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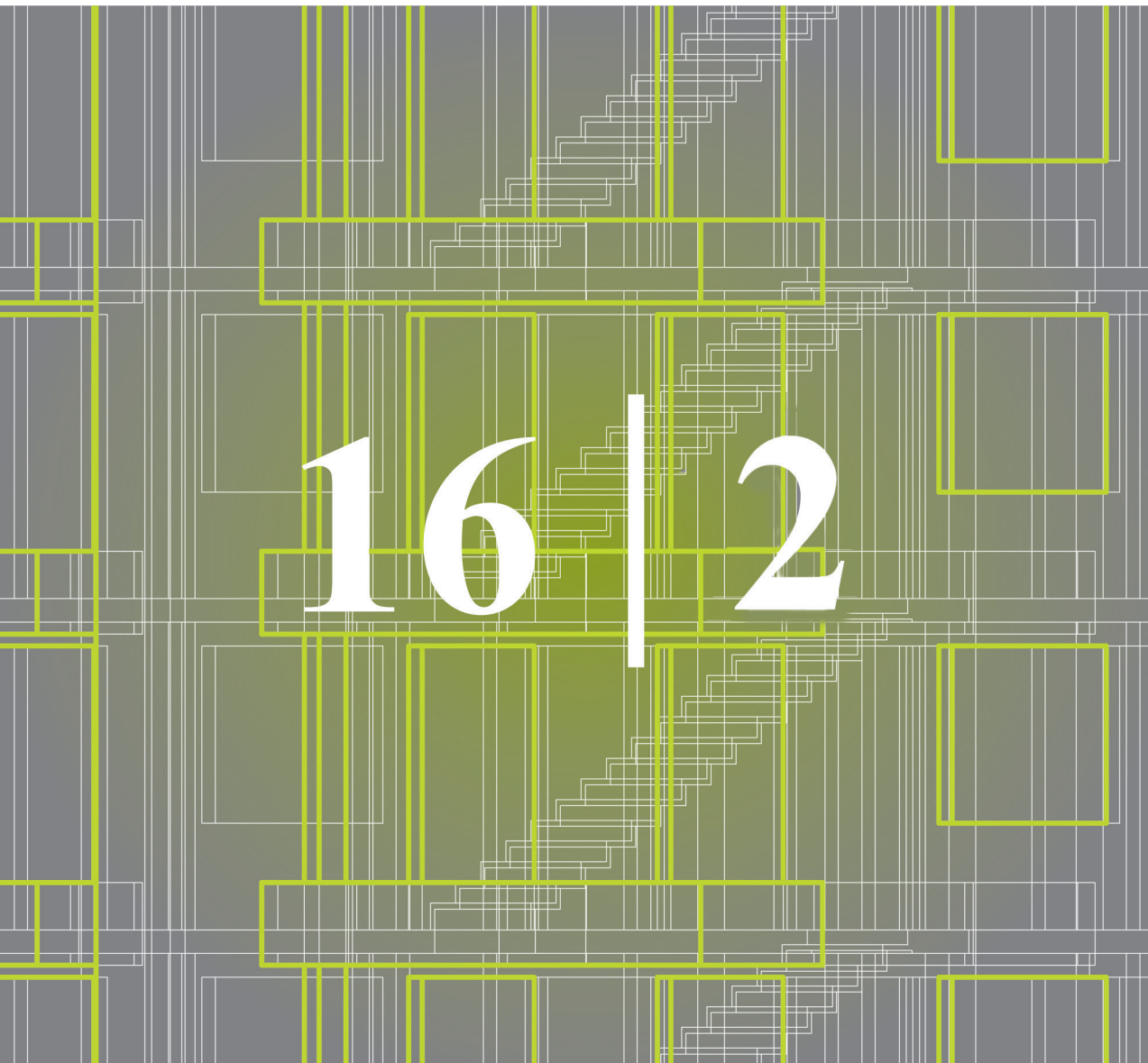

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3. Živković D.: Influence of front excavation on the state and deformity of montage lining of hydraulic pressure tunnels, Ph. D. University of Niš, 1988, pp. 95-108.
4. Kurtović-Folić N.: Typology of Architectural Forms-Strong and Weak Typological Characteristics, Facta Universitatis, University of Niš, Vol. 1, N^{o} 2, 1995, pp. 227-235.

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EARTH AS A MATERIAL FOR CONSTRUCTION OF MODERN HOUSES

UDC 624.012.8

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Abstract. *Earth was used for construction of residential buildings in the past. Due to the more widespread tendency toward the use of sustainable local materials, earth is present as one of the dominant materials for building of modern houses. The implemented techniques for construction of earth houses differ depending on the characteristics of a region and architectural tradition. This paper presents the characteristics of earth as a building material, traditional techniques for construction of residential buildings using earth, regulations which permit the construction in many countries of the world, as well as traditional residential building constructing techniques which use earth. Likewise, through the emblematic realizations of contemporary architecture it was shown that earth houses have the potential to provide the modern standard of living and to satisfy the aesthetic requirements.*

Key words: *habitation, house, earth as building material, construction techniques, building standards*

1. INTRODUCTION

Terms "to live" and "to reside" are logically inseparable from the term "house". According to Cvijić, a house is "a cultural subject exposed to evolution" (Cvijić, 1991). The change in residing can be traced through the history of architecture, from the moment when man felt the need to find shelter from natural disasters to the present days. He has always made his house in accordance with available materials trying to reduce unfavorable geographical and climate factors as much as possible.

Earth was one of the earliest used materials for construction of residential buildings at different times in the past on the territory of Europe, but also in Asia, South America,

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Africa due to its characteristics and distribution. The first architectural creations of the primitive man concerned modification of the habitat in caves and rock shelters, improvement of hydro and thermal insulation comfort by making floors of rammed earth and pebbles, as well as construction of dikes as protection from wind (Anderson et al, 2012). Natural materials that were abundantly used in construction such as wood, earth and stone are still used today. From the standpoint of the environmental protection, the traditional materials, which are present in the surrounding and easily accessible, are renewed during the proper usage (Zekić et al, 2010). Traditional natural materials are modified following the development of technology and adjusted to the new market demands.

The change in the way of construction has been conditioned by the increase in financial resources of the population, availability of standardized building materials, technological development, together with the increased speed of realization of modern constructions (Jovanović 2014, pp. 502). Introduction of laws and regulations in the current construction industry resulted in complete suppression of the use of earth as a building material. The Law of the Republic of Serbia in 1950 prohibited the use of earth as a building material for construction of all types of structures, and it is still in force today. The adopted regulations started the application of certified construction materials.

In spite of that, there is a greater tendency in the world towards construction of earth houses in the spirit of sustainable development, because earth is one of the environmentally-friendly materials. More than 30 percent of the world's landfills is construction waste, because in construction there is a mass use of non-renewable materials that cannot be recycled. (Vrančić, 2011) The price of such construction varies depending on the region. The total cost of construction of earthen houses in Australia exceeds the cost of construction with modern materials (Chilkoti, 2012), while in Africa such constructions are affordable and belong to the category of "low cost housing".

The following chapters present characteristics of earth as a building material, traditional constructing techniques for construction of residential buildings from earth, as well as regulations which permit the construction in many countries of the world. Through the series of emblematic realizations of contemporary architecture it was shown that earth houses have the potential to provide a modern standard of living and to satisfy aesthetic requirements.

2. Properties and Mechanisms for Improvement of Characteristics of Earth as a Building Material

The basic material for construction of earth buildings is loam, which can be found in the deeper soil layers, below the layer of humus (Krnjetin, Mrkajić, 2008). Before the building begins, it is necessary to remove the topsoil in order to use loam. That is the mixture of clay, sand and mud, and sometimes it contains bigger aggregates of gravel and sand, identical to the rock from which it originated. The most important characteristic of loam is the plasticity and the ability to design the material in moist condition (Marjanović, 2010). By drying the loam in the air a desired shape is retained until induration.

Stabilization is the term referring to the improvement of characteristics of earth in order to prevent possible fissures formed after drying and to improve the strength under

pressure. “To stabilize earth means to change the ratio in the earth-water-air system, which can greatly improve its characteristics” (Marjanović, 2010).

Due to the local specificities of earth of different locations, the same stabilizers are not always suitable. Before the beginning of building it is necessary to carry out testing of the earth. Samples of material with different supplements are observed after the induration. Every sample behaves differently, possibly deforming, according to the amount and type of the stabilizer. (Minke, 2006). According to the German standards, additive supplements are required, regardless the origin of earth. The regulation prescribes the ratio and type of stabilizers and they depend on the fat of earth and construction techniques. (Vollhard et al, 2007) Inorganic stabilizers such as sand, gravel and flying ash (Kabir, 2005) increase the strength of earth, while adding 5% of hydraulic lime causes the sample to absorb less water (Bui et al. 2009).

Organic stabilizers which increase the fat and decrease erosion of a dried earth wall can be urine, muck, blood, as well as fat and oils which contribute to waterproof earth structures (Minke, 2006).

Cement is also used as an artificial stabilizer. During the construction, especially if the method of construction is rammed earth, strength of the wall under pressure is increased by adding cement. In the construction sense, a wall is a carrying element and it is necessary to provide higher security. In the opinion of an Austrian expert on earthen architecture Martin Rauch adding of cement to soil in the process of building is not necessary, and it is even harmful, because that kind of material cannot be recycled. In that way, earth as a building material cannot be returned 100% to the earth from which it originated, and according to his opinion “it is impossible to build the house which will last forever” (Chilkoti, 2012).

3. Standards for Construction of Earth Buildings

Earth was used as main building material for the construction of houses in many parts of America, Asia, Africa, Europe, many years before standards and regulations stating that installation of certified building products is mandatory were introduced. At the moment almost 50% of world population lives in the structures made of earth (Guillaud et al, 2008). Most of those structures are in underdeveloped countries.

In France, in 1979, the school and laboratory CRATerre under the name of School of Architecture in Grenoble started to work. It was founded with the aim of preserving and promoting the earthen architectural heritage in France, educating students on earth construction techniques, laboratory research, publishing activity. It was only in 1986 that the French government supported the CRATerre School and officially helped further work. Germany has a long tradition of building structures from earth. In Germany there are three schools where methods and construction with earth are studied. The construction was officially regulated in 1944 when the first law for earth building was adopted (Earth Building Code), and it was changed in 2008 under the new name of „Lehmbau Regeln“. In Spain, in 1992 an official document was issued as the support for building with rammed earth and adobe under the name of “Bases for design and construction with rammed earth“. New Mexico has a state regulation concerning building with rammed earth and adobe from 1991. In Australia the first regulation for earth

building was adopted in 1952 in the edition of "Bulletin 5", which was being modified over the years, until in 2002 it was replaced by the new regulation "Australian Earth Building Handbook". New Zealand has the best organized regulation for building in this field, which considers many factors, area, height, basic material, pressure testing, as well as thermal properties. The only African country that made a regulation for earth building is Zimbabwe, where "Code of Practice for Rammed Earth Structures" was adopted in 2001 (Houben et al, 2008).

4. METHODS OF EARTH BUILDING ILLUSTRATED BY MODERN ARCHITECTURAL ACHIEVEMENTS

4.1. Methods of building in the bondruk [post-and-pan] system

Structural elements of buildings built in bondruk system (eng. post-and-pan) are the skeletal wooden structure and the filling of earth. Traditional bondruk system consists of vertical wooden columns and horizontal beams. Struts of a smaller dimensional cross-section than vertical poles are places in order to strengthen the overall system. A wooden frame in the shape of a frame is the basis for the substructure, which can be made of wooden planks and wicker. An earth wall is obtained by coating the entire system with a mixture of earth and straw or filling cavities with earth blocks. The advantage is fast and cheap construction. Bondruk system has been accepted in seismic zones due to the flexibility of wood as a support structure with a smaller deformation during the earthquake.

According to Luis Miles, bondruk system precedes a steel construction (Luis, 2008). The example from Chile shows a combination of modern steel construction and traditional application of earth as filling. The project from 2010 is a residential house built in Batuco, Santiago, Chile, by architects Patricia Arias and Pablo Alvear. The house is designed on two levels, the total area of 275 m2, with a separate ground level for guests (Fig. 1).

Fig. 1 The appearance of the house from the yard, north-western facade, Chile, Santiago, Batuco, architects Patricio Arias, Pablo Alvear[1]

The house was built outside the town, surrounded by a rich greenery. It was set free on the plot. The construction terrain was flat, without limiting natural and created conditions.

[1] http://www.archdaily.com/379734/casa-munita-gonzalez-arias-arquitectos-surtierra-arquitectura

The house was designed to have minimal negative impact on the nature and maximum passive use of solar energy. The wall oriented to the east which is discreetly inclined towards the ground and which on the ground floor and first floor has rows of windows, prevents the direct penetration of sunlight and overheating of the rooms during summer months. Connection with the exterior is achieved through large windows between the living room and the garden, while long windows were placed in the kitchen directly beneath the floor joists. (Alvear, 2013)

The basis of the structure consists of steel profiles, which were used instead of wooden horizontal beams and vertical columns. The walls consist of doubly welded wire cloth between the steel columns, plastered with loam and straw. On the ground floor the central element is the rammed earth wall in which the furnace for heating is located. In this way heat accumulation of earth wall is provided during the heating season, and at the same time the space between the kitchen and the living room is separated. The visual connection is not interrupted because the wall is one meter high.

The floor joist between the ground and first floor is a wooden coffered ceiling that was filled with earth and straw. All elements of the windows and doors are made by recycling old wooden structure. Foundations are strip-concrete with elements for embedding steel columns. (Alvear, 2013)

Fig. 2 The appearance of the house during construction, Santiago, Chile, the base of the ground floor and first floor, source 6

In the first part of the ground floor there is a living room, a kitchen, a dining room on a higher floor level, while in the second part there is a bedroom with a bathroom for parents (Fig. 2). On the second level there is space for children, space for rest and rooms with private bathrooms. Internal staircase leads from the living room to the first floor, the access part of the rest area and down the hallway that leads to other rooms. The roof plane follows the longitudinal line of the house and break in the middle with a different inclination (Alvear, 2013).

Fig. 3 The appearance of the basic structure and filling, the house during construction and after construction, Darmstadt, Germany, the project of the company "Schauer + Volhard[2]

This is the house project from 2012 of the company "Schauer + Volhard", of total area of 125 m^2, in Darmstadt, Germany, with the basic structure of wood, filling of earth and straw of the exterior walls. It was built in the urban part of the city, on a flat terrain, surrounded by greenery and a garden. Thermal insulation was installed on the inner side of the walls. The filling of interior walls consists of earth blocks, because (Fig. 3) earth blocks have greater density and weight, so in winter they provide greater thermal effect throughout the house. In the central interior wall there are chimney openings. (Plic, 2014)

The house is proposed for Terra Award prize awarded by an international organization under the auspices of the French school CRAterre-ENSAG Lab, supported by UNESCO "Earthen architecture" of a special section for the protection and promotion of earth architecture.[3]

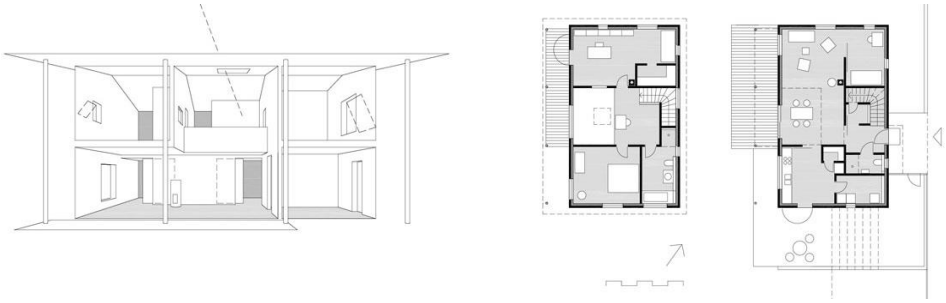

Fig. 4 Plan and cross-section of the house, Darmstadt, Germany, the project the company "Schauer + Volhard

The plan of the ground floor of the house is simple rectangle base in which are placed features of a living room, dining and food preparation. Upstairs there are bedroom and study room.

[2] More in: http://www.schauer-volhard.de/Seiten/2Bauten_und_Projekte/1Wohnhaeuser/1400_Haus_J/1400_Titel.html
[3] More in: http://terra-award.org/project/house-j/?lang=en

4.2. The method of construction by rammed earth

The traditional way of building a monolithic wall of rammed earth is done by filling and compacting of earth between the mold (formwork for filling of concrete is used nowadays) at a distance of 45-50 cm, up to 90 cm. Both sides of the formwork are placed between the vertical beams on prepared foundations. The formwork is interconnected with dowels, which are removed and re-installed after the completion of the lower layers (Hellwing, 1946). Earth compacting is nowadays done mechanically, by tires, which significantly increases the compressive strength. After drying of the entire building, which can last up to two years, the strength of the wall can be compared to the strength of stone. (Jernberg et al, 2015)

In Germany, Austria, New Zealand and Mexico there are numerous examples of construction of residential and public buildings built by the rammed earth method, where the centuries-old traditional method was applied. It was previously used in Tibet, Morocco, China but also in France, Spain etc. (Minke, 2006). The modern construction is based on adding new stabilizers in order to reduce erosion and increase the resistance to pressure because, in a constructive sense, a monolithic earthen wall is the carrying element and the ceiling and attic beams are supported by it.

Fig. 5 The entrance to the house in Victoria, Australia, architect: Jolson Architecture Interiors[4]

The example of a house in Victoria, Australia, measuring 465 m^2, is a blend of the modern design and traditional construction methods of supporting walls of rammed earth. The design was developed in cooperation with the design bureau Jolson Architecture Interiors and landscape architect. In terms of design, this house is like an earth sculpture in the desert environment in a balance with the environment that surrounds it.

The massive walls in the facade without windows are directly exposed to the wind and partly protect the inner courtyard. At the same time they are used for accumulation of heat from the sun. The house is with its front facade oriented to the west, while with its width towards the east. It was designed to be transparent, which made a connection between the interior and exterior.

[4] https://designrevolutionaustralia.wordpress.com/2011/04/10/earth-house-victoria-by-jolson-architecture-interiors/


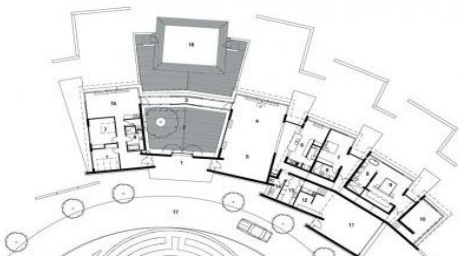

Fig. 6 Details of the interior of the hallways and a plan, source 6

The house consists of two separate parts, connected by an internal courtyard. On one side is the sleeping area for guests, and on the other is a large living room with a fireplace. The living room is followed by kitchen and a long corridor (Fig. 6) which leads to the rooms facing east. (Jolson Architecture Interiors, 2010).

The Austrian artist Martin Rauch, who discovered the architecture through sculpture, made many public and private buildings of terracotta in his home country. This house was built in Austria in 2007, using rammed earth technique with the addition of brick in each layer. Large window openings created a visual link with the outside environment. The roof is flat and covered with stone slabs (Fig 7).

A non-standard construction technique of rammed earth was used for construction of the Martin Rauch house. The technique consisted of inserting parts of the brick in each subsequent layer during the building process to serve as a protection of the earthen wall from moisture. In the rain, raindrops bounce off the projecting parts and protect the layer below. Standard roof overhangs that protect the earthen walls of the classical construction were replaced by baked bricks. Stone parts were also built in the wall with earth and bricks, so that the face of the wall can resist the erosive action of water. (Frey, 2013)

Fig. 7 The layout of the house in Austria, architects Roger Boltshauser, Martin Rauch[5]

[5] http://eartharchitecture.org/index.php?/categories/67-Compressed-Earth-Block

4.3. The method of construction with bags filled with earth

A California architect Nader Khalili, born in Iran, has made his long career of an architect humanist, lecturer and innovator in America. He devised a system of construction suitable for vulnerable people, called "ceramic houses." (Houben et al, 2008). Owing to the rapid building method, they are suitable for temporary accommodation of people affected by natural and humanitarian disasters.

The system consists of a vertical stacking of bags or strips filled with earth. The method was derived from the army as a technique by which earthen trenches were secured and shelters were made. In English speaking countries the term is known as the "earth bag", earth in sacks, which also became familiar among us. Filled strips are up to 25 cm high, arranged in a row, closing residential area by shearing to the top which forms a dome (Sruthi at al, 2013).

Bags can be made of a polypropylene polymer or of natural materials such as jute or hemp. Filling material is a mixture of soil, that is clay and sand, the composition is similar to that used in the construction of buildings with rammed earth.

Fig. 8 Construction of ceramic houses in America, architect Nader Khalili[6]

The houses made of earth bags are built over low foundations, they are waterproofed from the ground and for the installation additional profiles are pulled through, built from the outside. A building made in this way is then plastered by mud or cement mortar, outside and inside (Kristral, 2009).

Ceramic houses are, according to researches, non-flammable, they can be built quickly, with small areas in of the base, about 40 m^2 with a central room and additional rooms on the side, with a circular base (Fig. 8). According to Nader Khalili designs an experimental village was made in Hisperia, in the state of California in order to promote the earthen architecture as an alternative housing. At the same time, the non-profit organization "Cal-Earth Institute" (The California Institute of Earth Art and Architecture), Institute for the country, art and architecture with center in Hisperia were established as a support of the idea of human dwellings (Kristral, 2009).

After the devastating earthquake that struck Haiti in 2010, it was necessary to quickly rebuild the destroyed homes. The community of the affected city, together with a small Konbit Shelter Association, chose fast and safe building of houses using the technique "superadobe". Long strips were mechanically filled with earth with the help of the local

[6] http://calearth.org/galleries/eco-dome.html)

workforce. (Fig. 9) These houses with thick walls can keep a low temperature in the interior. The mixture which was used to fill the bags was made of 90% of earth and 10% of cement thereby achieving higher compressive strength. (Anderson, 2012)

Fig. 9 The interior of the living room, and the draft of the base, source 1

4.4. The method of construction with compressed blocks

Compressed CEB, in English "Compressed Earth Block", is the invention of the French architect Francois Cointeraux, who in the 19th century created a mechanical device which compressed earth block under pressure. In this manner the preparation of blocks for building was accelerated and it allowed an immediate use, similarly to the process of the cartridge (Kabir et al., 2005). To create the earth blocks it is necessary for the production material to be dry, sieved to particles of the maximum size of 6 mm.

Fig. 10 The layout of the house in Japan, Studio YAMASHITA, Yasuhiro / Atelier TEKUT[7]

Water or a certain stabilizer is added in thus prepared mixture. For the construction of low-cost houses - "low cost housing" in Zimbabwe, blocks that were kept in humid conditions for 7 days after being made were used, and then gradually dried for 21 days. (Zami, 2008). A block with such improved properties is still used in countries of Africa and Australia.

An example of a house in Chiba, Japan, built in 2008, is the result of the scientific research of a specialists in the field of earthen architecture The house is a contribution to the informing of a wider public about housing in the earth houses (Fig. 10). The project was done by the architecture studio Yamasita, Yasuhiro / Atelier TEKUT with the total area of

[7] http://www.treehugger.com/sustainable-product-design/japanese-flair-for-detail-elevates-earth-bricks-house-by-atelier-tekuto.html

54 m^2. The initial idea was to experimentally demonstrate that it is possible to increase the resistance of an earth block by adding stabilizers, in this case magnesium oxide. The block with magnesium oxide is more resistant to the pressure than the block with organic stabilizers and oils. In nature magnesium oxide can be found in oceans and in soil, and throughout the history of architecture it was used for the construction of the Great Wall of China and the pyramids in Egypt. The experimental house has one room with natural light coming from the roof and from glass prisms arranged under the roof cladding. The use of compressed blocks can be seen both in the exterior and in the interior (Mok, 2011).

An example of earthen architecture is the house in Napa, Australia. It was built with compressed earth blocks away from the town, on the land that is inclined. The material for the construction was of local origin. The walls were not further finished by mud mortar but the blocks rather remained visible in the interior and exterior.

Fig. 11 House in Napa, California, architect Juliet Hsu[8]

It was designed in three parts of rectangular form, with the ground floor and the first floor. In the front part that represents the front of the house, the living room and the bedroom are located. The central part which is an entrance hall connects the massive earthen walls using the transparent glass. The configuration of the terrain influenced the rhythmic movement of rectangular masses as well as roof planes with small inclination. The roof overhangs over the rectangular shape are accentuated, below which the windows are placed (Sardar, 2014).

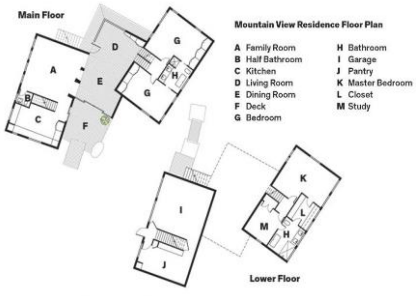

Fig. 12 The layout of the dining room, base of the ground floor, architect Juliet Hsu[9]

[8] http://www.rammedearthworks.com/modern-napa-rammed-earth-block-residence/

5. CONCLUSION

The traditionally inherited earthen architecture is the base that can be upgraded by using the technologically advanced principles of modern architecture. By using earth as a natural building material, we are able to create residential architecture with sustainable materials from the immediate vicinity of the building site. Modern residential architecture includes the use of inorganic additives, such as cement, which improves basic characteristics of earth, regardless of the composition of local soil, thus achieving greater safety of the building.

In accordance with the needs of the population and in order to achieve certain standards, many developed countries such as Australia, Germany and France have adopted laws which closely determine the method, control and application of earth as a building material. In that way countries actively engage in the control of construction and put the investors' needs in the legal framework, providing undisturbed use of adobe as a building material.

The old methods of building houses of adobe are not forgotten, but pushed out of use under the influence of new construction techniques. Based on the given examples, earthen residential architecture returns using the old construction techniques in modern architectural form and functional organization. The houses here presented are built outside of settlements, in accordance with users' needs and financial possibilities of the owner. The earth as a wall filling in its original color in the post-and-pan system is equally valued both for the interior and exterior. In addition to the fact that the method is economically acceptable, the natural color of the earth also fulfilled the aesthetic function.

The climate in which they were built did not closely determine the use of certain methods of construction. But regardless of the region in which it is created, earthen architecture is one of the ways to achieve environmentally sound construction standards and it contributes to environmental protection.

Earthen architecture is probably the only solution for financially vulnerable part of the world's population, providing them a suitable home at a very low price, especially if the population lives in the regions with temperate and warm climate. The technique of earth bags turned out to be the fast and efficient way of construction for all affected people after an accident or earthquake. The subsequently build houses are not only temporary accommodation but permanent solution for all people affected by a natural disaster.

On the other hand, in developed countries living in an earth house, with all the benefits that such construction provides, is a privilege. Mass use of the construction of earth houses allows the reduction of construction costs in developed countries so that it could be accessible to everybody with developed awareness of the ecological construction of earth houses.

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ZEMLJA KAO MATERIJAL ZA KONSTRUKCIJU MODERNIH KUĆA

Tokom prošlosti je zemlja korišćena za izgradnju stambenih objekata. Danas je prisutna kao materijal za građenje savremenih kuća. Jedan od razloga je sve aktuelnija težnja upotrebe održivih lokalnih materijala. Primenjene tehnike građenja zemljanih kuća razlikuju se u zavisnosti od karakteristika podneblja i graditeljske tradicije. U radu su prikazane osobine zemlje kao građevinskog materijala, pravilnici kojima se dozvoljava gradnja u mnogim zemljama sveta, kao i tradicionalne konstruktorske tehnike građenja stambenih objekata od zemlje. Takođe, kroz niz amblematičnih ostvarenja savremene stambene arhitekture pokazano je da je u kućama od zemlje moguće postići moderni standard stanovanja i zadovoljiti estetske zahteve.

Ključne reči: *stanovanje, kuća, zemlja kao građevinski materijal, konstruktivne*

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CONSTITUTIVE MOTIVES IN LIVING SPACE ORGANISATION

UDC 728

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Abstract. *Constitutive motive represents a concept of organization of living space. It can appear in the form of element, area, space or principle, i.e. it can be material or intangible. Constitutive motives have always been present in space organization domain, in vernacular construction and architecture. Their importance and appearance have changed in time, as the systems of social values changed. The decision on the selection of constitutive motives in the conception of the housing unit structure primarily depends on the subjective view of the creator, but also on numerous other contextual factors. This paper aims to review and examine innovative interpretation of their constitutive role in modern architectural practice. The goal is to examine the most significant motives in organization of the living space, as well as to offer suggestions for their theoretical systematization.*

Key words: *architecture, living space, concept, constitutive motive, housing unit structure*

1. INTRODUCTION

The first reference to the term "constitutive motive" in housing architecture is connected to the theoretical concepts of the architect Darko Marušić, according to which constitutive motive is a cohesive factor and the essence of the architectural concept. In a spiritual sense, it stands for pivotal force, a message or leading idea as the key of the concept, while in a material sense, it can be an element, surface or space (Marušić, 1999a:3). In terms of housing space, constitutive and integrative motives of the organizational concept have a role in articulating, collecting and uniting other space into an apartment or house unit. In multi-storey buildings the primary communication is the core with lifts and staircases, in apartments this is the lobby, dégagement or hall, and on an urban level it is the street or the square. However, this does not exhaust the scale of opportunities. The decision which constitutive motive to

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select in the concept of housing unit structure primarily depends on the subjective attitude of the creator, but also on numerous other contextual factors. By relying on Marušić's standpoint, Mirko Stanimirović and Goran Jovanović analyzed the influence of the loggia motive in contemporary housing architecture, and compared it with the motive of porch in the traditional house (Stanimirović, Jovanović, 2010:129). In addition to these authors and others who dealt with individual aspects of this topic (Abass, Hakim Ismail, Solla, 2016; Biondić, 1999; Alfirević, Alfirević Simonović, 2016b; Bajlon, 1979; Memken, Garber-Dyar, Crull, 1997; Rapoport, 2007; etc.), until now there has been no significant theoretical examination of the constitutive motives in organization of living space, which makes this topic current at present. Starting from the supposition that the constitutive motives include factors, both material and intangible, with an integrating role in forming the structure of different levels of space in architecture, the aim of this paper is to review the most significant constitutive motives in organization of living space, as well as to offer suggestions for their theoretical systematization.

2. CONSTITUTIVE MOTIVES

Constitutive motives have always been present in the space organization domain, in vernacular and general in architecture. In most cases, constitutive motives stemmed from the system of values shared in a community. A group of people who lived in one community, regarded certain elements such as the well, spring, meeting point, etc. as places of particular value, where the community gathered, used these elements collectively and treated them in a particular manner. Some constitutive motives that existed in the past and were part of tradition and lifestyle lost their significance in modern societies, due to the changes in the value systems. Constitutive motives such as the wells, drinking water fountains, hearths, etc. which, from the current viewpoint, could be regarded as "traditional", but not obsolete, were replaced by "contemporary" motives, such as a fireplace, a dining room, a balcony, or even by a TV set. According to Darko Marušić, characteristic constitutive motives of a housing unit structure are: a) dining as a form of extended communication, b) open space (loggia), c) technical block (kitchen, toilet and bathroom), d) biological rhythm (day-night), e) generational division, f) circular connection and g) flexibility (Marušić, 1999b:6–8). Starting from the existing review of the most significant constitutive motives in housing architecture which are neither particularly defined in time or space, nor systematized, this research deals with their reexamination and considers innovative interpretation of constitutive role they have in contemporary architectural practice.

2.1. Inner courtyard

The motive of inner courtyard is one of the oldest constitutive motives in architecture. Although it belongs to the group of traditional motives, it is still very current in modern architectural practice. The comparison of examples of traditional houses with inner courtyards and their modern counterparts, the main difference that becomes evident at first sight is the importance of inner courtyard in formation of the basic concept of unit structure. The use of atrium was in the past characteristic of situations when there was a stressed need for security and separation from excessive insulation in hot climates, in contemporary practice this element is the reflection of introverted desire for privacy (Abass, Hakim Ismail, Solla, 2016:2561). In order to say that an architectural object has

an inner courtyard as a constitutive motive, the basic condition is that all rooms within the unit are directly or indirectly lit through a central atrium. This concept of space organization was mostly present in the traditional house with inner courtyard (Rapoport, 2007:59). Contemporary houses with atriums are mainly not of the introverted type, i.e. they are not oriented only towards the inner courtyard, but at some points open towards their surroundings. The central position of the atrium with living space distributed around edges and oriented exclusively towards the center, indicates a clear change in the concept which was based on the constitutive motive of the inner courtyard.

The above mentioned approach was evident in the project of Solar Atrium House in Topola (Studio Alfirević, 2013), while the Earth House in Yangpyeong-gun (BCHO Architects, 2009) has the inner courtyard relocated to the peripheral part of the unit, which shifted the orientation of the main living space towards a single direction-the recessed yard. (Fig. 1a, b) Most examples with inner courtyards have a unit concept which includes orientation of rooms towards one center. However, there are examples, such as unrealized project of the Houses with courts (Mies van der Rohe, 1931) and the Weekend House in Usui-gun (Ryue Nishizawa, 1997), where the living space is oriented towards two, even three atriums. (Fig. 1c)

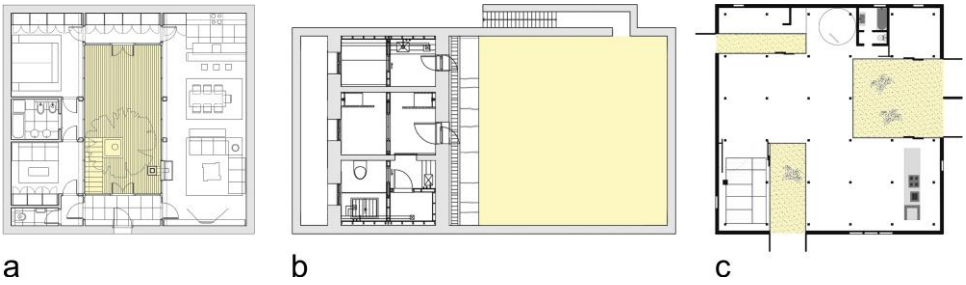

Fig. 1 Inner courtyard motive: a) Solar Atrium House, Topola, Studio Alfirević, 2013; b) Earth House, Yangpyeong–gun, BCHO Architects, 2009; c) Weekend House, Usui-gun, Ryue Nishizawa, 1997 (Source: author's private collection)

2.2. External "transient" space

Open spaces, such as terraces, loggias, balconies and porches, which are somewhere between the interior and the exterior, are very frequent elements of housing units. However, their role in generating the whole is not of essential importance, as they are considered secondary spaces, having in mind that frequency of their use is of low intensity. Still, in practice, there are concepts which regard the existence of external "transient" space of most importance (Stanimirović, Jovanović, 2010:130–131). One of the oldest shapes that applied this motive are traditional Japanese houses, where a covered porch (*engawa*) represented the extension of the living space as a terrace which offered unobstructed views of the natural surroundings or the zen-garden (Tadej, 2011:8). A similar principle was used in conception of the Wee House in Santa Rosa (Alchemy, 2016), which exhibited communication between the two spatial and functional units, and this communication had the function of the terrace at the same time. (Fig. 2c) The Motive of the loggia is of primary importance in the concept of units in the Housing Tower Y in Kragujevac (Dragoljub Bakić, 1978). The author thought that the central positioning of the loggia with shielding formation of the rooms around it, will achieve

a higher level of individuality and reduce the fear of heights which often accompanies taller objects (Bakić, 2012:28–31). (Fig. 2a) The dual role of the covered terrace in Zachary House in Louisiana (Stephen Atkinson, 2012), is at the same time segregating and uniting, which originates from its position between two functional blocks. (Fig. 2b) The space which is used as the entrance hall-communication and the terrace. A similar twofold character is found in the apartment in Bili Brig Housing in Zadar (Nikola Bašić, 1991), cited by authors Marušić, Stanimirović and Jovanović, where a loggia plays the role of entrance to both the apartment and the outdoor living room.

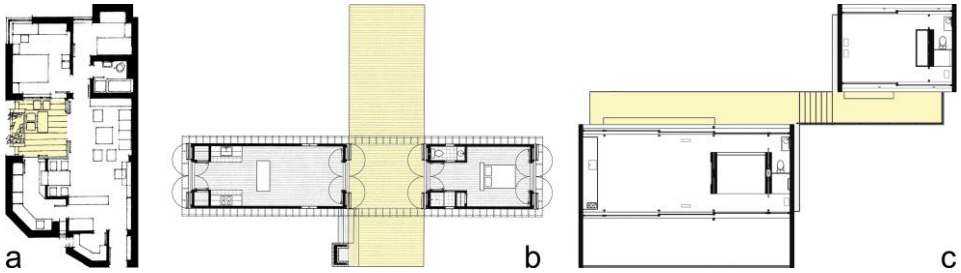

Fig. 2 Motive of external "transient" space: a) Housing Tower Y, Kragujevac, Dragoljub Bakić, 1978; b) Zachary House, Louisiana, Stephen Atkinson, 2012; c) Wee House, Santa Rosa, Alchemy, 2016 (Source: author's private collection)

2.3. Multi-use space as the core

One of the rooms in a house or an apartment can become the constitutive motive of the whole unit, in a situation when, due to particular reasons, it has a specific dual or multiple use, which is why its position is mainly central, dimensions stressed and the importance for the concept primary. This approach to space organization of a unit can be noticed in apartments with a central plan (the so-called "salon apartments"), built between the two world wars in Serbia. (Fig. 3a) Central anteroom had an important role in the organization of "salon apartment", as it was used as extended communication with the dining room. The

Fig. 3 The motive of multiple-use room as the core: a) Typical „salon" apartment, Belgrade; b) House Yagiyama, Sendai, Kazuya Saito Architects, 2012; c) Library House, Tochigi, Shinichi Ogawa, 2012 (Source: author's private collection)

room was of representative character and was used on special occasion for gatherings and celebrations (Nestorović, 1955:247–270; Alfirević, Simonović Alfirević, 2013:41–47). The application of open plan is more and more frequent in contemporary concepts of apartment organization, where the core of the unit consists of a combined room without partitions, most often in the form of incorporated living room, dining room and kitchen. The other rooms are adjoined to the primary core independently or in blocks. In the House Yagiyama in Sendai (Kazuya Saito Architects, 2012), the position of the central room is given to the ceremonial living room, which underlines its importance in family life and gatherings. (Fig. 3b) On the other hand, the Library House in Tochigi (Shinichi Ogawa, 2012), the central motive comprises multiple-use room which integrates the functions of the living room, the dining room and the library, while the other rooms are arranged peripherally. (Fig. 3c)

2.4. Natural or architectural accent

Accents in architecture include a wide range of natural and artificial elements, which, within a certain context, are stressed due to their characteristics and can be adequate motivators for formation of the concept of unit organization. The hearth, as one of the oldest constitutive motives, in its somewhat changed form, is still present in contemporary architecture, in the form of fireplace or furnace. The fireplace was a particularly important constitutive motive in unit organization of the prairie houses by Frank Lloyd Wright. It was placed in the center or close to the center of the composition and was emphasized as the center of a family gathering area (Koile, 2006:276). The most significant examples of this approach include Robie House in Chicago (Frank Lloyd Wright, 1909), and Darwin-Martin House in Buffalo (Frank Lloyd Wright, 1905). (Fig. 4a) A very frequent natural motive in the formation of the concept of unit organization is a tree found on the original location, which, due to its aesthetical and other characteristics has a protective role, as the house is constructed around it, which makes the tree the key accent in space. Characteristic examples illustrating this tendency are the Shell House in Kitasaku (ARTechnic Architects, 2008) and the Tree House in London (6a Architects, 2013). (Fig. 4b, c) In both examples the concept of unit organization was the result of consideration for the tree, by forming the loose façade lines and directing the interior views towards the exterior accent.

