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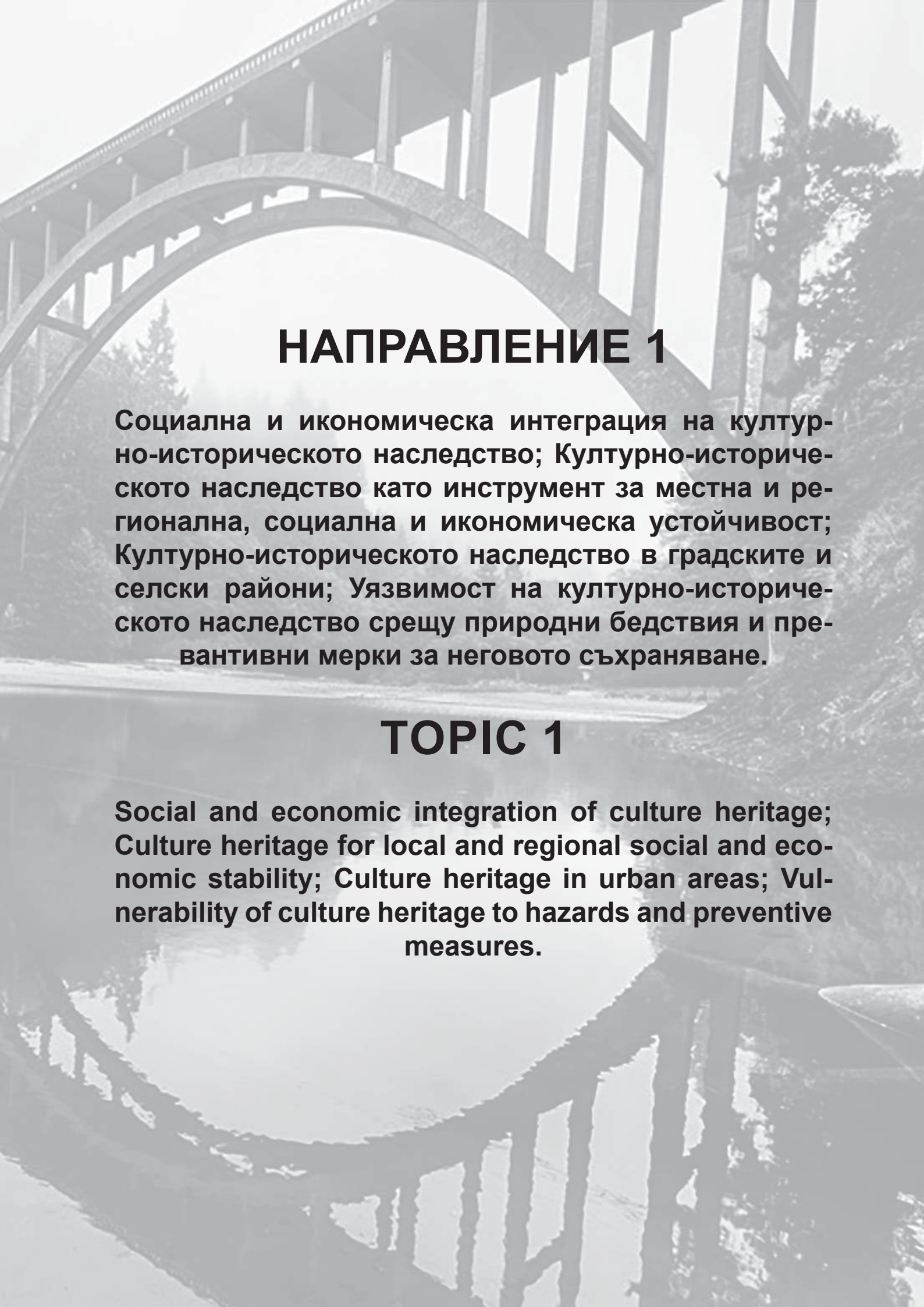
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НАПРАВЛЕНИЕ 1

Социална и икономическа интеграция на културно-историческото наследство; Културно-историческото наследство като инструмент за местна и регионална, социална и икономическа устойчивост; Културно-историческото наследство в градските и селски райони; Уязвимост на културно-историческото наследство срещу природни бедствия и превантивни мерки за неговото съхраняване.

TOPIC 1

Social and economic integration of culture heritage; Culture heritage for local and regional social and economic stability; Culture heritage in urban areas; Vulnerability of culture heritage to hazards and preventive measures.

THE QUEENSBORO BRIDGE, 1909 - 2019

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Abstract: *Queensboro Bridge is one of the four East River crossings in New York City. Its 5-span cantilever truss structure opened in 1909 and over the ensuing century has undergone several modifications. Today it carries 9 vehicular lanes and one pedestrian / bicycle lane on two levels, averaging 180 vehicles daily. The forthcoming replacement of the upper deck must accommodate the complex, and sometimes contradictory structural and logistical constraints of the structure and its essential service. The condition and capacity of the many fracture-critical details had to be determined by the most advanced non-destructive techniques available. The article describes highlights of these projects, essential to extending the useful life of the bridge into the 21st century.*

Key words: *Bridge, deck, eye-bars, grid, orthotropic, rehabilitation, ultrasonic.*

1. Introduction: design, construction, and management

The Queensboro Bridge (QB) in New York City is a five-span cantilever truss, connecting the boroughs of Manhattan and Queens with two piers in Roosevelt (formerly Blackwell) Island. In 1899 Richard S. Buck submitted a design for a 36 m wide bridge on one level. In 1903 Transportation Commissioner Gustav Lindenthal (1850 – 1935) assumed credit for modifying the design to two 20 m wide levels with 2 m wide lanes cantilevering outside the main trusses on the lower level. Figs. 1 and 2 illustrate a general view looking East and a summary of construction information.

On August 27, 1907 the Quebec cantilever truss bridge experienced the first of its two collapses during construction. Its main span, with a suspended portion between the cantilevers, was to have a record length of 550 m. There is no suspended span at the QB. Its five spans are 143 m, 361 m, 384 k, 300 m, and 140 m long, respectively. Despite the fundamental differences between the two bridges however, two investigations halted the Queensboro construction for a year. The results [1] were mostly favourable. Provisions for train and snow loads were increased. The bridge opened in 1909 with 2 subway and 4 trolley lines, 3 vehicular lanes, and 2 pedestrian walkways. The trolley service included an elevator connecting to Blackwell Island. Figure 3 illustrates consecutive traffic modifications. By 1955 all rail tracks had been removed. A proposal for light rail on the South cantilever for access to the airports did not materialize in the 1990's. That lane and

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maintenance of the preceding decades however, by then its roadways were heavily deteriorated, and major capital expenditures became necessary. The rehabilitation contracts executed on the structure since 1984 are enumerated in Table 1 [2]. The total cost adds up to an estimated total of \$1.05 to \$1.20 billion (not corrected for inflation). Two of the most recent tasks in Table 1 are briefly described herein.

Table 1. Capital improvements on QB 1984 – 2025 (cost not adjusted for inflation)

<u>QUEENSBORO BRIDGE REHABILITATION ITEMS</u>	<u>TOTAL ESTIMATED COST</u>	
<u>SCOPE OF WORK</u>	<u>YEAR MILLION \$</u>	
Repair lower outer roadways / reconstruct two ramps in lower Queens.	1984	18.80*
Reconstruct south upper roadway, replace inspection platforms, lighting.	1986	31.50*
Interim rehabilitation, repairs to lower deck and main bridge approaches.	1984	2.80*
Interim rehabilitation, repairs to lower deck, main bridge, and new median barrier.	1985	3.00*
Reconstruct north upper roadway and Queens approaches A & B, rehabilitate bearings at Queens approach.	1989	50.00*
Reconstruct ramps C & D (Queensboro only, not Thompson Avenue).	1988	10.40*
Rehabilitate bridge bearings, pier tops, and truss lower chords.	1989	18.00*
Rehabilitate Queens approach trusses, lower inner roadways on the main span and approaches.	1996	172.00*
Rehabilitate lower outer roadways main span and approaches, (bikeway) cleaning and painting.	2001	227.05*
Cleaning and painting main bridge upper trusses.	2009	168.24*
Installation of aviation lighting	2010	1.76*
Miscellaneous Items – Component Rehabilitation.	2016	43.88*
Eye-bar investigation.	2016	0.62***
Replacement of Upper Roadways	2020	150.00 - 250.00***
Seismic Retrofit.	2025	150.00 - 200.00***
TOTAL:	1,048.05 - 1,198.05	

* Complete; ** In Construction; *** In Design

As Table 1 indicates, the upper roadways were reconstructed in 1986 - 1989. They consisted of concrete filled grids, supported on the original steel stringers. During the 1990's, their wearing surfaces began delaminating, and their modular joints were malfunctioning. A new deck replacement was planned for 2020. As a first step, the condition and load-bearing capacity of the many fracture-critical elements had to be assessed accurately and realistically.

2. Non-destructive investigation of eye-bars and pins

2.1. Fabrication

The upper chords of the main trusses at the QB consist of eye-bar chains. In an innovative application for a long-span bridge, these members were fabricated of nickel steel [1], [3], [4]. That steel was about 70% stronger than carbon steel, allowing for slimmer, lighter members. The less highly stressed eye-bars in the tension diagonals are fabricated from the commonly used carbon steel. The QB is one of the few bridges where the nickel steel eye-bars were forged. On later bridges, eye-bars are cut out of flat plates.

Originally the eye-bar heads at the pins were spaced at 3 mm. Over the years, corrosion fused them together. Figure 5 illustrates a typical eye-bar configuration. Interior eye-bars and pins are entirely inaccessible for visual inspection. Moreover, visual inspections of

such fracture-critical elements are inconclusive. Hence, an in-depth investigation by the most advanced non-destructive testing system available had to be conducted.

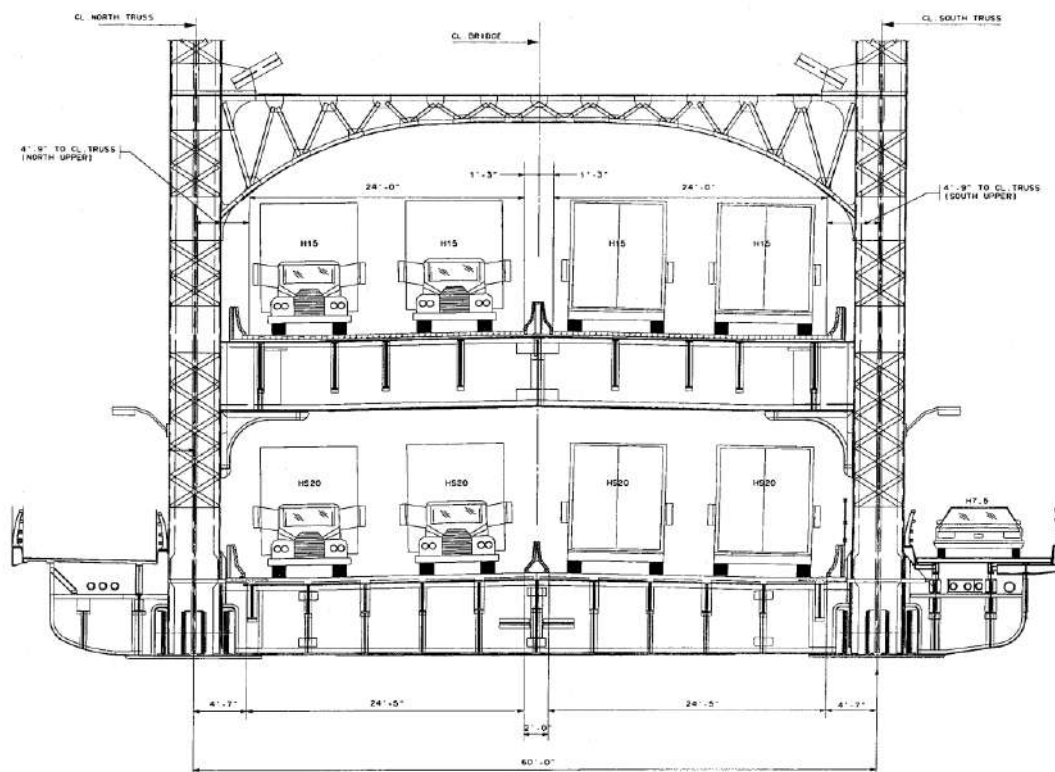


Fig. 4. QB: Typical cross section (dimensions in ft)

2.2. Ultrasonic testing

Phased-array ultrasonic testing (PA-UT) was best suited for the purpose. In PA-UT, a transducer generates a range of ultrasonic search angles. Defects are detected by an automated dynamic control of the search properties. Corrosion can be mapped. Edison Welding Institute (EWI) had developed this emerging ultrasonic technology. After a thorough selection process, NYCDOT retained EWI to perform ultrasonic testing of eye-bars and pins at eleven representative panel points on the north truss of the bridge. Critical in the selection of PA-UT was the requirement to distinguish between an “indication” of a significant defect and insignificant surface irregularities. Since the eye-bars / pin details occur at over 350 panel points along the truss upper chords, the outcome of the scanning would have to demonstrate both the capability of the PA-UT technology and the adequacy of the sample size.

