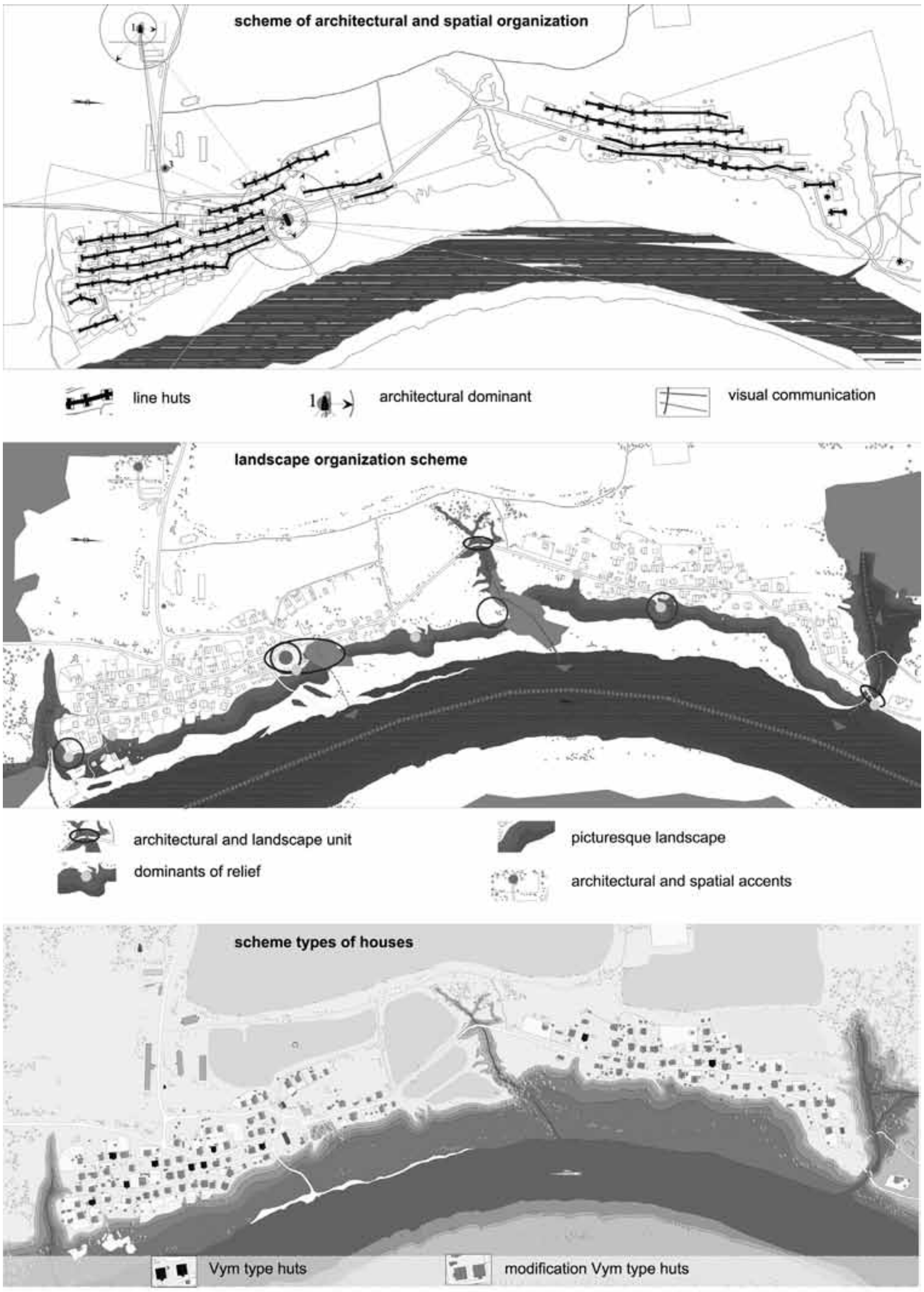

Fig. 2 The scheme architectural and spatial and landscape organization.

The modern condition of houses in the village Kony shows that the settlement continues to exist; it is possible to use the identified historical, cultural and architectural-urban potential for tourism as a way to ensure the preservation of heritage.