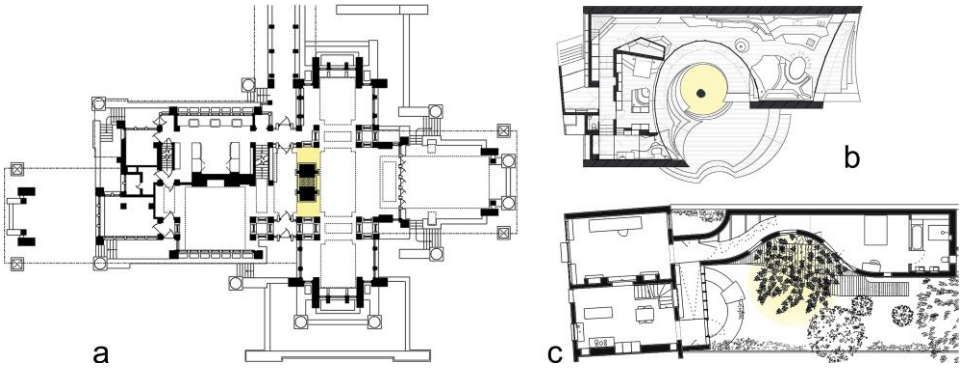

Fig. 4 Motive of natural or architectural accent: a) Darwin-Martin House, Buffalo, Frank Lloyd Wright, 1905; b) Shell House, Kitasaku, ARTechnic Architects, 2008; c) Tree House, London, 6a Architects, 2013 (Source: author's private collection)

2.5. Technical block

Constitutive motive of a technical block or the installations core emerges as the consequence of an attempt to group and optimize installations in space, which in practice meant joining the bathroom and the toilet, the bathroom and the kitchen or all three spaces into one. Within one housing unit, the technical block can exist in different positions: a) in the center, as a free unit; b) in the middle, with one or more walls inside the living space; c) "leaning" against one of the walls separating the space from adjoining living space (Kubet, 2015:161). If the technical block is situated in the middle zone of the living space, it can have a circular connection in the form of internal communication which constantly or occasionally connects the space around the core into one whole (Živković, Jovanović, 2012:27). When the technical block is formed around the partition from the adjoining apartment, the rest of the living space is formed in accordance with other motives, such as differentiation of functions, flexibility, etc.

Characteristic application of this constitutive motive is present in the apartment 40 sqm Refurbishment in Tel Aviv (Sfaro Architects, 2011), where the technical block connects the kitchen and the bathroom, and the circular connection is enabled by occasional opening of the sliding doors, which gives the impression of larger space within a smaller apartments. (Fig. 5a) Abstract House in Hiroshima (Shinichi Ogawa, 2002) has a technical block formed around the center of the base, but due to its linear proportion and configuration of the living space, its main role is to separate the daily from the night zone, although there is an option of achieving a circular connection. (Fig. 5b) A more complex space structure based on the same motive is found in the Villa Norrköping in Sweden (Sverre Fehn, 1964), with all auxiliary content integrated in the center of the house (toilet, bathroom, kitchen and pantry), while the peripheral zone is reserved for living space, which forms a clear concept of "space within space"(Alfirević, Simonović Alfirević, 2016b:30). (Fig. 5c)

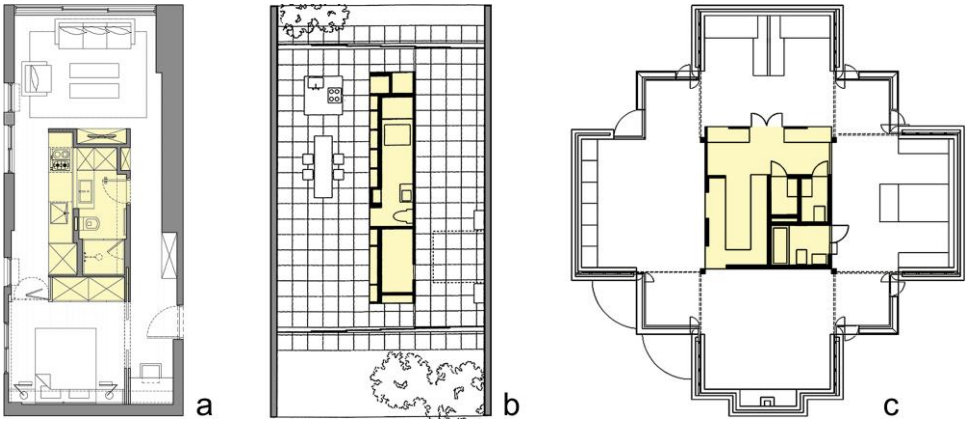

Fig. 5 Technical block motive: a) 40 sqm Refurbishment, Tel Aviv, Sfaro Architects, 2011; b) Abstract House, Hiroshima, Shinichi Ogawa, 2002; c) Villa Norrköping, Sweden, Sverre Fehn, 1964 (Source: author's private collection)

2.6. "Circular" connection

"Circular" connection[1] is a form of internal communication in a living space, aimed at establishing continuity of connecting the rooms in a row and minimizing or neutralizing the impression of cramped space (Živković, Jovanović, 2012:27). The application of this constitutive motive is characteristic of smaller apartments and housing units with more complex structures and a larger number of rooms. In smaller apartments, the motive emerges as the consequence of an attempt to achieve a psychological perception of a larger space, while in larger apartments it aims to deepen the perspectives inside the apartments and achieve representative effects such as baroque enfilades, as the circular connection is often linked to parts of other communications (Wook Seo, Sung Kim, 2013:79). In most cases, the formation of a circular connection in the living space appears around centrally positioned technical block, although there are numerous examples when it is placed around one of the utility rooms, such as walk-in closets, pantries, staircase, etc. (Bajlon, 1979:39–42). There are fewer examples of the cases where the main living space is connected to a continuous system of a row of rooms. According to Dragana Mecanov, a circular connection cannot be established in apartments which lack adequate grouping in space organization, i.e. where the direction of entrance movement interrupts access to some rooms (Mecanov, 2008:143).

A characteristic example of occasional circular connection is Housing for young people in Can Caralleu (Peris & Toral, 2008), where the center of the space is the bathroom, while further down in the apartment, next to the entrance, there is a kitchen and the dining room. The circular connection disappears when the sliding doors next to the bedroom is closed. (Fig. 6a) The Ant-house in Shizuoka (mA-style architects, 2012) was named after the concept of space within a space, where inside the central part of the house a smaller perforated house was formed and its boundaries define the core of the living space. Inside the core, there is a toilet, bathroom, pantry, staircase, sitting space, while all around it there is an uninterrupted circular connection making it possible to perceive the sculptural motive of the core. (Fig. 6b) The Retirement House in Kent (Alison and Peter Smithson, 1959), utility rooms are not grouped into one whole, but are freely arranged in space, which

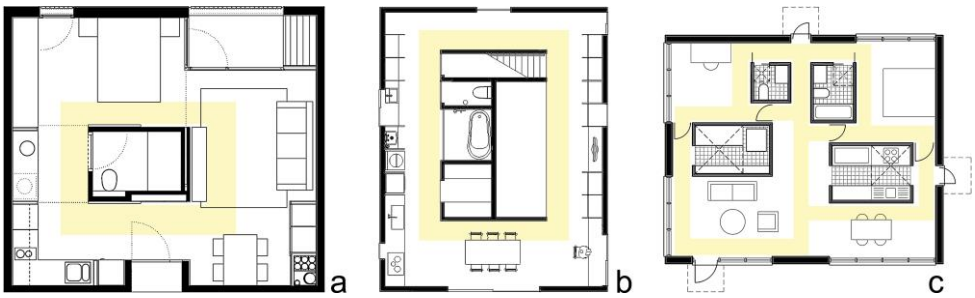

Fig. 6 Circular connection motive: a) Housing for young people, Can Caralleu, Peris & Toral, 2008; b) Ant-house, Shizuoka, mA-style architects, 2012; c) Retirement House, Kent, Alison and Peter Smithson, 1959 (Source: author's private collection)

1 Along with the term "circular connection", architecture uses other terms too, such as circular "enfilade", "continuous circulation", "concentric circulation", etc. which all stand for the same idea-the option of free, uninterrupted movement within the living space following a clearly defined trajectory.

stresses the motive of occasional circular connections that can be established in several places by opening the doors between different rooms. (Fig. 6c)

2.7. The view on the surroundings

Organization of the unit based on grouping and orienting living space towards natural motives in the surrounding, comes from creator's aspiration to use a highly aesthetic level of the view from the interior towards one or more directions, which more or less, as a consequence leads to the concept of external openness of the plan. Openness of the plan resulting from this concept can be: a) *total* – when it includes the whole living space, with the exception of sanitary rooms; b) *sector-based* – when it includes just the daily block*; c) partial* – when it refers to certain rooms within a flat, but not entire blocks; and d) *controlled* – when the application of flexible partitions, the connection can open or close according to the need (Čanak, 2013:67). On the other hand, openness of the living space towards the views in the surroundings, does not depend only on the internal arrangement of the rooms and the level of "diffusivity" of the façade, but also on the level to which the space opens to immediate surroundings of the object, which is determined by *SOI index (Spatial Openness Index*).[2]

Some of the most significant constructions illustrating the use of this motive in the definition of the concept are the Glass House in New Canaan (Philip Johnson, 1949) and the Farnsworth House in Plano (Ludwig Mies van der Rohe, 1951). (Fig. 7a) Natural surroundings of the object were of utmost importance to both examples, since it enabled the architects to establish total plan openness (internal and external). A representative example of one-sided openness of space to its surroundings is the Crescent House in Winterbrook (Ken Shuttleworth, 2000), showing a curved shape of the daily block which directs all views from the inside towards the picturesque segment of immediate surroundings. (Fig. 7b) The motive of directed views was directly determined by the crescent shape of the residence. A particularly characteristic example is the Princeton House in Princeton (Levenbetts, 2014), whose compact primary from, at first sight, does not suggest the concept of the view as its starting point. However, all the windows on the object are distributed that was that certain views of the immediate natural surroundings from the interior are perceived as framed paintings, which indicates the presence of constitutive motives. (Fig. 7c)

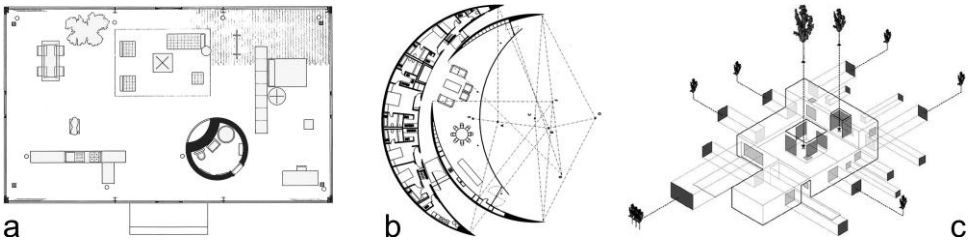

Fig. 7 Motive of view towards the surrounding: a) Glass House, New Canaan, Philip Johnson, 1949; b) Crescent House, Winterbrook, Ken Shuttleworth, 2000; c) Princeton House, Princeton, Levenbetts, 2014 (Source: author's private collection)

2 *Spatial Openness Index* – *SOI* includes a spherical segment of the surroundings volume, visible from a certain point in the space (Fisher-Gewirtzman, 2010:434).

2.8. Function differentiation

Function differentiation includes the widest group of constitutive motives in residential housing, as it is directly related to meeting the basic human needs. The use of motives of differentiation of functions is primarily encouraged by different needs and ways of using space. The rooms within the residential unit can be differentiated according to biological rhythms, by separating the day and night zone, i.e. the rooms with different regimes and intensities of use during the day (Marušić, 1999b:7). Complex residential units, with larger number of functions, are frequently differentiated into: individual and common areas (shared by family members), reception areas (for receiving guests) and utility areas (for servants) (Cunha, Trigueiro, 2005:37), or they are differentiated based on the gender of children, areas reserved for children and parents, etc. (Bajlon, 1979:45). Less frequently, when there is a need to organize the unit for three generations within one living space, it is possible to differentiate the rooms according to the age of users (Montgomery, 1972:41; Memken, Garber-Dyar, Crull, 1997:87).

A characteristic example of differentiation of function is an apartment in Buhgrindel Street in Zurich (Theo Hotz, 1985), which illustrates the differentiation according to biological rhythms established through separation of the day and night zone into two parallel blocks connected by the hall. (Fig. 8a) In Moriyama House in Tokyo (SANAA, 2005), the authors utilized a very inventive way to separate living space functions into a spontaneous composition unit, believing that the inter-space between the volume was a strong enough cohesive factor for space integration. (Fig. 8b)

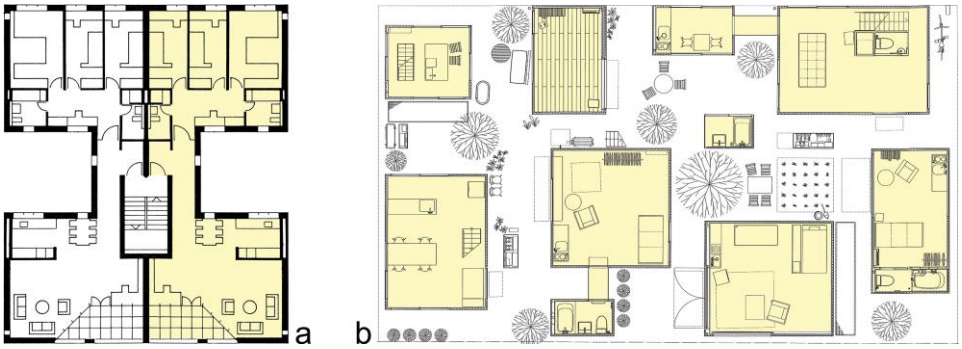

Fig. 8 The motive of function differentiation: a) Buchgrindel 2, Zurich, Theo Hotz, 1985; b) Moriyama House, Tokyo, SANAA, 2005 (Source: author's private collection)

2.9. Flexibility

Constitutive motive of flexibility in architecture primarily refers to space changeability, i.e. to conceptual and technical measures used to provide a certain level of changeability of housing space, with an aim of continuous adaptation to the dynamics of family life (Čanak, 2014:75). The application of the flexibility motive can be initiated by different factors, such as: a) changeable number and structure of family members; b) changeable cultural and economic situation of the family, c) changeable subjective factors etc. In numerous studies conducted so far on the topic of space flexibility in architecture, it was established that there is a different intensity of flexibility, i.e. potential, partial, prevailing and total flexibility

(Čanak, 2013:67; Biondić, 1999:70; Stoiljković, 2004:35; etc.). Depending on the applied intensity of flexibility, the motive can be more or less stressed. If the organization of unit applied partial flexibility, it will not be particularly apparent, however, if total flexibility was applied, the concept of organization bill be clear and the use of motive more evident. Depending on how the installations were grouped within the technical block, which could be centrally located or leaning against the wall with adjoining rooms, the level of flexibility changes significantly. According to Vladimir Kubet, Olga Carić and Ksenija Hiel, the highest level of space flexibility can be achieved by position of the technical block (Kubet, 2015:162; Kubet, Carić, Hiel, 2010:149), which brings the constitutive motive of flexibility into close relation to the motive of technical block and circular connection.

The motive of flexibly is, in practice, achieved in different ways, by using sliding doors, wall partitions, screens, partitions in the form of furniture, even space units. The examples are numerous, however, some of them, such as the Nine Square Grids House in Kanagawa (Shigeru Ban, 1997), show, in an innovative way, the limiting options in application of this motive. (Fig. 9a) The house has all fitted elements grouped in two elongated blocks, between which there is a square open plan space. The interior can be separated into smaller units, by sliding partitions in orthogonal directions (Alfirević, Simonović Alfirević, 2016a:56).

A particularly characteristic example is the Naked House in Saitama, (Shigeru Ban, 2000), with primary forms of space surrounded by flexible modules – sleeping capsules. The perception of the interior of the house and the character of the unit can be transformed easily by shifting or removing one of the modules. (Fig. 9b)

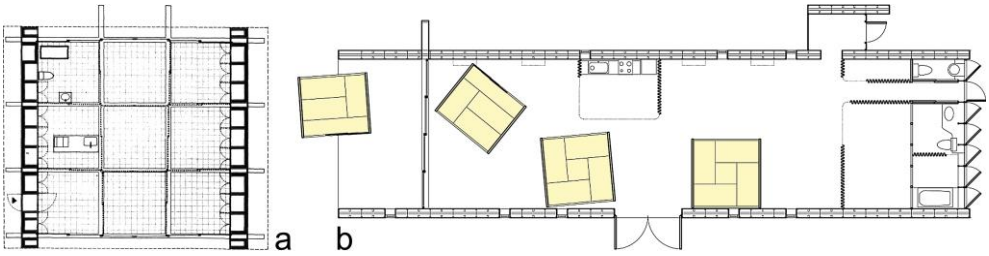

Fig. 9 Flexibility motive: a) Nine Square Grids House, Kanagawa, Shigeru Ban, 1997; b) Naked House, Saitama, Shigeru Ban, 2000 (Source: author's private collection)

3. CONCLUSION

The text discusses a concise review of the most frequent constitutive motives as initial steps in defining the concept of space-functional organization of an apartment or a house. Through analyses of numerous examples, attention was drawn to a variety of constitutive motives in conceptualization of the living space unit. The importance of theoretical consideration of this topic is multiple, because, on the one hand it contributes to the explanation of universal principles in the field of architecture, while on the other hand it encourages a creator to define more precisely the concept of unit in architecture.

Constitutive motive does not necessarily have to be in the center of the unit, nor exclusively of material nature, but it is necessary that its role be primary in forming the concept of living space and in integrating different space level or wholes into one unit. In practice, combining several different motives is most often present, however, it is

significant, for the concept of unit organization, that there is a clear hierarchy between them, even in cases when they are present in groups. It is important to stress that constitutive motives are present in the phase of design of a new object and in the design of adaptation or reconstructions of spaces, even though this happens to a lesser degree.

Current research already established that there are material and intangible constitutive motives. Material motives are connected to concrete natural or artificial elements (multiple-use room as the core, natural or architectural accent, external "transient" space, technical block, etc.), while intangible motives appear as ideas or principles (view towards the surroundings, flexibility, circular connection, differentiation of activities, etc.). Taking into consideration everything stated previously, we suggest that further research focus on the following systematization of basic constitutive motive of units in housing architecture (Fig. 10):

Material constitutive motives:

a) inner courtyard,
b) external "transient" space,
c) multi-use room as the core,
d) natural or architectural accent,
e) technical block.

Intangible constitutive motives:

f) circular connection,
g) view of the surroundings,
h) differentiation of functions:
- according to biological rhythm,
- according to children's gender,
- according to how public the space is,
- according to generation,

i) flexibility.

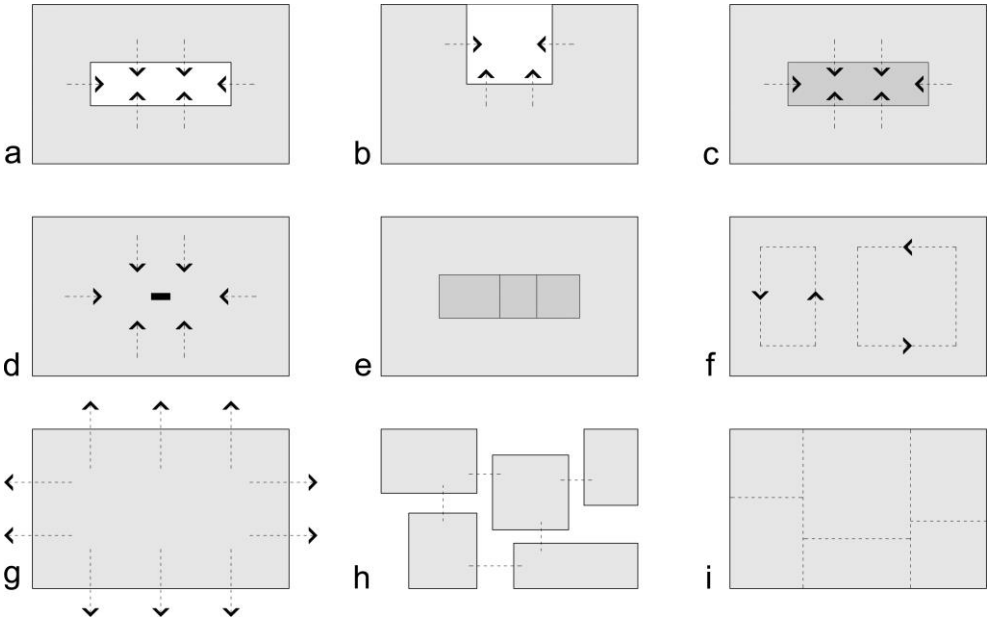

Fig. 10 Constitutive motives in organization of the house unit (Source: author's private collection)

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KONSTITUTIVNI MOTIVI U ORGANIZACIJI STAMBENOG PROSTORA

Konstitutivni motiv čini esenciju koncepta organizacije stambenog prostora. Može se javiti u vidu elementa, površine, prostora ili principa, tj. može biti materijalan ili ne materijalan. Konstitutivni motivi su oduvek bili prisutni u domenu organizovanja prostora, kako u narodnom graditeljstvu, tako i u arhitekturi. Njihov značaj i pojava su se vremenom menjali kako su se menjali i sistemi vrednosti u društvu. Odluka o izboru konstitutivnih motiva u koncipiranju sklopa prvenstveno zavisi od subjektivnog stava stvaraoca, ali i od brojnih drugih kontekstualnih faktora. Ovim istraživanjem se vrši njihovo preispitivanje i razmatra inovativna interpretacija konstitutivne uloge koju imaju u savremenoj arhitektonskoj praksi. Cilj rada je da se razmotre najznačajniji konstitutivni motivi u organizaciji stambenog prostora, kao i da se pruži predlog za njihovu teorijsku sistematizaciju.

Ključne reči: *arhitektura, stanovanje, koncept, konstitutivni motiv, stambeni sklop.*

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MODALITIES OF TENANTS PARTICIPATION IN THE REVITALIZATION OF OPEN SPACES IN COMPLEXES WITH HIGH-RISE HOUSING

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728.2

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Abstract. *Participation of tenants is an actual and very efficient instrument for revitalizing open spaces in complexes with high-rise housing. The share of tenants in joint activities in open spaces and in their improvement contributes to the development of the feeling of pride of the tenants and the responsibility for the housing environment. Therefore, through participation, tenants become motivated to undertake activities that can prevent further devastation of open spaces. Modalities of tenants' participation are diverse and some of the key are: tenants' personalization, learning to improve common spaces (semi-public, semi-private) and collective gardening. The aim of this paper is to affirm the participation of tenants in the programs of revitalization of open spaces and articulation of its significance in complexes with high-rise housing in the context of improvement of quality of life. In these complexes there often occurs alienation, lack of awareness of tenants for the improvement of open space, and encouragement of participation of tenants is of particular importance. In this context, this paper analyzes an example of good practice of revitalizing open spaces in the residential complex Eriksbo in Gothenburg, where a great diversity of modalities of tenants' participation can be identified.*

Key words: *participation, tenants, open spaces, revitalization*

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1. INTRODUCTION

The processes of urbanization and industrialization in the 20th century have caused a wide range of social, economic, cultural changes, as well as the intensification of housing needs in cities throughout Europe. The answer of architects and urban planners to the mentioned problem was the re-enrollment of residents into larger urban groups - housing complexes and residential areas, whose construction in some European countries marked housing construction until the late 1990s. The basic accompanying function with housing in residential complexes is recreation, and the modalities of the arrangement of open spaces as integral contents of the residential zone are realized in different ways. However, in spite of the generally known importance of open space for the quality of life of tenants of complex with high-rise housing, in current conditions there is a tendency of their devastation and non-compliance with the needs of tenants. Neglecting open spaces manifests itself in the disruption of their key role - the determinants of quality of life and the desired destination of the occupants for leisure time, whether it is on a daily or occasional basis. Their neglect, both at the design stage, inconsistent performance or poor maintenance, results in a loss of usable value, which contributes to the deterioration of the physical and social dimensions and the ambient value of the whole area to which they belong. Neglected and unsupported open spaces affect negatively both the health of tenants and social interactions, and may also be the initiators of anti-social and destructive behavior. Finally, people do not want to live in a residential environment that is not attractive, which does not motivate them and does not initiate the affiliation with the housing environment.

The sustainability of settlements and complexes with high-rise housing, apart from the mentioned factors, is conditioned by innovations in urban planning and planning practice, urban design and modalities of development and improvement of open foreign practices in the form of numerous programs and projects, in which their revitalization is treated as an integral part of the urban development. For several decades, various studies have focused on identifying the key factors for revitalization of open spaces in cities, which was particularly helpful for the Leipzig Charter [1]. It has become a political priority of the EU and at the national levels of many countries and it indicates the importance of promoting open spaces in the context of the quality of life. The modalities of advancement in current foreign practice are numerous, and include the application of spatial / functional, ecological, design and social measures. It is of particular importance to respect the requirements and needs of tenants of the housing complex, both in the finishing of the realization of innovative ideas and solutions, as well as in terms of the sustainability of the complex. In a plethora of instruments that are applied in revitalization projects of open spaces, the participation of tenants is emphasized. It is realized through various occupancy activities. The subject of the research of this paper is the consideration of the importance of the participation of tenants in the revitalization of open spaces as an instrument for improving the quality of life. The aim of this paper is to indicate the modalities of tenants' participation in the improvement of open spaces, as well as the articulation of the participatory approach, with consideration of the current practice. In this context, this paper analyzes an example of good practice of revitalizing open spaces in the residential complex Eriksbo in Gothenburg, where a great diversity of tenants' modalities can be identified.

2. TENANTS' PARTICIPATION IN THE REVITALIZATION OF OPEN SPACES

The participation of tenants as a right to participate in decision-making in the management of the housing community belongs to the group of political human rights [2]. Judging by the current development of global politics and a multitude of initiatives, the participation of tenants in joint activities in open spaces and in their improvement seems more current than ever. In this context, contemporary urban-architectural practice recognizes the diversity of measures and instruments to encourage the participation of tenants. Respecting the tenants' opinion regarding content and urban design of open spaces encourages control and responsibility for space and tenants becomes motivated to undertake activities that can prevent further devastation of open spaces. The key benefits of the participation of tenants are: the development of a sense of pride of tenants, increasing the sense of community, responsibility at the individual level, encouraging territoriality and intensifying the sense of belonging, self-expression and security, reducing the alienation and anonymity [3]. In addition, it is important to improve skills and knowledge, to improve mental and physical health, as well as to promote good neighborly relations. Identification and belonging to the open space manifests itself through the sense of pleasantness of the residence of the tenants, as well as participation in joint activities, which is shown by numerous foreign studies [4]. All of this is of special importance in the complexes with high-rise housing, where the devastation of open spaces, neglect and disorder of these spaces is often noticed. The consequences are the residents' dissatisfaction with open spaces, the absence of the tenant's identity with the housing environment, the anonymity and alienation of tenants, as well as the lack of interest in participating in the revitalization of open spaces.

On the other hand, through participation, tenants become motivated to undertake activities that can prevent the devastation of open spaces. Participation of tenants contributes to finding better solutions, whereby the following prerequisites must be met: motivate tenants for active participation, inform tenants about the importance of planning actions for revitalization of open spaces, educate them on the subject of work and timely involve them [5]. Participation also allows them to make choices for alternative urban design and affirmation of the quality of space such as security, readability, identity, which will enhance their sense of belonging and control [6]. The current foreign practice confirms the significant contribution of the participation of tenants in the efficiency of the program of revitalization of open spaces. Residents express their wishes and are involved directly in the creation of promotion projects. It is considered that without insight into the wishes, needs, habits and visions of the tenants, it is not possible to create a quality project for improving the open space, and the design of open spaces must refer to patterns of behavior and the value of the tenants to whom the space is intended. The successful participation of tenants can be seen only over a longer period of time, and it is desirable to combine the wishes of tenants with social issues and values of the housing community. Efficiency of tenant's participation can be seen in different stages of improving open space - participation is used as a driving force for mobilizing resources in the community itself and implementing activities through its own potentials. At the same time, it contributes to achieving better solutions, greater cooperation among different actors, strengthening local democracy, education and developing new skills, improving the culture of housing and raising tenant awareness, which is also important for achieving a sustainable urban development [7]. On the other hand, numerous studies show that the abandonment of open spaces is not only the result of planning failures, but also the absence of the participation of tenants in joint activities. In that sense, it is especially important to leave tenants the opportunity to create their own housing environment - open spaces and to be included in their revitalization.

2.1. Modalities of tenants' participation

Various modalities of tenants' participation can be observed in the literature and examples of good practice. They differ depending on the goals of revitalizing open spaces, socio-cultural milieu of tenants, social, political, economic and planning preferences of countries. In this paper, the following modalities of the tenants' participation are considered: tenants 'personalization, learning to improve common spaces (semi-public, semi-private) and collective gardening.

Personalization of tenants in open spaces can be considered as an important instrument for encouraging and imparting privacy, territoriality, and tenants' belonging to these areas and mutual feeling of closeness, which is of particular importance for tenants of high-rise housing. Affiliation is related to the physical distance from the space, but it also implies that the space really belongs to users and that they can edit and use it according to their needs and engage in its maintenance. At the same time, the belonging of open space to the primary housing group contributes to the degree of usable value of the living environment and encouraging personalization of the users. Many types of tenant personalization can be observed, which relate primarily to the design and improvement of primary open spaces in the immediate vicinity of the entrance to residential buildings, high-rise housing, fences, and urban furniture [8]. This type of participation of tenants in the improvement of open space contributes to the creation of the identity of the own corner in terms of operation, maintenance and regulated access, user translation into the tenant - provides a framework for the planned operation of tenants in the environment. There is a number of factors that positively influence the marking of space and personalization: the level of household income, ownership of the apartment, type of housing, topography and accessibility of space, regular maintenance of space, privacy concerns and the need to determine borders of the territory, possession and security, neighborhood perception, socializing and strong social relations with friends and neighbors [9].

Fig. 1 Personalization of tenants [10]

Fig. 2 Individual courtyard [10]

Personalization can also be defined as the activity of an individual to change space, in accordance with his own preferences, which are recognizable among others [11]. In this sense, territoriality and personalization can be realized and recognized in open spaces. Personalization is also a tool, which functions as an intermediary between an individual and a community to accept or eliminate social contact. There are various types of territorial markings and personalization. Some of them have borders, such as curbs, pillars and fences, as well as signposts by residents themselves, such as living fences, arranging ground floor plants and pots, seating mall, tracking personalization (Figures 1, 2). Identifying tenants with the space in which they operate means a positive attitude towards preservation and maintenance.

In addition to the personalization of tenants, participation in the improvement of common (semi-private or semi-public) spaces is also significant. The types of participation can be direct and indirect, and can be realized through: information, research, consultation, participation and delegation of tenants. In doing so, it is possible to notice the following activities (Figures 3):

- informing the tenants about problems, needs and measures for improving open space through press, web sites, billboards [12].
- research - interviews with focus groups or setting boxes for suggestions, and objections
- consultations through various techniques - conferences, workshops, inviting tenants to discuss development issues and priorities with other tenants and intensive groups seeking written responses to urban policies and proposals
- involvement in partnerships or delegate involvement in committees, whereby tenants are invited to participate actively in a process that involves identifying the problem and providing concrete proposals for improvement; the final decisions are made by members of local authorities
- delegations - where they have been officially selected by local authorities or other bodies in a committee that has the ability to decide on the improvement of open spaces.

a)  b)  c) 

Fig. 3 Forms of participation of tenants in the arrangement of open spaces a), b) planned greening c) discussions about the draft project of revitalization of open spaces [13].

In current conditions, apart from the mentioned modalities of participation of tenants, collective gardening is particularly important (Figure 3). It can be recognized as a form of joint activities in which tenants of the residential buildings voluntarily participate in the design, improvement and management of open spaces [14]. In projects of revitalization of open spaces it is possible to observe the following activities of collective gardening: exchange of ideas, problem solving and joint work with others, discussion, division of responsibility and other types of interactions, where the individual is part of the collective process. These activities include gathering information, socializing, discussing and other formal relationships that link local groups of tenants with external actors representing society as a whole. Collective gardening activities can be initiated and implemented in several ways:

- residential companies initiate tenants to participate in gardening and open space maintenance, so-called "self-management of tenants"
- tenants can get to use garden with plots within open spaces; the tenant's association signs an agreement on taking over responsibility of maintenance of common gardens from a residential maintenance company
- housing association can form a garden on an empty and unregulated open space in a residential complex as a key mechanism for the revitalization of open spaces and residential complexes (Figure 4).

Fig. 4 Example of collective gardening [15]

3. REVITALIZATION OF OPEN SPACES IN RESIDENTIAL COMPLEX OF ERIKSBO IN GETEBORG

The housing estate Eriksbo in Gothenburg was built in the 1970s, as a response from the Swedish authorities to the deficit of housing needs. The project of revitalization of open spaces in this complex represents a successful example of improving the part of the devastated residential complex initiated and realized with the participation of tenants [16]. In addition to the occupancy of the tenants, the new structure of the involved actors is significant, then the redesigned role of the City Residential Company in the process of revitalization and participation of the voluntary association. Ten years ago, the tenants of this housing estate formed a Volunteer Cooperative Association with the aim of improving buildings, open spaces and community activities. The aim of the tenant was to improve the open space in the immediate vicinity of flats and to maintain renting gardens. Director of the City Residential Company was responsible for the involvement of tenants in the discussions about their visions for improving the quality of open space. This initiative resulted in such a successful project that this settlement is no longer considered an unattractive living area. The project was realized thanks to the close cooperation between the municipal administration and the local tenants' association [17]. In support of this, there is also a social program that provides newly-resident tenants with the publication *Welcome to Eriksbo*, where all the benefits of this residential complex are explained in detail, especially in terms of arranging open spaces.

The program of revitalization, initiative and participation of tenants is represented through concrete activities, where the creation of individual gardens, common gardens and residential yards are first defined (Figures 5, 6). These activities represent the examples and personalization of tenants and participation in the arrangement of common gardens and open fingers, as well as the participation of tenants in collective gardening. In addition to the aforementioned activities, the project carried out the remodeling of nursery in the ground floor of one of the residential buildings and an oasis was formed for the stay of children in the open space. Private gardens have been expanded outside of public green spaces - which is very convenient, as it reduces the scope of work for managers of the residential complex (also an example of personalization of tenants). The volunteer association gradually assumed responsibility from the City Housing Company for the maintenance of open spaces. The association got funds that the housing company should otherwise use to hire workers, and 6 workers from the ranks of unemployed tenants for garden works and open space maintenance.

Fig. 5 Individual residential yards [17]

Fig. 6 Children's playground [17].

This system works very well, and all tenants are aware of their own potentials for improving the living environment. It is particularly important that tenants have the opportunity to discuss their visions with managers about what should be done. Alternatively, people with an idea or complaint can go to the Center for Housing Assemblies within the complex and talk to someone who can react immediately to the observed problem. Benefits include getting a meeting space, which also acts as an office for those who work to coordinate and improve the Eriksbo complex. The nearby park is also hired for the needs of the tenants - a children's farm with a playground for children (a joint tenant's activity) has been built and there is a board for its management and work, and the occupants spend a lot of time in volunteering there (Figure 7). Also, part of the open space is taken over by tenants for collective gardening (Figure 8). The jurisdiction of the maintenance is in the hands of a volunteer association. Applying this kind of comprehensive measures with the different types of tenants' participation, the usable value of open space in the Erikso complex increased. Besides that, contacts between tenants in open spaces and good neighborly relations were intensified, affiliation and territoriality of tenants were strengthened and the antisocial behavior was reduced. Particularly significant is the improvement of the quality of life in the whole residential complex, which is the primary goal of every revitalization project.

Fig. 7 Children's farm [18]

Fig. 8 Collective garden [18].

4. CONCLUSION

The current state of open space in most European countries is characterized by various types of deprivation and the lack of adaptation of open spaces to changing social, demographic, economic, cultural trends, as well as the needs of tenants of complex with high-rise housing. Given the wide range of open space issues, the current instruments of revitalization should ensure the protection of the existing values and at the same time provide new opportunities in accordance with the contemporary trends in the arrangement of open spaces and new lifestyles of tenants in the direction of ensuring a higher level of quality of life. In current conditions, the participation of tenants is considered as one of the basic instruments for achieving a successful and sustainable revitalization of open spaces. Through this process, tenants participate in the development, creation and implementation of plans for the revitalization of open spaces, that is, in the planning and decision-making that affect the improvement of the housing environment. The modalities of tenants' participation, which are discussed in the paper, are: personalization of tenants in open spaces, participation in the improvement of common spaces and collective gardening. Each of these modalities has a distinct significance, and it can be concluded that in order to create efficient and sustainable solutions, it is advisable that each of this modalities should be represented in the revitalization project. The mentioned modalities are recognized in the case of promotion of revitalization of open spaces in the Eriksbo complex. From this example, we can conclude that the effectiveness of the implemented measures was especially contributed by the application of various approaches to the design of open spaces, while respecting the needs and demands of tenants. The most obvious sign of the success of this project is the improved good neighborly relations, which can be identified through regular and intensive contacts between tenants, and they are realized thanks to the fulfillment of several interrelated requirements: offering adequate content, opportunities for meeting, gathering, socializing, adequate and functional urban equipment, aesthetics, as well as the symbolic meaning of open spaces. Opportunities for revitalization of open spaces in complexes with high-rise housing are realized by establishing an integrated planning and design approach in correlation with the partnership approach, adequate organizational and institutional structure and financial instruments. In doing so, it is necessary to respect the needs of tenants and to involve them in making decisions on the character of open spaces, which is a significant and necessary instrument for improving open spaces.