The PA-UT process [5] and a typical scan result are shown schematically in Fig. 6. The transducer is placed at the outside edge of the eye-bar and the ultrasonic energy is transmitted over a range of angles into the eye-bar head. From a given position, the beams may be focused to various intensities for desired scanning resolution. By repeating the scans at regular distance intervals around the perimeter of the eye-bar head, the entire eye-bar head can be scanned. The technology is still refined, however EWI was able to show good correlation between scan results and manufactured defects in a laboratory mock-up, even locating the root and tip of some cracks in the test samples. The PA-UT could detect indications down to a minimum length of 6 mm in the laboratory.

In the pins, relevant indications were generally limited to mismatch in the 50 mm diameter bore hole down the longitudinal axis of the pin. One pin was found to have a significantly reduced diameter. Figure 5 shows a typical testing of a pin in progress.

In eye-bars, the tests found “indications” of anomalous conditions suggesting potential flaws or defects at six of the eleven locations. At one location, as many as three eye-bars showed “indications” less than 6 mm deep in the bore surface. Two pins showed signs of measurable corrosion and section loss, and one pin was reported as having a “relevant” indication, possibly a sharp notch. With very few exceptions, the “indications” found in the

eye-bars occurred at the interface between the eye-bar and pin very close to the centerline of the shaft of the eye-bar. Only three “indications” were found beyond 30 degrees from the head of the eye-bar.

2.3. Analysis and further investigation

The initial test findings pointed to a need for further investigation of those “indications”, which might be service-induced. To that end, NYCDOT directed Weidlinger Associates, Inc. (WAI) and subconsultant Lucius Pitkin, Inc. (LPI) to study the stress environment of select bridge nodes in order to assess the rate of fatigue and to determine the possible effects of stress corrosion cracking (SCC). Because of their multiplicity, not all of the truss eye-bars are strictly fracture critical, whereas all pins are. Consequently, the study included analyses to determine whether flaws would propagate and at what rate. The stresses at four panel points deemed to represent significant “indications” were investigated for possible fatigue and corrosion cracking by a testing program and analysis.

WAI analyzed the global response of the bridge using the three-dimensional SAP 2000 (Computers and Structures, Inc.) model, illustrated in Fig. 7. The model includes the entire bridge from anchor pier to anchor pier. Truss members and floor beams are modeled as frame elements. The upper and lower roadway decks are modeled as shell elements.



Fig. 5. Phased-array ultrasonic testing of a pin

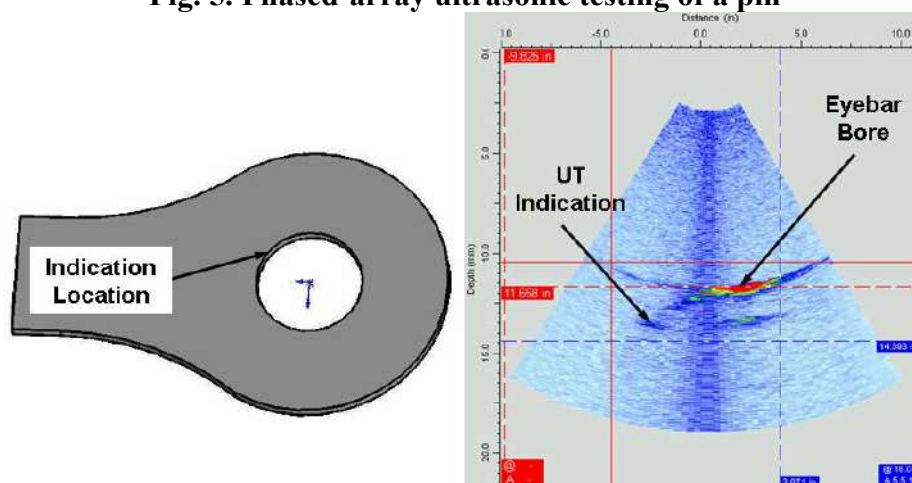


Fig. 6. PA-UT scan of an indication

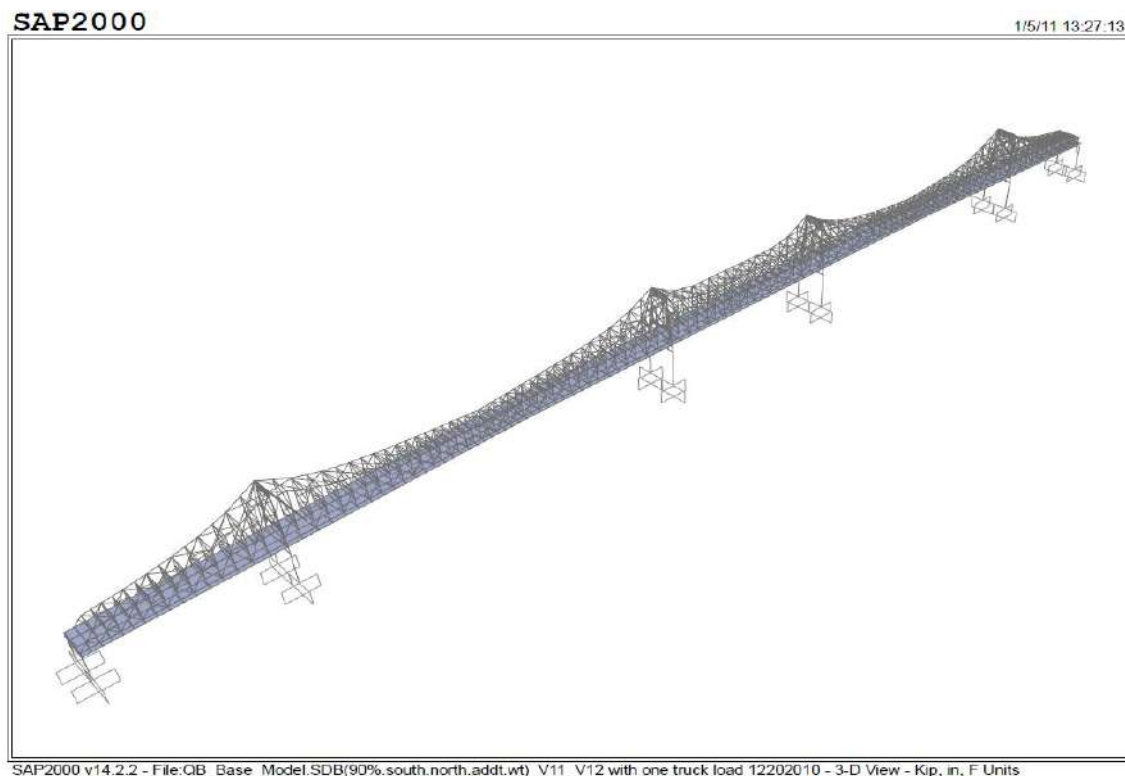


Fig. 7. Global F.E. model of QB for static / dynamic analysis

Global structural analysis was performed to estimate the forces in the eye-bars due to dead, live, wind and thermal loadings. Finite element models were used to estimate the complex stress environment within the connection as forces flow through the eye-bar shank, into the head of the eye-bar and, ultimately, into the pin. The analysis included excursions in the plastic range.

LPI performed short-term and long-term strain gage monitoring at strategic locations to record transient stresses in the eye-bars. Armed with the strain gage data and model results, LPI performed a fitness-for-service assessment and estimates the remaining fatigue and SCC life. By calculating the rate of crack growth according to fracture mechanics, LPI was able to estimate the expected useful life.

Very few gages registered peak stresses exceeding 70 kg/cm^2 . The peak stresses in the eye-bars were compared to the stress levels predicted in the SAP 2000 global model for the AASHTO fatigue loading combination. Low as they were, the measured transient stresses were higher than the model predicted. In some cases, they exceeded 3-fold the AASHTO value. WAI has observed similar results in previous studies where strain gage measurements on the floor system of a suspension bridge indicated that the regular truck traffic was considerably heavier than the AASHTO fatigue truck.

The fatigue life of the investigated critical elements was estimated based on the findings. Further investigations during subsequent projects were recommended, but no immediate remedial measures were deemed necessary. The results supplied the stress level and load-bearing capacity information needed for the design of the forthcoming upper deck replacement and the seismic retrofit.

3. Upper level deck replacement

3.1. Deck alternatives

The new upper deck would have to be lighter, allow staged installation, and provide a minimum service life of 40 years. WAI developed the following four conceptual deck alternatives [6]:

Alternative 1: A full depth grid deck with half-filled light weight concrete and thin wearing surface, along with new lighter supporting steel stringers.

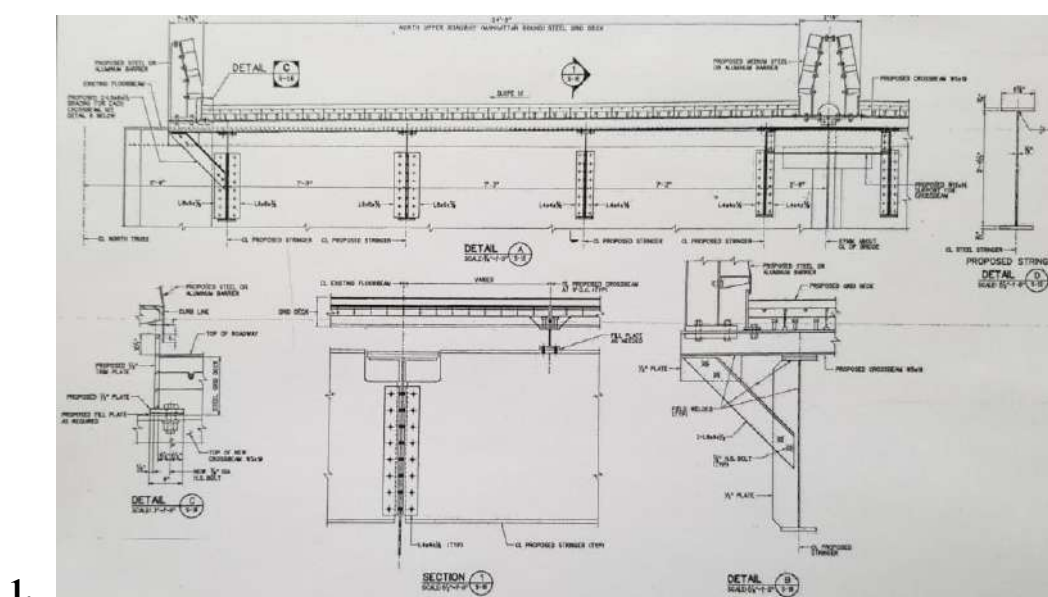
Alternative 2: An open rib steel orthotropic deck with thin wearing surface, along with removal of existing steel stringers in selected locations in cantilever and anchor spans.

Alternative 3: An aluminium isotropic deck with thin wearing surface, along with new lighter supporting steel stringers.

Alternative 4: Replace in-kind the steel grid with full depth light weight concrete fill and thin wearing surface.