5. RESULTS

Research historical, architectural and cultural landscape aspects of being one of the oldest settlements "Vym land" reveals the deep potential of the village Kony in relation to cultural heritage and its possible use in modern conditions. Valuable features should recognize the following identified in these studies the characteristic features of the settlement: unique wooden residential buildings – samples of the Vym type house; the ensemble of buildings

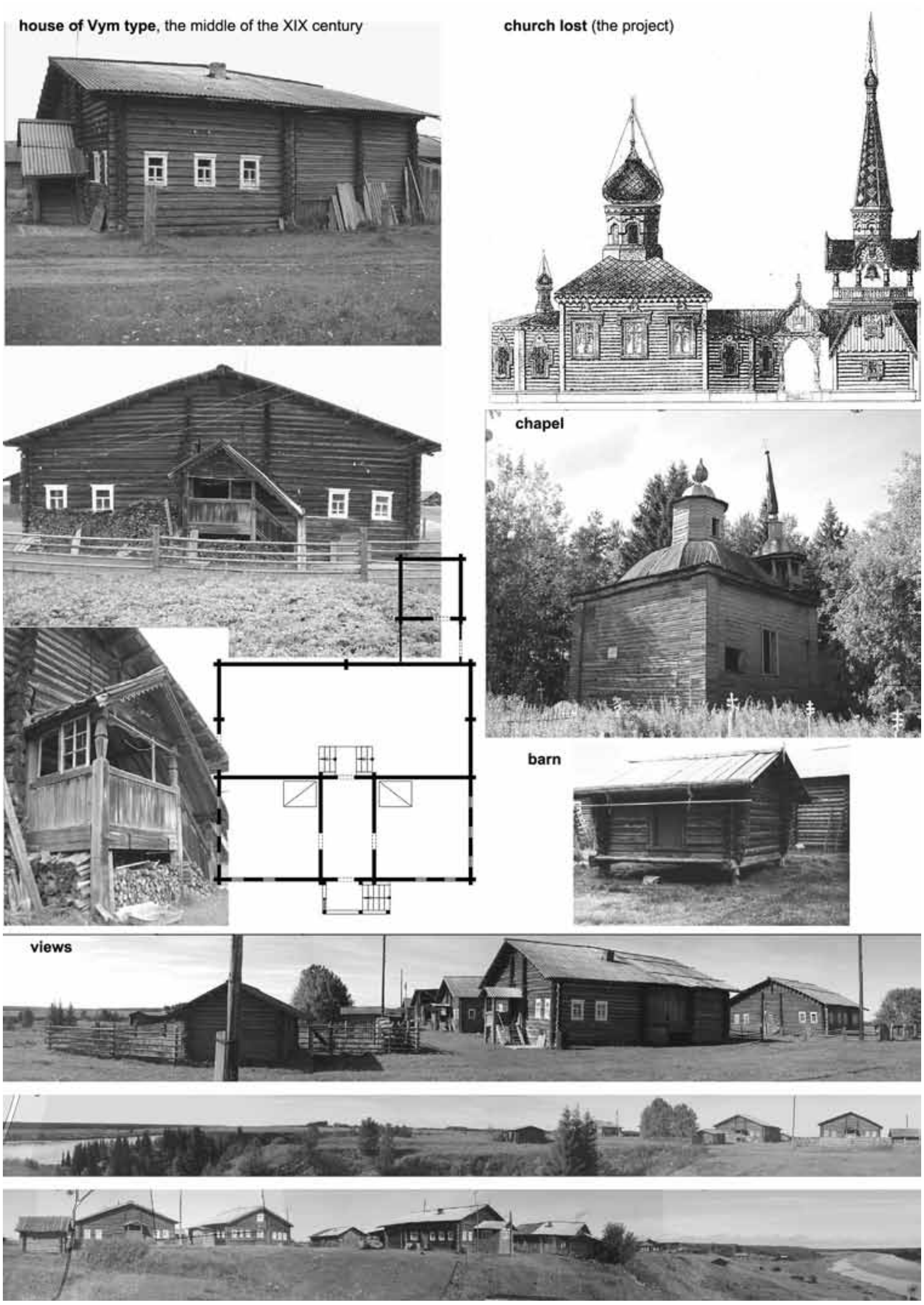

Fig. 3 Elements of architectural environment.

of the village – the original arrangement of houses along the shoreline with appeal the main facades to the river, regardless of the line; an organic connection of the settlement with the surrounding natural elements of the landscape; the presence of compositional landmarks and benchmarks that reflect the cultural priorities of their time and organizing space of the settlement and its relationship with the environment.

6. CONCLUSIONS

The obtained results allow approaching the development of the architectural-ethnographic Museum under the open sky on the basis of the village Kony. The Museum provides the translation to the new generations, the national historical and cultural features, traditional way of life of the people of the Northern settlements, and also allows you to save and update architectural and historic environment of the settlement.

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