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MODALITETI PARTICIPACIJE STANARA U REVITALIZACIJI SLOBODNIH PROSTORA U KOMPLEKSIMA SA VIŠESPRATNIM STANOVANJEM

Participacija stanara je aktuelni i veoma efikasan instrument revitalizacije slobodnih prostora u kompleksima sa višespratnim stanovanjem. Udeo stanara u zajedničkim aktivnostima na slobodnim prostorima i u njihovom unapređenju doprinosi razvoju osećaja ponosa stanara i odgovornosti za stambeno okruženje. Stoga, putem participacije, stanari postaju motivisani da pokrenu aktivnosti koje mogu sprečiti dalju devastaciju slobodnih prostora. Modaliteti participacije stanara su različiti, a neki od ključnih su: personalizacija stanara, učešće u unapređenju zajedničkih slobodnih prostora (polu-javni, polu-privatni) i kolektivno baštovanstvo. Cilj ovog rada je afirmacija participacije stanara u programima revitalizacije slobodnih prostora i artikulacija značaja njihovog unapređenja u kompleksima sa višespratnim stanovanjem u kontekstu unapređenja kvaliteta života. U ovim kompleksima često se javlja otuđenje, nedostatak osećaja stanara za unapređenje slobodnih prostora, te je od posebnog značaja podsticanje participacija stanara. U tom smislu u ovom radu je analiziran primer dobre prakse revitalizacije slobodnih prostora u stambenom kompleksu Eriksbo u Geteborgu, gde se može identifikovati veliki diverzitet modaliteta participacije stanara.

Ključne reči*: participacija, stanari, slobodni prostori, revitalizacija*

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THE NEUKOELLN PHENOMENON: THE RECENT MOVE OF AN ART SCENE IN BERLIN

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Abstract. *One of the positive developments in post-Wall Berlin was the emergence of an alternative art scene, with Mitte and Prenzlauer Berg having a leading position in the early 1990s among artists as the new centres of Berlin´s creative industries. Soon, Mitte and Prenzlauer Berg became places where highly commercial creative companies arrived, and for that reason the art scene moved to Kreuzberg-Friedrichshain after no longer being able to afford the increasing rents. Nowadays we are witnessing the move of the art scene to Neukoelln, one of Berlin´s most problematic districts, with higher than average total migration, ethnic tensions, poor socio-demographic indicators and a high crime rate. The art scene in this district is not as established as it was in Mitte. What is happening there right now is not about profit, it is more about the idea that something is going on at the moment. Thus, it is too early for final conclusions. How does the arrival of an art scene influence Berlin´s most problematic district and what is its possible future impact? For now, we have the redevelopment of Berlin´s Neukoelln district which will ultimately lead toward gentrification. The result of such a change is rising rents and anger from the older more established residents.*

Key words: *Art direction, branding, Germany, public space, globalization, post-Wall Berlin, Neukoelln, creative industries, sub-cultural, creative cities*

1. INTRODUCTION

For many living in Berlin, the name of Neukoelln is the synonym for a working class district with high unemployment and social problems. For all the students, artists and hippies who have come to Berlin in the last few years the area is the synonym for an exciting, rebellious, hedonistic and energetic alternative culture and club scene area. Small-scale crafts and shops located together in different buildings are all around the area.

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Neukoelln is being transformed from a dangerous problematic area, Berlin´s social trouble spot where immigrants clash in the streets, into a roaring bohemian district where new bars, galleries and studios are opening every week. This mix of influences and diversity presented here creates new forms of design. Until recently, ethnic tensions, poverty, drugs and raging violence with high crime rates were the only synonyms for Neukoelln. Today, the high concentration of different artistic and cultural communities in the area has changed its urban environment.

Berlin is known as a city with relatively little business and production, but with amazingly low rents, and Neukoelln is a district where rents are among the lowest. The Berlin ´art scene´ left Mitte, Prenzlauer Berg and Kreuzberg-Friedrichshain (in 2003 these two city districts were merged into one) and arrived in Neukoelln, a move which seemed like a natural spill over effect as Neukoelln is adjacent to Kreuzberg-Friedrichshain. We are witnessing today that rapid changes are occurring in this peripheral problematic pocket of Berlin, since Neukoelln has now been discovered by the ´creative class´ (Florida, 2002). The heart of this rich sub-cultural vibrant area is a street with one of the highest bar densities in Berlin, located in the north of Neukoelln, called Weserstraße. Numerous improvised galleries and studios have recently been opened there which have upgraded its club culture and music venues. Further to the north, located between Kreuzberg and Neukoelln, is Sanderstraße, also recently infected with this phenomenon of booming galleries and studios. There is a constant flow of people of diverse social and ethnic background, and a mix of rebellious characters with a hedonistic lifestyle.

People want to head for that energy, for that feeling, for that atmosphere, all hoping to find something special there. Neukoelln is the center of a new ´urban renaissance´ (Shaw, 2009) in Berlin. The move of the ´art scene´ here has brought unexpected developments which have resulted in rent increases and ultimately the possible gentrification of Neukoelln.

2. BERLIN´S NEUKOELLN DISTRICT BERLIN´S

The Rixdorf district changed its name to Neukeolln in 1912. The district had a bad reputation (even then) and the government renamed it Neukoelln in order to run away from its negative connotation (Der Ring Bahn, 2010). Neukoelln has an elongated shape and 44. 9 sq.km. It has approximately 306, 000 residents, and over half of them have Turkish citizenship (they make up about 9 % of Berlin's total population) (OECD, 2003). Immigrants make up 38. 7 % of Neukoelln's residents. In some parts, even 66. 1 % of the residents are immigrants. The share of Turks in the total foreign population of Berlin was 29.8 % in 1999 and they are mainly concentrated in the inner city districts of Wedding, Kreutzberg and Neukoelln (Eckmann, 2007).

By the beginning of the 21st century, this area was becoming a favourable location for the subtle migration of new creative professionals thanks to its specific character and environment of diversity. Here, different ethnic groups are able to create their own ethnic businesses, speciality shops and restaurants. It is common that this kind of so-called ghetto neighbourhood welcomes creativity.

According to a Humbolt University social study, almost every fourth Neukoelln citizen is unemployed (23 %). The average net monthly income is just 725 euros while in some parts of the district 73.5 % of the residents live on subsistence income (in Richardplatz Süd quarter,

every third resident is poor, with less than 630 euro/month). Neukoelln is home to 165 different nations. Reuterkiez is the most densely inhabited area of Berlin, with 18,500 residents to every 70 hectares (ha). Children in the area lack opportunities and around 70% of the children there do not complete compulsory basic secondary school (60% of children have immigrant origin). There are more green spaces (773 ha) than roadsides (771 ha) in Neukoelln. More than 80 % of old buildings from the Founders' Period (Gründerzeit), the period just before and after Germany´s 1871 unification, are still in use (BZ, 2008).

The S-Bahn metropolitan railway´s Ring Line runs through the district and connects the area with the historical inner-city. The subway line connects Hermannplatz, the central district square, with the Teltow Canal, Gropiusstadt and Rudow (Der Ring Bahn, 2010). Neukoelln is known for its social housing (*Sozialer Wohnungsbau)*, but also for some prominent architectural examples: the horseshoe shaped settlement, Britz, from the 1920s or the high-rise Gropiusstadt settlement (a mix of open green spaces and single family homes built by the end of the 1960s after the Bauhaus ideas and named after the architect Walter Gropius who designed it). South Neukoelln development from the 1960s and 70s demonstrating the trends in West Germany at the time, the building of large scale housing complexes (OECD, 2003).

Berlin had the specific status of an ´island´ within the former GDR, where due to the presence of the Berlin Wall, Neukoelln was positioned as a peripheral zone. After World War II, Neukoelln became one of West Berlin´s districts. The Tempelhof Airport which supplied West Berlin during the Soviet blockade was located in Neukoelln. Since the fall of the Wall, Neukoelln has become a more central area as it is close to the historical city center, the new government complex and new business centres in Friedrichstraße. In the biggest part of Neukoelln, the densely inhabited housing needs renovation. The urban structure is changing today with the arrival of the ´art scene´.

3. The Neukollen Phenomenon. The Current Move of an Art Scene

The Neukoelln district is changing. We are witnessing today that Neukoelln has been transformed from a socially disadvantaged to a hip urban district with a high concentration of young bohemian residents. Even during the last two years, many people have moved here. But what is it so alluring about Neukoelln?

One of the reasons for its attractiveness is that small studios are cheap enough for artists and students to afford to live in. A number of young people have moved to Berlin from other world metropolises where everything is much more expensive, like London or Paris, in order to be part of this bohemian atmosphere. For them, compared with their previous rents and standard of living, it is very cheap.

Artists have played an immense role in the transformation of the area into a cultural hub. Neukoelln definitely has a favorable position as it is adjacent to Kreuzberg-Friedriechshein which has already establised itself as an attractive alternative scene in recent years. Northern Neukoelln is a mix of trash and graffiti, pop-up stores, bars and cafes, start-up youngsters, emerging artists, small theatres, bohemians and window displays, with Weserstraße as its core. Neukoelln is the new home for global nomads moving from one place to another, addicted to this atmosphere of diversity and endless feeling of freedom, all seeking that ´right place´. Some of them are just young singles who want the active night life of trendy Berlin. To show how open for everyone Neukoelln today is, we have the example of the

culture festival *48 Hours in Neukoelln*. Held in the summer, this festival transforms the neighborhood into an open stage with workshops, readings, concerts, video installations, exhibitions and performances. Any resident of Neukoelln can take part. Thus, in Neukoelln, anyone can be and call himself an artist. According to Florida, ´places are also valued for authenticity and uniqueness. Authenticity comes from several aspects of a community - historic buildings, established neighborhoods, a unique music scene, or specific cultural attributes. An authentic place also offers unique and original experiences. Thus a place full of chain stores, chain restaurants, and nightclubs is not authentic. You could have the same experience anywhere´ (Florida, 2003). This is Neukoelln today, authentic and unique.

Fig. 1 Neukoelln Berlin distric.
Photographer and copyright Biljana Arandelovic

Emerging artists, designers and other start-up entrepreneurs aim to relocate to such locations and to invite others to move there. This kind of area then becomes a growing collective and sends image to the world of being ´a new place to be´. The residents of this collective have the aim of inviting not just new collective members (new members are also very important for spreading the activities in a collective network), but more importantly, to invite possible buyers, agents and dealers. The idea is to produce, gain attention, exhibit and sell in the same collective neighbourhood. They promote, run their small studios (galleries) and curate themselves using all the advantages of being a part of the ´creative´ collective. Here they have the possibility of personal contacts. Living and working at the ´scene´ is not something that modern generations have invented. The difference is that today, young emergining entrepreneurs often produce, run, curate, promote and sell their productes at the place where they live, usually in the ´right place´ in the right neighborhood. They give immense energy in marketing and in promotion of their neighborhood while trying to break into the real market of agents and dealers. While waiting for an agent to arrive, they promote their neighbourhood. By doing community promotion there is a bigger chance of bringing

agents to their neighbourhood, and thus a bigger change for them to be noticed. The more attractive the neighbourhood is, the bigger the chance of making people come to see their work.

There is also the approachability factor. Already established entrepreneurs have their networks of agents and customers who have no problem with travelling, while new entrepreneurs and emerging artists need to be reachable for possible visits. By being located and connected with the community in the neighbourhood they have bigger chances.

To raise interest in what they are doing, the new residents organize collective activities or events. For example, many events bring musicians and visual artists together. For creative community members living in Neukoelln, it is very important to make a venue and to spread the reputation of the neighbourhood that it is worth visiting again, which raises their chances for promotion, and eventually finding the right agent.

Fig. 2 Neukoelln Berlin district.
Photographer and copyright Biljana Arandelovic

Meanwhile, while waiting for the right contacts to arrive by making events, new Neukoelln residents do not have many options available to them. Berlin´s funding and support is usually used for creating tax revenue, and therefore put into already established creative entrepreneurs, such as Universal Music or MTV Networks Germany within the Media Spree complex. It is very hard for young non-profit enterprises located in Neukoelln to gain subsidies. There are some local fundings projects, but the rigorous evaluation process does not bring much help for the majority.

Neukoelln is definitely facing a rapid increase in its rents. The neighbourhood is changing too quickly. If you have in mind that you are in one of Berlin's poorest districts, it is not hard to guess what the reaction is of Neukoelln's residents, those who lived there long before the ´art scene´ arrived. Some of the old residents are convinced that they are being pushed out as they cannot afford to live in the neighbourhood anymore. In the opinion of some

people in Berlin, the rich young hipsters arriving in Neukoelln nowadays (whether as temporary resident or tourists) are responsible for driving up the rents. ´Tourists go home´ is just an example of the graffiti that has appeared recently as a protest.

Fig. 3 Neukoelln Berlin district.
Photographer and copyright Biljana Arandelovic

Fig. 4 Neukoelln Berlin district.
Photographer and copyright Biljana Arandelovic

Fig. 5 Neukoelln Berlin district.
Photographer and copyright Biljana Arandelovic

4. CONCLUSION

The Neukoelln neighbourhood has definitely benefitted from the arrival of young bohemian residents, who have improved the area for all its residents. This improvement and displacement are typical signs of the very complicated subject of gentrification, where politics, economics, culture, and identity intersect. Significant change in Neukoelln is visible but it is too early to talk about gentrification. One of the consequences of this is that rents have been raised, and this has happened because of the absence of strict rent controls. But, was there any alternative?

After unification and during the renewal process, real estate owners were bound to strict rent control, which prevented gentrification. At the beginning of the 21st century, mainly due to the financial crisis, the city changed its housing regulatory policy. Before this change, investors and real estate owners could gain profit on investments even with low rents, all thanks to subsidies. With these changes they were forced to increase rents to retain their profit.

Fighting against rising rents is the aim of the old Neukoelln residents. The same is true for the people who have recently moved in, young people who follow the trend. All the residents need to find a way to keep the neighbourhood stable, which is only really possible with the help of the city because only they have instruments to control rents.

In the case of Neukoelln, gentrification might be a positive process and the district can benefit by current development trends in Berlin. Small independent theatres and art galleries in emerging and dangerous districts attract commerce. With this, Neukoelln might become a more attractive site for investments which will in turn create numerous new opportunities for its residents in the future. However, the importance of Neukoelln as a tourist site and flagship city branding mechanism could be enormous. During the next few years, urban

growth coalitions must invest in the development of creative institutions in Neukoelln if the city wants to spur urban economic development in this area. Neukoelln should use this opportunity. If you force people to move out, then you remove the opportunity for low-income Neukoelln residents to prosper from the newly arrived creativity. If the government does not regulate the rise of rent in Neukoelln, the new art community that has arrived there will also be as forced to move again as they will no longer be able to afford it. This will result in having Neukoelln like it was in the past, poor and boring.

Berlin is unpredictable and in a constant state of change. Neukoelln has space available for new businesses, and its extensive green spaces and good transportation infrastructure are all beneficial for its future development. Cultural districts like Neukoelln, as mixed use areas, might help the process of urban renewal. Renewal policy should not miss this opportunity to develop this traditional poor distict and to integrate it within a wider urban structure. Creative industries could be used in the regeneration of this marginalized area. The arrival of the art scene is the first step.

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NEUKOELLN FENOMEN: SKORAŠNJA KRETANJA UMETNIČKE SCENE U BERLINU

Jedan od pozitivnih događaja u periodu posle pada zida bio je stvaranje alternativne umetničke scene, među kojima su Mitte i Prenzlauer Berg imali vodeće pozicije među umetnicima, kao novi centri kreativnih industrija u Berlinu početkom devedesetih. Ubrzo, Mitte i Prenzlauer Berg su postali mesta na kojima su stigle komercijalne kreativne kompanije, pa se zbog toga i umetnička scena preselila u Kreuzberg-Friedrichshain nakon što više nije mogla da priušti povećane rente. Danas smo svedoci premeštanja umetničke scene u Neukoelln, jednog od najproblematičnijih oblasti u Berlinu, gde su migracije u proseku više nego u drugim delovima grada, etničkim tenzijama, lošim socio-demografskim indikatorima i visokom stopom kriminala. Umetnička scena u ovom okrugu nije tako ustanovljena kao što je bila u Mitte-u. Ono što se tamo trenutno događa nije profit, već se više radi o ideji da se nešto dešava u ovom trenutku. Upravo iz tog razloga je prerano donositi zaključke. Kako dolazak umetničke scene utiče na najproblematičnije područje u Berlinu i koji je njen mogući budući uticaj? Za sada, vidimo obnovu berlinskog okruga Neukoelln koje će na kraju dovesti do gentrifikacije. Rezultat takve promene je povećanje rente i bes starosedeoca.

Ključne reči*: Umetnički pravci, brendiranje, Nemačka, javni prostor, globalizacija, posleratni Berling, Nojkeln, kreativna industrija, potkultura, kreativni gradovi*

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THE NATURE, QUANTITY AND QUALITY OF URBAN SEGMENTS

UDC 711.5

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Abstract. *The urban structure has no clearly visible boundaries between the content, function, form, and other, which is a consequence of the city's spatial development and a multitude of influences connected within this process. The city, however, has been created as a product of periodic construction and all possible interventions related to such a course of development. Plans, planning activities, projects, cycles, etc. have not eventually given a clear overview of the total urban structure and shown it as a clear and, to all of us, desirable whole. In order for such a structure to be understood, it was also necessary to review each individual situation where, due to the complexity, the city should be divided into appropriate parts and subparts, which can then be given different names (city element, part of the city, structural area, etc., but of all names, the concept and term 'segment' is most commonly used). In order to be analyzed, recognized and planned in the future, designed and built, the whole of the city must rely on such a division. The notion of an urban segment is related to the nature and number of elements of its content, and with such qualitative and quantitative nature, it becomes the basis for any further analysis. Analytical procedure of the segment also implies an additional analysis - of their mutual interactions or border areas. These areas are as significant as a segment, sometimes even more significant as they contain necessary information connecting the city into a whole.*

Key words: *urban structure, segment, influence, information, border area*

1. INTRODUCTION

Urban segmentation does not represent only simple physical division of the physical structure of the city. City, as a complex system of occurrence in space and time, has the need to present itself in a whole through its parts. However, city can never be represented as a unidentified whole, so its parts (segments) and their interactions cannot be represented that way

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either. There was always a question of how to arrange the city (of any size) as a place where the cause has a clear consequence, and where any form of nonconformity could be avoided. This generally was not the case in practice. Theoreticians of architecture and urbanism (Habermas, 1984) through the history, tried to create the idealess conditions necessary for the creation of such cities. They represented a communicative action, which is practiced in cooperation with urban design and planning theory, assuming divergent communications networks that leads to common sense.

When the idea of a segment is accepted, it is conceived as a flexible category with a lot of internal content that change and whose primary task was connection of urban structure, systems and organization through all necessary levels, according to the spatial and temporal requirements. Thus, the scientific area of the architectural and urban organization of the space is directed and grounded in a fairly wide framework and according to specific directions that cover life and social needs in a multidisciplinary manner. This prevents architecture, and especially urbanism, from having an isolated status and acting from the position of technical and artistic service, to which the classical architecture and urbanism have become accustomed. From the very theory of space and form, through the composition and structure, until the analysis of typology, urban renewal and the necessity of searching for new building technologies, architecture and urbanism have expanded and entered in such spheres as the urban environment, observed from the economic and social point of view.

There are even more complex spheres of space-time-place (genius loci-genius saeculi), boundaries, transition elements, readability and picturesque structure observed from the psychological point of view, biogenic and biogenic pathogens spaces (healthy places), all until the theory of the needs of modern urban reconstruction and new aesthetic (design) and compositional principles. Such a wide range of urban issues requires a new definition of problems and goals, as well as the creation of original connections between hypothetical concepts in theory and achievements in practice. The architectural artifact thus ceases to be an "art exhibit of an open museum called the city" and turns into an interdependent element of a variable space in time, and a carrier of significant planned forms and their implementation. A group of such elements gives an urban segment.

The ultimate goal of observation, analysis, and interventions in such parts of the urban structure is the desire and the need for general observation of the city's structure. There is also a necessary need for perceiving the nature of mutual overlap, not only formal analyses of constructed content. It yields benefits for the city as a product but also the methods used in the process which diminish the mutual disagreement between architectural and urban elements giving us the possibility to achieve the necessary concord of the city parts in further construction. This is the basic idea, the driving motive, the goal and ultimately the belief in the idea that classical zoning theory could be replaced by a more natural observation of the constructed reality.

To be exact, that is the very goal of every urban segmentation research as well of this one. The creation of the necessary database for every segment and border areas, research and efforts in achieving this. The layout of moves is following - the urban structure is large. The process and segmentation process aim to defragment it into a smaller number of perceivable and usable parts. These parts connect and overlap. The diversity of the content of the urban structure forces us to measure, categorize, compile and apply the elements of the urban structure through analytical methods and criteria which we will establish. Why is this necessary? Any future participant of a new constructional, architectural and urban project

would want to have an idea of the content of space he is dealing with. Surely, the criteria, methods, and approaches cannot be predefined, because they depend on each selected and analysed structure and its properties in particular, even though the approach might be the same. That could be also called by design of a particular atlas of space at the time where the specific urban structure would be represented including all necessary data obtained by the criteria of analysis of the forms, shapes, functions, historical parameters etc. That is a valuable collection of knowledge available to the construction participant and many would like it to exist in one way or another rather then not at all. On the contrary, every intervention would have to be founded on scarce information or on what we alone must gather. That would be the frame and the sense of every work of this kind.

The goal of research would also be a process, the ability and the possibility of collecting and shaping such data and ways of their preservation and use. It is possible that such collecting and shaping is difficult to achieve which would make this a demanding level of research work. The goal of research would also be levelled in justification and the practicality of the obtained results, since all urban structures and therefore the segments, are not the same, and neither is working on them, which would be proven from example to example.

2. URBAN SEGMENTS AND THE CITY

The definition of the urban segment, however understood and accepted, would not be possible without the corresponding architectural and urban legislation and regulations, the relations of government, citizens, architects, urban planners, state and its institutions, especially in practice. Thus, the urban segment becomes a complex cell of the city structure, which contains and transmits variable contents through the, only seemingly, intricate hierarchy of the influence on other segments and the city as a whole. These influences can be both, positive and negative, faster or slower, with more or less content... They can be (and mostly they are) under different limitations and self-limitations, but they are in an inconsistent function and continuity. Even the slowest and most limited influence of the segment is the influence worth of attention and analysis. In one of his earlier works, the author of this paper (Stojanović, 2015b) has written about such behavior of the segment (segments) and the processes involved in, that the change in urban structure is not only a simple physical event in time and space, it already contains reasons and goals of spatial planning, spatial levels and time phases, various classifications and systematizations in the process of planning the urban community.

Creating and designing complex compositions of buildings in the environment requires identification, collection and use of number of different types of information and meanings, from material and physical elements, through economic and legal criteria, social contents, psychology and culture of urban life, to art and aesthetics. Prior to this, about the relation between legislative and legislation process those recognized and visible, also those unrecognizable and invisible (Stojanović, 2015a) was noticed that urban legislation, in the worst forms, continually creates the consequences. That paradox is based on the fact that the law creates a structure and the structure created the law. The city is still perceived as a disrupted system where there is no order of events and where future advancement cannot find a sustainable relationship with the past.

Urban structure is an everlasting, changeable state, both in a spatial and temporal sense. The state of ongoing changes. It is mostly observed in the present moment. This manner of

observing civil engineering – architectural structures, in a narrower sense, or urban structures in a broader sense, creates problems in analyzing, designing and planning. The past and the future of such a state is the subject of the history of architecture and urban planning (construction as a whole), and new plans and planned projects. Thus, movement and change become hard to notice and even harder to register. It necessarily becomes a research goal since constructors have it in their interest to have insight into the entire flow of construction, change and development.

In contemporary circumstances of constructing cities, it would not solely be the goal of constructors, but also of a string of auxiliary areas that are indirectly or directly involved in urban construction. More precisely, the research goal would be a sample of constructed architectural – urban structure that could be analyzed several times since it would previously, depending on the criteria, be separated from the complete urban complex that is too large for a detailed analysis. Separation, levels of connection and boundaries are of prime importance for having an insight into the contents of urban structure. The quality of data is not the primary goal, since the sample from the content (called urban segment in the paper, but it can be called otherwise) would not evaluate the structure as good or bad, more or less successful and the like, but it would, primarily, serve as a quantitative collection of information that would be processed further in accordance with the needs, resulting in the necessary evaluation.

Evaluation, analysis and collection of data from such a limited section would aid (or would have aided) the final construction of a city as a whole. Connecting segments would open another research level. It would be a so-called conflict between various states, not just with regard to time, but also to the manner of construction, urban legislature, urban economy, styles, forms and aesthetics, etc. A method of such plotting or segmentation would also be a possible and necessary subject and goal of research, or, most probably, its inevitable part. The final product would be the notion of a city as a structure changeable on every level. Two-dimensional and, in the given time period, permanent projections of the constructed urban content would no longer be analyzed or created, not even the three-dimensional representations of the city's appearance with an interrupted ("frozen") conception, but every segment would be timely changeable and usable in real time and in all necessary states.

3. Interrelationships, Impacts, and Reaches of Urban Segments Contents

The interrelationship, impacts and reaches of the urban segments contents depend on the nature of the situation, but also on the current impacts and future development plans. None of these conditions were given as dominant. The past condition is, in fact, some previously planned condition lagged in the present, the present condition has both of these conditions, as a possible future planned condition which is debatable precisely because it is unknown and unrealized, and which is undoubtedly related to the previous two conditions. What does it mean? The old knowledge cannot be exclusively a museum category left with possessive interventions of revitalization and reconstruction, the current condition cannot be a polygon of rapid interest interventions, and the future situation can ot be a list of nice wishes set as a project - and not as a plan! A project that turns into a plan and wants to exist for an extended period of time, and that acts as an unchangeable project/plan, and which also has the support of the institutions that have created it, becomes a frozen condition that threatens planning and urban crisis.

Until now, the circle of urban transformations was closing and the problems were repeating. How to solve the problem which is the problem of impacts and domains of urban content? The urban segment contains enough necessary and unnecessary information (provided that someone wants and knows how to use them) to solve this problem. Architects and urban planners associated with urban design as a specific memory site (Boyer, 1994) believe that this is also supported by the fact that memory affects the "good" or "bad" image that the site provokes. This approach is trying to make subjective existence closer to objective existence of the place. Not only experience and registration of existence. Real-city theoreticians took less into consideration the subjective experience. (Healey, 1997), considering that collaborative planning integrates soft and hard infrastructure through procedures and communication protocols that allow wider participation and representation in the decision-making process.

For example, the comprehensive definition by Laguerre sustainable manner by individual residents and groups of particular city for the purpose of interacting, simulating, explaining, reinforcing, monitoring, neutralizing, criminalizing, expanding (locally or globally), processing, transacting, or undermining any political, social, economic, religious or communicational aspect of the daily activities of the urban community (Laguerre, 2005:1). Obviously, the digitalization creates an expanding sphere of information exchange through which cities and their society observe, control, evaluate and manage their vital systems. At the same time, the emerging software/applications/gadgets/tools represent another driver of progress, providing means for improving general urban performances and environmental quality Therefore, it is not surprising that the simulation, which has become the evolution of our digitized epoch, has been the focus of attention of many authors, especially during the last two decades (De Waal, 2014).

Due to the multiplication of economic and technological changes, which affect our behavior, needs and mutual interaction, the inherited urban patterns and typologies have been changed. Simulation could not, and still cannot give response to real changes that are important for urban analysis due to a multitude of impacts (Landry, 2005). The basis of the urban city is influenced by several factors: personal quality, will and leadership, human diversity and access to different talents, organizational culture, local identity, urban spaces and objects, networking dynamics. However, the most important among them are political will and appropriate organizational culture, which means that government and other interested parties should recognize the need for a creative city - as a model that stimulates and generates new ideas and approaches. At the same time, the existence of a digital platform, as an interface between interested parties, has already become necessary in the development and exchange of knowledge, especially in the area of climate/ecological awareness. Generally, the first prerequisite for the creation of the creative city can be found in human diversity and access to various talents who foster understanding and learning. A practical approach to such an understanding of the urban segment would be in a scope of real architectural and urban construction.

The contents and impacts that are certainly not linearly registered, would be linked through the urban segment as a theoretical and practical product. Simply, if some architectural-urban impact should exceed from the limitation of its urban environment, it must transfer data relevant to the development of the second segment. Thus, the so-called "urban chaos" would be avoided, and connections between city parts would be better linked.

This is not the formula of the " perfect city", nor it is possible. There was only given a possibility of better connection.

Public spaces are of transitory significance for the realization of this idea. The identity of public spaces is much stronger and more important than the identity of specially isolated spaces. The identity of wider spaces is more complicated and more difficult to understand. A critical overview of the meaning of open public spaces, without wider space, is of great importance for the transformation of the urban process. The identity is capable of recognizing the space as different and suitable in relation to other spaces because of its clear and unique character. (Lynch, 1981). Transition zones are particularly important. They are not just the boundaries between city segments but the most important areas of connection or secession. But, only the operation in locating process, within which the search and selection co-operate with the location, gives the final shape of the site.Truly, if we examine the flow of the locating process from the research through a successful operation until the final form, we could see that every successful operational result finds details and precision of the specification. For example, to establish a locating operation, only certain aspects of the location are given while the form cross-section is not specified. (Manheim, 1980). Architectural and urban product, process of creation and experience of use is a unique entity that requires an integrated approach. The center of our experience are designed events of our existence (Norberg - Schulz, 1971)**.**

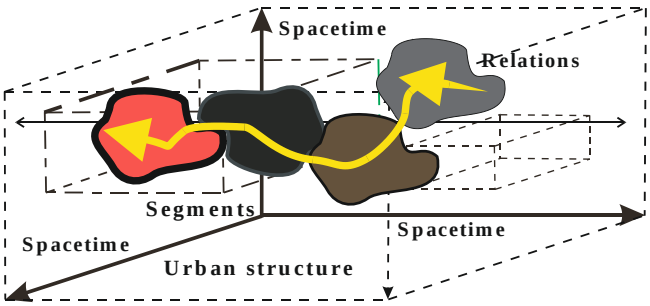

Fig. 1 The quantity and type of information, information transfer, the impact of segment content and the consequence of information effect (source: author)

Integral architecture and urbanism through the segmentation of continuous analysis can create a city that exists as a space without unnecessary divisions. The isolated segment can be analysed to a certain level and when it is exceeded, and the information flows terminated, the data from such a segment becomes less usable and valuable. Establishing a reconnection of the segment with the surroundings it was isolated from, creates problems that are equivalent to a period of isolation. Otherwise, is either becomes the structure for itself or we have to find ways to renew and reconnected its broken connections. Theory and experience do not have to be connected, but they are part of something that can or cannot exist.

The urban structure is, practically, chaotic. Theoretically, it should be regulated. But it is neither one nor the other. Theoreticians of the system accept differences, but they also theoretically and practically solve them. In architecture, urban planning and spatial planning it is only partially accepted. The desire for repetition is theoretically unsustainable. Identical

images in different spaces do not exist-identical images exist through the relationship between their borders, while the lines of delimitation (extension) exist-although the extension of the delimitation (extension) lines could always be different. (Sklar, 1976). The segment which in inself carries enough information, may be determined at many levels of its temporal and spatial structure and it is this flexibility than increases our analisis capabilities, in size, quality and content, especially when they comply with technology which is designed for that purpose and which provides it, as well (Fig. 1).

4. Border Areas of Parts of Urban Structure and Relationship of their Contents

In an urban structure, there are parts that are to a greater or lesser extent intertwined in terms of their content, function, form and other parameters. This immixture has a variety of causes. When it comes to the urban segment (a part of the urban structure that should be characteristic by the recognizable nature, the quantity of urban content), touching or bordering areas are also significant. The majority of urban segments are heterogeneous, multilayered in their content and therefore in their border areas. Only where pre-planning, design, and consistent application of urban legislation has created clear and recognizable units, this heterogeneity is smaller, both within the segments themselves and in their boundary areas. This is not the case in the majority of urban structures. One of the goals of this paper (if not the main goal) is to point to the need for this unnecessary diversity to be as lower as possible and therefore, for urban segments to be more arranged, both in themselves and in their mutual relations.

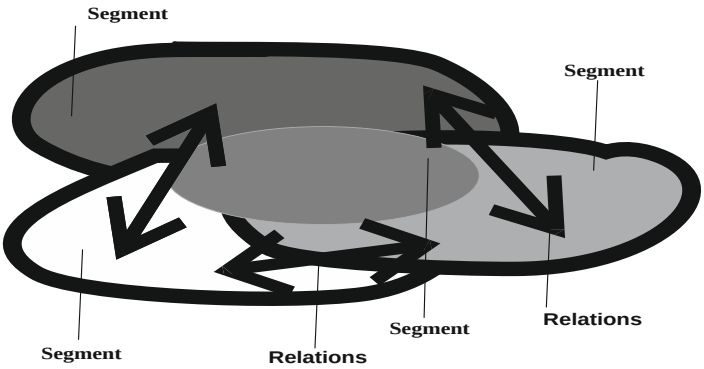

Fig. 2 Position of segments in mutual relation
(source: author)

Since in practice this is unlikely, we only have the analysis of those parts that separate urban segments, provided that each segment is previously defined to the clearest possible extent. There are several reasons why the segments, as well as their border areas, are different, sometimes even over all limits of tolerance. In addition to the aforementioned urban legislation that changes over time, there are also the effects of different styles and rules of construction, economic and social disturbances, changes in social habits, cultural patterns and many more. This is a problem that has been noticed and observed for decades. Lewis

Mumford (1946) and Siegfried Giedion (1948), the leaders of CIAM and famous architectural historians, more than 70 years ago spoke of the idea that a city could be put within the frameworks of its technological advancement, and that the continuing development of human capability could control developmental processes within the environment. They then considered that the construction of an urban and architectural environment, starting from the use of bare hands, through the use of tools, reached its peak by "push the button." Thus, decades ago, they forecast a hyperproductive manner of creating architectural-urban morphology with a potential danger of excluding the human factor.

Exploring the border areas of urban segments, one can observe that those are mostly very narrow and of irregular shape, which is shown in Fig. 2 and Fig. 3. This is the result of a spontaneous and long relationship between architectural and urban activities. However, in some cases, they are of a regular shape (shown in Fig. 4) with clearly distinguished differences between the two types of structure. The example of Fig. 4 shows the relationship between the old and new urban structure created in a short period of time due to the change in urban plans and the overall urban regulation. Both types of urban segmentation are sometimes referred to as "conflict zones" as they create conflicts of architectural and urban structures by many criteria that are very difficult to harmonize and arrange later. Conflicts or interactions between urban and architectural contents have no defined rules and have a set of architectural and urban contradictory parameters. This is where the functional, technical (building), aesthetic and formal levels mix.

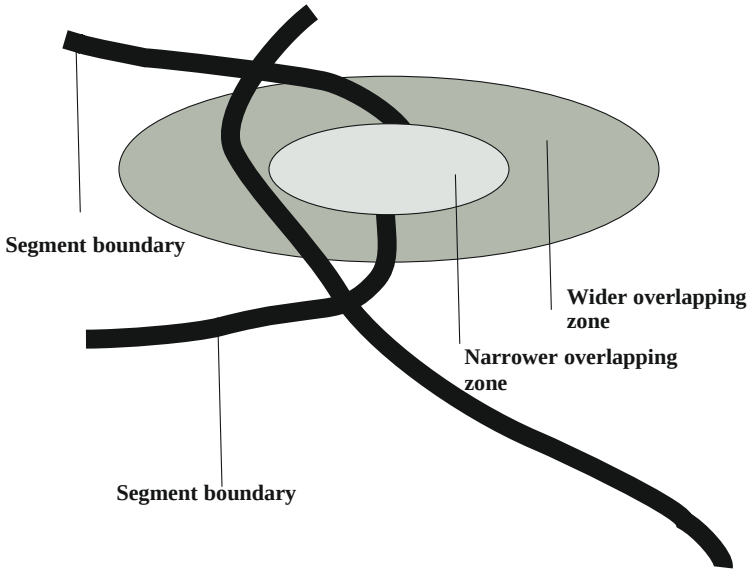

Fig. 3 Segments overlapping zones
(source: author)

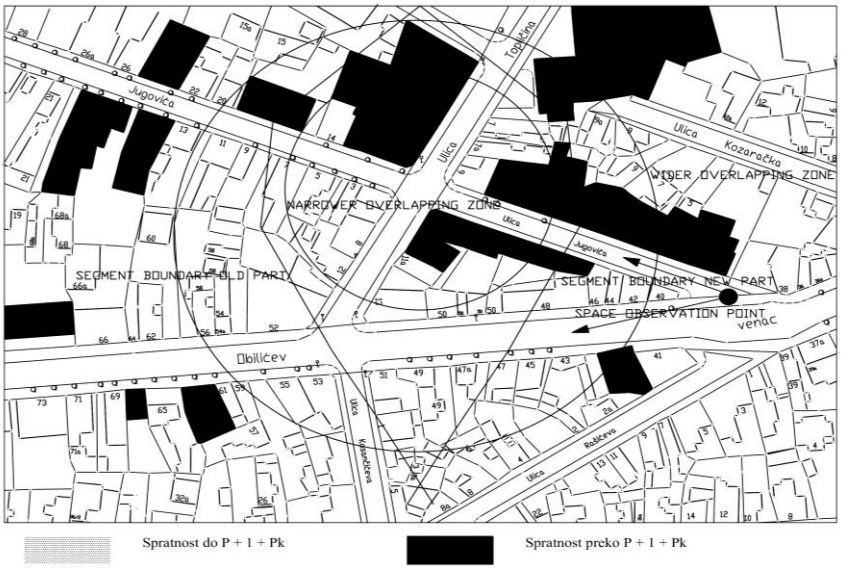

Fig. 4 Cartographic display of two segments overlapping in real space (two/dimensional view) (source: author)

Norberg Schulz (1980) considered this as the spirit of a place (Genius Loci) and was interested in changes that can be accomplished by a better conceived and true control of the existing and future space. He first did this at the level of intuition and then at the level of planning, designing, and construction. His view of the conflicts between architectural and urban structure was noticed and successfully analyzed by architects, cultural geographers, sociologists, and philosophers, starting from the fifties to the end of the seventies of the last century. When a city is built in the future, given its anticipated ever-increasing, intertwined, and mixed structure, the segmentation will be an unavoidable approach of methods and techniques, due to the easier viewing of the city's contents and easier data processing.