Alternatives 1, 2, and 3 are shown in Fig. 8. All the four conceptual alternatives exceed the minimum desired service life criteria. Alternative 1 has a projected service life of over 50 years period. Alternatives 2 and 3 provide an expected 75 years of life. Alternative 4 is estimated to have an expected life of approximately 40 years. The estimated construction costs for all four alternatives are reasonably close, with Alternative 1 being the most expensive. The life cycle costs for Alternatives 2 and 3 are about 20% lower than that of Alternative 1, primarily due to their longer service life. Alternative 2 – the orthotropic deck system, provides the most beneficial life cycle cost. Alternative 4 provides the least expensive deck but has the highest life cycle costs, primarily since it has the shortest service life.

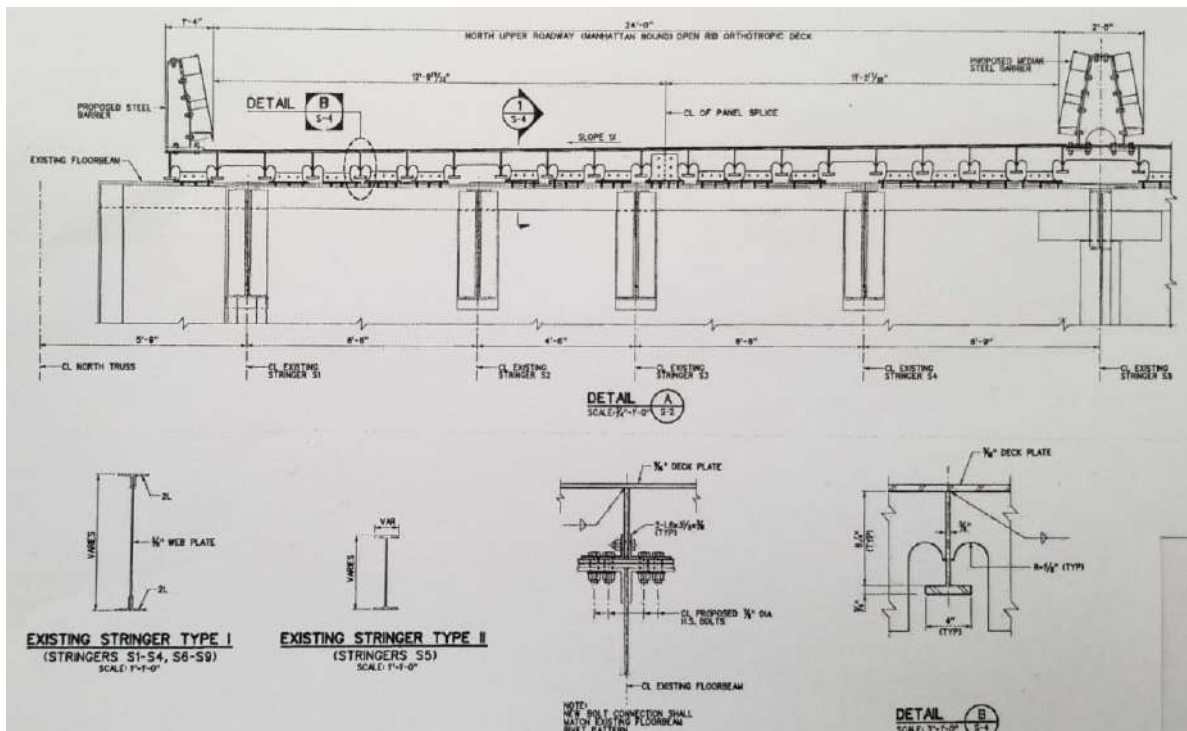
Among Alternatives 1 to 3, Alternative 1 reduces the dead load the least, by 0.74 t/m. Alternative 2 reduces dead load by about 1.6 t/m at locations where existing stringers will be removed, and provides almost no reduction elsewhere. Alternative 3 reduces the dead load most significantly, by 3.1 t/m, throughout the length of the main bridge. Furthermore, Alternative 3 can reduce tensions due to dead load by about 8% in top chords, and by 7% in diagonals. Alternative 2 reduces the same by 4% and 2%, respectively. Although the service life of eye-bars in the top chords and diagonals cannot be quantified at this time, the reduction in dead load tension should increase their service life, especially if the lower roadway grid deck is also replaced with a lighter deck in future contracts. Alternative 3 has the shortest construction duration, as it provides the simplest erection procedure. It also requires minimum maintenance since aluminium material does not require painting for corrosion protection. However, the aluminium deck is a proprietary system which may require a waiver for federal funding.



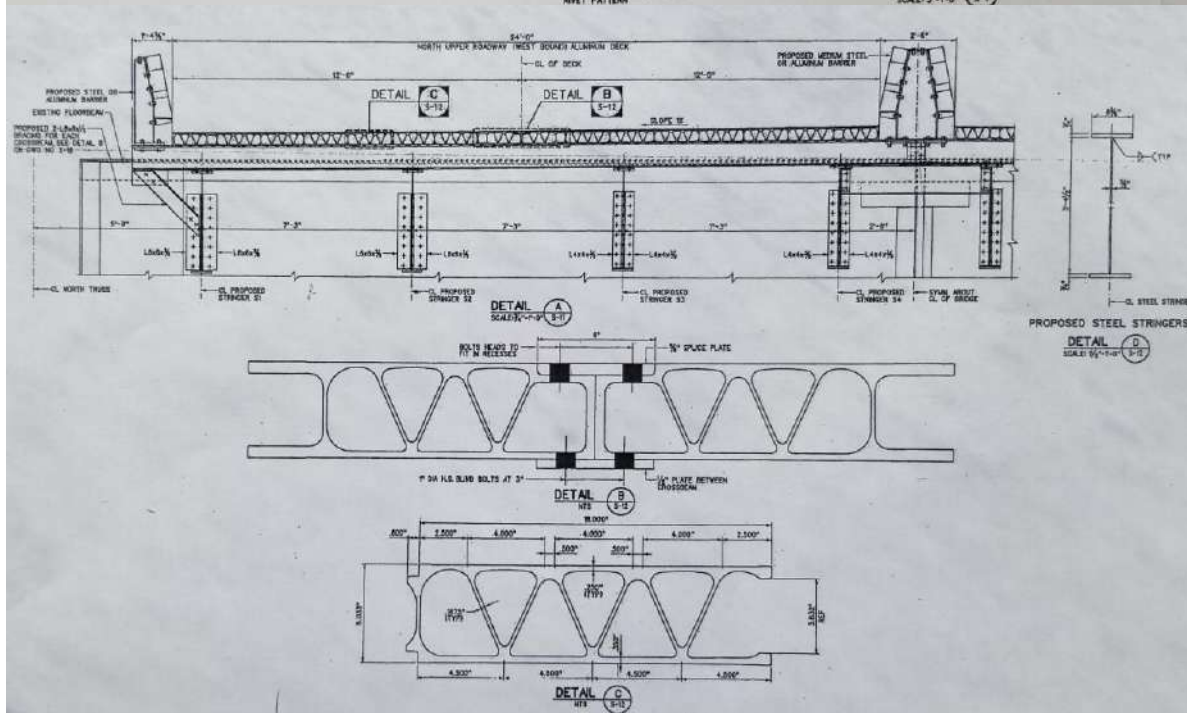
1.

Figs. 8. Replacement alternatives: 1. Steel grid with overlay

2.



3.



Figs. 8. Replacement alternatives:

2. Open rib steel orthotropic deck; 3. Aluminium deck

3.2. Recommendation

The four deck alternatives were evaluated based on the following criteria:

- Estimated construction and life cycle cost including fabrication, installation, floor system modifications and related incidental work such as deck joints & overlays in the main spans.
- The weight reduction associated with each new deck systems (including deck, overlay, crossbeams, stringers, and barriers) will improve load rating of trusses and alleviate high local stresses in eye-bars.

- Expected performance including reliability/risks of the deck systems and maintenance considerations.

The total estimated costs associated with the four Alternatives are summarized in Table 2.

Table 2. Cost estimates and construction schedule for the 4 alternatives (\$ in millions)

Option	Main Bridge	Approaches	Total Cost (2018) Closed Lanes		Deck, Support Struct. Removal	Contin. Closure Months Lanes		Project Duration Months Lanes	
			2	1		2	1	2	1
1	Grid Deck with Overfill & Stringer Replacement	Replace in Kind	233	273	84	16	26	32	44
		Repair (Overfill & Joint Rep.)	186	217	63	12	20	28	36
2	Steel orthotropic Deck & Remove Stringers in Select Spans	Replace in Kind	220	259	75	16	26	32	44
		Repair (Overfill & Joint Rep.)	173	204	55	12	20	28	36
		Replace Orthotropic deck	225	264	79	16	26	32	44
3	Aluminium Deck & Stringer Replacement	Replace in Kind	233	271	86	14	24	30	42
		Repair (Overfill & Joint Rep.)	186	215	66	11	18	26	33
4	Grid Deck Replacement in Kind & Maintain Exist. Floor System	Replace in Kind	201	240	64	14	24	30	42
		Repair (Overfill & Joint Rep.)	159	190	44	12	20	28	36

The steel orthotropic deck system (Alternative 2) is recommended. Included is the removal of stringers in approximately 40 spans. The dead loads of the bridge and hence, the forces in the existing overloaded truss members are reduced. The aluminium deck reduces the weight more effectively, however, it is not recommended, due to the lack of comprehensive design guidelines and long-term records of performance on comparable long-span bridges. Maintenance and repair information is almost entirely lacking.

The existing grid decks in the approach spans and ramps will be repaired in this contract to extend their service life until available funding is in place to replace them in the future. The deteriorated and failed concrete overfill and deck joints will be replaced.

In general, V or U shaped closed rib orthotropic decks are torsionally stiffer than open rib decks, leading to more effective lateral distribution of wheel loads. However, their fabrication requires technology and facilities not commonly available in the U.S. and the costs are significantly higher than for the open rib option. Despite its poor torsional stiffness, the open rib deck has the advantage of relatively easy fabrication by many

domestic manufacturers. It is taken into account that the deck carries mostly cars and sporadic buses.

The open rib deck fits best the existing geometry and has a simpler transverse diaphragm design (Fig. 8 – 2.). The bolted connections will utilize existing rivet holes. The open rib deck offers the same capability as the closed rib system and provides more flexibility to keep the deck depth shallow over the floorbeams. The critical vertical clearance could be compromised with a closed rib configuration.

The dead loads of the proposed deck alternatives were input into the finite element model (Fig. 7). All 4 proposed decks reduce the total number of overstressed truss members. Of the 65 over-stressed members per truss in the existing condition, the partially filled grid deck, the steel orthotropic, and the aluminium option eliminate 20, 36, and 54 members, respectively. The steel orthotropic and the aluminium options offer more substantive reductions in overstressed members than the grid deck option. The aluminium deck results in 11 members with some overstress, although only one member per truss would have a Demand / Capacity ratio $D/C > 1.05$. No alternative eliminates overstress completely, because the deck of the upper roadway accounts for less than 9% of the superstructure weight of the bridge. Consequently, a 50% reduction of the upper deck weight reduces the dead load at the trusses by only 4.5%. To fully relieve the trusses from overload, a future rehabilitation contract should replace the lower deck with a light-weight alternative.

3.3. Deck overlay alternatives

Only thin overlays are considered in order to minimize the weight of the deck and to maximize the travel clearance above the wearing surface. Polyester polymer concrete and epoxy asphalt concrete are not considered due to their greater thickness and weight. Four thin overlay products are considered:

A. Micro-Surfacing; B. Bridgemaster; C. Flexogrid; D. Flexolith

A. Micro-Surfacing

Micro Surfacing is a proportioned mixture of polymer modified emulsified asphalt, mineral aggregates, mineral fibre, and other additives. This system was installed on the grid decks of the Brooklyn Bridge in 2000, and was replaced in 2007 after some delamination occurred. It was also used on the North Upper, South Upper and Lower Roadways of Manhattan Bridge. On Manhattan Bridge the performance has been good, except on the South Upper Roadway where it was placed over a spray-on waterproofing membrane. Combining micro-surfacing and spray-on waterproofing membrane is not recommended. Overall, Micro-surfacing has performed well, however not particularly on steel orthotropic decks.