In order for the key observations to be fully compatible with the approach to such a sensitive topic, the basic principles of building individual parts of the city (segments) as well as their inevitable coexistence and intertwining in time and space must be emphasized. Those would be the following principles:

1. The city is conceived as a whole but is built partially, by parts and in line with the social - economic and economic - financial possibilities;

2. The city, regardless of the manner of its building, in any spatial framework and time period, cannot be treated or even analyzed as an undivided whole;

3. Subparts (segments) are (primarily) technical division, method and approach to the breaking down of the city into those parts prone to analysis that contain characteristic features, regardless of their origin in the past, present, or future;

4. Future interventions in the city and, therefore, in the city segments, should take into account differences of the segments due to which the city is easy to understand;

5. Sudden changes in the nature of the segments, especially their border parts (possible conflict zones) require a special planning, design and construction approach at all possible levels.

From these principles arises the level of construction of a place that, besides the architectural, has a psychological and cultural level. The degree of experiencing the city, places in the city and its continuous repetition is described by Heynen (1999) as obtaining (finding memories and returning own, personal history) that is the essence of living and that can be emotionally attained not only in the existing place but also outside the existing place, anywhere, in the literal sense of the word.

Fig. 5 and Fig. 6 show, in a real three-dimensional space, two selected areas (places) analytically followed in their urban and architectural development over the past ten years in the area of the City of Niš. The same places were previously shown in Fig. 4 with all the necessary markings and notes.

Fig. 5 Visual display of two segments overlapping in real space (three-dimensional view) (source: author)

Fig. 6 Visual display of two segments overlapping in real space (three-dimensional view) (source: author)

5. CONCLUSION

Unity of city structure will not be able to reach the level of connectivity in due time, which could allow an optimal interaction. It will not be a utopian level that wants a perfect city and urban structure, system and organization without the wrong needs and results. Even, this will not be the desired level of sustainable development which many people want and try to affirm. The connection of well-built urban segments associated with the appropriate planning strategy, remains a factor of new influence, interventions in urban space and time, and in the end gives their ultimate product. This ultimate product is a good foundation (theoretical and practical) for the patient upgrade of an efficient, all-appropriate urban environment. Generally, the elements that are segment (segments), become a simple and practical process of the analysis of all necessary architectural-urban interventions at all levels. However, this is not easy. Segments, in this paper, theoretically displayed, continuously change the system, structure and organization of urban city life with all its relevant and important connections. These connections can be viewed separately, partly interconnected and extremely interconnected. Only, connections cannot be viewed abstractly, in relation to the necessary, current space and time, and can not allegedly set, plan and change whatever the explanation of this process would be. The way of creating cities has clear definitions. (Lynch, 1960) thought, at the beginning of the sixties, that the future urban emphasis would be in the physical environment as an independent variable.

This study will be used as analysis of physical properties of the identity and structure of mental image. This leads us to a definition that can be called the image's ability. It is the quality of the object with great ability to cause strong images with any observer. That is the form of the color or arrangement that facilitates the creation of clearly recognizable, strongly structured, highly useful mental images of the environment. This can also be called readability or perhaps visibility in an enhanced sense, where objects don't need to be only visible, but presented strongly and intensely in relation to senses. Such thinking is not only an artistic vision and experience of an independent architect or urbanist. It is an analysis of the architectural and urban space that architects and urbanists have left to other sciences and professions.

Urban design is not a game, though it could be? It is the least professional, and the most scientific category, which, as such, must be accepted. (Karminia, 2009) sets the limits until where architects and urban planners can go. Life in public places in the micro scale is faced with various threats of reduction due to the transformation of social values. Our future public places are shaped by trends such as privatization and communication revolution. The integration of urban forms and social values appears as a concern for the development of a modern, urban design that increases the site's safety and promotes further integration. When the connection of the city structure becomes possible then theories will have to change too. Previous theories have failed to change the City.

If the City is a complex structure with its elements, sets, functions and constructions, the results and contribution of every research would be establishing the hierarchy of relations between such contents, with regard to quantity and quality of that which the City (or part of the urban structure) has. Mixing the constructed architectural – urban content is transferrable from a level of a single facility (from one to another), then from narrower or wider constructions, up to the level of the city itself (urban zones) as an extreme. The direct result of such research would be reduced to a necessary limitation that can be analyzed more easily and effectively.

The urban segment with its contents, border relations and analyses, already carries within itself the goal of necessary research that would in the end bring us to the corresponding scientific contribution, where that is necessary and requested. Architects, urban planners and the entire construction field cannot cover this research level individually, but it can be done in cooperation with other, broad or narrow scientific fields. Working on such a research level would offer the exact inclusive possibility that the architectural – civil engineering domain has been missing. The urban segment, or an analysis of a part of architectural, constructed urban structure would be an informational database that would be useful to many. By using, developing and filling out such a (elementary) database in multi-informational systems, the architectural – civil engineering sector and the levels of spatial and urban planning, together with urban and architectural design, would create a future framework in construction for the participation of all other important analyses and information, previously unavailable.

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PRIRODA, KVANTITET I KVALITET URBANIH SEGMENATA

Gradska struktura nema jasno vidljivih granica između sadržaja, funkcije, forme i ostalog, što je posledica vremensko – prostornog razvoja grada i mnoštva uticaja koji su se u tom procesu povezali. Grad je, ipak stvoren kao proizvod periodične gradnje i svih mogućih intervencija koje su bile u vezi sa takvim jednim tokom razvoja. Planovi, planske aktivnosti, projekti, ciklusi itd. nisu na kraju dali jasan prikaz ukupne strukture grada i nisu ga prikazali kao razgovetnu i svima nama poželjnu celinu. Da bi se takva jedna struktura razumela bilo je i potrebno je preispitivanje svakog posebnog stanja gde bi, zbog složenosti grad trebalo podeliti u odgovarajuće celine i podceline kojima možemo dati različite nazive (element grada, deo grada, strukturalno područje i sl, ali od svih naziva najčešće u upotrebi je pojam i termin segment). Celina grada, da bi mogla biti analizirana, prepoznata i u budućnosti planirana, projektovana i građena mora se oslanjati na takvu podelu. Pojam urbanog segmenta vezan je za prirodu i brojnost elemenata svog sadržaja i on sa takvom svojom kvalitativnom i kvantitativnom prirodom postaje podloga bilo koje dalje analize. Analitički postupak segmenta podrazumeva i jednu dodatnu analizu, njihovih međusobnih dodira ili graničnih područja. Ta područja su važna koliko i segment a neki put i važnija jer u sebi sadrže informacije koje povezuju grad kao celinu i koje su nam potrebne.

Ključne reči*: urbana struktura, segment, uticaj, informacija, granično područje*

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THE USE OF WEBER'S FOCAL-DIRECTORIAL PLANE CURVES AS APPROXIMATION OF TOP VIEW CONTOUR CURVES AT ARCHITECTURAL BUILDINGS OBJECTS

UDC 514.75
514.18

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Abstract. *One of the major aims when researching some problems in architectural design of buildings is to fully understand and adequately apply the underlying scientific foundations that architects use in their projects. In this paper we analyze the application possibilities of the Weber's focal-directorial curves in the approximation of ground-base contour line of architectural objects i.e. buildings. Thus, a Weber's curve with m foci and n directrices was defined. Furthermore, particular qualifiers were introduced in order to estimate the level of adequacy of the conducted approximation. The importance of the research can be sought in the fact that the exact procedure has been created with its applicability in architectural-urban design of contemporary forms as well as in the domain of the historical heritage and conservation in the sense of the creating proper geometrical models for further computer aided use.*

Key words: *Weber's curves, parabola, architectural objects, approximation.*

1. INTRODUCTION

The approximation of the contours of architectural objects with various curves is one of the problems that was dealt with by several authors. The importance of solving this problem is reflected for instance in the easier possibility of restoration of historic

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buildings. In that sense, Duvernoy and Rosin concluded that "the purpose of research on design problems in historic architecture is usually to understand and to reveal the hidden theoretical sciences that the architects applied in their projects", [4]. Some papers however studied the analysis and design of masonry arches, masonry arch bridges and buildings, [3], [7], [9] and [10].

Gonzalez et al. determined a curve, which best fits an architectural arch and its analytical equation, and then they apply this method to the 23 arches in Palau Guell, [8]. Authors have concluded that Gaudi experimented with the four types of conic curves (circle, ellipse, parabola, hyperbola) and the two types of hyperbolic-cosine curves (Rankine, catenary). Ginovart et al. determined the form of Taragona Amphitheatre. They analyzed the following geometrical forms: ellipsis and ovum, [6].

Plane Erdös-Mordell's curves have been of particular interest in our previous researches [1], [15]. Thus, the Erdös-Mordell inequality of a triangle, defined by a relationship between three-focal sum and three-directrix sum, has been investigated.

Curves, generated as a locus of points with the constant sum of distances from two or more foci have been so far widely investigated, not only by mathematicians but by artists, architects and engineers as well. The application of multifocal plane curves in the approximation of top-view as well as of various side-views contours of diverse buildings has been researched in [21]. Thus, the use of ellipse and egg curve has been analyzed in [17] and [5]. On the other hand, it has been found out that three focal curves turn out to be of a great importance in determining optimal geometric properties of infrastructural corridors as well as in solving in some loci and optimization problems, [18]. In order to achieve the above mentioned goals, curves being a locus of points with a constant sum of distances from multi foci and directrices, have been generated and derived in [20]. In the research [22] the comparison of conics and hyperbolic-cosine curves types in Gaudi's geometric forms approximation has been carried out. The importance of such curve approximation can be found as a base for further computer modelling for the sake of preservation of the cultural heritage [14].

The visualization of Weber's curves and surfaces with at the most three foci and/or three directrices as well as the investigation in particular problems of optimization has been discussed in the following papers [2], [19]. In recent years it has become possible to enlarge the family of surfaces suitable for application in architecture by constructing new surfaces, [23].

What makes this paper distinctive? In this paper a new mathematical form of Weber's curves of an arbitrary number of foci and directrices has been developed. Furthermore, a procedural methodology for the approximation of contours of architectural forms with two planes of symmetry using Weber's curves has been created. The quality of the Weber's curves approximation has been estimated using both the coefficient of determination and the absolute deviation of the real contour from the approximation curve. Likewise, the quality of approximation has been estimated through the comparison between the Weber's curve herewith defined and the parabola (which can be also treated as a Weber's curve but with a single focus and a single directrix). The practical use of the proposed method has been carried out on two different architectural structures, i.e. buildings.

2. METHODOLOGY

In the course of approximation base points of the ground-base contour curve are selected on objects that are approximated (points at the same height level). These points are the common points of the approximation curve's segments as well.

The approximation procedure demands the selection of the so called base points of the ground-base contour points of the analyzed object which are to be approximated (points at the same height level). These points are the fixed points of the approximation curve's segments. Taking into account the double-axial symmetry of the conic like ground-base of the object, three out of four ending points on the axes of symmetry are chosen as the base points.

In order to achieve as good as possible approximation of top view contour of an existing architectural-urban structures by a morphologically adequate Weber's curve, it is necessary to generalize the relationship established in Erdös-Mordell's curve 3 foci and 3 directrices [15], defining a locus of points in a plane for *m* points and *n* lines. Accordingly, the following definition is introduced in [20].

A Weber's focal-directorial curve is a locus of points in a plane of a constant sum of scaled distances from *m* fixed points (foci) and *n* fixed lines (directrices):

$$W_{fd}^{[\alpha_1,\ldots,\alpha_m][\beta_1,\ldots,\beta_n]}(S): \alpha_1 R_1 + \ldots + \alpha_m R_m + \beta_1 r_1 + \ldots + \beta_n r_n = S, \;\; m,n \geq 1 \tag{1}$$

where $R_1,\ldots, R_m$ and $r_1,\ldots, r_n$ are Euclidean distances of the point $T(x, y)$ from the foci $F_1,\ldots, F_m$, and from the directrices $d_1,\ldots, d_n$, respectively, and the scale factors $\alpha_1,\ldots, \alpha_m, \beta_1,\ldots, \beta_n \in R$ are the Weber's weight coefficients (at least one is of a non-zero value) and $S=const.$

The smallest value of the parameter $S=S_0$ for which locus (1) is a nonempty set represents Fermat-Weber's set of points $F = W_{fd}^{[\alpha_1,\ldots,\alpha_m][\beta_1,\ldots,\beta_n]}(S_0)$. When all the Weber weight coefficients equal to 1, all the previously defined curves are of a harmonic proportion such as at Paladio, since according to their genesis they can be related to an arithmetic mean of distances of all points from foci and directrices [20].

2.1. Approximation I

As known a parabola is the genealogically prime curve of the discussed Weber's curves, and it is a locus of points with the same distance from the focus and the directrix, (see Fig. 1). A point *T* that satisfies this condition and can be expressed by the following equation:

$$W_{fd}^{[1][-e]}(0): R_1 - e \cdot r_1 = 0, \;\; e = 1 \tag{2}$$

where R_1 and r_1 are the Euclidean distances from the point $T(x, y)$ to the focus $F(0, Y_F)$ and the directrix d_1: $y = Y_d = Y_F + p$, $p > 0$, respectively. The parameter $e = 1$ represents the eccentricity of the parabola. The parabola treated as a Weber's focal-directorial curve given in (2) can now be expressed as follows

$$\sqrt{x^2 + (y - Y_F)^2} = |y - Y_d|. \tag{3}$$

Because of the ground base contour's double-axial symmetry the choice of boundary conditions for the parabola of the equation in explicit form:

$$\langle parab \rangle : y = ax^2 + bx + c, \tag{4}$$

implies the defining of the following triple of points

$$\begin{aligned} &B(0, Y_B) \in \langle parab \rangle \Rightarrow c = Y_B, \\ &A(X_A, 0)\ ; \overline{A}(-X_A, 0) \in \langle parab \rangle \Rightarrow a = -\frac{Y_B}{X_A{}^2},\ b = 0. \end{aligned} \tag{5}$$

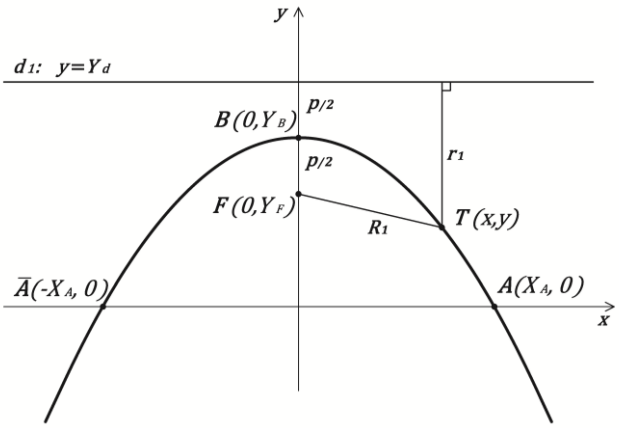

Fig. 1 Genesis of a Parabola (Weber's curve with a single focus and a single directrix)

The Weber's curve with a single focus and a single directrix given by the equation (2) where $R_1 = r_1$ transforms into its implicit form (3). After squaring the equation (3) and substituting the boundary conditions (5) we get:

$$y = -\frac{1}{2p}x^2 + Y_B \tag{6}$$

where $p = X_A{}^2 / 2Y_B$; $Y_F = Y_B - p/2$ and $Y_d = Y_B + p/2$.

2.2. Approximation II

The Approximation II involves the Weber's curve of two foci and three directrices (see Fig. 2), defined as follows:

$$W_{fd}^{[1,1][1,1,k]}(S) : R_1 + R_2 + r_1 + r_2 + kr_3 = S, \tag{7}$$

where $R_1 = \sqrt{x^2 + (y-f)^2}; R_2 = \sqrt{x^2 + (y+f)^2}; r_1 = |y-d|; r_2 = |y+d|; r_3 = |y|$ and $k, S \in$ R, of the boundary points *A*, *B* and *C*:

$$A(X_A,0)\in W_{fd}^{[1,1][1,1,k]}(S)\Rightarrow 2\sqrt{X_A{}^2+f^2}+2d=S,$$
$$B(0,Y_B)\in W_{fd}^{[1,1][1,1,k]}(S)\Rightarrow 2d+(k+2)\ Y_B=S, \tag{8}$$
$$C(X_C,Y_C)\in W_{fd}^{[1,1][1,1,k]}(S)\Rightarrow \sqrt{X_C{}^2+(Y_C-f)^2}+\sqrt{X_C{}^2+(Y_C+f)^2}+2d+kY_C=S.$$

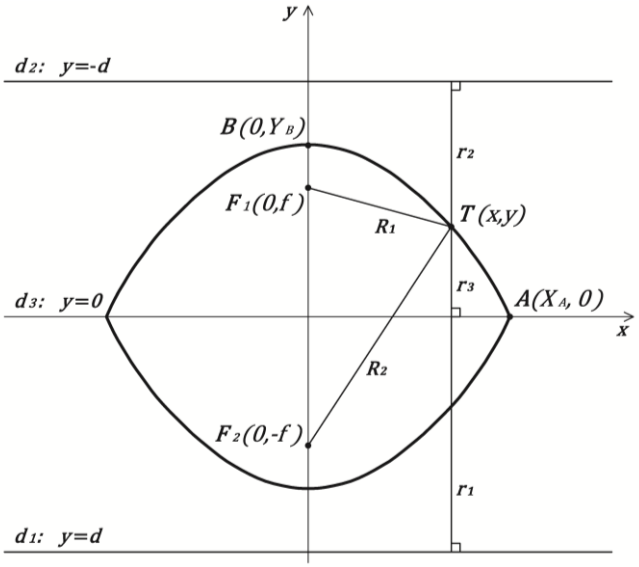

Fig. 2 Genesis of a Weber's curve with two foci and three directrices

2.3. The approximation procedure

Since this paper provides only basic principles of the approximation procedure, the analysis of the achieved procedural precision is based on the obtained values of two following qualifiers:

1) coefficient of determination R^2, [17] and
2) Δy - *fitting error*.

The large value of the calculated coefficient of determination is not necessarily the indicator of the maximal matching obtained by the approximation and therefore a new qualifier (Δy - *fitting error*) is being introduced. It represents the maximal difference of the specific pair of corresponding points' ordinates (of the same abscissa). Each pair of corresponding points consists of one point of a discrete set ***P*** and of one point of the Weber's curve i.e. of the parabola being the obtained approximation.

3. RESULTS

In this paper the proposed methodology of the approximation is carried out on two geometric models taken from architectural practice. In order to satisfy the initial definitions (analysis of plane curves) the case study demands two architectural structures whose facade sheets are vertical (i.e. cylindrical surfaces) with the basement edges on the same height level.

The first object is the "Dorton Arena–Paraboleum" – USA, Deitrick W.H. and Nowicki M., 1952., [11]. Dorton Arena features parabolic design that wisely combined architecture and engineering. The arena received the First Honor Award of the American Institute of Architects in year 1953. In 2010 an initiative was launched to have the arena designated as a UNESCO World Heritage Site.

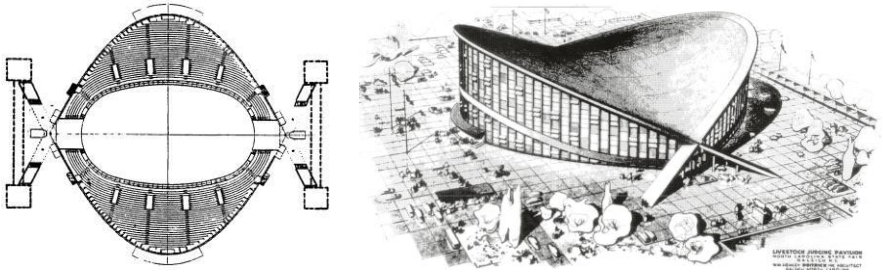

Fig. 3 The Paraboleum–Dorton Arena
(Source: http://www.remhaus.pl/pol_pl_staw_areny.htm, Accessed: 2015-3-25;
Source: http://www.ncstatefair.org/facilities/dortonhistory.htm, Accessed: 2015-3-25)

Taking into account that the contour of its horizontal basement consists of two axially symmetric parabola segments this building is set as the object in order to determine the level of precision of the conducted approximation (see Fig. 3). The dimensions of the ground base are taken from the technical drawings given at [16].

The ground-base contour curve of the control model is defined by the discrete set of points ***P*** containing 200 manually selected points $P\ (X_P, Y_P)$. The points are positioned in a local Descartes coordinate system (axes x and y are chosen so as to coincide with Arena ground-base's axes of symmetry). In order to increase the points' selection precision out of the graphical representation a vectorization of the control model's raster drawing is previously carried out (drawing from the Fig. 3 – left).

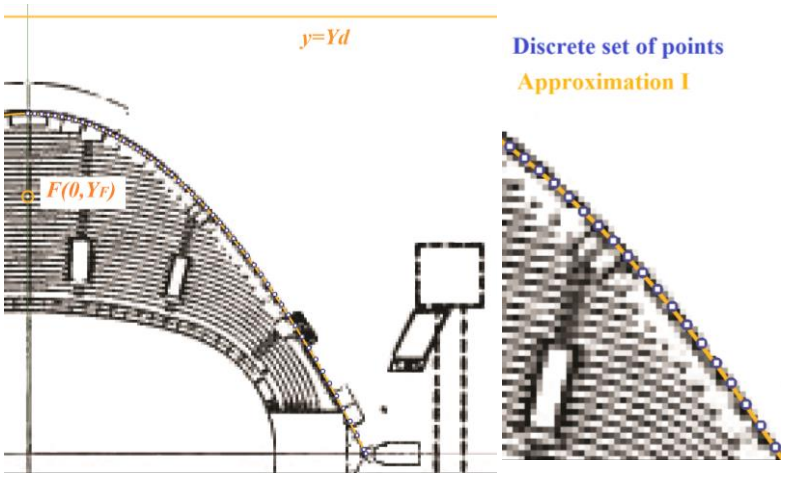

Fig. 4 The contour of the Dorton Arena's floor plan approximated by parabola
(Weber's curve with a single focus and a single directrix)

For the same reason, and in accordance with the fact that a floor plan has a double axial symmetry, the collection of points is reduced to a quarter of the contour. Hence, boundary conditions X_A and Y_B are defined as follows

$$\begin{aligned} X_A &= max\,(x), \quad \text{for all } (x, y) \in \boldsymbol{P}, \\ Y_B &= max\,(y), \quad \text{for all } (x, y) \in \boldsymbol{P} \end{aligned} \tag{9}$$

and their numerical values (given in metres) are $X_A = Y_B = 45.72$ *m.*

For the selected set of points $\boldsymbol{P}$ (see Fig. 4), the numerical value of the coefficient of determination is $R^2 = 0.99995$, while the numerical value of the fitting error is $\Delta y = 0.123$ *m.* The values for both analyzed quantifiers applied to the Dorton Arena's floor plan indicate the great precision of the conducted approximation procedure.

The second building that is to be analyzed is The Great Hall of the Textile Fair (in Serbian: Velika hala Sajma tekstila) in city Leskovac – Srbija, Balgač E. and Cvetić M., 1959., [12], [13].

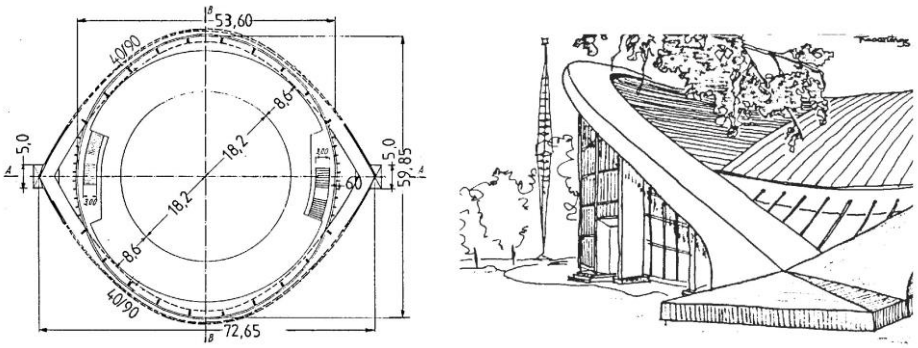

Fig. 5 The Great Hall of the Textile Fair (Source: http://rc5.gaf.ni.ac.rs/dec/arhcons/doc/homes/kostic/Osnovne%20Studije%20Arhitekture/Konstruktivni%20sistemi%20II/07-Viseci-03_KS2.pdf, Accessed: 2017-03-24)

The contour of the building's floor plan s a curve of unknown geometric properties, and it is to be approximated by the proposed procedure as accurately as possible. Its shape and dimensions are taken from the drawings presented in Fig. 5 – left.

The floor plan contour curve is defined by a discrete set of points $\boldsymbol{P}$ of 164 manually selected points $P\,(X_P, Y_P)$, in the same way as it is done in the case of the control model (see Fig. 6 – Approximation I). The points are positioned within the local Descartes coordinate system (of the axes coinciding with the axes of Fair hall ground-base's symmetry).

Numerical values for the boundary conditions X_A and Y_B are $X_A = 36.325$ *m*, $Y_B = 31.425$ *m.*

The approximation of the floor plan contour by the Weber's curve – parabola (Approximation I) also gives large value for the coefficient of determination: ${}_IR^2 = 0.998$. However, the maximal value of the Δ_y - *fitting error* is significantly larger: ${}_I\Delta_y = 0.851$ *m* and thus it is out of the range of the permissive tolerance for the architectural practice. From the latter it can be concluded that the ground-base contour of the object cannot be considered as a parabola!

In accordance with the previous, the following approximation of the contour curve (Approximation II) is performed by the use of a class of the Weber's focal-directorial curves initially supposed to be adequate from their morphological aspects.

The maximal value of the Δ_y - *fitting error*, obtained through the approximation of the ground-base contour with a parabola ($_I\Delta_y = 0.851\ m$), implies the necessity for defining a control point $C\ (X_C, Y_C) \in \boldsymbol{P}$. Numerical values of its coordinates are $X_C = 26.943\ m$ and $Y_C = 14.988\ m$.

After substituting the boundary conditions $X_A = 36.325\ m$, $Y_B = 31.425\ m$ into the system of equations (8), the following values for the Weber's curve $W_{fd}^{[1,1][1,1,k]}(0)$ parameters are obtained $f = 23.496\ m$, $k = 0.753$, $Y_C = -43.262\ m$.

The selected set of points $\boldsymbol{P}$ on the ground-base contour of the object through the Approximation II (see Fig. 6 – Approximation II), gives the following coefficient of determination $_{II}R^2 = 0.9992$. While the numerical value for $_{II}\Delta_y$ - *fitting error* of this approximation is $_{II}\Delta_y = 0.397\ m$.

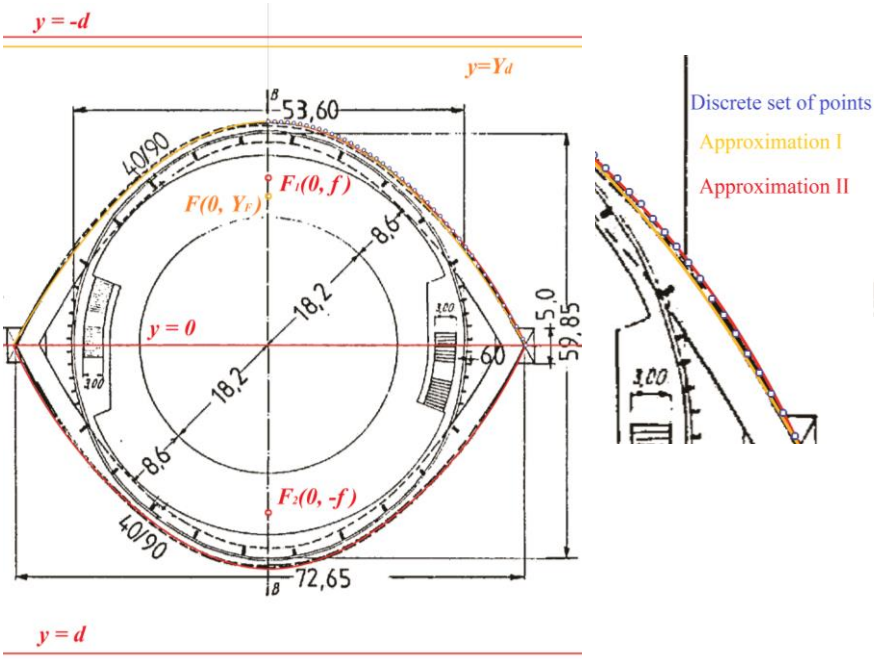

Fig. 6 The contour of the object's ground base The Great Hall of the Textile Fair approximated by parabola and Weber's curve with two foci and three directrices

For architectural practice, the obtained value for $_{II}\Delta_y$ - *fitting error* is within permissive tolerance.

Both qualifiers analyzed in the previous section applied to the building's,point out the fact that the approximation by the use of Weber's curves of multiple foci and directrices is a significant improvement, since: $_{II}R^2 > {}_IR^2$ and $_{II}\Delta_y < {}_I\Delta_y$.

4. CONCLUSION

The diversity of shapes that the Weber's focal-directorial curves offer, provides an opportunity of a proper approximation of many other curves even of those that are set of points found on various curved forms present in an architectural-urban design. Thus, the historically important even ruined buildings can successfully be modelled using computer aided design resulting in an important data base for any further use, such as preservation of historical heritage.

In this paper a particular class of Weber's multifocal and multi directorial plane curves was used in creation of a procedure for an adequate approximation of a ground-base contour line of a Fair Hall building situated a town of Leskovac in Serbia.

In our further research, other classes of Weber's curves both plane and special will be of a particular interest in seeking a solution for optimal approximation of other curves.

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PRIMENA VEBEROVIH FOKALNO-DIREKTRISNIH RAVANSKIH KRIVIH U APROKSIMACIJI KONTURNE KRIVE OSNOVE ARHITEKTONSKIH OBJEKATA

Jedan od glavnih ciljeva istraživanja nekih problema u arhitektonskom dizajniranju zgrada je potpuno razumevanje i adekvatno primenjivanje naučnih načela koje arhitekte koriste u svojim projektima. U ovom radu analiziramo mogućnosti primene Veberovih fokalno-direktrisnih krivih u aproksimaciji konture osnove arhitektonskih objekata, tj. zgrada. U vezi sa tim, definisana je Veberova kriva sa m fokusa i n direktrisa. Osim toga, uvedeni su posebni kvalifikatori kako bi se procenio nivo preciznosti izvršene aproksimacije. Važnost istraživanja se posebno iskazuje u činjenici da je postupak kreiran sa mogućnošću primene u arhitektonsko-urbanističkom dizajniranju savremenih oblika, kao i u domenu zaštite i revitalizacije istorijskog nasleđa u smislu stvaranja odgovarajućih geometrijskih modela za dalju upotrebu pomoću računara.

Ključne reči: *Veberove krive, parabola, arhitektonski objekti, aproksimacija*

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DEGRADATION OF ARCHEOLOGICAL SITES – CASE STUDY CARIČIN GRAD

UDC 902.3(497.11)

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Abstract. *Archeological sites, as highly complex parts of the cultural heritage, require special care in all parts of planning, research, conservation and presentation. An archeological site, from the moment of excavation and further on, is permanently exposed to external, potentially harmful conditions: starting from structural problems during excavations, and exposure to atmospherics (rain, frost...). Influence of vegetation on site degradation cannot be neglected, as well as influence of people. All the mentioned factors that influence degradation of archeological sites are classified in this paper and presented through an example of the Caričin Grad early Byzantine site located near Leskovac in Serbia*.

Key words: *Caričin Grad, degradation, deterioration, damage, conservation.*

1. INTRODUCTION

Archaeological sites are a very complex category of cultural heritage, which must be approached very carefully, both when planning excavations and archaeological exploration and later when protecting the archaeological remains and presenting them to the public. Very often, there is a lack of awareness of this type of historical monuments and of the need to engage numerous institutions for planning and putting into practice of the works on such sites. Remains of the buildings during excavations are firstly exposed to the change of structural conditions of the environment, and then to the potentially detrimental effects of air, sun and weather… All this, because of the nature of materials used for their construction and because of disruption of an equilibrium with the soil they were buried in for a number of years, leads to an acceleration of the deterioration process of the remains. This is the cause of a number of deterioration processes at archaeological sites.

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The paper analyzes deterioration processes at the archeological site Caričin Grad, which is not the only case, with a goal to point out the problem of degradation of this type of cultural heritage.

2. EXPLORED AREA

Caričin Grad is an archeological site located nearby Lebane, close to the present day Leskovac, in Serbia. The site extends in the northwest-southwest direction for over 500 meters, on the elevated plateau between the Svinjarička river in the west, and the Caričinska river in the east. In urban terms it consists of: Acropolis, Middle town and Lower town with suburbs and monuments in immediate and wider surroundings. On the top, most prominent place is the Acropolis, having a polygonal form, and a diameter of approximately 100 meters. On the Acropolis, there are most important structures of the city; it represented both a church and military center of the city. It is divided into two subunits, a northern and a southern one by a street extending east-west. The north part houses the Episcopal palace, as an administrative center of the city, and the south part contains the Episcopal basilica with Baptisterium and Consignatory. [1]

Below the Acropolis is the Middle town. Its walls on the northern side almost surround the Acropolis in a circular form, while they become narrower on the south side. The Middle town extends for around 300 meters in length and around 230 meters in width, on its northern end, and 100 meters on its southern end. Two streets, intersecting at the circular square, divide it into four subunits. It contains both sacral and secular buildings. The Middle town contains the basilica with the crypt, cruciform church, basilica below the Acropolis, but also Principium, commercial and residential buildings along the city streets, the house with arcades, etc [2].

The Lower town is an extension of the highest parts of the city. It is located on the elongated part of the plateau, extending in the southeast direction. It is around 200 long and around 100 meters wide. In addition to the basilica with transept, double church, the area explored so far also contains thermae, a cistern for water supply of the city and a large residential area. Outside the city walls, there are suburbs, too. Immediately around the city the archeological discoveries include thermae, "J" church and a triconch church. There is also a weir for water accumulation. The abundance of various types of sacred buildings in Caričin Grad needs to be pointed out, as well as the fact that all the mentioned structures were constructed in a very short chronological interval, from 527 to 565 AD [3]. The city had a well-developed water supply system and a sewer system. The total city area is around 70.000 m^2. (see Fig. 1).

The city was built by one the greatest Byzantine emperors, Justinian I (527-565), who wanted to mark the place of his birth [4][5]. If it is accepted to identify Caričin Grad with Iustiniana Prima, then, on the basis of historical data the times of establishing the city and construction works duration can be approximately dated. Caričin Grad was built during the fourth decade of the 6^{th} century AD, and the process of its extinction was completed by the campaigns of the Avars and Slavic tribes at the start of the second decade of the 7^{th} century AD, when it was consumed by a conflagration. It is an archeological site which, except historical, has significant architectonic and artistic values. It is of extreme importance for studying the early Medieval period architecture.

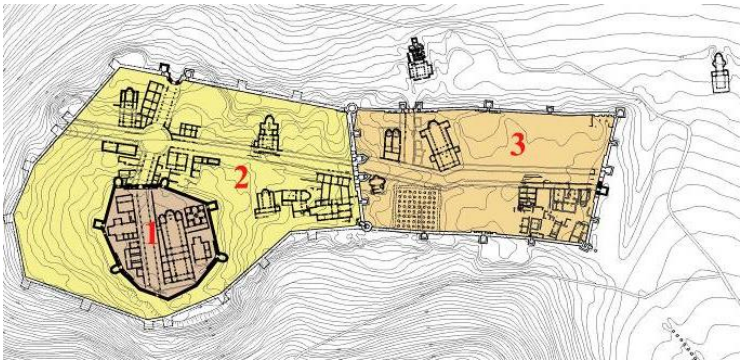

Fig. 1 Structure of the town: 1-Acropolis; 2- Middle town; 3- Lower Town
(drawing A.M.Petronijević according to the documentation Institute for Cultural Heritage Preservation Niš)

This archeological site has an exquisite historical and cultural value. The site is placed under protection of the state in by the decree of the Institute for protection and scientific study of the cultural monuments of the People's Republic of Serbia, no. 572 of 12th February,1949, and it was categorized as a cultural property of extreme importance by the decree of the Assembly of Socialist Republic of Serbia no 29 of 29th March 1979. The value of the site was recognized by the world experts. Caričin Grad was on 15th April 2010 it was preliminarily listed among the cultural properties to be nominated for the World Heritage list of UNESCO.(Tentative List) [6].

3. Background of the Research and Conservation Activities at the Site

The research of Caričin grad has lasted for more than 100 years. With some interruptions, starting from August 11th 1912, this site has continually been dealt with by the researchers [4]. The first archeological explorations were done on the Episcopal basilica on the Acropolis, after which the research was interrupted because of the wars. The excavations continued in 1936. In several years, the entire area around Acropolis, around the Circular square, Cruciform church was excavated, and some of the structures outside the city walls were examined, too.

During 1940, the circular square with the streets that led to some of the gates were fully excavated. [7] World War 2 interrupted the research for several years. In 1947, intensive archeological excavations were continued on the structures around the circular square, among others on the Basilica with a crypt and on the Eastern city gate [8]. Excavations of the Lower Town also began, and they uncovered the Southern gate and corner towers of the walls. The weir at the eastern perimeter of the site was discovered, and the surrounding sites were recorded by the research.

In several following years the archeological excavations were intensively performed on: Basilica with transept, Triconch church outside the walls, cistern in the Lower Town, thermae outside the city walls. Until 1968 the basilicas at the Acropolis foothill were discovered, as well as double church in the Lower Town, thermae inside the city walls basilica with transept in the Lower Town. [8] [9] At some later date, the "J" church outside

the walls and the brick kiln in the western section of the Svinjarička river were explored, at the foothill of a hill on which the city was erected. Since 1978 Ecole Francaise de Rome became involved in the research project of Caričin Grad. Since then, explorations of the south-east sector of the Lower Town were performed, and the elements of fortification systems were assessed [10]. The works were interrupted in the period 1990-1997, because of the international isolation of Yugoslavia. Since 2006, experts fro Germany joined the excavation program at the site. With the French partners, a new excavation program was started in 2009, which included the north part of the Middle Town, below the Acropolis, which was previously was not explored. The works were preceded by geotechnical surveys of the terrain [11]. Laser LiDAR terrain scanning yielded very important results in terms of outlining the structure of the city itself. Newly conducted research offered a new and wider picture o this site [12] [13].

Conservation activities at Caričin Grad site, on the other hand, were performed to a much lesser extent. The first conservation works were undertaken as late as around 1950 in a very small extent: concrete caps on the Acropolis building walls were places. Slightly more extensive works were undertaken in the period 1949-1968, on the Basilica with the crypt, house with the arcades, south gate of the Middle Town, east part of thermae outside the city walls, and it was then when small interventions on the mosaics in the Basilica with transept, Triconch and Thermae were done [14].

Since 1972, the conservation works at Caričin Grad site were entrusted to the Institute for protection of cultural monuments of Niš. In the period from the first half of the 70's and in the following ten years, the conservation was performed on the Episcopal Basilica, Baptisterium, Consignatory and Episcopal palace, and part of the Acropolis walls, part of the walls between the Middle and Lower Town, on the Double church in the Lower Town, Triconch church, Thermae, "J" Church and part of the Aqueduct outside the walls [10] . In the period since 1980 – to 1987, the conservation activity was considerably reduced, only to be stopped in 1987 for a number of following years. Since 2006, an extensive research, conservation and presentation project of the Acropolis walls was initiated. In its scope, a large amount of architectonic rubble accumulated during earlier archeological campaigns was removed. During 2010, 2011 and 2012 there were conservation works on the Acropolis walls, after which the conservation activity was arrested again [15]. In 2017, conservations activities on the mosaic, brick floors and stone plastics of Baptistry have been underway.

From the previous statements, it can be concluded that conservation activity at the Caričin Grad site has largely lagged behind archeological excavations. On a large number of structures, it is not possible to perform conservation, because archeological research has not yet been completed.

The degree to which the Caričin Grad site has been explored can be observed from two aspects. On one hand, it can be expressed by comparing the areas of explore and still unexplored parts of the city, whether inside or outside the city walls. The sum of areas of all pits and excavations of numerous structures inside the walls amount to approximately 3300 m^2, i.e. 3,30 ha. This makes around 50 % in respect to the total city area inside the walls which is around 70.000 m^2 or 7 ha. In the zones outside the walls, approximately 1800 m^2 was explored (thermae outside the walls, "J" church , triconch church and a part of the aqueduct), while the total area outside the walls was not defined. Such a mechanical approach creates a numerical image of the degree of explored site. Observing the numbers, one could conclude that a large part of the city was explored and examined. [1]. In general,

conservation was performed on a surface of approximately 12500 m^2, inside the walls, i.e. 1,25 ha, which makes slightly more than a third of explored structures (around 35 %). All the mentioned buildings outside the city walls were also conserved. (see Fig 2)

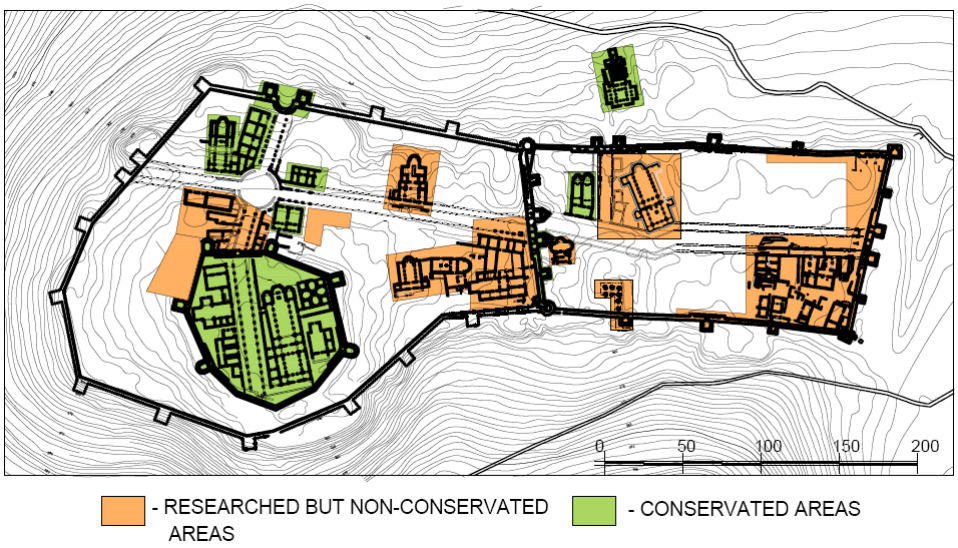

Fig. 2 Ratio of conserved and non-conserved areas on the site
(drawing A.M.Petronijević according to the documentation Institute for Cultural Heritage Preservation of Niš)

4. Deterioration Processes at Archeological Sites

Deterioration of immovable cultural heritage depends on a large number of factors, and primarily from the material properties, environment in which the structure exists, time coordination between archeological excavations and conservation.

The nature of the material plays an important role. All the material remains of the archeological sites, according to the type of material can be classified as organic and inorganic. Organic materials are much more susceptible to deterioration, and thus far less durable. Wooden elements which were under the ground for many years, deteriorate quickly after being exposed to oxygen. It is similar for all other organic materials: textile, leather etc. Inorganic materials are more resistant to environmental effects (they are not sensible to light, for instance) but to a certain limit (mortar and masonry are porous, and also is the stone)...

The structural material, apart from its physical properties, may also differ in quality. Intensive deterioration of archeological remains result from poor properties of materials, small durability of built-in material or because of incompatibility of used materials.

In addition to the material properties, environment plays an important role. The factors such as: climate conditions (frost primarily), erosion, directions and intensity of wind, air pollution, salt effects, flora effects all have important roles in a service life of a a structure. The most detrimental effects are caused by moisture which by capillary rise penetrates the walls from the ground because such effects are permanent, and subsequent prevention of

damp penetration is difficult [16]. Very detrimental is the effect of atmospheric water causing huge damage, unless the exposed remains are protected with an adequate structure. In addition to weathering off of the material from the top of the wall, rain with strong wind can penetrate deep inside the walls. Frost has the most adverse effects on the structures. Porous materials, such as bricks, lime and hydraulic mortars, which have certain amount of moisture are damaged by the alternating freeze-thaw cycles. Freezing increases the volume of the water in pores. If water volume increase in the pores is prevented, no ice will be formed, but rather a strong hydrostatic pressure on the pore walls will be exerted. In addition to the hydraulic pressure, the main cause of onset of cracks in mortar is occurrence of osmotic pressure caused by the increase of solution in pore water in boundary areas with frozen points. This creates a system of fine and relatively short cracks around the cavity filled with ice. After thawing, subsequent capillary absorption of water and repeated freezing, the ice pressure will expand and deepen the initially formed fine cracks. After a large number of freezing-thawing cycles, the material will disintegrate.

Lack of synchronization of conservation and excavation works creates conditions for intensification of deterioration processes. Time mismatch of archeological excavations and conservation is most frequently caused by the lack of resources, slow administration, poor communication between different institutions, etc.

On the occasion of archeological excavations, due to the inexpert change of land configuration, structures can become undermined and/or soil bearing capacity can be reduced, which causes more or less damage at the site. High internal stress in the material, due to an increased static load, can lead to the damage of structural elements.

The damage on the cultural heritage buildings start during their operation. Immediately after construction of a building, there is a certain degree of degradation of materials and structures, which were caused, primarily by the interior imbalance of a structural complex. In time, stationary equilibrium is gradually established, which changes very slowly. Changes of this equilibrium are followed by slow changes of material properties, whose ultimate result are the processes which lead to material degradation. This degradation is a consequence of natural effects and processes, known as natural ageing of materials [17].

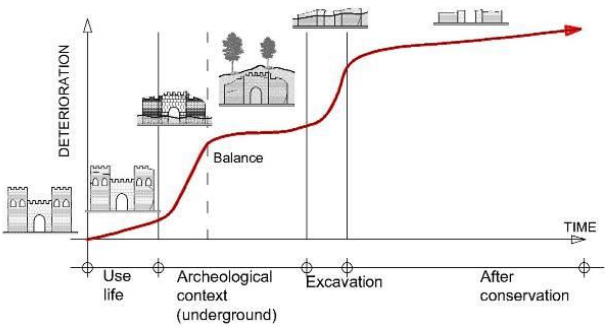

Fig. 3 Diagram of deterioration of structures, before, during and after archeological excavations. (drawing A.M. Petronijević)

After the structures have been abandoned, there is a considerable damage of the structure. The abandoned structures are not maintained, the roofs become damaged, which gives rise to damage caused by passage of atmospheric water into the structures, which in long term can cause damage of the very structure of the building. Add to that looting and sacking, which are often the cause for moving of a population out of a region, then this initial damage is not negligible.

When the equilibrium is changed, because of the mentioned actions (abandoning the structure and its ruining), it takes considerable time for the equilibrium to be established in the altered conditions, when the building remains become completely buried. After a number of years, centuries, the structures deteriorate, collapse and get covered by dirt. A certain micro conditions are then established, and a sort of an equilibrium is created, and the deterioration of the structure decelerates (see Fig. 3). When after a long time, sometimes after many centuries they are excavated, the deterioration processes abruptly accelerate. The material starts to deteriorate rapidly. The condition of archeological finds after excavation mostly depends on the reaction of the materials with the environment conditions they were exposed to for a long time. [18].

As already said, the structures of buildings under the ground reach a certain equilibrium with the surrounding soil. When excavated, the structure must adapt to a new and radically different environment. The reactions can include chemical and physical changes [18]. The types of deterioration processes occurring can be classified as: physical and chemical. These processes more or less occur simultaneously. Chemical deterioration is a change in material structure due to a reaction with some other material (water, salt, acids in soil etc.) or action of temperature, sunlight... An example of chemical deterioration is wood decomposition. Physical deterioration is damage to physical structure of an object. It is most often caused by the action of a mechanical force or because of variations in temperature and humidity (crushing of rocks, timber, falling off of mortar due to frost etc.). Additional static load due to the deposited soil during excavations can also affect the destabilization of structures in the soil.

Causes for deteriorations are: temperature, humidity, sunlight, air pollution, salts, acidic soil, etc. The degradation results can be structural (static), esthetic and structural problems. [19].

5. Types of Material Used at Caričin Grad

The prevailing materials used at this archeological site are stone, fired bricks and mortar. The stone was used for masonry, structural architectonic plastics and production of mosaics. Gneiss of good mechanical characteristics was used for building. All foundations were built of stone, then the walls were made of alternating stone and bricks courses (opus mixtum), walls were made of stone slabs, while the face of thick walls was made of stone slab and the inside of riprap. The stone mostly used for building was Gneiss [1], which is very durable.

Structural architectonic plastics was made from andesite, which has slightly weaker physical-mechanical characteristics, so it is more suitable for dressing but more susceptible to wear. This stone was used for construction of capitols, pillars, bases and plinths. It is featured on all the gates of Middle and Lower town (opus quadratum), but not on the gate of the Acropolis. It was used for paving of all the streets at the site, both on the Acropolis, Middle and Lower Towns. In addition, it was used for the doorsteps and parapets [1].

Brick at the site features in the alternations for bricklaying – layers of stone, separated with several courses of bricks (opus mixtum), then in the walls laid exclusively with bricks and mortar (opus tastaceum), for construction of pillars, aqueduct structure, certain parts of cloaca, for arches (opus latricinum), and for lining of street porches. Brick was fired nearby the site. The earth used for bricks often had considerable impurities, but otherwise they bricks were well fired.

6. Deterioration Processes at Caričin Grad

One of the biggest problems of this site is lack of coordination of archeological and conservation activities. Because of lack of following the archeological excavations with appropriate conservation works at Caričin Grad site, the explored structures are in a very poor condition. Even the conserved structures, due to exposure to weather and growth of weed over years, sustained severe damage. (see Fig 4)

Fig. 4 Southwest corner tower of Lower Town within a span of several years (photo: A. Momčilović-Petronijević)

After excavation, the structures are not immediately conserved, or at all. A large problem at the site is precipitation water which accumulates in the pits and depressions created by archeological excavation (see Fig 5). In autumn and winter, water pools around the walls due to poor draining. Several freeze-thaw cycles results in damage, first of the mortar, and later on bricks and stone.

Fig. 5 The problem of precipitation water during archeological excavations (photo: Č. Vasić)

Durability of stone structures at the site depends on the type of stone, but also of a number of various factors. Poor bricklaying technique on certain locations resulted in swelling and falling off of the wall core. Degradation of stone on at the archeological sites was most frequently connected with porosity and lack of stone resistance to frost. The stone develops cracks and fissures, mostly due to weathering. Flaking and crumbling from the surface inwards depends on the natural defectiveness of the stone. A special problem on the surface of stone plastics, in addition to the previously mentioned damage, is formation of a film due to chemical action of salts and other agents (see Fig 6).

Fig. 6 Stone damage: flaking and crumbling
(photo: A. Momčilović-Petronijević)

Damage on the bricks is most frequently mechanical: disintegration, crushing due to the topsoil weight, due to the fall of structural parts. There is also damage incurred by the cyclical frost and salt efflorescence on the brick surface (see Fig. 7)

Fig. 7 A detail of brick pavement – the brick is cracked (left);
poor quality bricks used for conservation
(photo: A.M.Petronijević)

One of the problems is mortar which in time lost its binding properties so the bond between the bricks, or stone elements is weakened. Such mortar, after excavation, is exposed to the Sun, that is, freezing, and almost certainly degrades (see Fig. 8). Mortar

loses its binding properties in the period while the structure is still buried under the soil. The moment it is excavated, the mortar is exposed to drying, that is to the dampening and drying cycles, freezing and thawing which causes the highest level of degradation. The mortar crumbles, and the bricks or stone blocks which were bound with it fall out of the wall (see Fig 9 and 10).

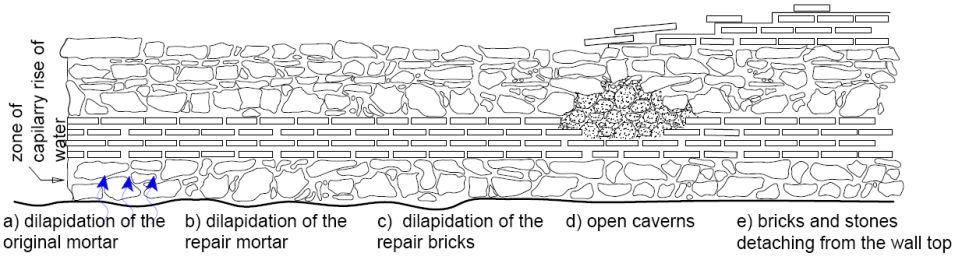

Fig. 8 The most frequent forms of wall degradation due to frost action
(drawing P.Petronijević)

Fig. 9 Open caverns in the massive fortification walls
(photo. A.M.Petronijević)

Fig. 10 Degradation of bricks, and mortar after conservation
(photo. A.M.Petronijević)

Biodegradation is also not negligible. The excavate parts remain in the open, so in time moss and lichen attach to them, and also the get covered with grass and shrubery whose root systems additionaly degrade the structure. The plants roots penetrate the wall structure and exerts pressure on the stone and bricks (see Fig 11).

Fig. 11 Vegetation in the damaged bricks (left); lichen on the parts of a stone plastics (middle); cut tree at the base of the wall (right)
(photo: A. M. Petronijević)

Usage of incompatible materials used for conservation, such as concrete caps with brick walls, was a common practice of the first conservation activities. (see Fig 12) Time has shown that this is not the best solution. The water from the caps, which are less porous than the original matter, trickles down the walls and damages the mortar and bricks. The cement mortar which was used is stronger than bricks, which causes wear of material in the immediate contact, due to strong micro-pressures of mortar on the surrounding materials. [19] The mortar used for restoration and conservation should contain a low level of salt, and it should be as similar as the original material as possible, regarding its mechanical, chemical and structural characteristics.

Fig. 12 Inadequate concrete "caps"
(photo: A. M. Petronijević)

The local population also contributed to the degradation of the structures of the Caričin Grad site, since it used the ruins as a free quarry of construction material. For instance, in the St. Ilija church, whose layout belongs to the 15th century churches, and whose foundations were used for construction of new church, there are a lot of pieces of stone plastics taken from Caričin Grad. The large alter is, in fact, the base of a column, and Justinian capitols were built

into the wall. Even now, one can see the ancient bricks or capitols or column bases built into the local houses, fences, stables and other buildings. [1] (see Fig 13)

Fig. 13 a) Pieces of stone plastics from Caričin Grad built into St. Ilija church (photo: Institute for Cultural Heritage Preservation of Niš), stone from the site built into the foundations of the walls of surrounding buildings (photo: A.M.Petronijević)

There is also frequent evidence of physical degradation caused by action of quasi-archeologists or gold diggers, who dig the site with no regret, while looking for the precious objects. The freshest case dates back to 2010 when these diggers destroyed a part of conserved mosaic in the baptistery looking for riches. The solution of this problem is in raising awareness of people about the importance of this form of cultural heritage and employing of a security person at the site.

Fig. 14 Illegal diggers looking for gold at the site (left: photo A.M.P, right https://www.blic.rs/kultura/vesti/strogo-zabraniti-detektore-metala/s5m16zb (sept., 2017))

As it was previously said, the conservation activities at Caričin Grad have been conducted on slightly more than on 1/3 of explored structures, but due to the irregular maintenance and lack of conservation activities, only around 15% of site can be considered to be in good condition. From the graph (see Fig. 15 and 16) it can be concluded that the structures and fortifications of the acropolis are in presentable state. Simultaneously, those are structures which were conserved, protected and/or reconstructed in good time. By a comparative chronological analysis of the documents of the Institute of monument protection of Niš on Caričin Grad, and based on the assessment of the condition of wall masses at the site, it can be concluded that occasional, belated and partial interventions did not yield satisfactory results. After archeological excavations of: cruciform church, basilica with transept, principium, villa urbana, thermae aetc, there was a

number of years of total negligence. This resulted in an extremely poor condition of the most part of wall masses of these structures. Further conservation and protections is almost not possible any longer, and the mentioned structures call for significant reconstruction works.

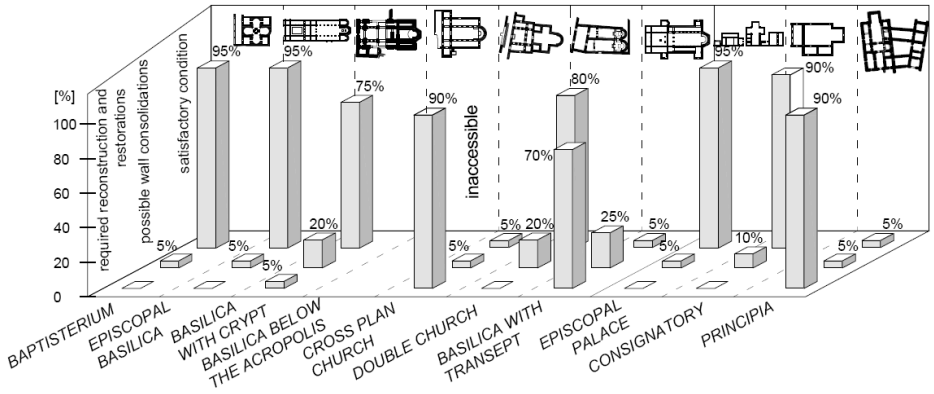

Fig. 15 Assessment of the condition of wall masses on the individual structures in Caričin Grad (drawing P.Petronijević)

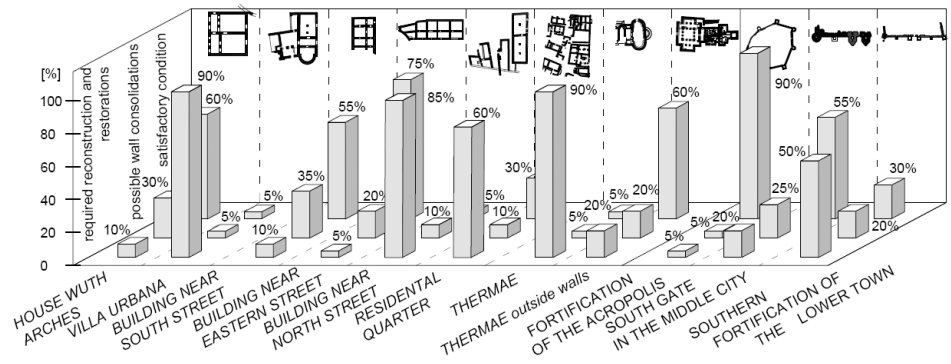

Fig. 16 Assessment of the condition of wall masses on the individual structures in Caričin Grad (drawing P.Petronijević)

7. CONCLUSION

Protection of the cultural monuments calls for a permanent care and maintenance. Archeological sites require great care and good organization in terms of planning, research, conservation and protection. Cooperation on these activities is necessary because they intertwine in many segments.

Excavation of archeological remains changes the environment of the structures, and often the static conditions. It is very important that the archeological excavations are followed by appropriate conservation works. If this is not the case, the material remains are left exposed to the weather: rain, sunlight, wind, frost; also, to biodegradation, mechanical influences by

the people and animals… Unfortunately, even after conservation activities, if there is no adequate protection from weather and presentations, there is a renewed damage to the structures, which is confirmed by the condition of this site.

Archeological research represents an invasive intervention for the building structures when very often spent several hundred or thousand years buried under ground. if they are not followed by conservation and restoration, often the case of destruction is such that some structures become lost forever or are rendered totally unrecognizable. [20]. On the basis of assessment of wall masses at this site, it can be concluded that occasional or partial conservation interventions of cultural monuments do not yield satisfactory results if they are preceded by long years of total negligence.

Due to the uncoordinated archeological and conservation interventions at the site, because of occasional and partial conservation works on the excavated structures, and because of the lack of awareness of importance of this site among the local population, certain parts of Caricin Grad have been become critically damaged. Almost all the excavated structures, except the Acropolis structures and Acropolis fortification, are in a rather poor condition.

The archeological works should be focused on finishing the started research, in order to form closed, archeologically explored entities and this would allow conservation and presentation works of cultural heritage. New non-invasive methods used lately are commendable, such as LiDar – laser terrain scanning, geoscanner [13]. During 2017, conservations works on the mosaic in Baptistry were conducted, and it is planned to cover and present this part of the site. Also, in August 2017 the first action camp World Heritage Volunteers Initiative, WHV-Heritage in our Hands Decorated Stone Elements Rescue and Conservation was held at the site under the auspices of Unesco, whose goal was recording and protection of stone plastics on the site. This is another step forward to bringing the site into the condition it deserves [21].

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DEGRADACIJA ARHEOLOŠKIH NALAZIŠTA – STUDIJA SLUČAJA CARIČIN GRAD

Arheološka nalazišta, kao veoma kompleksni deo kulturnog nasleđa, zahtevaju posebnu pažnju u svim delovima planiranja, istraživanja, zaštite i prezentacije. Arheološko nalazište, od momenta iskopavanja i nadalje tokom eksploatacije je neprestano izloženo spoljnim, potencijalno štetnim uslovima: od konstruktivnih problema prilikom iskopavanja, preko izloženosti atmosferskim uticajima (kiši, mrazu,...). Nije zanemarljiv ni uticaj biljaka u degradaciji nalazišta, kao ni uticaj čoveka. Svi ovi loši uticaji na degradaciju arheološkog nalazista su u radu klasifikovani i prikazani na primeru lokaliteta Caričin Grada, ranovizantijskog nalazista lociranog u blizini Leskovca u Srbiji.

Ključne reči: *Caričin Grad, degradacija, deterioracija, oštećenje, konzervacija*

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CREATIVE CITY: CHALLENGING CONCEPT

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Abstract. *Culture and creativity were always an essential part of city growth, but today they are integrated in the life of cities as a part of official strategies or as an action of a group of artists and people, working in the cultural and creative industries. Culture and creativity form part of many concepts of urban development promoted as an acceptable response to the challenges of globalization. As a part of urban development policy, they are expected to enable sustainable development, and they rely on human potential, local comparative advantages and development of technologies. The main principles of these concepts are communication, social networks, technology, adaptability, concentration, synergy and inclusion. As any paradigm, creative cities are challenged on many levels, in theory and in practice. Using culture and creativity as a resource and marketing value should be thoughtful, since it can have a significant impact on society. This paper will present some arguments about policies and critics of creative cities, as well as the required preconditions, organizational forms, their development path and relation to inclusion. This paper will present the case study of Savamala, as an example of urban regeneration through creating a cultural and creative quarter in Belgrade, and within a method of multicase study, include two more examples of cultural and creative strategies, the cases of Shanghai and Copenhagen, and by analyzing top-down and bottom-up initiatives, some conclusions about potentials and risks of those strategies will be drawn.*

Key words: *Creative city, urban regeneration, inclusion, Belgrade*

1. INTRODUCTION

"City in crisis", "Globalization problems" or "Sustainability", are high topics, today, viewed and challenged at different levels and from many different perspectives. Culture and creativity are seen as one possible answer on the way to achieve a "successful city" and are promoted as an acceptable or even sustainable response to the challenges of globalization. The main reasons for choosing these policies is their expected economic

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effect, the possibility of high competitiveness and application of principles of sustainable development, as they rely on human potential, local comparative advantages, development and the application of the latest technologies. If we speak of Cultural, Creative, Inclusive (Landry, 2000), Smart (Komnios, 2008; Townsend, 2013), Cognitive city (Novak, 1997; Tusnovics, 2007), or any other similar concept, it is always about creating better conditions for living and creativity (Djukić, at. all, 2016). The extent to which these changes are significant is illustrated by the fact that creativity today is referred to as the job of the future. It is foreseen that in twenty years jobs that will survive are primarily those that involve creativity, the second area being occupations that require close and complex relationships with people and the third area that of specific services that will not be computerized (The Guardian, 2017).

Culture and creativity are integrated in the everyday life of cities today, as a part of official strategies or as an action of groups of artists and people, working in the cultural and creative industry. For most of the twentieth century, culture was spatially and symbolically zoned as a product of successful economy, not as its integral part (Zukin 1995, Freestone, Gibson, 2004). In the 1970s, it was obvious, with the first projects of urban regeneration, that the role of culture in city development changed. As economic changes particularly affected large cities, it was necessary to find an alternative to traditional production, which led to a balanced development of the tertiary sector, services in culture, tourism, banking and finance (Richards, Wilson, 2007a). The mutual competition of cities is becoming more and more pronounced due to increased mobility of finance and human resources (Landry, 2006). As a result, culture and creativity become one of the main resources of city development. Culture and creativity are contained in most human activities and their use as a resource should be considered as something of a great importance, with a significant impact on the society. As we speak of complex strategies, many authors find that more longitudinal and more profiled research are needed, to deal with positive, but also with negative implications (Markusen, Gadwa, 2010; Kratke, 2011), as well as research about non-visible elements such as experience, community cohesion, identity, that are not quantifiable and easy to analyze (Vickery, 2007, pp. 16).

Two the most influential concepts emerged in the 1990s, Landry's creative city and Florida's creative class theory. The main difference between those related models is that the creative class theory is based on human resources, while the creative city places more emphasis on art projects than on art professionals, although Landry incorporated a loose version of Florida's approach (Miles, 2013). The third popular approach is the cultural cluster strategy, based on a tendency of creative industry towards clustering, and a need to cluster close to the center of cities, where there is higher possibility to attract potential consumers. That opens possibilities for the regeneration of run-down inner city areas (Richards, Wilson, 2007b), and some authors even consider that there is no alternative to cultural and creative policies in urban regeneration (Evans, Shaw, 2004, pp. 23-24). Those and other mentioned concepts have similar aims, to create more job opportunities, more leisure activities, a healthier environment, culture promotion, social security and a greater involvement of citizens in city strategies and everyday life (Djukić, at. all, 2016).

There is the question if culture and creative strategies are reaching expected benefits or failing, and what is the relation between the implied model and the result. Competitive values, such as identity, authenticity, continuous regeneration and vitality, depend on creative people, social networks and inclusion. These elements are achieved differently in two opposite models of cultural and creative initiatives, the top-down and the bottom-up approach. A bottom-up initiative brings together creative people with new, authentic

ideas and energy, but without the financial and organizational means that will ensure growth within a longer period. On the other hand, a top-down approach means that the public administration is in a position of "steering" creativity process, creating and developing projects for those who are supposed to participate. It is important to find a balance between those initiatives (Fesel, 2012), but the question is, not only how to strategically steer economic processes, but also how to reach the non-visible elements.

Analyzing the scientific debate about the cluster concept, Fromhold-Eisebith and Eisebith drew a conclusion that there are three shortcomings: 1) the focus is on cluster policies, with a lack of analyzing private initiatives, 2) promotion, organization and governance are not sufficiently explored, and 3) there is a lack of evaluating impacts of different cluster support, as being methodologically complex (Fromhold-Eisebith, Eisebith, 2005, pp. 1251). When speaking of cultural and creative strategies, there is a research gap in analyzing those important questions in the context of balancing between top-down and bottom-up initiatives.

A considerable number of scientific papers in the field of cultural, creative policies and urban regeneration are based on the case study method, as an approach within which the complexity of those policies can be define. In this paper, using a multi-case study method, different development models and key challenges of the creative city concept will be analyzed. This will enable the analysis of the same phenomena within each situation and across situations (Yin, 2003, at Gustafsson, 2012). Projects differing in the implied model and scale will be analyzed and confronted, to point out similarities and key problems in their development path, in order to reach some mutually beneficial conclusions.

In the first part, the cultural and creative city concept will be introduced and elaborated, regarding its definition, basic principles, required preconditions, development goals and benefits, resources, theoretical approaches and linked concepts, with an aim to emphasize the complexity of the concept and its importance for urban development. Some models and organizational forms will be presented, as well as some critical approaches.

The second part, via the multi-case study method, will analyze some key challenges in the implementation of the creative city concept. Two of the case studies are about culture and creative clusters developed as bottom-up initiatives in different contexts. The third is an example of a successful creative city, developed through the top-down approach. The preconditions, development goals and implied models will be analyzed.

In the last part some conclusions will be drawn and suggestions made for further research.

2. Cultural and Creative City Concept

Cultural, creative cities, are forms of urban economic development policies in the post-industrial economy, based on the concept of consumption (Ritzer, 1999). They include an environment that encourages innovation, culture and creativity, a knowledge-based economy, technology and developed social networks, with principles of adaptability, synergy and inclusion. The dominant objective is economic growth and employment, followed by developing infrastructure, city regeneration, developing tourism by organizing events and branding, education, training, and programs for supporting talented people (Evans, 2009). Culture is also linked to the city image, comparative advantages and attractiveness for investment (Freestone, Gibson, 2004). There are many definition of creativity. It can be described as a socially produced value, rooted in the network of

interrelations of social and economic actors (Kratke, 2013 in Schlichtman, 2013). The concept of a creative city policy implies recognizing the potential for competitiveness, which includes understanding the available resources and the ability to create an environment suitable for their full development (Landry, 2006). Resources of these strategies, and the symbols contributing as added value, are buildings and spaces, people with their creativity, talents and skills, as well as the life of the local community. Implementing the techniques of place marketing today should not rely just on the marketing mix, but more on the other abstract characteristics that have much greater importance, such as identity, image and performance (Djukić, at. all, 2016).

In the 1980s, usual models of cultural and creative policies were based on large projects and hallmark events. They evolved into a mixture of more sophisticated, especially chosen and focused policies and activities (Mommaas 2004). Cultural and creative strategies are developed in variety of forms and models, considering spatial, organizational forms, programs and production, financing, management, and used resources. Evans notices that what he named a "heritage/culture-based visitor economy", is the most common model, as being most economical due to its lowest cost and required skills (Evans, 2009). The role of public financing is important but there are more projects with a different form of coalitions with private enterprises and investors, and projects could be results of top–down planning, bottom–up organic growth, or their mixture (Mommaas, 2004). Analyzing cultural clusters in Netherlands, Mommaas pointed out that it is problematic to plan these places from scratch, because this depends, as he cited van Vliet "on the cultural atmosphere of the environment" (Mommaas, 2004, pp. 516). As Baily suggests the success of creative city strategies relies on a pre-existing collective sense of local identity (Bailey, at all, 2004).

Cultural and creative strategies are being developed both vertically and horizontally, to be inclusive, process-oriented, integrative and multidimensional, and there are different actors in completely new roles. Mommas notices that cultural clusters significantly depend on the people involved, their knowledge and commitment, and that in spite of the fact that control can be the reason for the interest in culture, the complexity of those strategies needs "a more robust institutional permanence and a more reflexive and strategic approach" (Mommaas, 2004 pp. 529).

Florida's creative class theory introduced creative people as an economic resource, that is highly mobile, looking for places distinguished by tolerance and diversity, and he noticed that for economic development and vitality, regions need to understand and cultivate the three "T" – talent, technology and tolerance, which form the creative index (Yucht, 2006). Landry identifies seven groups of factors that are needed in the implementation of the concept of creativity: 1) personal qualities; 2) will and leadership; 3) human diversity and variety of talent; 4) organizational culture; 5) local identity; 6) urban spaces and buildings; and 7) networking. He implies that cities can achieve a satisfactory level of creativity if some of these factors are present, but that they would achieve the best creative performances if all factors are there (Landry, 2006). Richards and Wilson point out that there are four main types of stimulating economic development: iconic structures, that are creating and changing image, like the Guggenheim museum in Bilbao; heritage mining, where historic buildings and quarters are used as a resource; mega-events, like the Olympic games, World Expos, EU City of Culture; thematisation, like New York "Cultural Capital of the World", or Stockholm and Bruges as "Venice of the North" (Richards, Wilson, 2007).

A social turn in cultural politics was part of the process that led to the Inclusive city concept. This was a result of a need to overcome the consequences of economic, social and

political restructuring (Gerometta, at all, 2005). UN habitat defined the inclusive city as: "It is a place where everyone, regardless of their economic means, gender, race, ethnicity or religion, is enabled and empowered to fully participate in the social, economic and political opportunities that cities have to offer" (UN-Habitat, 2001, p.3). At the same time, as social equity was seen as one of essential part of creating a sustainable city, the involvement of the community, the development of social networks (Putnam, 2000, at Richards, Wilson, 2007a), investment in human resource (Florida, 2002 at Langdon, 2004) were seen as basic elements of urbo-economic development. Both concepts are complementary and they depend on creating the opportunity for their goals to be achieved.

The bases of a critical approach to cultural and creative policies are: critique of a concept, emerging theories and their shortcomings or results in their application. The critique of a concept is based on a critique of the ideology of the consumer society, seeing it as a fundamental change that is to restrain development of independent individuals, as a bare transformation of the profit motive to cultural forms, where culture loses autonomy and the consumer becomes the object instead of the subject (Adorno, Rabinbach, 1972). At the end of the 1960s this criticism was losing its momentum, with the emergence of social movements, which have also been identified as cultural movements, and it was already clear that culture, societies and economy were becoming more connected (Bianchini, 1993, at d'Ovidio, 2016). The late 1990's, brought a social turn in cultural politics, the economic impact was less emphasized and local and participatory cultural activities became more important (Stojanović, at. all, 2012). The critique of the theory deals mostly with Florida's creative class, as a "fuzzy" concept (Maruksen, 2006), too simplified and academic, but it is positive that the theory brought on a new and intensive debate and influenced many city governments to foster a creative policy.

It can be noticed that some features, accepted as advantages and contributions of cultural and creative policies, are also highlighted as places that can have negative consequences, whether viewed as essential shortcomings or problems that are related to understanding the concept and approach to policy implementation. These policies are seen as an opportunity to increase social cohesion and inclusion, self-expression and self-confidence of the individual and the community, but they can lead to social polarization and gentrification (Zukin, 1987, Grodach, 2017); investing in large facilities and manifestations is emphasized as an incentive for economic development, but such large investments reduce investment in other, less economically viable public purposes, such as health, education and social protection (Borén, Young, 2012); design led regeneration can be a part of strengthening identity (Landry, Bianchini, 1995), successful creative cultural projects can be encouraging for other projects, but all this can lead to repetition of already seen forms or to a serial production (Dall 2002, Richards, 2006). Cultural development may be contrary to economic, environment and physical regeneration objectives, and it is common in project evaluation to emphasize two opposite sides, such as benefit gained through participation and gentrification (Evans, Shaw, 2004).

Analyzing cultural tourism, Gronay and Panikkos underline standardization and creation of series of stereotypical attractions, with flagship museums and galleries, bars and restaurants, which did not follow the tourist demand for authenticity (Gronay, Panikkos, 2008), as it was a matter of creating strategies by following one successful formula. Authenticity is important for tourists and it means an experience of something different, opposite of standardization and globalization (Laliberte, 2005). It must be considered that not well 'tailored' plans can lead to failure of the project or affect the community itself. It

can happen that local culture is marginalized, or that "the promised prosperity did not arrive, while the aestheticizing of space led to gentrification" (Miles, 2013).

The cultural and creative city concept is a complex phenomenon, and there is no single formula for achieving success (Mommaas, 2004). Florida brought the 3T formula, Richard, Wilson emphasized the main methods and Landry identified the seven groups of factors needed for successful implementation of cultural strategies. Those strategies depend on organizational forms and skills, inner resources, capability to create social networks and adaptability.

3. CULTURAL QUARTER DEVELOPMENT

This section will present three case studies, two of a creative clusters created as bottom-up initiatives, Savamala in Belgrade and 50 Moganshan Road in Shanghai, and the third, Copenhagen, as top-down creative city initiative. The aim is to analyze some important issues challenging the creative city concept.

3.1. Belgrade Savamala creative city quarter

Savamala is a Belgrade city quarter, situated between the southern bank of the River Sava and the Kalemegdan fortress. In the 19th century, Savamala was known for some of the most beautiful buildings, its streets, port and railway station. These two important infrastructure hubs, and good connections to other parts of the city in that period, made the area an important trade center (Jocić, at. all, 2016). In the years that came after the establishing of Yugoslavia, in the period of ambitious urban projects of socialist modernization, with the building a new modern city on the other bank of the river (Kulić, 2014), there was no interest to invest in the development of the Savamala quarter. In spite of its closeness to the center of the city it was treated as peripheral, traffic and infrastructure zone. Today with its position, cultural heritage, vacant spaces and urban structures, Savamala is one of the most interesting and most important waterfront brownfields, with the potential for recreating a new consensual identity (Mrdjenović, at. all, 2015).