B. Bridgemaster

Bridgemaster is a fast curing, Methyl Methacrylate (MMA) resin-based screed combined with an aggregate over scatter and sealer. It has curing time of less than one hour to a dry surface restoring service at temperature below 32°F. Moreover, damage can be easily repaired throughout the life of the structure. At the Bronx-Whitestone Bridge Bridgemaster replaced the deteriorated Flexogrid in 2012, and at the RFK Triboro Bridge it replaced the deteriorated T-48 in 2011. The Triboro Bridge and Tunnel Authority (TBTA) reports good performance on both bridges.

C. Flexogrid

Flexogrid is a thin, impervious polymer overlay consisting of copolymer, formed by an epoxy and a urethane molecule. The urethane molecule keeps the copolymer flexible at low temperatures, resulting in better fatigue performance. The system is installed in two layers manually or by machine. Flexogrid was installed on the Bronx-Whitestone Bridge in 2005. There were areas of widespread cracking, delamination, and loss of aggregates. Moreover, the material seems porous. In 2012, it was replaced by Bridgemaster.

D. Flexolith

Flexolith is a low modulus, moisture insensitive, thermoset epoxy binder, combined with aggregates over scatter and sealer. It is normally used for rapid strength development, low temperature applications, and increased skid resistance of concrete and steel decks. It is on the polymer material approval list of NYSDOT, presumably after passing laboratory and field tests.

3.4. Recommendation

Bridgemaster overlay system is recommended for the steel orthotropic and concrete-filled grid decks, due to its good performance on similar decks in the New York City area. Flexolith overlay system is recommended for the aluminium decks, since it has performed well on them.

4. Conclusion

Managing a critically important heavily used vehicular bridge in a major metropolis after 110 years of service presents many unique challenges. Every such structure has specific needs and accommodates highly particular communities. The condition and operation of the Queensboro Bridge (recently re-named after the former Mayor of New York City, the late Ed Koch), has received, and will continue to receive continuous attention by the managing engineers. The projects reported herein are steps in this perpetual process. As such, they are advancing the state of the art in two critical areas: Non-Destructive Structural Testing & Evaluation (NDT&E) and bridge rehabilitation with minimal service interruption. Conclusions are never final, but some are forming so far.

The Phased-array Ultrasonic Testing (PA-UT) is a powerful NDT technique, requiring highly specialized expertise. To the extent possible, it must be accompanied by alternative corroborating methods and by thorough analytic evaluation. Short-term monitoring invariably falls short of satisfying all expectations. Sampling of test locations at a large bridge presents particular difficulties, because the measurement method and the measured conditions combine to different degrees the uncertainties attributable to randomness, ignorance, vagueness, and locally induced systematic errors. Thus, any such investigations must plan for adjustments along the way. Deliverables typically include recommendations for future (improved) measurements. The information gained in the NDT&E project was essential in the design for the replacement of the bridge upper deck.

Before the final selection, NYCDOT directed a Value Engineering (VE) team, consisting of experts from different consulting firms to evaluate alternatives 1, 2, and 3, and propose possible improvements in the following areas: bridge and deck durability and maintainability, constructability, construction impact, riding quality, cost, and schedule. The VE [7] team presented numerous ideas in the following alphabetically ordered groups: extend life; join sections, manage traffic, match profiles, prevent corrosion, reduce weight, stage construction, support drainage. The team confirmed the cost estimates. It revisited the grid options, including an open grid, and one half-filled with lightweight concrete, and a closed rib orthotropic deck, fabricated in the U.S., as well as repairing, rather than replacing the approaches. Many recommendations addressed construction scheduling and traffic management.

NYCDOT is taking into account the VE recommendations, and proceeding with Alternative 2 of the original proposal. The steel orthotropic deck alternative provides a long service life expectancy of more than 75 years. The alternative comparison shows also that the orthotropic deck is the preferred alternative resulting from the life cycle cost evaluation. It provides a smoother riding surface durable against de-icing salts. Welding of the deck panels allows for minimal joints reducing risk of water leakage and potential

under deck steel deterioration in comparison to the other alternatives especially the grid deck that requires concrete closure pours.

Overall, the steel orthotropic deck alternative offers the most competitive replacement deck scheme. However, this comparison does not intend to discredit the aluminium deck or the grid deck options since they are both proven deck systems and have comparable construction costs, and individual benefits noted within this report.

The alternative selection demonstrates again that spending a quarter of a billion dollars on a bridge upgrade with and expected life expected to exceeding half a century cannot be optimized rigorously by a numerical algorithm. The factors influencing the decision include material properties, some exactly measured, others estimated; the structural response based on field measurements and analytic models; fabrication and construction costs depending on variable economy and skills; and finally, the intangible costs to the users. Many experts in numerous private entities and the public sector, along with input from the community contribute in order to arrive at a final choice, which will ultimately be the base line for further life-extension bridge management decisions.

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NEW RATING OF SHELTER ON ARCHEOLOGICAL SITE MEDIANA NEAR NIS AFTER STRUCTURAL CHANGES

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Abstract: *Mediana is an important archaeological site from the late Roman period, located in the eastern suburbs of Nis. Protection of archaeological findings is a continuous process aimed at preventing devastation of historic monuments, creating conditions for work on their conservation and a kind of museum "in situ".*

The authors of this paper proposed basic elements for continuous monitoring and an appropriate method for assessing the effectiveness of existing protective constructions and assessing changed conditions at the site itself (effects of the water in different aggregate conditions, instability of micro-climatic conditions, temperature, humidity and lightening, and biological effects). According to this methodology, they have carried out a continual multi-year monitoring of the Mediana shelter, and the results obtained are presented in this paper.

The aim of this paper is to initiate "shelter management system" on archaeological sites and to form objective databases as well as to point to the necessary conditions for applying the proposed method for estimation of the shelter success effects on the archeological findings.

Key words: *Shelters monitoring, Methods of assessment, Shelter Management System*

1. Introduction

The Roman Nais, today's Nis, is located at the intersection of European roads, where many civilizations was confronted in the distant past, which made it an exceptional place of strategic and military-political significance.

Mediana is an important archeological site from the late Roman period, located in the eastern suburb of the Nis. It represents a luxurious residence with a highly organised economy. The residence dates to the reign of Constantine the Great 306 to 337AD. Excavations have revealed a villa with peristyle, thermae, granary and water tower. Although Roman artifacts can be found scattered all over the area of present-day Nis, Mediana represents the best-preserved part of Roman Naissus. In 1979, Mediana was added to the Archaeological Sites of Exceptional Importance list, protected by Republic of Serbia.

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Constantine the Great (280–337) was born and raised in Naissus. He erected a majestic residence in one of the luxurious suburbs of ancient Naissus, where he often resided and attended to state affairs. After Constantine's death in 337, the imperial residence in Mediana was used by several other emperors, either as a place of rest on their long journeys or during preparations for war. Thus, Constantine's sons, Constantius II and Constans, stayed in Naissus in the winter of 340, for they signed an edict there.

In 364 AD, Imperial Villa Mediana was the site where emperors Valentinian and Valens met and divided the Roman Empire and ruled as co-emperors [1]. The residence was abandoned after the city of Naissus was devastated by Attila's hordes in 442.

The residence was erected on flat terrain, on an area which covers over 400,000 square metres, on a high bank, some distance from the river, at the foot of the hills which frame the Nišava Valley, near a thermal water source. There was a street in the east-west direction which passed on the south side of the villa with peristyle and the granary located 150 metres from it. From this street it was possible to approach these buildings. The central area was occupied by the villa with its open peristyle, nymphaeum and thermae; to the west of the villa was the granary, and somewhat to the north a spacious building with octagonal and circular rooms. To the south of the villa are the remains of several villas and functional service structures. What strikes the eye is that the luxurious buildings of solid material with columns, decorated with marble facing, mosaics and frescoes, are concentrated mainly around the central villa and its peristyle, while the economic buildings are located to the west of the granary towards Naissus.

The villa comprises an area of about 6.000 m² (98,6 x 63 m) and included thermae on the west side and a smaller nymphaeum on the east side. The villa was luxuriously decorated, to which testify the marble columns, basis and capitals of different sizes, reliefs on pilaster capitals and parapet slabs, the remains of wall covering of expensive, multicoloured marble, frescoes, etc. The mosaic floors that covered the whole of the peristyle porch (450 m²) and the audience room have been well preserved.

The thermae of Mediana were probably used by the owners of the villa, who could reach them directly from their rooms. The corridor on the way to the baths is decorated by floor mosaics, with geometric patterns of the same quality as the mosaics in the peristyle.

The Granary (horreum) is located about 150 metres west of the villa. This is a spacious rectangular building (91 x 27 m), with the longitudinal axis oriented east-west. Along the west wall there were basins 1.40 m deep, which served for storing liquids, (olive oil and wine).

A water tower (castellum aquae) was ordinarily found at the end of each Roman aqueduct. Water was supplied from this reservoir to the wells and fountains, basins, thermae and maybe the irrigation canals. Its longitudinal axis is oriented north-south.

Two Early Christian churches have been excavated, both built simultaneously sometime after 378. The first church was unearthed in 2000, when a monogram of Jesus was found. Only 8 metres south of the first, a second church was excavated in 2007, among the findings was a bronze ring with a cross. The findings are evidence of Mediana being a highly Christian community.

2. Mediana Shelters

Archaeological sites in the world covered with modern structures which offer protection for the sites from the influence of the sun, rain, wind and snow, and at the same time offer protection for the visitors as well. In our profession these structures are known as “shelters”.

After systematic and detailed research of the Mediana site, during 1932 and 1933, numerous and valuable findings pointed to the need to continue digging at this locality during the summer of 1934, when parts of Roman bath and several important and valuable

objects were discovered. Persistence, dedication and research passion led in 1935 to the exceptional discovery of the Roman building with an excellent preserved floor mosaic. Knowing its significance and value, as well as the fact that it is necessary to permanently protect the found mosaic before the coming winter, the first protective structure was build - Museum building, which will become a recognizable symbol of Mediana and the city of Nis (Figure 1).



Fig. 1. First Mediana shelter: a) look; b) additional graphic perspective

The architectural form of the building, as a Roman temple, was done by Vladimir Hodanovic, artist and engineer of the Moravian Banque Administration, and the building was constructed by the end of 1935.[2]. Thus, the hardest and most important part of the work has been successfully realized so that the mosaic is protected before winter. Final works on the building and landscaping of the surrounding terrain were completed in the first half of 1936, and the ceremonial opening of the Museum on Mediana was held on Vidovdan on June 28, 1936. years. This is the first protective structure built in our country.

New Mediana shelter (Figure 2a) begun erected in 2013, as yet incomplete. The excavation of the foundations (Figure 2b and 2c) was done in September and October, and their concreting in November of the same year (Figure 3a).



Fig. 2. New Mediana shelter: a) look; b) and c) Excavations for foundations

The construction of the timber frame was done in September and October 2014 (Figure 3b and 3c) and the covering was done in April 2015 (Figure 4a).



Fig. 3. New Mediana shelter in construction

Krajem 2018 i početkom 2019. godine završeni su radovi na montaži i pokrivanju nedostajućih čeonih strana Mediana shelter (Figure 4b and c).



Fig. 4. New Mediana shelter: a) covering progress ; b) look; c) Inside look

The more information about the new shelter is given in the Table 1 - Basic Identification card of Mediana.

Table 1. Basic Identification card of Mediana -Villa with a peristyle

SITES	<u>Archaeological site</u> Mediana near Nis, Serbia	 Photo 1. Inside look 2017.
	<u>Characteristics of the site</u> The ancient settlement erected in the vicinity of Niš mentioned for the first time in the 4 th century has been decreed an immovable cultural goods of exceptional importance. It flourished in the time of the emperor Constantine the Great. The settlement is known for its residential objects, and includes thermae, as well as accompanying facilities including barracks, servants' quarters ...	
	<u>The identification of archaeological remains</u> The most important object on the location of Mediana is the Villa with a peristyle, which was mostly covered with a protective structure in 2014.	 Photo 2. External view 2015-2019.
	<u>Period</u> The end of the 3 rd and beginning of the 4 th century A.D.	
ARCHAEOLOGICAL	<u>Excavation and conservation work</u> The first registered data on the remains of the mosaic and the buildings date back from Felix Kanitz from the end of the 19 th century, while the first systematic excavations began in the 1930s. The systematic excavations continued in 1959, 1979, 2011, and were completed in 2015.	 Photo 3. Overlap the two structures ("old" and "new")
PROTECTIVE	<u>Type</u> Shelter – Hybrid protective structure Erected over the archaeological remains. <u>Architect / Construction company</u> Mile Veljković, A&E /Institute for the protection of cultural monuments Nis (architectural phase), Dragan Zlatkov, MSc., /ProjektInženjering Niš	

PROTECTIVE STRUCTURE	<u>Year erected</u> Begun in 2013, as yet incomplete	<u>Range and covered surface</u> L=72,5m, P=10.000m ²
	<u>Function and purpose</u> Protection from atmospheric influences (sun, rain, snow). Work on the conservation of the mosaic, presentation to the public.	
	<u>Principles and project tasks</u> The project task is based on the idea of implementing very shallow arch constructions made of plywood with a cover made of textile membranes, with open sides to allow natural ventilation.	
	<u>Construction system and material</u> A shallow arch system with a range of 72,5m with arches each at a distance of e=5m, b/h=18/150cm Plywood with segments bound with metal connectors at each third of the range. A cover with a polyester membrane with PVC protective layers d=1mm. The north and south dome-like parts are not completed, have not been covered. The construction is bound with semi-arches in the northern part by means of metal connectors along the first arch.	
	<u>Project requirements for the control of microclimatic parameters</u> No data.	
	<u>Monitoring internal / external microclimatic parameters</u> The pilot project of the Central Institute for Conservation from Belgrade from July 2016 has been monitoring the temperature and humidity of the soil via a probe located immediately beneath the mosaic in the north-west part of the Villa.	
	<u>The problems of conservation and possible causes</u> The National Institute for the Protection of Cultural Monuments does not allow the mosaics to be put on display until the necessary conditions for it have been met: the relocation of ventilation openings from which water often drips onto the mosaics in the peristyle of the Villa, covering the northern part of the cupola and its frontal northern façade, which allows the protection of the mosaics in the festival hall and side feast halls, and the prevention of the penetration of atmospheric conditions by constructing a side north-west wall. By inspecting the influences, detrimental effects were noted (of the wind, water dripping from the ventilation openings and condensation from the membrane and metal parts of the construction, as well as snow build-up and the penetration of snow and rain from the sides and from the front). The cited detrimental influences must be dealt with in order to prevent the devastation of the mosaics and frescos in order for them to be made available to the public. Until the completion of the structure, the mosaics will remain covered by sand.	
	<u>Modification of the protective structure to lessen the problem</u> No modification is planned but it is necessary to prevent vapour condensation on inner side of membrane	

3. The proposed method of evaluation of shelters

Archaeological sites which are protected with shelters differ from one another and even date back from paleolithic to byzantine archaeological remains, ranging from earthen structures, to the remains of walls made of clay and rock, to mosaics which predominate (from the Ancient Greek, Roman and the Byzantine period). The trend of the presentation of mosaics developed intensely during the 1990s with the primary aim of presenting the all-encompassing architectural-engineering context and the authentic artistic aims of that time [3]. At the beginning of the new millennium, intense work was done on the development of protective strategies of architectural sites and on the erection of shelters above them.

A shelter on an architectural site represents a structure which is meant to satisfy the basic, but also the complex requirements of the conservation of the architectural remains,

their interpretation and presentation "in situ". Considering that we are dealing with mutually contradictory project conditions, the complexity of the set task is clear.

The basic relevant conditions which the protective structures are meant to satisfy are primarily their adhering to the characteristics of the site itself (the historical period of the archaeological remains, the characteristics of the material and the structure which should be protected, the optimum microclimatic conditions for working on the conservation and preservation of the archaeological remains), the geo-morphological characteristics in the vicinity of the site (the relief, the vegetation, proximity of any rivers/seas/lakes), the concept of the presentation of the sites to a wider audience (education, scientific research, tourists, marketing), the life span of the protective structure. These structures are meant to satisfy the strict requirements for the protection of archaeological sites from destructive meteorological influences for a period of several years.

The proposed method includes all the parameters which define archaeological sites with protective structures, as well as their status, and includes all the basic items in the database, as well as the factors of the increased spectrum of the contamination of the environment and the noted shortcomings.

The method classifies two different groups of elements which are being evaluated. The first group is made up of elements of the protective structure, the existence and efficacy of the drainage systems (the roof, surface and drainage of the sites), the efficacy of the insulation, the type and appropriateness of the ventilation system. The elements of these groups are quantified with an appropriate grade from a three-level scale, and if there are none or if they are superfluous they are given the grade 0. The state of the construction material of protective structures is evaluated on a five-level scale (in good shape, exposed, threatened, damaged or ruined as a result of age). In addition, in the first group we evaluate whether there is any superfluous humidity within the protective structure and what the sources of this increase in humidity are, as well as if the climate is stable in the protective structure.

What is evaluated is whether the protective structure is damaged from the influence of birds, insects (wasps, spiders, rodents (mice, rats, badgers), people, microbiological vegetation (algae, mold, lichen, moss) and vegetation (grass, and other woody plants).

We also evaluate whether there is any monitoring of the protective effects of the structure by monitoring the internal environment, external surroundings, giving an evaluation of the state of the archaeological remains and a comparison of the current state with the one on historical (earlier) photographs, as well as measuring humidity and the temperature of the air and soil.

These influences are evaluated on a five-tiered scale (never, rarely, sometimes, very often and always). In addition, a five-level scale is used to evaluate the efficacy of the protective structure in the protection of archaeological remains and of mitigating the risks in the surrounding environment.).

The other group of elements which are evaluated include the state of the archaeological remains located underneath the protective structure. What the archaeological remains underneath the protective closed structure are and what their frequency is can be quantified by the factor of frequency based on the percentage of the prevalence of mosaics, frescos, cement, stone, clay (blocks, bricks) and crumbling of the structures on the site. The state of the covered remains - ruins is evaluated on a five-level scale (in good condition, exposed, threatened, damaged and ruined). For mosaics, frescos and the other structures the phenomenon of deterioration and the severity of the aggravated state is evaluated on a five-level scale (very serious, serious, moderately serious, mild deterioration and very mild deterioration, and if there is none the awarded grade is 0).

Visual evaluations are used to identify the damage, and based on the determined state an inspection is then used to evaluate state which is entered into the formed database. The

evaluation of the state describes the severity and extent of the damage. Each of the cited described evaluations was quantified by means of an appropriate numerical value. Based on that we can calculate the *Site Health Index*, which represents the basis for the development of a *Shelter management system*, and thus the application of stochastic and other methods [4] used to predict future states.

Inspections are performed every 2 years, even though in some cases evaluations may be needed over shorter periods of time. For newly constructed objects, the interval between the initial commission and the first inspection can even be up to 5 years.

The inspection data such as the class of the state, the recommended intervention, the extent of the damage, details of individual cases of damage are compiled for each level of the hierarchy, and the inspection report is generated for all the examinations.

The prognosis of the deterioration of the state is calculated within probability theory with the help of Markov chains [4], which are defined for every type of element and type of damage. For each damage of a certain type, a catalog predicts an appropriate intervention. Standard interventions are predefined based on the evaluation of the state and process of damage (replacement, renewal, repair, etc.). The program provides recommendations for whether it is necessary to carry out certain interventions, or whether no measures should be taken. In addition, the owner should of his own volition decide at which level of the hierarchy certain standard interventions should be implemented, which is the basis for the formation and development of the *Shelter management system*. Based on the proposed method, the first calculated *Mediana Health Index* is 155, after covering 2015. The first inspection as part of an ongoing multi-year monitoring was done by authors of this paper at April 25th, 2017. Calculated *Mediana Health Index* was 157. Last inspection was done at September 16th 2019. Recalculated *Mediana Health Index* increased to 169. Despite the improvement of the protective structure properties with the completion and covering of the front sides of the shelter, deterioration of the condition of the laminated wood main beams (figures 5a and 5b) was observed, as well as the degradation of the roof cover membrane received worse grades, which led to an increase in *Mediana Health Index* (the higher the HI value, the worse the shelter properties).

It should be noted that there has been an increase of only partial HI construction, while the partial HI archaeological site has remained unchanged since the mosaics preserved and covered with a protective film and a thick layer of sand. The aim of the paper is to evaluate the implemented method for the evaluation of the efficacy of the shelter for a specific object.



Fig. 4. Degradation of the main girders

4. Conclusion

Based on the proposed method, database formed in 2017th was upgraded in 2019. Discovering of the monitoring project on the Mediana archaeological site indicate partial deterioration of the shelter structural elements, while the state of the historical remains is unchanged because they are covered and inaccessible to visitors and adverse impacts. By remodeling the existing protective structure in Mediana can prevent formation of condensation on the interior surface of the roof membrane which is the main adverse impact. If the conditions for achieving dew point been eliminated next inspection results will decrease *Overall Health Index* to open Medana site in full capacity.

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SOME NEW EXPERIENCES IN BUILT HERITAGE RESTORATION

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Abstract: *In the last few decades, the restoration of the built heritage has undergone significant changes due to the new opportunities provided by new principles, methods, materials and technologies. At the same time, the use of traditional restoration materials has been significantly improved and is now available in more creative ways. It is now insisting on a clear, but subtle distinction between the old, original and new elements of the building. That is very difficult to achieve. In order to overcome this problem and to ensure that adding materials and applied technologies would act as integral parts of the restored building in each, even aesthetical way, and the conservators started with the application of new and old materials and technologies not only to ensure stability of the old buildings, but also to express new aesthetics in restoration process. There are many examples of applying new principles and new methods that are not so conspicuous and do not diminish the dominant shape of the to-day state in which the architectural monument existed before restoration. The paper examines the applicability of new and old materials and technologies for stabilization and historic buildings appearance and assesses the results of this concept in terms of architectural compatibility, reversibility and aesthetics.*

Key words: *Built heritage, New materials, Conservation, Restoration, Extensions.*

1. Introduction

In all areas of work, including certainly work on cultural monuments, the question arises from which of their past we begin to consider the problem. Is it a total past, or is it a past of cultural monuments that we find today when we begin to deal with it? The reason for this question is the evolution of restoration concepts that has left a mark on the legacy that we find today in a particular physical state. Here we can recall some of the most influential views.

Starting with E. Viollet-le-Duc (1814-1879), learning about the structures and researching old texts and construction documents were of great importance. During the first half of the 20th century, different attitudes towards new materials and their uses emerged. C. Boito (1836-1914) believed that modern materials and modern techniques should be used to a minimum. G. Govanonni (1873-1947) was of the opinion that modern techniques, especially the use of reinforced concrete, should be used where traditional methods and materials are not sufficiently reliable. A. Evans (1851-1941), who canned the palace in Knossos, used concrete in large quantities and thus significantly influenced the increased use of this material by other conservators. N. Balanos (1860-1942) accepted reinforced concrete, considering it a useful, solid and durable tool for the restoration of most important Greek architectural monuments. These views were merely a preparation for final acceptance and recommendation for the use of all available modern techniques and materials, especially reinforced concrete, as concluded in the Athens Charter in 1931.

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The most important document adopted after the World War II, the 1964 Venice Charter, recommends the use of traditional materials for structural stabilization and general restoration. New materials and techniques should be used only in cases where traditional materials cannot be applied. The 1989 Italian Restoration Charter showed distrust in the use of new, mostly hidden, materials such as steel, grouting with cement mortar or various resins, and concrete [1]. They indicate their limited durability, incompatibility with original materials, and therefore the commitment to traditional materials that are easier to control and change can be emphasized. Today it does not raise the question of uses new materials and technologies. They have become indispensable, because their composition and method of application is such that it can fulfill the basic principles of protection of the built heritage [12].

2. Some new experiences in built heritage restoration

Certain conservators still believe that it is best to use original materials, which means traditional wood, stone and brick (as well as iron and glass in original processing). However, when analyzing the processes of work on such treated buildings, it is almost certain that at least one part of the jobs in which materials and techniques have been applied will always be found. It should be emphasized that, in addition to new materials, traditional materials that are technologically innovated and preventively protected are nowadays also included in the work process and should be accepted as a specific form of new experience in conservation and restoration of the built heritage.