Creative industries are not new in Serbia, but are increasingly becoming an important component of the path to access creative economy and creative society (Mikić, 2014). It is evident that culture is still not regarded as a tool of regeneration (Stojanović, at. all, 2012). In spatial planning and cultural policy in Serbia, the concept of cultural and creative cities is emphasized but is not clearly defined in a sense of priority and methodology. In the Spatial Plan for the Republic of Serbia (Official Gazette of Republic of Serbia, 2010) and urbanistic plans, culture and creative strategies are not integrated in a consistent manner, there is a lack in coordination between sectors, especially of tourism and cultural heritage, with inadequate definitions of key terms. The heritage of the 1990s, of political and economic circumstances related to the socialist legacy, and the decomposition of Yugoslavia, were the starting point in 2000s for Serbia to create a pluralist political culture and a marketing-oriented economy. The legacy in the spatial and urban planning system was a top-down approach that was not accompanied by strategic planning or strategic governance, but was rather dominantly in the service of private interests (Vujošević, 2010) and without the interest to invest in culture. In the period from 2005 to 2009, the Government adopted several relevant documents that promote culture and creativity as potential resources for urban development, but still significant change did not happen.

According to the Screening Report for the Republic of Serbia, most of the strategies lack action plans and are not linked to budgetary provisions (EU Commission, 2015).

Savamala started as a bottom-up cultural initiative and it opened up the city's unused resources. The first center for culture and debate, named "KC Grad" was opened in 2009, but expansion happened in 2012 with the festival of creative industry "Mixer". It began, according to tendency of the creative industry that Richards and Wilson pointed out, to cluster close to the center of the city. The area was suitable because of its position and accessibility, low rent and specific atmosphere. There are dozens of NGOs in several cultural centers, organizing festivals, exhibitions, workshops, performances, arts, conferences, debates, book promotions and other activities, such as restaurants and clubs, each with something specific to offer, in an area of approximately 50.000 square meters. The balance of activities, presentation and production for different interest groups, activation of unused space, connecting of creative people, education, are elements that should be strengthened Savamala is positioned as a creative quarter (Jocić et all, 2016). Since the Savamala area was neglected in the past decades, these initiatives make an ideal environment for testing out new forms and approaches to city quarter development (Urban Incubator, 2017).

The main initiative comes from NGOs, some of them with support from European funds and organizations. For example, "KC Grad" was supported by a Dutch private foundation and the Ministry of Foreign Affairs, and the Urban Incubator project was supported by the German Goethe Institute. It was important that, although the city government was not supportive, the local municipality recognized the development potential of the district, and a communication and cooperation in organizing programs and actions was established, but still there is a problem of project financing (Jocić et al., 2016).

A few years later, in broader area of Savamala another project started, the "Belgrade waterfront", a strong national initiative and a large public-private investment, with more than 6000 residential units and commercial areas with offices, hotels and other similar facilities planned. These two projects are going on with a lack of open communication, this being one of the major problems in "re-creating and re-generating the Savamala district towards Castell's project identity" (Mrđenović, at all, 2015, pp. 761). Those two projects, with different brownfield and market concepts, are bringing different qualities of space. The

Fig 1 The Savamala quarter, Belgrade, Serbia: "KC Grad",
European Center for Culture and Debate, located in an old industrial building.
Source: the author, 2017

Savamala culture district is about relying on creative people, social networks and existing city resources and its history, and "Belgrade waterfront" is focused on housing and business areas with modern architecture. The Savamala cultural quarter has its advantages, it has become a vibrant place with a developed network, people participate in forming its identity, authenticity and autonomy. On the other hand, it must be taken into account that large project-oriented public-private partnerships often result in more exclusionary institutions (Moulaert et al., 2002, 2003, cited at Gerometta et al.). The "Belgrade waterfront" Project is about creating a new identity "from scratch" and it is a question if it will have qualities to attract people and if that new image will be seen as attractive and authentic or not, as well as how it will affect the community from an economic and social perspective.

In the Savamala case, the complete neighborhood serves a cultural and creative strategy. The attractiveness and success of the quarter can be represented by the number of visitors: for the "Mikser festival 2015" about 75,000 visitors in five days, and for "KC Grad" around 70,000 people in that same year (Jocić et al., 2016). There are also comments regarding gentrification and the need for a more mixed cultural space, because of the opening of too many nightclubs (Coldwell, 2016). New activities brought many changes to the everyday life of inhabitants, but these kinds of initiatives can strength the inclusion of the community (Mercer, 2006). In this case, the increasing number of night clubs is challenging this opportunity, as well as the authenticity and creative impulse, because of a change of the audience and more conformist expectations (Jocić et al., 2016). Mercer suggested that such projects should be part of a wider, general program of regeneration and community development (Mercer, 2006), but here it is not the case. It is interesting that creative people engaged in Savamala cultural activities show a high level of social responsibility, they started a number of projects pointing out the problems of the district, trying to animate the local community (Jocić et al., 2016). In 2017 Mikser festival moved to Dorćol area, a neglected industrial zone, and there are speculations if it was for economic or political reasons. After that, the Mixer project developed in Sarajevo, Bosnia and Hercegovina, with the same idea and creative impulse. The construction of the Mikser House is in progress. A music and theater performance space, art gallery, education and innovation lab, Balkan design center, canteen, community garden and kids zone are planned, but there are financial problems to complete construction works (Mixer House, 2018). This shows the sensitivity of cultural and creative strategies and the mobility of creative people.

3.2. Shanghai creative hub 50 Moganshan Road

The example of China urban regeneration shows a highly organized top-down approach, with little public participation (Hui, 2006). These impressively executed projects of urban regeneration "from scratch" rely on using a best-practice model, but lack long-sightedness; although there are pilot projects, testing changes in the cultural system (Hui, 2006), a macro-level of restructuring the "government institutions, information database, and public participation is needed" (Ho, 2012, pp. 110). The majority of the creative industry and creative clusters are planned or supported by city governments, and just a few in Beijing and Shanghai started as artists' initiatives. One of the earliest, most successful and influential is hub M50, located at 50 Moganshan Road in Shanghai, an intentional cluster of artists and designers, created in an old textile industrial district built in the 19th century. The development of the cultural and creative cluster started in about 2000, with the first artist who built his studio (Wang, 2009) and this is now the largest creative cluster in Shanghai, with more than 140

artists' studios, galleries and other organizations, from over 20 countries and regions, attracting creative people and tourists both from home and abroad (M50, 2015). There is a variety of creative activities, such as fine art, fashion, furniture design, architecture, film and animation, crafts like pottery and jewelry, as well as art education, with galleries, organized exhibitions, different performances, competitions and annual awards in different fields (Lan, 2014). Wider communication and networking was established through Web sites and individual blogs (Wang, 2009).

Fig 2 50 Moganshan Road in Shanghai, China: cultural and creative cluster, area with café in a renovated old industrial building.
Source: https://www.flickr.com/photos

The area of 50 Moganshan Road was attractive for low rent and possibilities of using and transforming the space. The old buildings, with large interiors build in brick and wood, with large industrial windows (Gu, 2014), apparently were aesthetically and functionally adequate for avant-garde artists (Wang, 2009), being also attractive for their traditional industrial architecture. The hub occupies an area of approximately 24,000 square meters, with more than 50 buildings engaged in creative cluster activities (Gu, 2014). It is interesting that in the same period when the first historic buildings were renovated at 50 Moganshan Road, the long struggle of conservationists came to fruition, and in 2000 a legislation with conservation principles and intervention guidelines for the preservation of monuments and sites was adopted (Wang, 2009). After the initial success, in 2005 M50 hub got the support of the local government, driven by the ambition to make Shanghai a global city that will surpass its competitors in the region (Zukin, 2008). Despite this success, Zukin points out that local authorities demolished old buildings, like 50 Moganshan Lu, and whole districts near the river, and also that some of the artists had to move out of 50 Moganshan Lu, because they were no longer able to pay the rent (Zukin, 2008).

3.3. Copenhagen - creative city

On the other hand, the experience of Denmark is specific, because of a tradition of an instrumental use of culture in urban economic development (Bayliss, 2007). One fine example is Copenhagen, a top-down initiative of creating a successful city through an inclusive concept

of tolerance, variety and difference and strong marketing. In the EU Commission report on cultural and creative cities in Europe, Copenhagen is pointed out for its high quality of governance and according to the criteria for monitoring, it is among the four best ranked European cultural and creative cities (EU Commission, Joint Research Centre, 2017). In 1996, Copenhagen was awarded the title of European Capital of Culture. The growth of the city is connected to a strong service, knowledge-based economy, growing entertainment scene and expansion in creative industries (Andersen, Winther, 2010). The city of Copenhagen has impressive public buildings, such as the famous Opera house, Øresund Bridge, Concert Hall, National Aquarium Denmark, Royal Danish Library and Royal Danish Playhouse. There is also a new urban center for a new lifestyle in the Ørestad area, with museums and many other flagship attractions, a dock area transformed into an attractive urban quarter, a variety of cultural infrastructure and industry, and lively public spaces for people to meet and create social interactions, as well to attract "creative capital" (Vanolo, 2008, Bayliss, 2007).

Fig. 3 Copenhagen, Denmark: Superkilen park, divided into three areas for different activities, music, sport, and rest area with a fountain, benches and a park for picnics and sports.
Source: https://www.flickr.com/photos

Copenhagen cultural and creative strategies are following Florida's 3T formula (Bayliss, 2007), three of the four methods that Richard and Wilson point out are applied, and at least 5 of 7 Landry's factors are strongly present. In 2010 the city government agenda was: "Fundamental to the future is economic growth, and they favor a city that is dynamic and lively, with identity and a pulse" (Bayliss, 2007). Copenhagen Cultural and Leisure Policy 2011-2015 had eleven action plans prepared as a proposal through participation of associations, institutions and other stakeholders (City of Copenhagen, 2012). The Policy for 2016-2019 is focused on "Working together for the whole city" (City of Copenhagen, no date, pp. 18). Inclusion is seen to be achieved as information accessibility through digitalization and equal access for disadvantaged citizens. Not only that the idea of working with and promoting the explicitly cultural planning methodology by the government is of great importance, but also orientation toward a holistic approach in mobilizing inner cultural resources. The criticism of the concept refers to social costs: social exclusion (Smidt-Jensen, 2007), gentrification and that "direct top-down planning is unlikely to generate creative

environments" (Bayliss, 2007, pp. 900). Pratt referred to a music album with an interpretation of creative city as: "'Nice' cities: For shiny happy people" (Pratt, 2011), and this shows the controversy in planning a creative city, as creating an image of the ideal place.

3.4. Creative city challenges

These were presentations of cases of cultural and creative cluster projects and a project that includes a city as a whole. The table shows three cases, analyzed through the needed preconditions (Landry, 2006), development goals (Florida, 2002) and applied model (Richards, Wilson, 2007). It shows a variety of developmental paths that comes from the local context, that includes cultural policy, resources, organization and financing, and similarity the presence of factors needed in the implementation of the concept of creativity.

The case of Savamala cultural quarter and 50 Moganshan Road hub are similar, although there is difference in size, specifics of local culture, history, cultural policy and planning. In both cases, the process of regeneration of the city quarter started from an initiative of artists and producers and it demonstrated success.

In the Savamala case there is still no framework that will support such projects: the concept of cultural and creative strategies is not clearly defined in spatial and urban plans, culture and creativity are not seen as a favorable model of urban regeneration and public support and financing are missing. A group of creative people brings life to a neglected neighborhood, and they manifest what creativity can do for the city, but the question remains if the quarter will go on to be creative, or will become commercialized.

The case of the Shanghai creative cluster also started as an initiative of a few creative people, developed with government support, but there is the question of a sensitive balance between the bottom-up and the top-down concept, of inclusion and of keeping vitality and authenticity.

The case of Copenhagen is an excellent example of a creative city: highly organized impressive projects and a government devoted to implementing cultural and creative strategies. Still not all goals are achieved, as a top-down initiative it is challenged by the problem of how to foster a creative environment.

Bottom-up initiatives need, and they encourage, inclusion of the community, they have more sensitivity for local circumstances and more prospects to create space with an identity and to offer authenticity, but they can lead to gentrification and they usually need public financial support. If public support is missing, cultural and creative clusters will face many difficulties, and the direction of the future development of that particular area could be challenged. A combination of motivated, creative people and neglected, historical inner city areas has a high potential to succeed and become recognizable for its identity and authenticity. Cultural and creative cluster development that is not planned, organized and supported can be encouraging for other investment, but challenged through generated commercialization. On the other hand, public intervention in cultural and creative initiatives can lead to a loss of authenticity and vitality that are as important as a competitive advantage. Top-down initiatives have resources to organize and develop projects, to create image, promote involvement of the community. They can also lead to gentrification just like bottom-up initiatives, but these depend on creative people and the community and the prospects of those projects depend on their ability to adapt, change and be creative.

Table 1 Cultural and creative strategies – preconditions (after Landry, C.), development goals (after Florida R.) and models (after Richards, G., Wilson, J.)

	Savamala cultural and creative quarter	50 Moganshan Lu cultural and creative cluster	City of Copenhagen
Landry's preconditions for creative city:			
personal qualities	group of talented people	group of talented people	fostering talent and creativity
will and leadership	three main, motivated organizations	motivated artists, support of city government	city government dedicated to success of projects
human diversity and variety of talent	artist, architects, musicians etc.	international group of artist, designers	larg scale of artists and creative people
organizational culture	as inside resource: personal experience, support of European cultural institute or funds	spontaneous initiative, later highly organized, top-down approach	high quality of governance
local identity	strong local identity, bottom-up initiative	strong local identity, bottom-up initiative	constantly working on city image, question of direct top down planning
urban spaces and buildings	historical quarter, variety of public space, meeting space	historical quarter, variety of public space, meeting space	great variety of creative space
networking	network of creative people, IT communication	network of creative people, IT communication	network of creative people, IT communication
Florida's 3T: talent technology tolerance	there is no city strategy of fostering creativity, support of local municipality; technology is present as a part of art, production and communication	city policy of fostering creativity, technology is present as a part of art, production and communication	policy of fostering creativity, technology and tolerance
Richards, Wilson, main types of strategies: iconic structure, heritage mining, mega-events, thematisation	heritage mining	heritage mining	iconic structure heritage mining mega-events

4. CONCLUSIONS

At the beginning strategies of creative city, cultural, creative clusters, were part of urban regeneration projects, but have now become a standard of city development. They are seen in two extremes, as having magical powers, solutions for almost all problems challenging cities in a process of globalization, or as a smartly hidden agenda of politics and capital which is bringing new problems. In reality it is about complex strategies and phenomena, where there no one path or one solution. There are many risks of implementing those strategies, cities are changing and in this process not all are seen as winners or as losers. It is obvious that all resources must be considered equally in developing creative city strategies as well as all possible outcomes. No matter if strategies are developed as top-down or bottom-up, they cannot be successful without involvement of the community, forming different networks, creating an enabling environment, quality of space, identity and authenticity of experience. Public funding is very important and different coalitions can be

formed. Bottom-up projects are creative initiatives that should be considered with their advantages. Impacts of different cluster support, a balanced relation between top-down and bottom-up cultural and creative projects is to be further explored in the context of fostering authenticity, adaptability, vitality, inclusion and creative use of space.

Cultural and Creative City strategies are not a matter of statistics in economy, employment, number of tourists, cultural places and activities, square meters of regenerated or new built areas, they are a matter of quality of life and space as a legacy for the next generations. Bianchi, quoting the inspired speech of the Irish Minister of Culture, Michael D. Higgins, adds:

"Higgins's argument about play is especially important in relation to the phenomenon, discussed earlier, of the danger of transforming cities more and more into theme parks. It would be more interesting and productive to try to, as Higgins suggests, recover a dimension of playfulness in cities, not primarily as an experience of consumption and carefully manufactured and staged commercial entertainment, but as a genuine expression of creativity, and as a process of education and rediscovery." (Bianchini, 2004).

This contributes to the thesis that personal, group and community involvement and creativity is an essential part of urbo-economic development through cultural policy. Spontaneous, bottom-up developed projects have initial energy, authenticity and it is important to support them in a way that will allow further growth.

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KREATIVAN GRAD: IZAZOVAN KONCEPT

Kultura i kreativnost su uvek predstavljali bitan deo razvoja gradova, ali su danas postali deo zvaničnih politika ili akcija grupa umetnika i ljudi koji rade u kulturnim i kreativnim industrijama. Kultura i kreativnost su deo brojnih koncepata urbanog razvoja koji se promovišu kao prihvatljiv odgovor na izazove globalizacije. Od ovih politika urbanog razvoja se očekuje da obezbede održivi razvoj gradova jer se oslanjaju na ljudski potencijal, lokalne komparativne prednosti i razvoj tehnologija. Osnovni principi ovih koncepata su komunikacija, društvene mreže, tehnologija, prilagodljivost, koncentracija, sinergija i inkluzija. Kao i svaka paradigma, kreativni gradovi se osporavaju na mnogim nivoima, u teoriji i u praksi. Upotreba kulture i kreativnosti kao resursa i robe na tržištu zahteva pažljiv pristup, jer može imati značajan uticaj na društvo. U ovom radu će biti predstavljeni argumenti za i protiv politika kreativnih gradova, kao i potrebni preduslovi, organizacioni oblici, njihov razvojni put i odnos prema inkluziji. Ovaj rad će, metodom studije više slučaja, prikazati dva primera spontano nastalih kulturnih klastera, koji su pokrenuli urbanu obnovu četvrti u Beogradu i Šangaju i primer Kopenhagena, kreativnog grada koji se razvija brižljivo vođenom politikom i kroz ovu analizu će se predstaviti zaključci o prednostima i nedostacima razmatranih pristupa.

Ključne reči: *kreativan grad, urbana obnova, inkluzija, Beograd*

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IMPACT OF TROMBE WALL CONSTRUCTION ON THERMAL COMFORT AND BUILDING ENERGY CONSUMPTION

UDC 697.7

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Abstract. *Energy consumption has reached its highest level globally. Buildings have the largest share in total energy consumption, so designers must take into account their functioning and the consequences that can arise. Passive solar design is an imperative in modern architecture, and Trombe wall, as one of the principles of this design, is certainly distinguished. The paper presents an overview of the characteristics of the construction of the Trombe Wall in order to improve thermal stability and reduce energy consumption in buildings. Starting from the consideration of climatic influencing factors, through the heat capacity of the materials applied and their thickness and color of the thermal mass, it is very important to know in detail all the factors that can lead to the improvement of the efficiency of this system. The specific heat of the walls in the building, the time delay, the decrement factor and the influence and position of the thermal insulation were also taken into account. The effect of glazing as well as the influence of the ventilation openings were highlighted as significant elements. On the basis of the analysis of the above components, the conclusions and guidelines for designing this type of constructions were made in order to improve the efficiency and reduced energy consumption while providing adequate comfort in the facility.*

Key words: *Climate conditions, Heat accumulating materials, Insulation, Glazing, Ventilation, Final Energy Use*

1. INTRODUCTION

The house has always been a place for a man to feel safe and secure. In the earliest periods of human civilization, the role of the house was only to physically protect the host, but in time, parallel to the greater needs of people and finding new materials, its role changed significantly. Over time, the house became a hallmark of not only individual users but also of

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the whole settlement and sometimes of the whole village. People have always adapted to climatic conditions and environment as evidenced by traditional ways of building in different geographical locations and in different natural conditions. External influences (climate, wind speed and their dominant direction, sunshine, precipitation, built environment and accessibility of building materials, etc.) defined the designs, and gave architects constraints or freedom in their design. Thus, favorable microlocation and thermal performance of the building envelope can significantly contribute to the energy efficiency of buildings, as a building capacity to consume less energy, which is imposed as a necessity in the aspiration for sustainable construction [1]. If decisions made in conceptual and project phases are compatible with sustainability requirements, many negative outcomes can potentially be prevented or at least minimized [2] In situations where the potential of the thermal coating is not used, it is possible to intervene later in order to improve energy efficiency, which has been shown in many works, such as [3].

There is a large number of scientific papers related to the concept of green buildings [4]. Ali and Al Nsairat [2] in their research attempted to contribute to a better understanding of the concept of green building assessment. They have developed tools and their importance in achieving sustainable development through energy efficient green buildings, as well as the housing appraisal system in Jordan. The development of such systems is necessary due to significant ecological, social and economic problems worldwide. Passive solar design represents a real challenge for architects and contributes to the improved energy efficiency of the projected objects. O'Brien, Kesik and Athienitis [5] have provided guidelines for a correct passive solar design. There is a number of structures that are internationally recognized and represent pioneers in the application of modern solar design. The challenges in building passive solar houses are in innovative materials and techniques, knowledge, information, education, new design and construction process, as well as quality control [4]. In 1881, French scientist Edward S. Morse first patented the Trombe Wall. He noticed the potential of using solar energy by thermal heat accumulation through a massive wall. Accumulating solar energy contributes to heating, ventilation and improved heat comfort within the rooms. In this way, savings in the consumption of energy for heating and cooling are achieved. This construction began to be widely known and gained significance thanks to French engineer Felix Trombe and French architect Jacques Michel who further developed this system. The principle of functioning of the Trombe wall is shown on Fig. 1.

It is extremely important to take into account the economic aspect and the cost of construction as well as the savings during the lifetime of the facility (Life cycle costing - LCC) [7]. It is recommended to use passive solar systems regardless of their price, as this reduces energy consumption, preserves the natural environment and reduces the emissions of gases which contribute to the greenhouse effect [8]. Many studies have shown that the combination of multiple strategies is generally more effective than applying one strategy. However, the mixed effects of different strategies make it

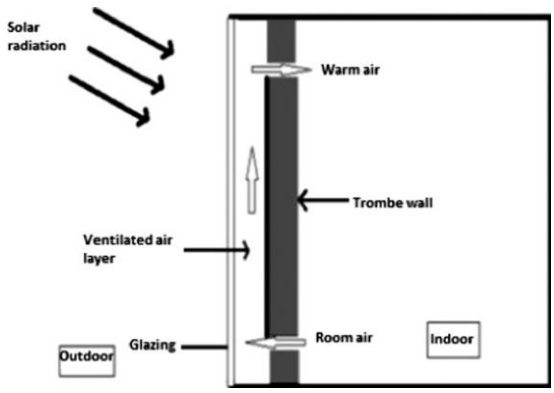

Fig. 1 The way the Trombe wall works [6]

difficult to determine which strategies actually contribute to the overall effect of the improvement. The most important advantages of applying this constructive element are the possibility of its integration with new technologies such as Photovoltaic (PV) systems, reduced energy consumption, reduced humidity of the interior, improved thermal stability, preventing the excessive decrease of solar radiation into rooms, relatively low cost, time delay of amplitude oscillations of daily temperature, improvement of comfort (not only directly but also indirectly in adjacent rooms). When innovative systems are used, it is possible that they will not work just as intended. They must be carefully monitored and evaluated in order to take their advantages and also improvements should be made where necessary. There is a mistaken belief that the construction of the Trombe wall must be of full height and width, as well as that it with its structure completely blocks the light and direct solar gain within the building. On the contrary, the Trombe wall can only partially cover the room in which it is built which contributes to accommodating the needs of tenants. Reducing the dimensions of this structure simply reduces the surface absorbing the sun's radiation, but at the same time this surface blocks direct sunlight and heat in the structure [9]. Balcomb [10] in the book *Passive Solar Design Handbook* gave specific guidelines for designing of this system, which significantly contributes to making the right decisions when designing energy efficient buildings.

2. Analysis of the Trombe Wall Construction Aimed at Improving Efficiency of this System

The Trombe wall is also known in the literature as Trombe-Michel wall, solar wall, thermal storage wall, collector storage wall, or simply a simple storage wall. In order to fully use the potential of this system, it is important to fully understand the functioning of the Trombe wall, as well as the role of all of its components. Various additions such as ventilation openings and insulation, its dimensions, thickness and colors of thermal mass, applied materials, finishing layer and type of glazing significantly affect the efficiency of the Trombe wall [6]. The Trombe wall contributes both to the reduction of energy consumption and to the reduction of the negative impact on the environment compared to buildings without a Trombe wall [11]. The appearance of the computer model of the Trombe wall is illustratively shown on Fig. 2.

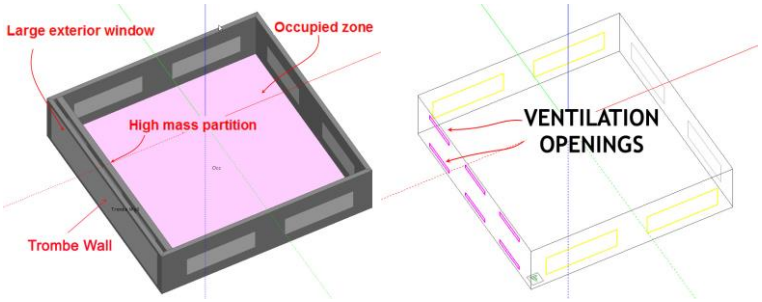

Fig. 2. The appearance of the computer model of the Trombe wall [12]

2.1. The influence of climate factors

Strategies of energy efficient passive design are largely dependent on meteorological factors, and therefore designers require a wider understanding of climate factors. Depending on the climate, the time of day and outside temperatures, efficiency of this system can significantly oscillate. The application of the Trombe wall system provides significant benefits in the Mediterranean climate region. The benefits are reflected in the lesser need for energy systems and reduced fuel consumption [7]. Based on the research in the Greek region (mild Mediterranean climate) that Kontoleon and Eumorfopoulou [13] carried out for the cooling period and the influence of the wall orientation and the solar absorption of the outer surfaces, for the time delay and the decrement factor of several isolated wall systems, it is concluded that the effect of the external absorption coefficient in combination with the effect of solar radiation on the air temperature within the building, for each wall and orientation, factors must be seriously taken into account in order to get the best possible time delay of thermal waves and reduce the decreasing relationship of the internal temperature. Bojić, Johannes and Kuznik [11] state that a building with a Trombe wall in Lyon, France, while using solar energy saves about 20% of operational energy during heating season compared to the buildings that did not use the Trombe wall system.

In order to adapt this system to different climatic conditions and user needs, we distinguish various forms of the Trombe wall. Namely, Saadatian and others [6] state that in addition to the basic variant (Classic Trombe wall), there are Zigzag Trombe wall, Water Trombe wall, Solar transwall, Solar hybrid wall, Trombe wall with phase-change material, Composite Trombe wall, Fluidised Trombe wall, PV Trombe wall. The potential for the application of solid heat-storage constructions in order to save energy for heating and cooling is a well-known and scientifically proven principle. A wall with potential for heat storage represents a great potential for reducing heating needs (40-50%). This technology is sufficiently developed, and there are European and international standards for calculation and analysis of their heat behavior in SRPS EN ISO 13790:2010[14]. This standard gives the calculation methods for estimating annual energy used for the spatial heating and cooling of residential buildings or their parts, or "buildings".

The most developed thermal storage system is the wall and its variants. Thermal accumulation walls are considered constructions in which the thermal mass is located on the inner or outer side in relation to the insulating layer. The thickness of the thermal mass (L_{mas}) varies between 0 and 50 cm keeping the Rn-value constant. Investigations show that for the given critical thickness of the thermal mass, greater potential energy savings are obtained with: walls of solid concrete blocks, walls with the lower absorption surface, and walls within the heat mass.

Knowing the thermal characteristics of all elements of the building envelope can significantly contribute to the improvement of the dynamic thermal characteristics of the building. By adding high thermal capacitance materials from the inside of the building envelope, the amount of accumulated heat or cold increases, which reduces the amplitude of oscillation of the temperature, and therefore reduces the amount of energy consumed. In this way, the influence of variations in the outside temperature during day and night on the heat comfort inside the object is reduced. The optimization of the building envelope implies the optimization of the thermal properties of building materials. Thermal rehabilitation implies a properly designed wall structure. Attention should be paid to the calculation of the thermal conductivity of all materials in the wall.

Al-Sanea, Zedan and Al-Hussain [15] carried out research under constant periodic conditions using the Riyadh climate data. The concept of potential energy savings has been developed using thermo-massive constructions and for the first time a diagram for determining L_{mas} is needed to obtain the desired percentage of energy savings for any thickness of the insulation. The results have shown the following:

- Daily transmission losses during the summer and winter months do not depend on Lmas
- For average months, the daily need for cooling and heating decreases with the increase in Lmas regardless of whether it decreases to zero or decreases asymptotically to constant values.
- The annual need for cooling and heating decreases with increasing Lmas and achieves asymptotically constant values.
- As the Lmas increase, the greatest cooling and heating requirement and decrement factor are reduced, while the time delay increases with the increase in Lmas.
- While the nominal resistance (R_n-value) is constant, the dynamic resistance (R_d-value) of the wall changes with the amount and position of L_{mas} and represents the actual variations in the transmission load.

Relations between the critical value of the thickness of the thermal mass ($L_{mas,cr}$) and potential energy savings by thermal mass (Δ) were obtained [15] by means of heavy concrete (in which a heavy natural aggregate was applied) it was found that:

- $L_{mas,cr}$ increases with higher Δ.
- For given L_{mas}, the potentials for energy saving on cooling and heating are the same.
- For Δ in the range of 70-99%, $L_{mas,cr}$ varies between 6 and 30 cm.
- For given Δ, $L_{mas,cr}$ is less for a wall with an external insulation compared to a wall with internal insulation. In contrast, for the given $L_{mas,cr}$ of a wall with an external insulation a larger Δ was obtained.
- The maximum savings for annual transmission loads are about 17% for cooling and 35% for heating as a result of optimization of thermal mass.
- For a given thermal mass, the wall with external insulation gives better overall heat performance compared to the wall with internal insulation.
- It is recommended that the walls should contain a minimum critical amount of heat that corresponds to potential energy savings in the range of 90% $\leq\Delta\leq$97%, and that the insulation layer should be placed on the outside for situations with continuous operation of the air conditioner.

The most benefits in terms of thermal properties and heat transfer through convection can be achieved only with the appropriate amount of thermal mass, together with appropriate external climate factors. Anđelković and others [16] based on the conducted computer simulations, have shown that the addition of a thermal mass has a greater impact on the requirements for heating and cooling of space and energy in buildings with conditioned radiation than those caused by convection. It is thus proven that heat transfer by radiation plays an important role in the behavior of thermal mass. An analysis carried out by Florides and associates [17] have shown that, in relation to the heat mass, the increase in the thickness of the walls and the roof and the use of night ventilation is not enough to reduce the house temperature to acceptable limits during summer.

Jeanjean, Olives and Py [18] suggest tools for the selection and comparison of construction materials, and above all materials with high heat capacity. Andjelkovic and others [16] conducted a research in which they studied the relationship between increasing the

amount of thermal mass in the building and its energy performance. The study focused on the analysis of the performance of the building with passive systems and the annual energy needs for heating and cooling the space for a building where several different applications of heat were applied. Since the coefficient of heat transfer within the structures for the most commonly used building materials is small, the effect of convection cannot be neglected. For the storage of heat, concrete and steel are better than wood, but the steel is not far superior to concrete if the effect of convection is taken into account [19].

Thermo - massive wall systems are too expensive to be competitive on the market. Al-Sanea, Zedan and Al-Hussain [15] have developed concepts of potential energy savings by applying thermal mass (Δ) and critical thickness of thermal mass ($L_{mas,\ cr}$) in order to determine the thickness of the thermal mass (L_{mas}) needed for the selected percentage of energy savings. The results show that L_{mas} does not affect the daily load transfer for representative days of the month and years and in winter. By examining the construction materials as a thermal mass, and not just as a structural material, Ma and Wang state in their research [19] that there is no reason to use thicknesses greater than the optimal thickness of the thermal mass. The capacity of the heat accumulation of the inner thermal mass reaches the maximum value for the optimal thickness of the thermal mass. There is a big difference between materials, not only in volumetric specific heat but also in optimal thicknesses of the thermal mass.

Another way of using thermal elements is by using water. Water retains heat that accumulates during the day very well, and when the nights are cooler, this heat can be used in several ways. The simplest way are tin cans, painted in black, filled with water, exposed to sunlight through windows, or a hothouse. In the evening, these elements can be moved to other rooms in the facility, where heating is required. A more complicated system contains pipelines that conduct heated water into other rooms in the house. They are regulated by means of a valve so that users have control of which rooms will be heated and which will not. In this case, we do not need to use a regular barrel, but a pipeline that extends over the entire length and width of the wall exposed to solar radiation.

Building thermal elements in the floor of the building accumulates heat during the warm part of the day, while in cooler periods, excess heat is released inside the building. This type of heating is perhaps the most comfortable one for housing, because it is similar to the floor heating effect. It is only necessary to take into account that enough mass is exposed to solar radiation and that there is a system that will prevent the warming of the floor during warmer days. If solar energy is used for passive cooling, only solar chimney is more efficient from the Trombe wall, but although similar to the Trombe wall, the solar chimney is less advanced technology. Although some energy gains are expected, however, there is still significant potential for optimizing this system.

2.2. Influence of applied materials, thickness and surface color of material used

People have built thick walls (primarily of stone or brick) since ancient times to keep the sun's heat during the day. This heat is then slowly and evenly released during night, which would further contribute to heating of rooms inside the building. Today's low-energy buildings are improving this ancient technique using a system called the Trombe Wall that allows storage and distribution of heat. Named after the French scientist Felix Trombe, the Trombe wall serves as an effective component of a passive solar design since late 1950s [6].

Andjelkovic and others [16] conducted a study in which they studied the relationship between increasing the amount of heat in the building and its energy performance. The study focused on the analysis of the performance of the building with passive systems and the annual energy needs for heating and cooling the space for a building where several different heating applications were applied. The results of the simulation show that with the use of heavy massive structures for analyzed climatic conditions in Belgrade, the capital of Serbia, there is potential for reducing energy needs for heating and cooling of space [16].

For the same wall thickness, high-density materials have a higher thermal capacity compared to low-density materials. This means that high-density materials can accumulate more solar energy than low-density materials, which allows more solar energy to be used to heat the object instead of using operational energy [11]. Anđelković and others [16] conducted a research in which they concluded that the addition of thermal mass has a greater impact on the requirements for heating and cooling of space and energy consumption in buildings conditioned by radiation than those caused by convection. It is thus proved that heat transfer by radiation plays an important role in the behavior of thermal mass. The heat accumulation capacity of the internal thermal mass reaches a maximum value for its optimum thickness. There is a big difference between the materials, not only in the volumetric specific heat but also in the optimal thicknesses of the thermal mass [19].

Any materials that have a high thermal capacity can be used in the Trombe wall [6]. The high degree of heat accumulation has concrete, stone, earth, but also water, so they are most suitable for making such heating elements. Concrete and steel are better for storing heat than wood, but steel is not far superior to concrete if the effect of convection is taken into account [19]. Concrete, terracotta and limestone are the most advantageous inertial materials for use in housing: they offer simultaneously a fairly high thermal storage capacity, low energy consumption during the production process and low cost [18]. To accumulate heat during the day it is recommended to orient concrete, stone or brick walls, to the most exposed side to the sun during the year. Accumulated heat is emitted into rooms during cooler nights. This transmission does not have to be direct, but the natural character of the air can be used, due to which the warmer air rises, and the cooler descends.

In the case of electric heating, the optimum thickness of the layer (clay-brick) is about 0.35m, and in the case of natural gas heating, about 0.25m [11]. If the Trombe wall is of extremely high thickness, heating by natural gas can even lead to the loss of primary energy. Saadatian and others [6] state that the massive Trombe wall of 30-40cm thick concrete in many geographical locations works well. The finishing of the Trombe wall is very important for the efficiency of this system. Coating materials with a high degree of absorption contributes to the improved storage of heat in the Trombe wall. However, when designing these systems, particular care must be taken to avoid unwanted overheating during the summer period. Dark colors are recommended because they absorb much more energy. The bright colors reflect solar radiation, while the darker surfaces absorb much more sunlight. The white absorption coefficient is 20-30%, while for black it is 90-100% [20]. The dark-colored modified Trombe wall surface of $2m^2$ with 14cm of space between glass and thermal mass can induce 20-90m^3/h ventilation [6].

Abbassi, Dimassi and Dehmani developed a numerical model of the Trombe wall system, and the results were confirmed by the experimental study [21]. Thermal insulation of buildings and optimal surface of the Trombe wall can significantly reduce the annual consumption of heat energy. Insulation of the inner surface of the Trombe wall contributes to the increased degree of ventilation in the summer period, which reduces the amount of energy spent on cooling. In this way, it also prevents unwanted overheating of the internal

air due to heat transfer from the wall through convection and radiation [22]. Strictly, correct insulation from the inside of the wall is recommended in order to avoid the reverse heat transfer. Insulation not only increases the efficiency of the solar system by up to 56%, but also reduces the size of solid walls, which reduces the weight of the entire building [6].

The greatest need for heating and cooling is less in the cases having a thermal mass on the inside of the insulating coating [16]. Jaber and Ajib [7] recommend the use of blinds in order to prevent the penetration of solar radiation into the building, as well as insulation curtains between glass and wall layers to avoid heat transfer to the building during summer. Moreover, the foundations must be protected in the usual way by rigid insulation, in order to reduce heat losses between the solar wall and the foundation.

2.3. Specific heat of the walls in the building

Zeng and others [23] provided new concepts and approaches for the development of energy-efficient buildings. As an initial step, the ideal specific heat of the walls in the building is determined. The results have shown that:

- For analyzed cases, the ideal specific heat of the walls in the building consists of the baseline values and ideal excess values. The ideal excess heat is approaching the δ function.
- The critical values of the extreme volumetric enthalpy are different in different climatic conditions, but the corresponding characteristic temperatures of the ideal thermal mass are in the Chinese region closer to one another. They fall in the temperature range of about 18.3°C - 19.3°C in winter and around 26.5°C -26.7°C in summer.
- The ideal excess volumetric specific heat of the thermal mass over the whole year is in the close superposition of the thermal mass in the winter and summer periods.

2.4. Time delay and decrement factor

Since the increase in the thermal mass does not increase the phase shift of the system an appropriate amount of thermal mass should be used in the passive solar design.

Buildings of solid constructions generally have less oscillations of the interior air temperature than buildings with lightweight structures, but there is a time lag and reduced maximum cooling requirements [24]. For locations with high daily temperature fluctuations, this process can significantly reduce the energy consumption of mechanical cooling systems. This technique refers more to offices and other buildings that are empty during the night, so the room can be cooled by the use of night ventilation. The air-conditioned building can also be pre-cooled during a period when no one was in them, which leads to significant energy savings. Small variations of interior temperatures in the rooms also have a positive effect on the user's thermal comfort [24].