New materials and technologies are being applied in several of the most significant processes of conservation and restoration work such as:

- structural stabilization of the historic building or its remains;
- architectural conservation, restoration and reconstruction;
- during major interventions on the whole cultural monument or on extensions they are most often needed due to a new functions or the incorporation of smaller historic units within most new complexes of buildings [18].

The limited length text does not allow to specify all new materials and technologies that are being applied today in the protection of cultural heritage. One can only point to materials and procedures that today produce good results by meeting three basic technical protection criteria:

- **minimal intervention:** means that the expressive qualities of the building and environment resulting from its original form and all other significant changes that have followed over time must not be destroyed by new works on heritage.
- **compatibility:** means that the characteristics of the materials used in the conservation and restoration work, especially new materials, must be harmonized with existing materials. Compatibility must be checked over a long-time period to avoid undesirable side effects.
- **reversibility:** means that all applied works can be removed and replaced with new, appropriate measures if new knowledge about the advancement or innovation of conservation materials and techniques is obtained. If it is not possible to achieve complete reversibility, contemporary work should be done in such a way that it does not compromise some future interventions [25].

2.1. Some innovations in soil improvement techniques

Reinforcing the soil above which the historic buildings were erected is a very delicate task. Some soils are expansive because they contain minerals such as brown clay, which absorbs water and varies in volume (shrinks and expands). As a result, forces occur that cause cracks in foundations, floors, and walls in lower zones. This is a problem for

which innovative techniques and materials have been devised in recent years that depend on the use of natural materials that strengthen the soil, do not pollute the environment and significantly strengthen the historic character of the building. At the same time, these are approaches that successfully mitigate the risk of an earthquake.

Very simple and good method is explained in the paper “Soil improvement and Foundations Strengthen Methods for Preservation of Syrian Islamic Historical Heritage” from which is the following citation with clear explanation of the process.

“LIME PILES TECHNIQUE

The method of soil improvement using lime piles technique consists of screwing a hollows in the ground to the desire depth and at the time the direction is reserved, the prepared quick lime is injected. After lime column installed, the lime or calcium is pumped into soil surround the lime pile and that will change the soil properties around lime column resulted by the chemical reaction between lime and soil. For an efficient stabilization, calcium and hydroxyl ions should migrate through the clay, because hydroxyl ions cause highly alkanic conditions give rise to the slow solution of alumina-silicates which are then precipitated as hydrated cementitious reaction products (Fig. 1.)

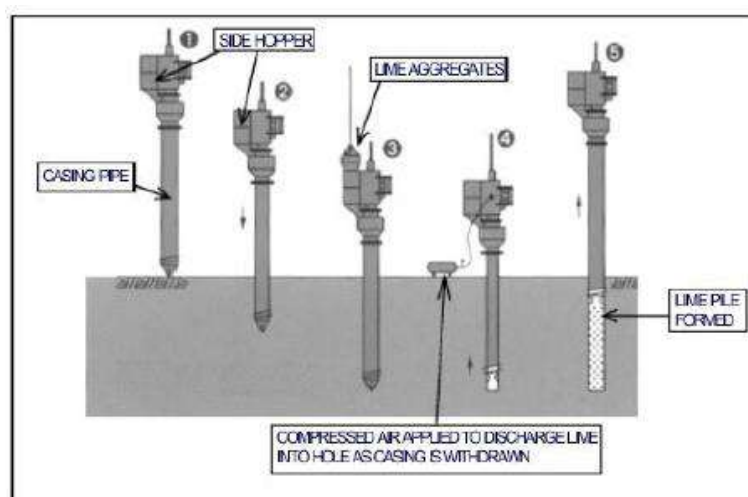


Fig. 1. Lime piles technique (after [4])

This mechanism will control the strength of the soil surround the lime column. Lime is an excellent choice for short-term modification of soil, and it can modify almost all fine-grained soils, but the most dramatic improvement occurs in clay soils of moderate to high plasticity. Modification occurs because calcium cations supplied by the hydrated lime replace the cations normally present on the surface of the clay mineral, promoted by the high pH environment of the lime-water system. Thus, the clay surface mineralogy is altered, producing the following benefits: 1. Plasticity reduction; 2. Reduction in moisture-holding capacity (drying); 3. Swell reduction; 4. Improved stability” [4].

Another ground improvement through a natural process was developed by the company Soletanche Bachy. This is a method which use biocalcification, called Biocalcis®. This process respects the environment and delivers a major increase in the mechanical resistance of soils and in their cohesion, without a significant change in their initial permeability. Biocalcis® mimics the natural process of calcification. The procedure is based on enzymatic hydrolysis of urea in the presence of *Sporosarcina pasteurii* bacteria, followed by precipitation of calcite in contact with a calcifying nutrient solution. Biocalcis® won the French National Public Works innovation award in 2015 (Fig. 2) [23].

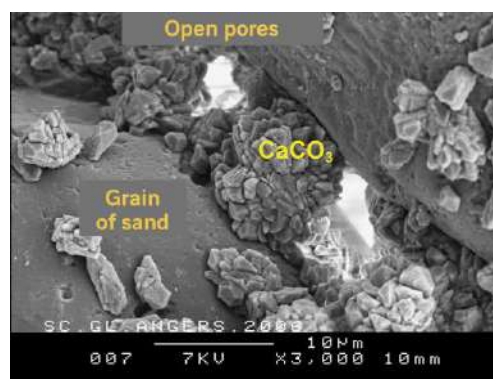


Fig. 2. Microscopic slide showing soil calcification (after [23])

2.2. Conservation and restoration of built heritage architecture and construction

In this area of technical approach, one of the biggest problems is protecting the walls from moisture and salting, which is characteristic of traditional materials. Over the course of time, a number of different coatings have been tried that could be slowed down or completely prevented. Today, the most commonly used cement mortar is almost completely discarded, and in some countries it is banned. It is constantly experimenting with mortars that should be able to remove portable salts from the mass of the wall while maintaining its durability. Some of the most significant experiments are related to the influence of natural zeolite as an additive in lime mortars. Basic physical and mechanical properties such as absorbability, capillary absorption, density, total porosity, compressive and flexural strength were tested in the laboratory and the results were compared. Specific additives such as: hydrophobizer, methylcellulose-water retaining additive, vinyl acetate and ethylene copolymer powder, the redispersible additive for improvement of adhesion have been used. Experimental results have shown that mortars modified with natural zeolite stand out due to their good sorption properties and can absorb a sufficient amount of salt. Lime mortars with natural zeolite are completely complementary to traditional materials and can, without fear of bad consequences, be used in the restoration of built heritage (Fig. 3) [13].

Other experiments have shown that when added to lime mortars and lime-metakaolin mortars, synthetic zeolite pellets can act simultaneously as pozzolanic material and water reservoir. Thus modification of lime mortar with synthetic zeolite could be used for restoration of medieval wells and tanks in fortresses, monasteries and town squares [7] [20].

In order to obtain the highest quality coatings and protect for the wall tissue of the architectural heritage, very complex laboratory experiments are carried out with the latest generations of nanomaterials. Some of those materials are already known and are used in other fields, such as, for example, titanium. A water dispersed Titanium dioxide/poly(carbonate urethane) nanocomposite was prepared by means of cold mixing of single components via sonication. The work was aimed at achieving a new material with properties suitable for eco-sustainable applications in cultural heritage as protective coating. Interrelationships among structure, properties and uses in conservation of this kind of nanomaterial were appraised [19].

In addition to the TiO_2 nanoparticles dispersed in an aqueous colloidal suspension, a range of new nanomaterials are being used, based on the advancement of some of the already known particles and compounds (Fig. 4) [22].



Fig. 3. Condition of the plaster samples after examination on resistance to salt crystallization

Fig. 4. Static contact angle of a water drop of untreated (a) and (b) treated limestone by a water repellent product based on nanomaterials (after [22])

In addition to new solid wall coatings, recipes have been refined to protect the original elements. One of the highest quality recipes, the composition of which is not fully known, has been used for years for the protective coating of elements of the wooden roof structure of the Church on a hill in Sigişoara, Romania. The Romanesque Church, originally dating from the 13th century, restored in the Gothic style, this refined piece of religious architecture has an exceptional high-rise roof construction, which is mostly original and protected solely by coatings (Fig. 5.) [17].

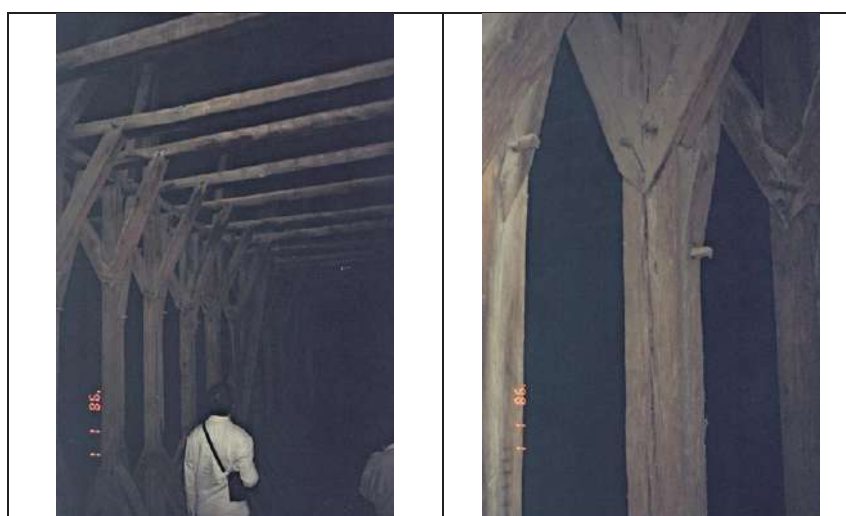


Fig. 5. Church on a hill in Sigişoara, Romania

When it comes to stabilizing whole structures or debris of built heritage, the use of reinforced concrete is almost completely replaced by various metals and fiber-reinforced plastic (FRP).

Steel reinforcement elements are used as visible or hidden depending on the principles that the conservator accept. Two examples are presented here to address this difference in approach (Fig. 6) [4].

The aforementioned titanium, laboratory-processed in coating, is used in its original form, as a metal that is embedded to stabilize historic buildings. It is widely used in the protection of ancient Greek buildings, of which the writings Vayas and Papadopoulos are very exhaustive: "One of the most characteristic aspects of the modern restorations of ancient monuments in Greece is the extensive use of titanium for: i) the reinforcements of

broken architectural members, and ii) for the new connectors constructed to replace the ancient wooden poles and empolia in columns interfaces and the iron clamps and dowels of the stone blocks. Titanium was chosen for these applications due to its high resistance to all types of corrosion and its high strength in combination to its low weight" (**Fig.7**) [26].



Fig.6. Visible and hidden use of steel elements for reinforcement of the floor beams

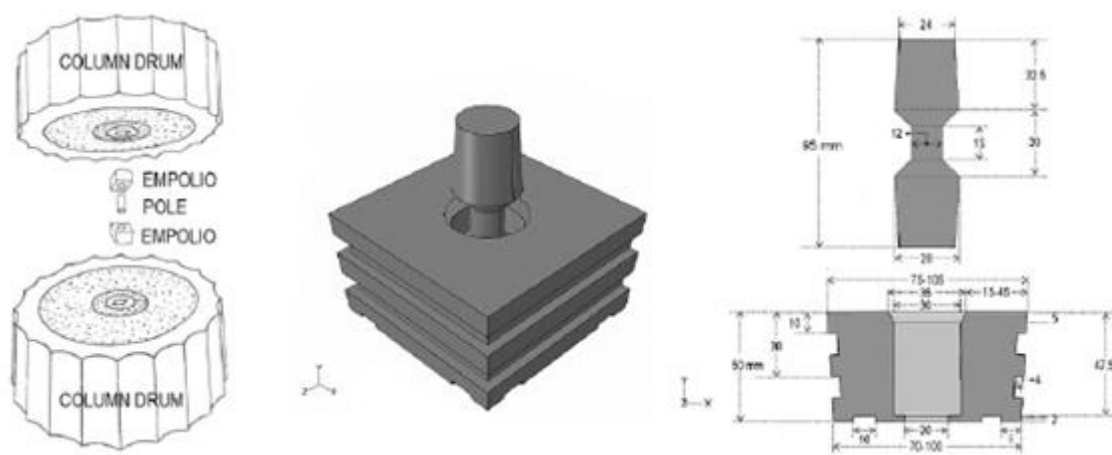


Fig. 7. Drawings presenting the connectors between adjacent drums of classical columns (left) and the new titanium connectors for the columns of the temple of Apollo Epikourios (after [26])

Much has been written about the use of FRP materials and their application has been shown through numerous examples, so here it is only referred as a form of protection that is constantly being improved for a variety of cases. The composite fibres with high modulus of elasticity and tensile strength can increase the in-plane and out-of-plane strength of the masonry wall, columns, vaults and domes. Fibre-reinforced plastic is also useful in terms of corrosion protection such as stress corrosion cracking. Fibre-reinforced plastic is produced using a wide range of fibres depending on the final usage requirements. Fibers can be sourced from glass, carbon, aramid, basalt and other sources. It is vital to ensure that the fibre source of fibre-reinforced plastic suits the application that it is to be used in. (**Fig. 8**) [6] [1].



Fig. 8. Different uses of FRP reinforcement (after [1])

2.3. Large-scale modern interventions on built heritage

Basic factors affecting the restoration design of built heritage are: architectural style, actual state of the building, type of the building material, the condition of the building material and construction and the exposure conditions. Especially in case of low-strength constructions exposed to the natural and man-made activity disasters [15]. The most important problem is obtaining adequate insight into and feeling for the requirements that play a role with regard to the restoration. In the last few decades, the professional attitude has significantly changed in relation to the restoration of the architectural heritage. It is now insisting on a clear, but subtle distinction between the old, original and new elements of the building. That is very difficult to achieve, In order to overcome this problem and to ensure that adding materials and applied technologies would act as integral parts of the restored building in each, even aesthetical way, and the conservators started with the application of new materials and technologies.

Repair of built heritage take place in the context of a set of requirements, which range from philosophical to purely assumptions and constraints:

- The basic approach implies an objective evaluation of all the properties and the authenticity of the built heritage;
- The next step is definition of conceptual requirements that include checking of compatibility, retreatability and reversibility of the works that will be done during restoration;
- At the same time, functional requirements are also considered as they could be subjected to certain limitation;
- The technical requirements are in the focus of this paper because new materials and technologies that considerably change the relationship to some principles of restoration are being considered, and

All the above requirements influence the advanced methodology of the mixed design. Before starting the discussion on restoration of and historical building with large interventions or extensions many aspects have to be evaluated in conjunction with one another. The justification for this are several, as above mentioned. Practice has proven that approximating the restoration of built heritage solely from as a technical point of view, will easily lead to the interventions, where basic aspects such as authenticity and the historical context are neglected or insufficiently seriously considered.

The need **to change the function or increase the capacity** of a historical building is currently the most challenging reason for specific forms of restoration followed by large extensions of the structure. Changes in buildings, which allow them to gain a new purpose or use, often represent the only way to ensure survival and a sustainable future. Getting the right balance between development requirements for conversion, construction regulations

and special needs of cultural monuments is a very demanding task that is solved with the help of numerous specialized expert teams, as well as negotiations between different stakeholders in the venture.

During the interventions, the type of functions that the architectural heritage is gaining is significantly expanding. The traditional selection of new functions such as museums, galleries, cultural centres, souvenir shops is also overcome and the number and type of new purpose of old structures is very wide. Today, it is no longer surprising that churches are converted into comfortable living quarters or industrial halls in shopping malls, town houses in gym. In this way, preserved and renovated historic buildings enrich the city's cultural image and lifestyle. It turned out that such a transformed heritage is not only attractive for residents but also for tourists [16].

Observed in this way, the preservation of heritage is one of the essential parts of the modernization and identification of social identity. The community identifies itself with preserved heritage and supports various ideas on how to present it and use it. Protected wholes of some areas are among the most restrictive parts of spatial, or urban or rural planning policies. The feeling that they protection also implies significant limitations in manifest forms and features of cultural monuments. Such an approach, which stands out as an attitude in numerous international and national documents, is, however, becoming more and more flexible, especially from the beginning of the 21st century [10].

Restoration of built heritage is a process that is constantly refreshed with new ideas, techniques, technologies, and follow the civilization development of the society in which the events unfold [5]. Many ways to encourage further research on this topic are just opening up. Current conservation treatments, restoration methods and enlargement of old historic buildings with traditional materials bear the risk of conjecture between the original and new elements, whereas the high consolidation demands often result in visually invasive and irreversible solutions. Nowadays, there are still three options of restoration method, and there is an international debate which of them is the best one for the historic building.

The first option is that the aspects of the aspects of materiality and aesthetics appear as integral parts of restored building. In that case, the observer can be misled by the look of a building that seems to be completely original, may be only a little cosmetic dressed and well maintained. In these examples of restorations, original materials are used, and more and more concrete, modelled and painted to reflect the stylistic features of the building (**Fig. 9**).



Figure 9. Heritage restoration by using concrete elements (<https://timberhawkhomebuilders.tumblr.com>)

In the **second case**, restoration is achieved by the use of extremely contrasting materials that complete the missing parts of the historic building. Most often brickwork is used to complete the originally stone-built structure and vice versa. The difference in material can often be very noticeable and aesthetically unsuitable (**Fig. 10.**).



Fig. 10.. Golden Gate of Diocletian Palace, Split – missing part is restored with brickwork

Third approach uses new materials and technologies that enables the simultaneous perception of the historic building in both its original whole and ruinous state. The emerging technologies have set ground for using several already known materials, but improved in structural way minimizing the need for substructure and maximizing transparency, while protecting the existing sensitive historic materials.

Contemporary conservation approach aims to actions that should be distinguishable in order to reflect their time and avoid falsified interpretations of the original structures. On the one hand, the stratification of the historic building should not by no means be concealed and on the other hand the new materials should not be disguised, enabling an honest dialogue between old and new, the past and present [14]. One of the crucial principles, the principle of reversibility suggests that every intervention should give the possibility for future removal, either due to the evolution of conservation philosophy, to the development of new materials or in case it proves inadequate for a particular type of historic building. The conservators find themselves in an internal conflict, being asked to respect and leave the monuments in the state as it is applying reversible method, but at the same time efficiently safeguard for future generations.

The development of structures in space can not be frozen in time, in spite of the very often unperturbed conservation approach, but continual development must be permitted. There is no room here for presenting and commenting on numerous examples of historic buildings in which the means of accessing large-scale interventions range from some kind of replicas, imitations, associations, restrained creative activities to extreme excesses in space. In residential buildings, space for a more comfortable life is required in upgrades for modern needs (elevators, balconies, fire stairs, etc.). Medieval churches turn into luxurious housing, libraries, hospitals.

The objective is clear: to emphasize the imposing historical building by adding a new layer to the landmark, a fashion statement in the form of a complex building overlooking the city. More and more designers and conservators together decide that old-new combined structure does not try to blend in or to hide its modern extension appearance. They threatred this approach as a fitting apotheosis for what was, until recently, a heap of crumbling structure.

Modern materials are very different from historic ones regarding their improved physical, mechanical, chemical, and expressive properties. The emerging technologies allow for their implementation in a smart way to order to achieve a better performance. As original materials were chosen to satisfy a purpose in a certain context, which no longer

exists, the use of contemporary materials and techniques appears more pertinent reflecting our time, our social relations and culture. Artistic restoration show a trend towards transparent means in order to complement the original volumes and express the “authentic image” without imposing on it. One way to generate transparency is to give the outline of the general shape of the missing parts of the historic building using frameworks [21].

Wood, as an old building material, has significantly changed its properties due to the technological innovations. It is very flexible and prepared so that it has become resistant to climatic, chemical, physical and biological effects and is used in the restoration of historic buildings at places unusual for its use through history (**Fig. 11, Fig. 12.**).

Various **iron elements** were also embedded into buildings throughout history, but now iron and other metals are processed so that they are perfectly complemented with their structure and surface treatment with the remains of historic buildings [24]. In 2011. the same architects, Fidone and Messina, have designed structures with eight layers with **steel profiles and oxidized copper plates** to recall the geometries of the cross vaults of the side chapels of the same church in the Convent of S. Maria del Gesù in Modica, Sicily (**Fig 13**).



Fig. 11. Wooden barrel vault of the church of S. Maria of Gesù, Modica, Fidone and Messina, 1996.
(<https://www.bta.it/txt/a0/06/bta00699.html>)



Fig. 12. The new wooden dome of San Filippo Neri, Bologna, Cervelatti, 2018.
(<http://www.cantabo.it/oratorio-di-san-filippo-neri/>)



Fig. 13. Interior and exterior of the side chapels of the Church of S. Maria del Gesù, Modica
(<https://www.bta.it/txt/a0/06/bta00699.html>)

The Basilica of Santa Maria Maggiore di Siponto in Manfredonia has become one of the great attractions that have been visited by hundreds of experts and tourists since 2016. The artist Tresoldi did very bravely majestic architectural sculpture of **steel wire mesh** that tells the volume of the existing early Christian church and update the relationship between the ancient and the contemporary (**Fig. 14.**).

Stone as an old building material is now used in different, creative way. A former warehouse in Würzburg now accommodates the municipal collection of art and the Peter C. Ruppert Private collection of Concrete Art. Cubic structures were added at both ends of the building to enlarge the existing floor area. The facades of these new tracts consist of open-spaced horizontal **lime stone strips** that harmonize with the old stone facades and also allow light to enter the linking corridors (**Fig. 15.**).



Fig. 14. Restoration with the wire mesh – Basilica of S. Maria Maggiore, Manfredonia
(<http://www.italianways.com/a-wire-mesh-paleochristian-basilica/>)

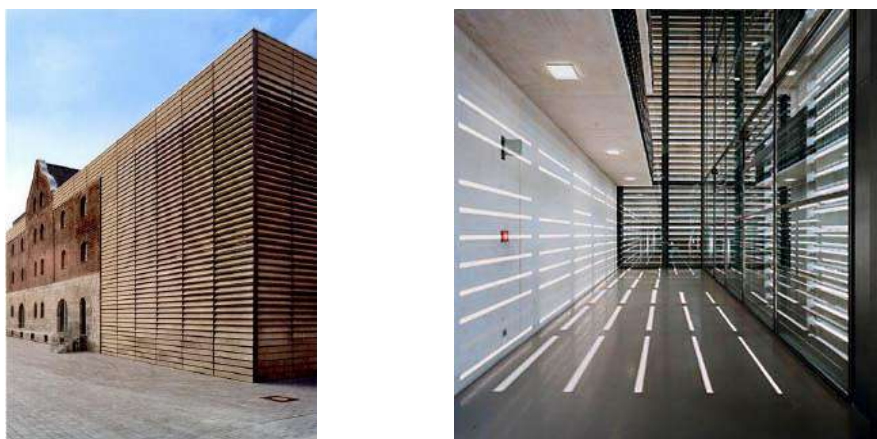


Fig. 15. Extension of the old warehouse in Würzburg with lime stone strips
(<https://inspiration.detail.de/cultural-centre-in-wuerzburg>)

In architectural restoration the transparent elements should contribute somehow to the consolidation of the damage historic building. The prerequisite discourage the exclusive use of non-transparent materials (steel, concrete, stone, bricks) and encourages the use of materials with inherent transparent and structural properties. When such materials come into discussion, **glass** is the only one that creates an almost dematerialized intervention due to its transparent properties, durability and highly compressive strength [3] Restoring a damaged building by glass is the closest action of not restoring it at all. ‘All traces of history are free to narrate their own story as ‘wounds that are healed but not hidden’ [8]. Trough transparency of the glass, the historic buildings are related in a direct and honest way to their surrounding the present setting. The present setting and the way it has been shaped trough the passage of time is what reflects their importance and values

their cultural significance. Considering the challenges and potentials in the use of glass for the restoration of historical buildings (structural compatibility aesthetics, reversibility), it is important to decide which type of glass should be used in a particular case. The available glass used for architectural and structural applications today is limited to float, cast and extruded glass types with respect to configuration, scale, and transparency. Further divisions of, for example, float glass affect the impression that leaves the building as a whole after adding the glass elements. In restoration practice it could be used float glass that could be matte, translucent, transparent, textured, tinted, and with optical quality, with different thickness.