The thermal mass has the ability to store heat during the day and release at night. In desert climatic conditions with all-day high room temperature and intense sunlight, resulting in increased heat storage during the day compared to heat release during the night. As a result, the use of cooling energy will increase. Florides and associates [17] conducted the analysis which have shown that, in relation to the thermal mass, the increase in the wall and the roof thickness and the use of night ventilation is not enough to reduce interior temperature to acceptable limits during summer. In cases where space heating is intensified during the day, it is necessary to try to use walls with a lower thickness of thermal mass [8].

Buildings of solid constructions generally have less oscillations of the interior air temperature than buildings of light structures, but there is a time lag and reduced maximum cooling requirements [24]. Asan [25] investigated the time delay and decrement factor for real building materials. Twenty-six different construction materials were selected for the analysis. The calculations were repeated for each material for eight different thicknesses and the effect of thickness and he studied type of material on the time delay and decrement factor. The results of this study are useful for making more efficient passive solar buildings. The use of different materials results in different time delays and decrement factors. The thickness of the material is also determined by time delays and decrement factor [25]. The heat is distributed to the interior in the afternoon, and the effect of air heating is even more pronounced through the ventilation holes during the day [12]. In Fig. 3 - A time delay in the zone of residence occurs as a result of the Trombe wall effect it is clear that there is a time delay in the zone of residence resulting from the effect of the Trombe wall.

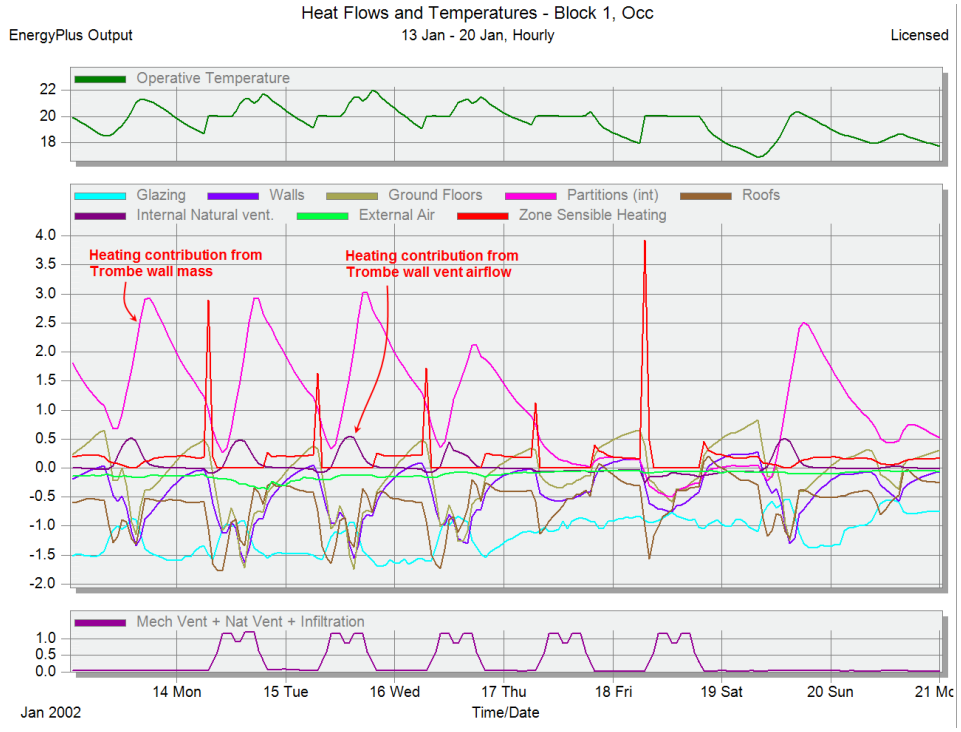

Fig. 3 A time delay in the zone of residence occurs as a result of the Trombe wall effect [12]

2.5. The effect of glazing

There is data on the wide application of glass in architecture, as well as on its characteristics in many papers, such as [26]. The thickness and type of glass significantly affect the performance of the Trombe wall. The Trombe wall, due to glass main characteristic of letting through the short-wave solar radiation, and of retaining radiation (which is the main carrier of heat) for a long time, is functionally based on the effect of

the hothouse. The effect of glazing also depends on the geographical characteristics of the site, as well as on the orientation of the wall [27]. The energy collected by applying a low-emission double and standard double glazing varies greatly depending on the thermal mass, as well as the type of wall. Glazing in front of solid elements is designed to prevent heat loss, while helping to accumulate it. The use of a double instead of a single glazing for the Trombe wall system not only reduces the heat losses in the winter, but also improves the passive cooling in summer [22]. The distance between the glass and the thermal mass is usually between 3-6 cm. From the economic point of view it is justified to use a double glazing in combination with a 30 cm thick thermal mass. It is also preferable to apply a combination of 20 cm thick thermal mass and a single glazing compared to a 10 cm thick wall with a triple glazing. The thermal mass made of 45 cm thick wall in combination with single glazing is also a better option compared to a 20 cm thick thermal mass combined with a triple glazing [8].

The main characteristic of passive houses is the maximum utilization of solar energy for the achievement of high-quality heat comfort. In contrast to active systems, passive systems do not require additional electricity for their functioning. Using only location natural conditions contribute to the improvement of comfort within the facility. The fundamental principle of passive use of solar energy is that the building is oriented towards the Sun and uses its energy. The moment the Sun is no longer functioning and when the external conditions become unfavorable, it should be protected from heat losses by closing it to the environment. The Trombe wall provides passive solar heating without the negative impact of light and reflection in the building. In order to reduce unwanted summer gains, it is necessary to design permits to prevent overheating. The use of the Trombe wall increases if a curtain is placed over its outside to prevent heat loss overnight. For an average well-insulated 100 m^2 house, the Trombe wall can save up to 30% energy for heating. This constructive improvement contributes to increasing the efficiency of the implemented system primarily in the summer period of the year.

2.6. Influence of ventilation openings and ventilation

In order to allow air flow, this system originally has ventilation openings in the lower and upper part. This flow can be natural, but sometimes it also provides forced air flow (by installing a fan). The efficiency of this system decreases with the increase in the input air temperature in the input channel. Due to constant solar radiation, with increasing air speed in the inlet channel, solar walls increase efficiency. This simplified method allows users to evaluate the efficiency of the heating system, as well as to perform comparisons and predict the behavior of thermal behaviors under working conditions.

Dragićević and Lambić [28] conducted a numerical analysis of the efficiency of the modified Trombe wall with a double glass and a solid wall with an opening and a central channel in it with forced convection (flow). In order to increase efficiency, a fan is provided in the lower part of the wall. This system is more advanced compared to the simple Trombe solar wall with relatively low thermal resistance, which is taken as a reference in experimental analysis. In Fig. 4., solar thermal accumulation of different variants of Trombe wall are shown.

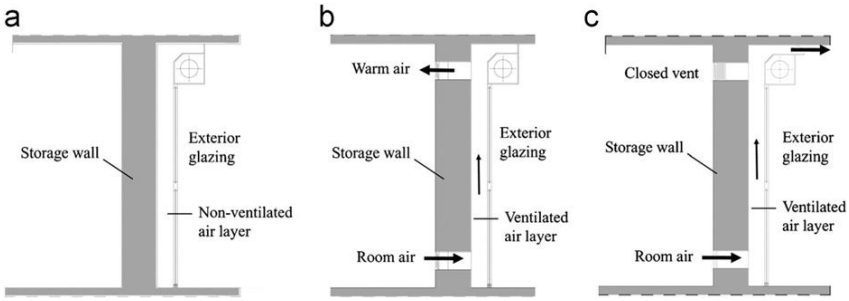

Fig. 4 Solar thermal accumulation of different variants of Trombe wall: a) without ventilation b) winter mode with thermo-circulation c) summer mode with ventilation [27]

Ventilation openings, ventilation and insulation are three components of the Trombe wall which have a significant impact on its efficiency. The dimensions of the inlet and outlet openings are increased by changing the width of the channel, while increasing the distance between the wall and the glazing also increases the ventilation rate [22]. Liu and others [29] have experimentally and numerically determined that the optimum time to open the ventilation ducts on the Trombe wall is 2-3 hours after sunrise, while the optimal closing time is 1h before sunset. Trombe wall reaches the maximum value of the capacity of the heat accumulation at 16h, while the minimum value is recorded at about 7-8 o'clock in the morning. The research results provide a reference basis for optimization and operational management in passive solar houses with a Trombe wall.

3. CONCLUSIONS

Based on the literature review and characteristics of the elements of the Trombe wall, it can be concluded that the implementation of this construction positively influences the reduction of the total amount of heat needed to heat the object. Concrete walls thicker than 15 cm do not conduct heat from one side to another, they provide some kind of insulation, and the excess heat accumulated during the day, the walls emit inside the building. Regardless of the fact that along with the increase in the degree of coverage of the southern facade with the Trombe wall proportionally reduces the required amount of heating energy, the most optimal variant does not always have to be the one with the greatest coverage with this massive construction. Orientation also plays an important role, and along with reducing the amount of energy required to heat the building, the degree of total energy savings is changed.

The application of the Trombe wall represents a good choice in order to passively reduce the consumption of energy. A number of constructive elements of a structure as well as behaviour of its users, can significantly affect the efficiency of this system. The benefits of using this system are primarily reflected in saving energy needed for heating and cooling the space, which is mostly contributed to heat accumulation during the day and distribution of this heat during the night. The application of this system is possible in various climatic conditions, but the most favorable ones are the regions with high temperature fluctuations during the day and night. The greatest disadvantages of applying

this system are the degree of efficiency depending on the external climatic conditions (in the summer when temperature periods are too high the problem with room cooling can exceed the benefits achieved in the winter period). Cloudy weather periods can also be a major problem that could contribute to unwanted heat transmission losses. Low thermal resistance of this system affects the increase of heat flux, and the gain is difficult to predict.

It is important to point out that the best values of dynamic thermal characteristics of the walls also depend on: building types (public or residential) and occupancy (permanent or occasional) of the facility or part of the building. The desired level of internal temperatures, as well as the tolerance to temperature oscillations, presence or absence of air conditioners, existing glazed surfaces and external environment also play significant role. Adaptive approach and level of tolerance of the users of space related to thermal comfort in the interior plays a major role in the final energy consumption. By lowering the temperature in the apartment by only 1^{o}, the cost of heating will be reduced by about 7% [30]. Interaction with objects in the environment, as well as potential obstructions by surrounding structures, then the configuration of terrain and the complexity of design in order to enable all the necessary comfort in the facility, are the constraints that must be considered. Changing the temperature at the very construction of the Trombe wall is a very important parameter. Computer analysis of the thermodynamic properties of this construction, and experimental research confirm the importance and advantages of using this system. Aesthetic aspect can sometimes play a significant role in deciding whether and how to apply this system. Architects and engineers must be aware of all possible positive and negative consequences of the application of this system.

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UTICAJ TROMBOVOG ZIDA NA TOPLOTNI KOMFOR I SMANJENJE POTROŠNJE ENERGIJE U ZGRADAMA

Potrošnja energije je na globalnom nivou dostigla svoj maksimum. Zgrade imaju najveći udeo u ukupnoj potrošnji energije, pa se mora povesti računa o njihovom funkcionisanju I posledicama koje mogu nastati. Pasivno solarno projektovanje predstavlja imperative u modernoj arhitekturi, a kao jedan od principa ovog načina projektovanja se svakako izdvaja Trombov zid. U radu je dat pregled karakteristika konstrukcije Trombovog zida u cilju poboljšanja toplotne stabilnosti i smanjenja potrošnje energije u zgradama. Počev od sagledavanja klimatskih uticajnih faktora, preko toplotnog kapaciteta primenjenih materijala, ali I njihove debljine i boje termičke mase veoma je važno detaljno poznavati sve faktore koji mogu dovesti do poboljšanja efikasnosti ovog Sistema. Specificna toplota zidova u zgradi, vremensko kašnjenje i dekrementi factor i uticaj i položaj termoizolacije su takođe uzeti u obzir, a kao značajni elementi su se izdvojili I efekat zastakljenja, kao I uticaj ventilacionih otvora. Na osnovu analize navedenih komponenti izvedeni su zaključci I date smernice za projektovanje ovakvog tipa konstrukcija u cilju poboljšanja efikasnosti I smanjenog utroška energije uz obezbeđivanje adekvatnih komfora u objektu.

Ključne reči: *klimatski uslovi, termoakumulacioni materijali, izolacija, zastakljivanje, ventilacija, finalna potrošnja energije*

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INFLUENCE OF PRIVATE OPEN SPACES ON THE QUALITY OF LIVING IN LOW-RISE HIGH DENSITY HOUSING

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Abstract. *In contemporary theoretical approaches and practice, low-rise high density housing is recognized as appropriate housing model for solving spatial, social, economical and environmental problems in many urban situations. In addition to investigation of basic characteristics of this type of housing, the research focus is on analyzing benefits of implementation of private open spaces, which are recognized as one of main elements of low-rise high density housing. The research relies on the analysis of relevant literature and best practice examples.*

Key words: *low-rise high density housing, private open space, quality of living*

1. INTRODUCTION

A series of socio-economic changes that have occurred in recent decades, caused the whole set of spatial and economic problems, as well as problems related to environmental protection in many cities. The following problems have been identified as the most significant: 1) deterioration of the central city area and 2) an uncontrolled spatial expansion of cities, caused by the growth and spread of suburbia and urban sprawls, often at the expense of quality agricultural land. In contemporary theoretical approaches and practice low-rise high density housing (further in the text LRHDH) is recognized as an appropriate type of housing for solving these problems in many urban situations. In addition to other characteristics of LRHDH, one of the basic features is application of a wide range of open space, with their specific planning and design treatment.

This paper deals with the open space typology with an emphasis on ownership structure, including relationships between public, semi-private and private open space in the organization of this specific type of housing. The focus is the role, significance and design of private open spaces that are located within a building in order to increase the

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quality of living. In this regard, a key research question in this paper is: how different types of private open space affect the quality of housing and living?

The comfort of occupants as a result of existing private open space within dwellings and/or buildings is examined through two key aspects: 1) physiological needs (protection against noise, wind, thermal comfort, etc.) and 2) socio-psychological needs (protection from view of neighbors, clean perspective, safety, security, the availability of visual control, the availability of various forms of social interaction, etc.). Examples of good practice have shown that from the social and utilitarian aspects, only those solutions that bring these two aspects into balance can be considered successful.

In addition to considering the definition and importance of LRHDH, this paper relies on a typology of open spaces in the context of their content, role and ownership, and analyzes aspects and principles of their organization with the focus on private open spaces.

2. Definition and Importance of Low-rise High Density Housing

LRHDH has emerged as an alternative model for solving housing problems in the 70s of the last century, mostly emerged as a consequence of application of two hitherto dominant, mutually opposed models: 1) individual housing - sprawls and the suburbs, and 2) residential towers, as the primary model of social housing.

According to Sauer (1970), LRHDH means areas with the following characteristics: 1) density of 350-550 inh/ ha; 2) maximum number of floors of residential buildings up to three stories; 3) compact physical structure and urban composition; 4) a high degree of individuality and privacy of residential units, which is achieved by clear identification of space and implementation of appropriate urban planning and architectural elements and forms at the ground level, input and access party; 5) elimination of space without clearly defined territorial specificity, especially through the privatization of space that is in direct interdependence with residential units on the ground floor of buildings; and 6) application of a wide range of open spaces. The most important projects that determined the emergence and genesis of LRHDH as a new, alternative model of housing in the second half of the twentieth century are: Halen, 1961, Bern, Switzerland; Penn Landing Square 1969, Philadelphia, United States; and Marcus Garvey Village housing complex 1973, Brooklyn, United States.

The original definition has retained its basic determinants to date, with a correction of a few of them, especially those related to the housing type and number of floors. So, today both in theoretical approaches and in practice, this type of housing often imply buildings with up to five floors. Based on numerous case studies in Europe as well as the four key factors in the successful planning of LRHDH, we could single out the following: 1) the location and the "spirit" of the site; 2) successful urban planning policy; 3) effective management policy, and 4) quality urban planning, urban and architectural design [1]. Application of LRHDH has brought a large number of advantages, such as: increased value of land and real estate, mixed use of the space (application mix-use concept - housing, shops, services), attractive and energy efficient buildings, safer streets and attractive outdoor spaces, as well as the ability to create a sense of belonging and identity. On the other hand, there are many limitations to the application of this type of housing,

such as: mistrust and conflict of interests, institutional inertia, lack of capacity and the inability to respond adequately to the challenges of designing. There are many comprehensible differences between countries in the recommendations for the implementation of this kind of housing, caused and shaped by different institutional, systemic and planning framework. However, several common recommendations, criteria and principles can be recognized and identified. In addition to the criteria such as long-term economic and social sustainability, different forms of public-private partnerships in the implementation and management of these areas, or the use of mix-use concept, some of the most important criteria in the treatment of open spaces are: 1) generous standards in open space designing; 2) providing of private gardens for the apartments on the ground floor and 3) the application of the spacious terraces and balconies when there is no possibility of designing private gardens.

3. Types of Open Space in Low-rise High Density Housing

Open space is one of the basic factors of sustainability of LRHDH from the social as well as economic and environmental development point of view. There are three disciplinary approaches to the open space: 1) for designers it is a factor of public health both in terms of recreation and respiration; 2) for political scientists public space is an immaterial space of debate; it is thus a model for political discussion or at least a space of conviviality; 3) for sociologists public space is a place accessible to anybody and reflects a notion of basic equality, social freedom of circulation and anonymity [1]. The literature suggests that three interrelated elements constitute a definition of open space: physical properties [2]; the activities onsite, such as recreation [3]; and user perception [4]. The importance and role of open space can be also seen through: 1) the appropriate urban composition and architectural expression, appropriate characteristics of the physical structure; 2) the characteristic scheme of spatial organization; 3) the typology of open space in relation to its purpose; 4) typology of open space in relation to the ownership structure – its share and characteristics caused by relations between public, semi-private and private open spaces.

3.1. Typology of open space

Typology of open space in LRHDH can be seen through its purpose and with respect to its ownership structure (Table 1). The focus of research in this paper is the typology of open space in relation to the ownership structure, particularly the observation and analysis of private outdoor space within homes and/or buildings, as one of recognized and significant types of open space from an ownership's point of view.

LRHDH leave a special mark on the city landscape, while open spaces contribute significantly to the sense of belonging and identity of the area. According to the ownership structure, open spaces can be identified as: 1) public; 2) semi-private and 3) private (Fig. 1). Public open spaces (Table 1) are: river fronts, large lawns directly connected to the housing area, pedestrian paths, access roads with restricted motor traffic as well as the borders of open space, tree-lined and adequate movables, playgrounds. The semi-open space may include: atriums, courtyards, playgrounds. The private open spaces are: private courtyards on the ground floor flats, terraces and balconies and roof terraces -

all of them are architectural and functional elements within the buildings themselves or in their immediate surroundings. The last type is especially in the focus of this research.

Table 1 Typology of open space

Typology of open space in low-rise high density residential areas	
Ownership stucture	**Purpose**
Public	**Public parks** Park; Park within the neighborhood unit; The inner courtyard **Streets** Pedestrian paths Streets without motorized traffic or with reduced traffic **Green areas and linear parks** **Shoreline**
Semi-private	**Common open spaces** Residential buildings courtyards; Playgrounds; Inner courtyards **Atrium/patio** **Inner courtyards**
Private	**Private garden for the apartments on the ground floor; Balconies and terraces; Roof terraces/gardens**

Source: [1]

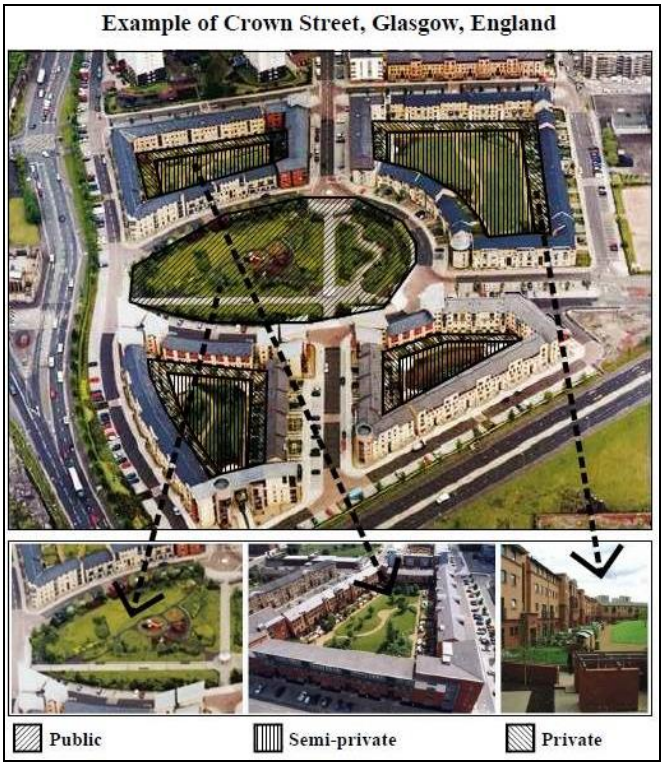


Fig. 1 Types of open space to the ownership structure

3.2. Aspects and components of quality of open space

The quality of open space in LRHDH can be seen from the following aspects: 1) design and comfort; 2) differences in its usage and morphologic characteristics; 3) safety and 4) the ability to achieve various forms of social interaction [1]. Each of these aspects has its own characteristics that are shown in Table 2, and the focus of this research is on the role, importance and the architect's approach to private open space within the building in order to increase the quality of comfort. Open space should provide safety of all users, and in this regard they should be secured with active and passive surveillance for a better security. A well planned and designed physical structure is one of the most important measures in terms of safety, affiliation and caring for open spaces (cleaning, maintenance and repair), which are key factors for residents and users of the space.

In order to achieve a better urban and architectural design of open space in LRHDH, high level of safety and a sense of identification, some of the key principles are: 1) the correspondence of the site in the wider spatial context, 2) various purposes and contents of open space and clear hierarchical relation, 3) different ownership, 4) generosity in the size and layout of open space, whether they are private, semi-private or public space, 5) accessibility of open areas, 6) social integration and equality, 7) the quality of the natural environment and 8) ecologically sustainable design and construction.

Table 2 The aspects and components of open space in LRHDH

Aspect	Components
Design and comfort	The content and size of space
	Microclimate
	Physical characteristics
	Accessibility
Diversity and abilities	Frame/ the scope of potential purposes
	Attractiveness and accessibility for different user groups
Safety	Visual surveillance
	Physical characteristics
	Maintenance of public open spaces
	Accessibility
Social interaction	Purpose
	Accessibility
	Design and comfort

Source: [1]

4. PRIVATE OPEN SPACE IN FUNCTION OF INCREASING QUALITY OF LIVING

The positive relationship between people and their environment is one of the priorities in terms of sustainability. Residential buildings are considered viable if they are designed in accordance with local cultural heritage, life, climatic characteristics of the location and environment is [5]. If this preference applies to the concept of LRHDH, it can provide a real answer and the solution for the many socio-economic and demographic changes, especially non-population pressure certain cities are exposed to.

Designing buildings for multifamily housing is a particular challenge for urban planners and architects in terms of achieving a comfort in multi-storey buildings that should be as close to living conditions in family homes and, therefore, should be as close as possible to the principles for designing individual houses [6]. Both experts and residents agree that the high quality of private open space is very important [6]. Many people, who often change their place of residence, suggest that they almost never accept the flats without open space, which clearly indicates that the private open space - "domestic garden" is an important aspect of the quality of the apartment and residential environment [7]. Private outdoor space can initiate users' identification with their living environment. By providing a greater degree of flexibility in relation to the interior of the apartment and the possibility for conducting day to day activities, private open space contribute to the perception of extra space within the apartment. With maximum architectural variation, one of the main criteria for the organization of LRHDH is the implementation of different types of private open space within the housing. Their diversity is reflected both in function and design. As for the design and organization of private space, the application of the principle of hierarchy and flow of space is clearly recognizable - to establish a connection with other open areas. This principle can be recognized even in the pioneering LRHDH projects and it remained in contemporary architectural approaches and examples of good practice (Fig. 2A-D). As the dominant forms of private open space, in order to increase the comfort of living, the following occur: 1) *private garden for the apartments on the ground floor*, 2) *terraces and balconies* and 3) *roof terraces.*

A) Private open space with different purposes and design - balconies and private garden for the apartments on the ground floor; **B)** Protruding balconies as an element of social sustainability in architectural design; **C)** The roof terrace as an element of open space for the apartments on the top floor; **D)** The roof terrace as a private space of all tenants of multi-family buildings

Fig. 2 Different types of private open space – Examples from Vienna neighborhoods, Austria

Private garden for the apartments on the ground floor as the type of open space is nearly always present in LRHDH. This type represents a buffer zone for the ground floor apartments, providing a higher degree of privacy, with a clear boundary between private and a semi-private open space (Fig.2A). According to their function and style, they are closest to the gardens of individual houses. They are in most cases directly connected to the apartment through the living room, which can often be designed as the entrance area to the apartment, which increases the quality of living. Residents get perception of the yard as an extension of living space to perform many daily activities. In our conditions it is often considered that the apartments on the ground floor have a lower quality compared to the apartments on the higher floors [8], but on the basis of researches and interviews with tenants, it can be concluded that the application of individual yards improves quality of apartments on the ground floor and even leads to a higher level in comparison to the apartments on the upper floors. By applying the concept of this kind of private open space, ground floor flats could become interesting to families with children (room for outdoor play, which is visually connected with the interior space to allow parents to control children) and elderly (direct connection and access to the outside).

Terraces and balconies are one of the most implemented private open spaces in LRHDH. This space provides a sense of individuality and association with open space and the environment which affects the overall perception of the comfort of the apartment. Balconies and terraces are valued as a space for outdoor living as well as a buffer zone between residential interior and external influences, primarily noise, wind, overheating, dust. Therefore it is very important to understand and pay attention to that when designing the protection from these impacts. Residents often use this space for hobbies, everyday activities, reading or just resting. In the LRHDH, this element gains importance because it is often associated with the external identification of users with their apartments as well as a space for interaction with neighbors and the environment. Surface area of terraces and balconies is getting bigger with a view to increasing flexibility through the use of alternative flat space that allows users to make contact with the environment without leaving the residence. Application of generous standards in dimensioning terraces and balconies offers unique design features, which become a part of the distinctive architectural expression and design of buildings (Fig. 2A,B). This treatment of terraces and balconies reduces the number of tenants' remarks such as too small a space, too warm and insufficient privacy and the like.

The roof terrace, as an architectural and structural element in the LRHDH has got different design variations. It is recognized in two ways: 1) as an element of open space for the apartments on the top floor and 2) as a private space of all tenants of multi-family buildings. Solving functional problems of the top floor apartments in the form of duplexes or apartments with setback façade level, private outdoor space, as an element of open space for the apartments on the top floor, is obtained in the form of roof terraces for various purposes, which contributes to improving the quality and comfort of apartments, which are often seen as inferior. However, with this treatment of flat roofs, flats are becoming more luxurious compared to other (Fig. 2C).

As a private functional space for all tenants of the building, a flat roof is designed for various activities such as rest, recreation, socializing, playing with children, growing plants - urban farming, which is gaining importance in recent decades. In this way, their quality is improved from the standpoint of functionality, sustainability, and social

integration of tenants. A flat roof as an element in a LRHDH gave a whole new dimension to the concept of a flat roof as an element that contributes to the creation of heat islands in apartment blocks because it is very often performed as a green roof, thus reducing many negative climatic conditions. Once considered as an unusable open space, a roof terrace as a type of private open space, got its usefulness and qualitative value (Fig. 2D).

4.1. Overview of regulations for design of private open space

Minimal surfaces, minimal dimensions, architectural treatment in terms of private open space in developed countries are defined by regulations and other state and local legal recommendations. In addition to the minimum area, minimum dimensions of open space, the front door, and then the same for people with disabilities, are also determined. For example, the Australian standards and guidelines for the design of residential houses, development of modern housing models including LRHDH, should contribute to the creation of a private open space that is accessible, attractive, safe and comfortable for its users [9].

Table 3 Areas of private open space in residential buildings

Apartments structure /number of rooms/	S	1	1.5	2	2.5	3	3.5	4	4.5	5
Serbian standards for minimal surfaces for balcony/terrace (m^2)	-	1.0	1.3	2.0	2.0	3.0	3.0	3.0	3.0	3.0
English national standards for social housing (m^2)	-	-	-	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Republic of Ireland (m^2)	-	-	-	5.0 (1.5m)	-	7.0 (1.8m)	-	9.0 (2.0m)	-	-
Recommendation (m^2)	2.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0

Source: [8]

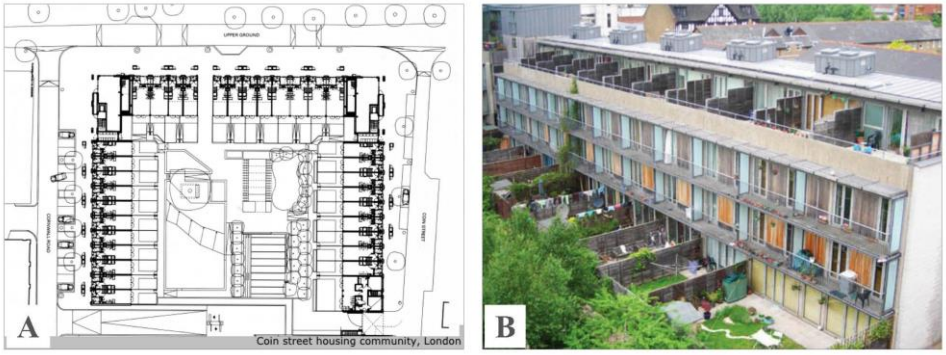
However, in our *Act for the design of residential buildings and dwellings* from 2012, private open spaces in dwellings are defined only through their minimum surface that is in relation to the standards in developed countries much smaller and it does not recognize the element of private garden for the apartments on the ground floor [10]. Thus, the Act provides the minimum area of $1m^2$ to $3m^2$ of terraces, balconies and loggias, depending on the structure of the apartment (Table 3). On the other hand (Table 3), it is evident that in England the recommended surface of private open space is two times bigger in the largest apartment (two and three bedroom apartments-Serbian nomenclature) and it ranges from $4m^2$ to $6m^2$. The situation is similar in comparison of our rules and regulations to those of the Republic of Ireland, where the minimum size of private open space ranges from $5m^2$ to $9m^2$, where their minimum depth is also defined. It is often the case that acts and recommendations for the design of residential buildings at the city level are much stricter than the state regulations.

6. EXAMPLES OF GOOD PRACTICE

In order to recognize importance of LRHDH, as well as private open space within them, the paper analyzes best practice examples from London, England, which is facing a dramatic housing crisis [11].

6.1. Iroko housing complex, Coin Street Community Builders, London

The project is a winning Competition design by the consulting company Haworth Tompkins Architects for low-rise apartment block, primarily intended for social housing. High density of population, particularly children, can cause huge social problems. The concept of Iroko complex is simple and clean solution for three housing tracts around a semi-open space, with a total of 59 housing units of different structures (Fig. 3A). The architectural treatment is in accordance with the environment, the facade fronts facing the street are lined with brick in contrast to the facade facing the inner courtyard where the final wainscoting is of wood. Buildings are designed as galleries with housing units for at least two levels. The designers have fully recognized the potential of the location when they set three residential tracts that converge with their functional solution towards central semi-private open space: sports field, children playground, greenery. In this way, all apartments on the ground floor have private outdoor space/gardens, as well as all apartments from the upper floors have terraces and/or balconies overlooking the inner courtyard, which is very important from the aspect of social interaction between neighbors (Fig. 3B). The tenants have recognized good concept of LRHDH, because they often emphasize in their statements that it is unbelievable how many inhabitants live in the place and at the same there is no sense of overcrowding [12], which is result of existence of large surfaces of private open space and semi-open spaces, especially those for playground. This is the proof that in the process of urban and architectural design, urban planners and architects have to be careful when determining the purpose of public and semi-private open space in a way that does not jeopardize the tenants safety and privacy.



A) Functional organization of the ground floor; **B)** The representation of all types of private open spaces

Fig. 3 Iroko buildings - Coin Street Community Builders, London, England

6.2. **Adelaide Wharf,** West London

Adelaide Wharf is one of the most important steps in resolving a dramatic housing crisis in London and traditionally isolated areas of the city. Architects A. Hall and M. Morris used modern architectural designing model to create low-rise high density apartment block with 147 dwellings, structures of one-to four-room apartments, which contributed to the urban and architectural quality of the area. The apartments are intended for the private sector but also for social housing, which is in the designing approach treated equally. The bordering of the lot by channels, streets and a park, determined the design of the building to be three residential tracts in the shape of the letter U, facing the interior patio with emphasized entranceways and the vistas on the ground floor level (Fig. 4A). The inner courtyard as a type of semi-private outdoor space is intended to be used by all tenants. The use of geometric lines, lines of movement through the courtyard, created a series of smaller spaces for different purposes: for leisure and/or playground. Ground floor apartments are the biggest and through private courtyards are connected to the internal open space. Accentuated by greenery, the private yards of the ground floor flats are physically and visually separated and isolated from the view and noise from the inner courtyard. Each apartment on the upper floors has a balcony which is a distinctive architectural element and achieves the identification of tenants with their housing (Fig. 4B). Balconies of smaller apartments are big enough to meet the requirements of private open space for different purposes. Vertical and horizontal dislocation of balconies of one tract represents protection from excessive sunshine and thus from overheating of the interior, while for the other tract it is decreasing shadowing of space. Adelaide Wharf is a high-quality and sustainable solution to LRHDH. The organization itself, the location and the space is an innovative prototype for future housing solutions.

A) Functional organization of the ground floor; **B)** Emphasized hanging balconies and orientation towards the inner courtyard

Fig. 4 Adelaide Wharf, West London, England

6.3. Beaufort court, Lillie Road, London

Beaufort Court is another example in a series of LRHDH cases in London with 65 apartments intended for market and social housing. Architectural work of Feilden Clegg Bradley Studios is an innovative and energy efficient with generous functional organization. Organization of the housing block is in three tracts with a public open space for sports activities (Fig. 5A). The units have different structures from single to multiple rooms. The sustainability of the building from the point of social interaction of tenants is achieved by the application of all three types of private open space (Fig. 5B). The generous dimensions of these areas significantly influenced the increased comfort of the housing units. For residential tract of higher floors, private courtyard apartments on the ground floor are facing the central recreation ground and increased privacy of these areas is achieved by denivelation of the ground. Private gardens for the apartments on the ground floor in one wing are organized on the back of the building and are not mutually partitioned which affects the very usability of space. All units have spacious balconies facing the inner courtyard (Fig. 5B). By setting back the flats on the top floor of the heights tract, spacious private roof terrace are obtained. The existence of a green roof contributed to the increase in thermal comfort.

A) Functional organization of the ground floor; **B)** The representation of all types of private open space; private courtyard on the ground floor flats positioned towards the sports field

Fig. 5 Beaufort Court, Lillie Road, England

7. CONCLUSIONS

LRHDH represents an alternative housing model both to sprawls (low density housing areas) and high-rise buildings and public housing (high density areas). However, analysis and practice show that density itself does not appear to be an issue - there is no such thing as an optimum density, and density alone is not the key to successful housing. Many other factors contribute to this, such us good urban and architectural design, and quality of housing management. Cultural and social factors also contribute to whether high-rise living is a success or a failure.

Well-designed private outdoor space in LRHDH should seek to achieve comfort and greater degree of user privacy by controlling the intensity of their interactions with neighbors, in addition to fulfilling their personal social and cultural preferences and activities [13]. The feeling of comfort for the tenants can be viewed through the following aspects: 1) physiological needs (protection against noise, wind, thermal comfort, etc.) and 2) socio-psychological needs (protection from view neighbors, clean vistas etc.), which must be in balance. To achieve the greatest possible comfort it is primarily important to have a sufficient number of private open spaces, noise and wind protection, as well as protection from view of neighbors, but with vistas to the environment.

In the physical sense, a private open space is an extension of the living space to the outside environment and provides an access to the outside with a certain degree of privacy and territorial control. Usually, they are directly and immediately connected with the housing units, mostly through the living room. Use of this type of open space must be viewed through the structure of the family itself, i.e., users and their needs, which points to a variety of private open space purposes: psycho-physical relaxation, drying laundry, plant growing, playing with children, working space, etc. Therefore, the challenge in designing LRHDH is even greater if we acknowledge the fact that the urban planners and architects do not know the future users of flats, which is a variable category (changing the owner of the apartment, an increase of family members, flats, etc.). It may be noted that the Serbian regulations do not recognize multifunctionality of private open space regarding users and contents. That raises the question of the usability of such a type of open space, as well as its treatment in terms of increasing comfort and quality of living. An outdoor space should be facing the nature, internal, semi-public and public space, with as small as possible vistas onto the roads and transport, in order to reduce the feeling of overcrowding and create an impression of privacy.

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SOURCES OF ALL ILLUSTRATIONS

Fig. 1 Authors based on following sources:

http://www.czwg.com/works/crown-street-regeneration-project
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Fig. 2 Authors

Fig. 3A https://image.slidesharecdn.com/aurkezpena-100309151659 phpapp02/95/aurkezpena-6-728.jpg?cb=1268148154

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Fig. 4A
https://www.ahmm.co.uk/resources/res.aspx?p=/FCF175F18A83EC9F832D303E3393C083C234259939195E302B7EB87E2AEDA43A/ground-plan.gif

Fig. 4B http://www.akt-uk.com/medias/images/diaporamas/76/adelaide-wharf-03_1180x580.jpg

Fig. 5A https://fcbstudios.com/assets/imgsupl/Feilden_Clegg_Bradley_Studios-Beaufort-Court-London-02-Site-Plan.jpg

Fig. 5B https://fcbstudios.com/assets/imgsupl/feilden_clegg_bradley_studios-beaufort_court-london6.jpg

UTICAJ PRIVATNIH OTVORENIH PROSTORA NA KVALITET ŽIVOTA U STANOVANJU NISKE SPRATNOSTI-VELIKE GUSTINE

U savremenim teorijskim pristupima i praksi, stanovanje niske spratnosti-velike gustine prepoznato je kao odgovarajući model stanovanja za rešavanje prostornih, socijalnih, ekonomskih i ekoloških problema u mnogim urbanim situacijama. Osim sagledavanja osnovnih karakteristika ovog tipa stanovanja, fokus istraživanja je na analizi značaja i prednosti implementacije privatnih otvorenih prostora, koji su prepoznati kao jedan od glavnih elemenata stanovanja niske spratnosti-velike gustine. Istraživanje se oslanja na analizu relevantne literature i primera dobre prakse.

Ključne reči: *stanovanje niske spratnosti-velike gustine, privatni otvoreni prostori, kvalitet života*

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THE SOCIAL DIMENSIONS OF SPACE IN SCHOOL ENVIRONMENT

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Abstract. *Children's patterns of behavior in the school environment, conditioned by various levels of individual or group needs, represent the basic modalities of their relationship towards the immediate, both social and physical, environment. This paper studies the connection between the behavior of school children, whose relationships with their given social environment can take various forms, and certain spatial characteristics of elementary schools. The results indicate that there is a need to achieve a balanced relationship between a strictly defined and an open form of the physical environment in order to create conditions in which school children will express their current orientation and attitude toward their immediate social environment through their behavior in that particular physical environment. This includes the organization of a dynamic and shifting environment, spatial planning which needs to enable a greater degree of privacy in certain zones and the organization of spatial flow which enables adequate visual communication between the school children and the flexible structure of the space meant for education.*

Key words: *school children, social behavior, interaction, physical environment, space*

1. INTRODUCTION

Conceptualization of suitable school environments creates the conditions for the development of varied pedagogical methods, as well as the development of the school children which are supposed to result in their significant cognitive and psycho-social achievements. (Tanic et al., 2015)

School physical environments can support positive development. Or, on the opposite side of the spectrum, they can contribute to increased disruptive behaviour, less positive social interaction, and increased stress levels among preschool and elementary school children.

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(Ahrentzen, Jue, Skorpanich, & Evans, 1982, Moore, 1986, Maxwell & Chmielewski, 2008, Stankovic, 2008). A special contribution to the criticism of the existing forms of the spatial organization of the environments in which children spend their time was made by Itoh (2001), who studied how children's interactions with the physical environment take place and what they mean in the everyday life at school. He viewed the school as a setting for children's socio-cultural development, and studied how space works in this context. (Tanic et al., 2015)

The significance and role of the environment in the process of elementary education is connected not only to the formal organization of the curriculum, but also to a great extent to the role of the participants in that process during their informal, leisure activities. Some researchers have examined the effects of the benefits of small and private spaces to which children can retreat from action when they feel tired, overwhelmed or unhappy (Lowry, 1993; Moore, Sugiyama & O'Donnell, 2003). Although privacy is related to environmental control, it is also an environmental attribute believed to be related to the competence of young children. There are specific environmental characteristics that directly affect children's abilities to achieve privacy (Maxwell, 2007). The concept of privacy is central to understanding the relationships between the environment and behavior; it provides a key link among the concepts of crowding, territorial behavior, and personal space (Altman, 1975).

2. A Study Framework

The conditions of the physical environment, within which the determined patterns of behavior form various relationships with the social environment, represent one of the basic frameworks within which we can study the qualitative features of a school's environment.

On the basis of the determined levels of spatial behavior of school children and the various forms of their attitudes to the social environment, connections were established between their psycho-social activities and the school's environment.

Through a projection of the analyzed patterns of school children behavior, specific locations in space have been determined. The studied pair the *behavior of school children – a location in school space* mutually determine one another through their internal relationship. It is precisely the character of these relations that determines the functional range of certain parts of the school space in which they are actually realized.

3. Specific Patterns of School Children in the School Environment

The ambient properties of the educational space, thus, could be viewed as a kind of mediating element not only in the different forms of pedagogical activity, but also during the leisure time activities of the school children. In that sense, the implications for the possible contextual changes, especially at the spatial level of the classroom, are also studied from the aspect of the leisure time activities of school children in relation to the architectural characteristics of the immediate environment.

We should certainly not neglect the significance of any of the dimensions of human activities, and should also point out that each activity has is spatial aspects, since every activity contains within itself movement and relations towards various types of space (physical, social and so on). Speaking of the totality of the existential space, K. Norberg-

Šulc (1999) points out that the "orientation of man towards various objects can be cognitive, but also affective. In both cases the aim is the establishment of a single dynamic balance between him and his environment. According to T. Parsons, action consists of construction and procedure, which human beings use to form preplanned intentions, and thus, apply them more or less successfully, to specific situations. Most human activities also contain a spatial aspect, in the sense that objects of orientation are divided based on internal and external relationships, whether they are proximal and distal, separate or united, continuous or intermittent" (Norberg-Šulc, 1999, Nešić et al., 1995, 1998).

According to N. Rot, the spatial characteristics which are manifested in the interaction are often referred to as spatial behavior, or as the anthropologist Hall first referred to them, proxemic communication (Rot, 1978). "As the main forms of spatial behavior, we can distinguish between proximity and distance during interaction with other individuals, one's position in relation to others in contact with them and territoriality or the parts of the space which we consider our own or important for us" (Nešić, 1996).

The levels of spatial behavior of school children can differ, but also, depending on the context in which they occur, they can be specific. Especially in the case of a school's environment, they can be manifested in various ways both in the individual and collective sphere. Thus, the following can be in a certain relationship within/in relation to space:

- an individual,
- an individual vs an individual,
- a group,
- an individual vs a group,
- a group vs a group.

Territoriality is usually defined as behavior, that is, "as one individual in his own way laying claim to a certain space and defending it from other members of his own kind. Territoriality makes up the spatial frame in which things take place – these are the places where one learns, the places where one plays, where he finds safe places to hide and so on. The basis for territoriality is the sharp, acute sense of the limits which mark the distance which has to be maintained between individuals" (Norberg-Šulc, 1999).

Territoriality is the pattern of behavior which stems from the basic human need to control the degree to which one is open/closed towards others (Altman, Chemers, 1980). In the case of a school's physical environment, certain situations in which we recognize territoriality range from the individual to various group forms of the spatial behavior of school children.

The formation of one's own territory in the individual sphere is conditioned by the need for security and the need for identity, and is most often manifested among younger school children. School children take up or build up their personal micro space in the complex of the social environment by using not only fixed (pillars, the space between the pillar and the wall, the parapet, stairs, the railings of the stairwell, the space between two tables, corners, niches, built-in benches, and so on), but also mobile (chairs, benches, shelves, bulletin boards, and so on) elements in their immediate physical environment. This level of the spatial behavior of school children is manifested in particular activities which take place in different places. These can be places to study, safe places to hide, but also places for playing games and the gathering of a smaller number of close school friends. Frost and Holden (2008) found that schoolchildren value adequately resourced spaces at school. In that sense, the mobility of school equipment is of special importance since it allows, if necessary, a greater freedom to use space.

Taking up various parts of the space which they consider their own or important, in certain situations school children, in their own way, establish a suitable distance in relation to other school children or groups of school children. The specific nature of this pattern is that the school children, distancing themselves from their classrooms as the center of all their activities, most often choose a place which enables visual contact with the classroom. At a certain distance from the class, school children establish a certain level of privacy, at the same time maintaining a visual connection with it, and a sense of belonging to that group. The patterns of behavior in which the maintenance of distance-contact is dominant represent the balance between privacy and the sense of belonging to a group (Itoh, 2001).

The question of physical proximity among individuals is a somewhat complementary question of their distribution in space. Especially in the case of group work, immediate interaction occurs among those individuals who sit one across from the other and one next to the other. For example, among younger school children, "sitting one next to the other or at the same table makes a greater contribution to the occurrence of an emotional and interactional connection than many other features, whether personal or situational" (Havelka, 1980).

Spatial proximity represents a significant precondition for a more comprehensive and intense interaction among individuals. "People who during their independent movement through a common space find themselves in the vicinity of others, have a greater chance of participating in various forms of conventional interpersonal interaction" (Havelka, 1980).

Influencing the relations between individuals (individual – individual, individual – group and group – group), the distribution of certain physical elements in space can in a variety of ways contribute to the manifestation and maintenance of interaction. The physically differentiated parts of space, either horizontally and/or vertically, can especially be a significant factor which, contributing to a more active relationship of school children towards the environment, inspires the occurrence of interaction between school children, leading them into a certain spatial structure.

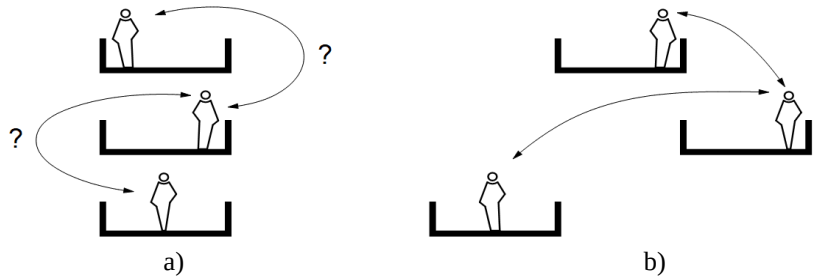
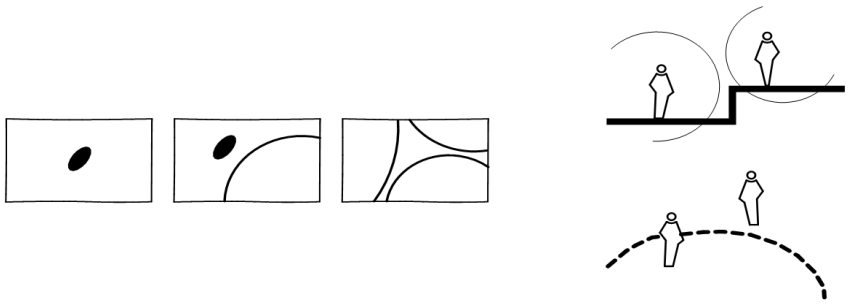


Fig. 1 The levels of interaction by H. Hertzberger (2009) – Montessori College Oost in Amsterdam, NL, 1999.
a) The physical environment that prevents the occurrence of interaction among individuals.
b) The physical environment that encourages the occurrence of interaction among individuals

High interaction values of the physical environment can be achieved through the preplanned organization of mobile elements such as furniture and equipment, in a suitable relationship to the fixed framework of the environment. The deliberate change in a certain part of the structure of the physical environment is characteristic of a pedagogical-

psychological situation in which, through the mediation of the physical environment, we transfer a message to the school children regarding future activities and social forms of work. This indicates the importance of the organizational role of the teacher from the viewpoint of the formation of encouraging physical conditions which might contribute to the interactional enrichment of the educational situation.

Higher levels of territorial behavior are based on group identity. On such occasions, the patterns of behavior usually represent a social organization into groups based on class-membership at a certain spatial level. Certain specific patterns of behavior which are especially pronounced in the educational environments are established in the so-called inter-class interactions. Certain areas in the common space of the school are mostly used by school children from the same class. Especially during leisure time activities, school children usually remain within their own classrooms or in their shared space, which is usually the territory in front of their classrooms. According to Itoh (2001), the boundaries of these territories are determined by the space where the interaction between school children belonging to various classes takes place (inter-class interaction). Some of the parts of the school space which are used by school children as their territory include the doorways of their classrooms, the railings of the stairwell, the gallery or leveled units in space. The inter-class interaction includes verbal and visual communication, and the events that occur between members of various classes are at a certain distance from or on the border/threshold between them.



a) b)

Fig. 2 The structure of behavior in space by S. Itoh (2001)
a) An individual, an individual vs. a group, a group vs. a group structure
b) The physical distinction between space and space differentiation of the behavior

Certain studies on group interaction indicate the fact that inter-class interaction occurs at the borders of what the school children might consider their semi-private space, and that this pattern of behavior is applicable only in the case when the school children have recognized this territoriality. Territorial behavior is not realized in the physically differentiated parts of the space, but on the basis of the mutual identification of school children from different classes and their behavior (Itoh, 2001; Minami & Yoshida, 1993). We could say that the differences in the space based on behavior could represent the result of the daily actions of the school children which are aimed at creating a dynamic balance between them and the environment.

4. The effects of the Spatial Characteristics of Schools and the Behavior of School Children

On the basis of the established connections between the psycho-social processes and school space, as the designed and constructed physical environment in which the school children spend their time, the possible ways in which the school children could use the school space was evaluated, and within these situations, the influences of individual spatial characteristics of the school on the behavior of school children and some of their activities. By analyzing the psychological needs of a child, in terms of the space it spends time in, certain groups of needs have been differentiated, which include the child's safety and its being superior to the space, then a group which refers to the child's needs for various devices within this space, the possibility of encouraging a child, and reconstructing the space, as well as the group of needs for a child's identity and privacy in the space (Stanković & Stojić, 2007).

The school children's choice on how to use the available school space can be different, and is conditioned primarily through the individual or group affinities of the school children. On the one hand, there is the possible situation in which, among certain school children, there exists a need for separation and self-isolation, while on the other, we can recognize the need for belonging and a more pronounced participation within smaller or larger groups of school children.

In the situations where several school children take up certain parts of the space, it is possible to note that the social relationships between these school children are transferred into the category of clearly determined spatial relations. Spatial relations, thus, determine the social relations and the behavior of individuals, including their status and position in a group.

The spatial models indicate the possibility of a concentration of a large number of different activities of school children in individual functional domains. However, the internal organization of each functional domain in the school's environment should offer an entire range of intermediary forms for the realization of the studied relationships in the individual and collective sphere.

By systematizing the potential places within which certain activities of school children are realized, it can be concluded that the patterns of behavior of the school children are closely related to the factors of the architectural solutions, such as the function of certain parts of the school's environment, structure, form and space volumetry, then to the distribution of certain mobile elements in space, as well as to the symbolic meanings which are attributed to the space during its use.

5. Concluding Remarks

The possible patterns of social behavior of children at various levels of their interrelationships clearly determine the domain of the physical environment. In the educational process, the social behavior of the school children and their relationship towards the physical environment are conditioned primarily through the organizational role of the teacher and thus the applied pedagogical methods. However, during leisure, extracurricular activities, which also represent an important part of the pedagogical process, there is the possibility of expressing considerably more flexible patterns of the behavior of school children.

Indication of the need for security and the need for identity, territorial behavior in the individual sphere of the school children is the way in which one asserts his place in the complex of the physical environment, as well as his position in regard to others who are in contact with him. Most of the manifestations of the forms of interaction take place in the boundary areas, between partially physically separate spatial wholes or between spaces separated by the various behavior of school children. Special importance, in this context, is ascribed to the physical differentiation of space, horizontally or vertically, since it greatly contributes to the occurrence of social interaction. All this is important for a more complete articulation of the awareness of oneself as an individual who is socially involved and acts so as to establish a relationship with other individuals.

Even in the case of school space, the opinion of the renowned Dutch architect Aldo van Eyck can be corroborated, in that "every space is multi-suggestive" (Norberg-Šulc, 1999). By conditioning the way in which school space is used, the factors of the architectural solution influence the relationships between the individual and the group, at the optimal levels of verbal and visual communication. And while, on the one hand, there is a need for space which enables a greater degree of privacy in certain zones, on the other hand, priority is assigned to the organization of space which can provide adequate visual communication. Thus, the structure, shape and volumetry of the classroom and its immediate physical environment must create the conditions for the school children to use their spatial behavior to indicate their current orientation and attitudes towards their immediate social environment.

The different levels of school children's perception of the school space, which in part depend on the habits they formed in their family life, indicate the achievement of a sort of balanced relationship between a strictly defined and open form of the physical environment, the relationship which would be in the function of various formal and informal social relations, the satisfaction of various needs, specific patterns of behavior and the activities of the school children. Unlike traditional architectural models of elementary schools, the goal now is towards the establishment of a single dynamic and variable environment, with harmoniously defined, non restricted boundaries and relations in space, which would offer the school children a choice, whether in terms of pedagogical activities or some other forms of their engagement.

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UTICAJ PEDAGOŠKIH KONCEPCIJA SOCIJALNE SREDINE NA ORGANIZACIJU FIZIČKE SREDINE

Obrasci ponašanja dece u školskoj sredni, uslovljeni različitim nivoima individualnih ili grupnih potreba, predstavljaju osnovne modalitete njihovog odnosa prema neposrednom, kako socijalnom tako i fizičkom okruženju. U radu je istražena povezanost ponašanja učenika, u različito formiranim odnosima sa datom socijalnom sredinom, i pojedinih prostornih karakteristika osnovne škole. U funkciji stvaranja uslova u kojima će učenici svojim prostornim ponašanjem iskazati svoju trenutnu orijentaciju i opredeljenje prema neposrednom socijalnom okruženju, rezultati ukazuju na neophodnost postizanja uravnoteženog odnosa između strogo definisane i otvorene forme fizičke sredine. To podrazumeva organizaciju dinamične i promenljive sredine, planiranje prostora koji treba da omogući veći stepen privatnosti u pojedinim zonama i organizaciju prostornog toka koji obezbeđuje adekvatnu vizuelnu komunikaciju između učenika i fleksibilnu strukturu prostora za nastavu.

Ključne reči: *učenici, socijalno ponašanje, interakcija, fizička sredina, prostor*

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ARCHITECTURE AND CERAMIC MATERIALS, DEVELOPMENT THROUGH TIME: CERAMIC TILES AND CERAMIC ROOF TILES

UDC 72:691.4

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Abstract. *Ceramic tiles and roof covers have been used in construction of architectonic structures from the earliest times. Their relatively simple production, as well as acceptable cost, contributed to the mass usage of these products. The paper presents a review of ceramic tiles and roof tiles, by laying out their development, shapes, physical properties and usage through history in various climates and time periods. The aim of the paper is understanding the importance of use and development of these products in architecture.*

Key words: *ceramic materials, ceramic tiles, ceramic roof tiles, ceramo-plastics.*

1. INTRODUCTION

Ceramic products appeared very early in the area of civil engineering and architecture. Prior to gaining knowledge about how high temperatures modified clay characteristics, and prior to the beginning of mass usage of fired production in architecture, it was in its unfired form used in civil engineering as adobe. Usage of clay products is almost as old as architecture.

Products obtained by shaping and baking of various types of clay – ceramic products, according to their appearance and purpose, can be classified as coarse and fine ceramics. The coarse ceramics are those intended for industrial use and use in civil engineering. In the first part of the paper, dealing with the development and historical background of usage of ceramic materials in architecture are presented adobe and bricks, as very common building materials in almost all epochs. This part provides a review of the development of tiles some architectonic decorative ceramic elements and of ceramic roof cover.

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2. TYPES OF CERAMIC PRODUCTS

According to the technological procedure of production and processing techniques, as mentioned in the first part of the paper, ceramic products can be divided into: terra cotta, majolica, faience, porcelain …

Terra cotta (terra-cotta – baked earth) is a sort of unglazed ceramics. It is yellow, orange or dark red in color. Terra cotta is both the name for utensils created in this way and for decorative objects in architectonic formation, which were obtained in this way (ornaments, profiles etc.). Terra cotta was used as early as by the ancient Assyrians. It was used for making sculptures, elements of roof cover… The oldest sculptures were dried in the sun and later fire on an open hearth [1]. In the Etruscans, it occupied an important place in their art. Particularly well known are the Etruscan terra cotta sarcophagi, as well as their sculptural treatment of the exterior and interior of their temples using this material. Even though it was primarily known by its porcelain, China can also boast with its usage of terra cotta. The soldiers and horses of terra cotta, around 8000 of them in full scale, placed inside the royal tomb around 210 BC are widely known, (Fig 1).

Fig. 1 Soldiers and horses made of terra cotta in full scale – China, source [2]

Majolica is a type of ceramics, semi-porcelain made of fine clay. It got its name from the city of Majorca on Balearic islands, where production of Moorish-Spanish glazed ceramics flourished since 9th century [1].

In 15th century, this type of ceramic products reached Italy, and its use expands to France, Switzerland, Holland and Germany. Majolica is a ceramic product which is glazed. Clay with a lot of limestone is used for it, because of which the end product is very porous. The shaped object is first fired to obtain toughness, and then immersed in viscous mass creating a glossy glaze of metal oxides (for instance tin white glaze – tin oxide). Majolica is a transition from the simple products made of terra cotta, to faience, and element of artisanal art. This is the method for obtaining tiles, but also vases, cookware and other utensils and decorative objects.

Faience is semi-porcelain made of fine clay baked at lower temperatures, which has an opaque with glaze suitable for painting on it [1]. The faience technique has a Moorish-Spanish origin, even though this production technique was somewhat known as early as in the times of ancient Egypt, Babylon and Assyria [1]. It was taken to Europe from Arabia in 14th century. It was named after the city in Italy, Faenza, near bologna which became famous for the ceramic products in 18th century. Under the term of faience is nowadays considered the white color pottery which was later painted (Fig 2). Decorative, hand painted ceramic tiles are widely used.

Fig. 2 Palazzi di Firenze Faience Cupola source [3]

Porcelain is the white semi-transparent ceramics made of fine kaolin clay baked at temperature ranging from 1200 to 1400ºC [1]. It is mostly painted. It is used for production of various decorative objects and cookware. Probably the most famous porcelain is the Chinese one.

The ceramics can be decorated in several ways. One of them is **carving or imprinting of decorations** (carving, impression of seals and marks...). By using the **engobe application** technique a layer of white or colored clay mixture is applied as a base layer for painting or carving of images. Engobe application is the process in which, by mixing the solution of clay and melt-resistant oxides, are obtained colored coatings on ceramic materials. Engobe covered surfaces have no gloss. Decoration is performed using also relief, glazing and in the recent period, numerous other mechanical procedures. **Glazing** is the glassy layer which prevents absorption of liquids and serves as a decoration. Glazing is made from the quartz sand and easily meltable materials – lead, tin, potassium, borax etc. [1]. Glazing can be transparent or opaque (white or painted, made of tin). Painting of glazing are almost performed using metal oxides resistant to high temperatures. According to the method and temperature of firing, the oxides change the quality and shade of colors. The most durable ceramic paints, which can endure firing at high temperatures beneath the glazing are cobalt paints (various shades of blue), manganese (brown to violet), ferric (red to brown and yellow), copper (red to green and turquoise), antimony (yellow), chrome (grey-green and yellow-green), tin (white) [1]. For the painting are also used gold, silver, iridium and titanium (gray and black). Such paints are applied on the baked glazing and fired for the third time, at lower temperatures in special ovens.

3. Ceramic Tiles

Ceramic tiles include tiles of various dimensions, made of fired clay, with a finish layer which can be treated in various ways. They are mostly quadrilateral, but they can be found in other forms as well. They can be glazed, non-glazed, white or colored, with various patterns and motifs. In civil engineering, both in the past and nowadays, their main function is covering of floor or wall surfaces.

Regarding the vast range of colors which can be used to paint them, glazed, and then to be laid in most different forms and patterns, they were readily used in architecture of both housing and monumental buildings. Tiles can be arranged in an infinite number of patterns and motifs. They can be used for tiling entire walls but also for border trimming, for friezes, murals, floor and wall mosaics…

They can have different forms. The quadrilateral, trilateral and hexalateral tiles were most frequently used for architectonic structures. By combining all the forms at the same time, it is possible to create several different patterns. It is a so called Archimedean technique, semi-regular arranging of tiles used in Islamic architecture, Italian medieval architecture, and on contemporary structures [4].

The emerge very early, in history. There are remains of this ceramic product found in the period 4000 years ago, in the dynastic period of ancient Egypt [5]. Also, in Mesopotamia, in addition to the brick production, a sophisticated technique of painted decorative ceramics was also developed. There are remains in the ancient Babylon [6] In Persia, they reach a considerable degree of decorative treatment, and along with glazed bricks they were extensively used for covering and decorating of wall surfaces… The Etruscans used them in a somewhat unusual way. Due to the shortage of stone, they clad wooden pillars and beams in ceramic tiles, to imitate the Greek Doric style [7].

In Rome was used the opus Alexindrinum, a technique in which small regular tiles in combination with the pieces of marble stone and glass are arranged around large marble circles [4]. This technique was revived later, in 12th century, owing to the Cosmati family, after whom it was then named.

Ceramic tiles were changing through epochs, from lavish facades and interior decorations of Spain [8] and Portugal, through the ceramics of renaissance Italy to the blue drawings on white tiles in England and Holland [1].

In the western countries, since 12th century, ceramic tiles have been used as floor covers in churches. At first, for these covers were used non-glazed tiles, red, brown and yellowish color with imprinted or engraved ornaments.

Encaustic tiles are tiles made of clays of various colors, which are used to achieve a certain pattern, just as with the glazed ones. They are made by compacting the clay in profiled moulds, so as to obtain depressions which will later be inlaid with a different type of clay which creates a pattern on the tile which is baked afterwards (Fig 3). This technique was observed on the structures from 13th century [4]. They were later used in the Victorian age [9].

Fig. 3 Encaustic tiles, source [10]

Glazed and faience tiles are also used. In the renaissance age, the floors in French courts were covered with faience tiles of bright colors [11]. The painted tiles produced in Europe left the mark on production of tiles in the entire world. The produced tiles in the medieval times often had religious motifs of extreme complexity painted on them.

The tiles with the motifs from the Old Testament, scenes from the life of Jesus Christ and other biblical scenes are not rare during the medieval times. The Chertsey type of tiles from the 13th century, which are laid in one monastery, display Richard the Lion heart fighting Saladin, (Fig 4) [12].

Fig. 4 Richard the Lion heart fighting Saladin, display on ceramic tiles [12]

In 13th century are used ceramic tiles with a pressed relief and colored arabesques. With the emergence of faience in Italy in 15th century, the ceramic tile glazing technique was improved. This technique was taken over to the countries of northern Europe, and in 17th and 18th century it reaches and high level of perfection in the Dutch city of Delft, where a special type of glazed ceramics was developed [1]. This type of tiles was named "Delftware"). The base color of the tile was white, and on it was drawn a drawing mostly in various shades of blue, but also of other colors. The colors cover only a small surface of the tiles. Delftware type of tiles was extremely popular in Holland, and these tiles were exported through northern tip Europe, starting from 16th century onwards.

The royal courts in that period could have the so called porcelain rooms which were almost completely covered in such tiles.

There are several types of traditional tiles which have been produced in Morocco even nowadays. This type of tiles has small mosaics and brightly colored "Zellige" tiles.

Zellige is mosaic tilework made from individually chiseled geometric tiles set into a plaster base. This form of Islamic art is one of the main characteristics of Moroccan architecture. It consists of geometrically patterned mosaics, used to ornament walls, ceilings, fountains, floors, pools and tables (Fig 5).

Fig. 5 Zellige Morocco [13]

In Europe, there was tradition to set the tiles of terra cotta on the walls of post-and-pan structures, so as to form a certain pattern by their combination and overlapping. In England was developed the so called “mathematical tile“ for cladding walls, so that from the outside it would appear they were made of bricks [4].

With the advancement in the production of tiles during XIX century, a breakthrough was made in the domain of production of terracotta for cladding of walls. Arts and crafts (the full name is the Arts and Crafts Exhibitions Society) is a style which developed in the years between 1880 and 1900. This movement was affected by the development of artisanal crafts in Europe, and it became one of precursors to Secession and Bauhaus. The trail to a new art was blazed by England, where the society of Arts and crafts was founded under the leadership of William Morris and John Ruskin who tried to revive crafts and arts. The motifs on the tiles designed by Morris were sailboats, birds, fish, plants…. The production of designed tiles saw its revival and popularity in the Victorian times. Arts and crafts encouraged the manual production of terra cotta tiles. A good example of usage of these tiles is the Natural history museum in London (1880). In the USA, the tiles made of terra cotta were intensively used, mostly the glazed ones. Louis Sullivan clad all full elements on his buildings with modular tiles, using his original system of ornamenting [4] (Fig 6). It is interesting that the tiles from the Victorian times became the standard for arrangement of kitchens, bathrooms and public spaces in the modern age.

Fig. 6 a) Guaranty Building, Buffalo, N.Y.,Dankmar Adler and Louis Sullivan, 1894–95; b) National Farmers' Bank, designed by Louis Sullivan, 1908, Owatonna, Minn, source [14]

At the turn of 20th century, Antoni Gaudi (1852-1926) to a great extent used the ceramic tiles on the facades of his buildings [15]. Yet, Gaudi most often used a kind of mosaic from the shards of ceramic tiles, as a sort of an art form, for which he remained remembered. Such details feature on the Guell pavilion (the riding hall), chimneys and vent ducts of the Guell Palace, as well as interiors of almost all his designs. Certainly the most impressive mosaic made of ceramic shards is in the Park Guell, with famous curvy benches (Fig 7) and the dragon – guardian of the park done in the same technique [15].

Fig. 7 Usage of the ceramic shards, The Park Guell Barcelona, photo A.M.Petronijević

Azulejo are faience, multicolor-painted (most often blue, green and yellow) glazed tiles for cladding of walls and floors. The art of making of these tiles was brought to Spain by the Moors in 13th century, and the main center of production was Seville. The Azulejo were often used in the baroque interiors of Spain and Holland [9]. In Portugal, the tradition of Azulejo tiles was continued, and they are used even nowadays to decorate buildings, ships and even stones and rock used for interior arrangement. Tiles with various motifs are nowadays mass produced in factories, meaning that their cost is lower than before.

Oskar Niemeyer is one of the architects who used the ceramic tiles successfully on the facades of some of his buildings (St. Francis Church in Belo Horizonte). Eduardo Nery also readily used ceramic material and its shards in his designs. He used these irregular ceramic shards when designing the mosaics on the Municipia Square in Lisbon, and on the retaining wall in the Infante Santo Avenue (Avenida Infante Santo) in Lisbon [16] (Fig 8).

Fig. 8 Eduardo Nery: a) Town Hall Square Lisbon Portugal [17]; b) The Avenida Infanta Santoin Lisbon [18]; c) Underpass system [18]

Islamic architecture, especially the sacral one abounds in usage of ceramic glazed tiles. These structures are unmatched in terms of decoration level regarding the use of ceramics. In Persia, in 9th century, the old tradition of production of glazed tiles was revived. The previously mentioned Imam's mosque in Isfahan, built in 17th century was clad with 472000 of glazed tiles of vibrant colors. The sheik Lotfollah's mosque situated on the same square attracts attention by the exterior cladding of the cupola made of glazed tiles in various colors, with floral motifs, while the interior enthralls with the prevalent blue color of the glazed tiles. The cupola is on the outside clad with copper glazed tiles in combination with blue patterns, while the dominant color on the wall under it is blue. The segments painted in various coloration ranges and proportions of floral motifs on the separate architectonic elements – cupola, arches differ from one another [4], [19].

4. CERAMO-PLASTICS

The ceramic elements of specific forms which are used as decorations on the facades can be classified in the special group of these products. In the group of Serbian medieval monuments build in Byzantine style, the ceramo-plastic elements are used as decorative elements. These decorative elements are classified in two groups: cups and tiles. Both types are inlaid in mortar in a wall recess between two courses of bricks, so their front surface remains visible in the facade [20] [21]. The mostly have a quatrefoil or circular form on the front side. Neither the cups nor decorative tiles are glazed (Fig 9).

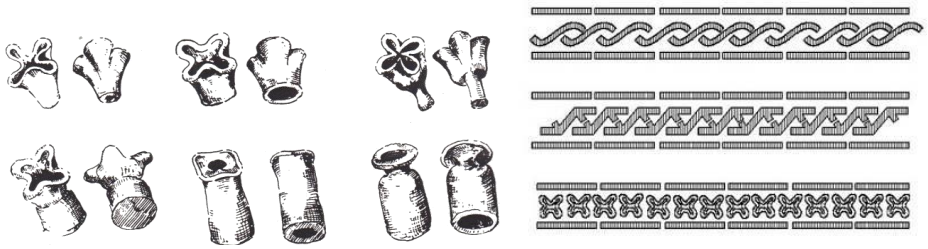

Fig. 9 a) Fired earth decorations on the church facades [20]; b) usage of bricks in decorative purposes [21]

Regarding that during religious service churches were a place of chanting, the acoustics of the churches was improved by the usage of earthen pots which were built in the walls at specific points, and worked as resonators. These ceramic pots have various forms and can have various sizes. There are pots which are medieval beakers, adapted to serve as resonating boxes, by having their handles and bottoms removed. There are pots which were made with a purpose to be used as resonators. [21]

Ceramic elements of most various forms are even today readily used on the building facades (Fig 10).

Fig. 10 Usage of ceramic elements in façade decoration, Subotica, foto A.M.Petronijević

5. ROOF COVERING

Roof covering made of fired earth probably goes as far back as the fired brick. The old method of making of the first elements for covering made of clay is similar to making fired bricks. A wood mould is laid on a flat surface and filled with clay mixture. The upper surface of the mould is leveled and the mould is removed. After a period of drying the roof tiles are fired. Curved roof tiles after being removed from the mould are placed on the new mould of a desired profile, and then fired.

Terra cotta was in ancient Greece used for decorations, and it was also used as a roof cover. In Lerna, nearby Argos on Peloponnesus were found roof tiles made of terra cotta dated back to the period of 2600-2000 BC. The Greeks used three types of cover tiles, called the Laconian, Sicilian and Corinthian [22]. The terra cotta roof tiles were considerably more expensive than straw as a roof cover, but they were readily used because of their considerably higher resistance to fire.

The ancient Greek cover tiles – *tegulae*, are laid one next to another, with the upper rows overlapping the lower rows of tiles, which had raised lateral borders edges. The joints between the tiles were covered with narrow elements called – *imbrices*. The ends of tegulae obtained decorations – acroteria [7]. Acroteria decorations can be observed on the roof ridge, as well (Fig 11).

Fig. 11 Imbrex and tegula, source [23]

The Etruscans used the high quality clay both for adobe and for fired ceramic products. In this way large ceramic tiles for closing of tombs were made, then roof covering tiles, decorative elements for decorations of temple cornices… The Etruscan roof covering was tile, like imbrex and tegula in Greece, with special elements covering their joints. In Rome as well, the roof covering was mostly made of ceramic products. The fired clay covering is like imbrex and tegula in Greek architecture.

There are various specific types of tiles with specially shaped profiles, for ventilation, corners, ridges… The rounded tiles have a mildly conical shape and they are placed in

two rows like the S-tiles. The curved tile which was used in Holland known as the Flemish tile has a cross –section of an asymmetrical letter S. [4]

After the emergence of the press of tile production, the potential for production of the tiles of most varied forms and dimensions was created. The machine-produced extruded tile with a single groove was invented by the brothers Joseph and Xavier Gilardoni of Alsace in the 40's of the 19th century. This tile was patented in Great Britain in 1855 after which several variants were developed in France after that. [4]. Sometimes this tile was placed on a rectangular grid on the roof, and sometimes it was laid in staggered rows. Often these tiles were called the "French tiles", the Marseille tiles being exported all around the globe. The tile was connected to the roof structures with wires passed through the hole in the lower side of tiles

The Marseille tile is a French roof covering which belongs to the broader category of Gilardoni tiles which the Gilardoni brothers started to produce in 19th century, using a new press for tile production. Those are rectangular tiles with a central web as a reinforcement, and with a groove on the lateral longer side so that it would be more resistant to weather conditions, and with a rounded shorter side which is in contact with the face of the next tile. This tile was one of the top export articles of France in this period. (Fig 12). [4].

Fig. 12 "French tile or Marseille tile" by the French Gilardoni Brothers in 1850. Source [24]

Nowadays a wide range of tiles of most varied shapes, dimensions and colors are available. Often used are polychromic tiles, which perhaps are most characteristic of roofs in Russia.

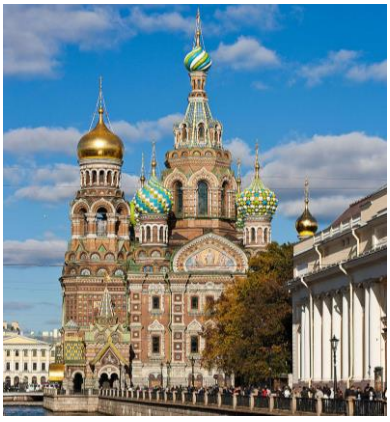

Fig. 13 The Church of the Resurrection of Christ in St. Petersburg, Russia [25]

The Church of the Resurrection of Christ is an example of colorful clay tiles used to make roof mosaics (Fig. 13). As well as a number of other countries, Czechia also has roofs constructed in multiple colors. The use of variously-colored tiles in Serbia, on buildings in Subotica, is shown in figure 14.

Fig. 14 Usage of tiles of various colors, Subotica, photo A.M.Petronijević

6. CONCLUSION

The beginnings of ceramic products go back to distant past. The peoples of Mesopotamia, as a cradle of civilization, of the Near East, and of ancient Egypt used the ceramic tiles since the earliest time. As early as in the age of pharaohs, around 4000 BC, in Egypt were made decorative clay tiles. We can encounter them in the architectonic edifices of Assyrians, Babylonians… Tiles were used for tiling the access to temples, palace courtyards… The later historical civilizations also produced and used the ceramic tiles: Persians, Greeks, Romans… The ceramics is in use in the countries of the Far East, India and especially China which remained remembered primarily for the use of porcelain and glazed ceramics. Throughout centuries, ceramic tiles passed through various phases, most varied motifs, treatment and laying techniques were used...

Even today the ceramic tiles occupy an important position both in the interior and the exterior. Development of the ceramic envelopes of buildings is dealt with scientist all around the world.

Remains of the earliest tiles of fired earth found on Peloponnesus, in the area of Corinth, where the tiles were produced using firing technique replaced the reed roofs. After emergence of roof tiles as a new construction product, it abruptly spread to continental Greece, to the west coast of Asia Minor, south and central Italy…

By covering buildings with roof tile, the fire resistance of buildings was increased, so roof tile, even though considerably more expensive than the reed and straw, was readily used. Mass production of roof tiles started in Holland in 14th century.

Roof tile has advantage over other types of roof coverings. With its properties: durability, shaping potential and large range of colors, it allows the architects all around the world to make their ideas come true in architectonic works of art.

It is concluded that the ceramic is one of the oldest materials in the civil engineering and architectonic construction throughout history, which occupied and still occupies a significant place as a bearing element of the structure, as a cover (roof tile), as a lining in the interior (tiles) and exterior (facades, paths, squares). By its continuous improvement of ceramic products properties, it remains competitive with other contemporary building materials.

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ARHITEKTURA I KERAMIČKI MATERIJALI, RAZVOJ KROZ VREME: KERAMIČKE PLOČICE I KERAMIČKI KROVNI POKRIVAČI

Keramičke pločice i krovni pokrivači se od davnina koriste u građenju arhitektonskih objekata. Njihova relativno jednostavna proizvodnja, kao i prihvatljiva cena koštanja doprineli su masovnoj upotrebi ovih proizvoda. U radu je dat pregled keramičkih pločica i crepova, kroz prikaz njihovog razvoja, oblika, fizičkih osobina i primene kroz istoriju u različitim podnebljima i vremenskim epohama. Cilj rada je sagledavanje značaja upotrebe i razvoja ovih proizvoda u arhitekturi.

Ključne reči: *keramički materijali, keramičke pločice, krovni pokrivač, keramoplastika*

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