The use of glass in the restoration of historic buildings can be twofold. The first approach could be called the conventional use of glass as a protective structure, the most common archaeological finds (**Fig. 16. Fig. 17.**). The second approach is very creative, imaginative and it brings to light all the qualities of glass as a restoration material.



Fig. 16. Abbay of Saint Maurice de Auguno, Switzerland
(<https://www.archdaily.com.br/br/01-54296/>)

Fig 17. Bayazit Library, Istanbul

<https://www.metalocus.es/es/noticias/biblioteca-beyazit-por-tabanlioglu-arquitectos>

One of the finest example of creative use of glass could be seen in Pozzuoli, Italy. The ruins of the Augustus Temple are restored with a glass façade that consists of fins and plates outlining the shape of the original columns. Some details are really very original such as detail of the current entrance with pronaos columns serigraphied on the plate glass (**Fig. 18.**).



Fig. 18. Float glass restoration of the ruins of the Augustan Temple, Pozzuoli

<https://travelguide.michelin.com/europe/italy/campania/naples/pozzuoli/temple-augustus>

The flexibility in forms that can be attained using cast glass is the best solution for restoration treatment aiming to resemble the original shape as faithfully as possible. As a

case study, the restoration of the Lichtenberg Tower in Maastricht is proposed. The Lichtenberg Tower - the oldest castle ruin in the Netherlands – could be restored with glass components that fill the missing parts and prevent the monuments' walls from drifting apart and collapsing (**Fig. 19.**). The innovative contribution of this glass restoration approach, besides allowing for a transparent addition, lies in the development of a completely reversible system [19].



Fig. 19. Cast glass elements proposed for the restoration of Lichtenberg Castle, Maastricht
https://commons.wikimedia.org/wiki/File:2016_Maastricht_St-Pietersberg_Lichtenberg

The use of extruded glass could be adequate for the restoration of linear structural elements, such as the gothic columns in the standard cross-sectional area (**Fig. 20.**). A modern and abstract configuration of extruded glass is also possible to be used in the form of truss structures, to create lightweight horizontal components.

However, the combination of steel elements and glass surfaces is most popular solution and often used during restoration of historic buildings in the last decades (**Fig. 21.**).



Fig. 20. Hypothetical case of restoration of bundled column with extruded glass tubes
(<https://www.researchgate.net/publication/330423091>)

Fig. 21. Thermae in the archaeological park Xanten, Germany
Photo Magnus Manske

3. Concluding remarks

The restoration of the architectural heritage is seen in the context of a set of demands ranging from philosophical to technically applied. Work on the reconstruction of historical buildings has significantly evolved in the 21st century. The typology of buildings that are valued increasingly is more numerous. Economic value is increasingly affecting the

sustainability of the heritage. Except for cultural monuments on the UNESCO Cultural Heritage List, all other categories are subject to change in function. This often involves adding new parts that connect with the original building or its remains. The restoration of the architectural heritage is seen in the context of a set of demands ranging from philosophical to technically applied.

In addition to the demonstration of the application of wood, brick, stone and iron, processed in a modern way, attention is especially dedicated to glass. It has been estimated that glass is the only one that creates an almost dematerialized intervention due to its transparent properties, durability and high compressive strength. Restoring a damaged building by glass is the closest action of not restoring it at all. Due to its exceptional quality, it is estimated that the glass is increasingly the material of choice for the restoration of historic buildings.

In order to open a discussion on the subject of re-evaluation of cultural goods where large interventions and extensions were carried out, examples were drawn from which it can be concluded that such large undertakings entered consciously and with the obvious acceptance of institutions that decide on the values of the architectural heritage. Experiences are different, somewhere the extensive changes are accepted immediately and with approval, they are accepted somewhere after a certain time, but nowhere in the public that has more or less violently reacted did not raise the issue of legalized re-evaluation. Criticism and praise seemed to have not been officially re-evaluated in the institutions that were responsible for the newly created combined structures. When these cases are analysed in depth, there is, however, one link that connects them. The fact that in such bold actions, there were exceptionally talented architects, who are not conservators by definition, who put their creativity on trial and exposed to the court of the public. Undoubtedly, they followed the basic conditions and principles of conservation, but, like their predecessors from history, they treated construction as a process that is constantly refreshed with new ideas, techniques, technologies, and following the civilization development of the society in which the events unfold. Many ways to encourage further research on this topic are just opening up.

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(NO) PROTECTION OF CULTURAL HERITAGE IN BOSNIA AND HERZEGOVINA

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Abstract: *Over the past centuries, an enormous amount of cultural heritage structures have been destroyed in Bosnia and Herzegovina. Many structures were destroyed due to the conflict and the others have been heavily affected by the weathering conditions. Our influence and impact vary from the inability to do anything as in the period from 1992-1995, to the point where we as citizens we can do a lot. However, how eager are we to do that? How willing are we to fight for cultural heritage and its values? How aware are we what is cultural heritage and what is its value to the next generations? Several cases have shown that the awareness is rather low leading to the devastation of historical pearls. In this paper, several examples will be shown where protection has been omitted leading to degradation of cultural heritage and them being abandoned and forgotten. In this way, we as a society are depriving future generations of their history and their heritage.*

Keywords: *Protection, cultural heritage, ICOMOS, UNESCO, hazards*

1. Introduction

Cultural heritage is a harmonized relationship involving society (systems of interactions connecting people), norms, and values (ideas such as belief systems that attribute relative importance). Generally, cultural heritage can be divided into tangible and intangible heritage. *Tangible Cultural Heritage* refers to physical artifacts produced, maintained and transmitted intergenerationally in a society. It includes artistic creations, buildings, and monuments as built heritage, and other physical or tangible products of human creativity that are invested with cultural significance in society. *Intangible Cultural Heritage* indicates 'the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artifacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their Cultural Heritage' [1]. Examples of intangible heritage are oral traditions, performing arts, local knowledge, and traditional skills.

In the last years, as a consequence of deliberate action, or due to accidents by natural disasters damage or destruction of cultural heritage has been seen throughout the world. Theft, civil disorder, terrorism, war, neglect, and vandalism are human factors in the accidental or deliberate destruction of our heritage [2]. Manmade disasters can even exceed natural

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disasters in the harmful effects on the collective remembrance of the past. Besides the deliberate and systematic destruction of cultural heritage during wars which was and still is evident, neglect and no protection of cultural heritage are evident in peacetime as well. What is society's level of awareness of the importance of cultural heritage? Do we know how to protect our cultural heritage? Are we aware that it is our obligation to transfer the values of cultural heritage to the new generations? Have we become insensitive to the importance of our culture and became "prisoners" of new construction technology and neglect?

In the paper, several examples are given regarding potential neglect and the possibility of damaging cultural heritage in Bosnia and Herzegovina. It is not the intention of the author to criticize but to lay out the facts and leave it to the readers and the wider audience to form their own opinion and stand.

2. Cultural heritage structures

2.1. Tašlihan in Sarajevo

In the history of Sarajevo, the 16th century was the "golden age", thanks primarily to the emergence of Gazi Husrev-beg, indisputably Bosnia's most important governor. Tašlihan (translated stone khan) is a former caravanserai located on the site of the current garden of the Europa Hotel in Sarajevo. The main purpose of caravans and khans was to house people and horses. They were built along all major roads. In 1659 there were 23 khans and three caravanserais in Sarajevo, and in 1878 there were 50 [3]. The most significant are Kolobara, Tašlihan, and Morića han. Tašlihan was the third stone caravanserai built in Sarajevo. It was built in the period from 1540 to 1543 as stated in the legacy of Gazi Husrev-beg, after his death. It was built next to the Gazi Husrev-beg's bezistan (covered bazaar) on its western side. It is interesting to point out that masters from Dubrovnik participated in the construction of this building as well as the neighboring bezistan. It had a square base with a length of 47 meters. In its backyard, there was a fountain, and above it on wooden pillars was a small mosque. The rooms for passengers were located on the first floor. Domestic and foreign merchants had their shops within Tašlihan. It is believed that this caravanserai was used more for the trade than stayover by passengers (Fig. 1). The Tašlihan was burned for the first time in 1697, then in 1831 when a barn space was added to the far north, which has not yet been explored. It was completely destroyed in the 1879 fire [4, 5].



Fig. 1. Model of the Tašlihan as was before the 1879 fire

The archaeological area – remains of Tašlihan in Sarajevo was declared a national monument of Bosnia and Herzegovina in November 2004 [5]. In the decision, it is stated that the memorial space will be open and accessible to the public and can be used for

educational and cultural purposes. However, the Commission to Preserve Monuments, at its meeting on July 2016, decided to amend the Decision from 2004. The amendment to the decision relates to the protection measures prescribed by the November 2004 decision. According to the obtained information, the plan was to build a new building having a ground and one floor, allegedly to be of a commercial character. Following this information, the profession reacted, as did the citizens of Sarajevo, who had launched an online petition against the decision of the Commission to Preserve Monuments. Until now no construction took place, however, will there be some changes in the near future remains a mystery.

The current state of the Tašlihan is shown in Fig. 2.



Fig. 2. Tašlihan today

2.2. Jewish cemetery in Tuzla

The Jewish cemetery in Tuzla bears witness to the presence of Jews and their life in this location since the 19th century. Jews in Tuzla began to settle in large numbers with the arrival of the Austro-Hungarian administration, and until then the presence of Jews in Tuzla was sporadic. In Tuzla, there were two Jewish communities and two synagogues. The old and neglected Jewish cemetery in the settlement of Borić in Tuzla was declared a national monument of Bosnia and Herzegovina just in June 2018 [6], although it dates back to the 1800s. The cemetery was formally established in 1900 and covers an area of 2760 m², although burials were made earlier, as evidenced by the inscriptions on the tombstones (1868, 1892, 1893, 1894, 1897). It is unique in that it is still active today and what makes it even more exceptional and specific is that both Sephardi and Ashkenazi are being buried here, which is usually not the case.

Additionally, the significance of the cemetery lies in the fact that the forms and shapes of the tombstone are diverse. The oldest stones are in the form of ground-in stone coffins belonging to the Sephardi, represented in many Jewish cemeteries in Bosnia and Herzegovina. However, with the arrival of Ashkenazi in the second half of the 19th century, more modern forms of tombstones appear in the cemetery originated in Western Europe. Two tombstone forms dominate the cemetery, namely stelae and obelisks tombstones that occur as stand-alone structures, on a pedestal, or in combination with a horizontal slab. A large number of inscriptions have been preserved, which is an important document on the families who lived in Tuzla during that period. The inscriptions are bilingual, carved in Hebrew square script and Latin script.

Shapes, decorations, symbols, and inscriptions provide one of the best-documented evidence of the development of the tradition and culture of the Jewish community in Bosnia and Herzegovina.

In the cemetery, 161 graves were recorded and 60 surnames registered, but most of these families no longer exist or their descendants do not live in Tuzla. Munisa Kovačević,

an expert associate for cultural, historical and monumental heritage at the Institute for the preservation of cultural heritage, in an interview given to Anadol Agency on August 2018, said: “The inscriptions we have recorded on the monuments are written in Bosnian and German. Usually, when it comes to the inscriptions, we talk about the year of birth and death of the deceased and what is interesting is that we saw on several monuments’ writings stating how the person died. Also, from the form of the monument one can conclude how it was built, which material was used, type of the decorative motifs, this all points out to the valuable cultural and historical property” [7].

The aforementioned national monuments have not been maintained for years, so the old and damaged monuments were overgrown with grass and shrubs and the state of the cemetery was as given in Fig. 3.



Fig. 3. Jewish cemetery in Tuzla [7]

In August 2019 people from the Islamic Community Majlis from Tuzla cleaned the cemetery with the goal to rescue the national property of BiH, and they were helped by young volunteers from Germany, Poland and other parts of Europe, who have been staying in Tuzla for several days. Fig. 4 shows the process of cleaning the Jewish cemetery.

Improper maintenance and inadequate restoration of the tombs led to the destruction and deterioration of the monument. Certainly, in addition to the human factor and its negligence, the destruction of certain tombs was also caused by the landslides.

Is it acceptable to leave these valuable treasures to be unprotected? Can we as a society be so numb and negligent to the significance of historical values?



Fig. 4. Cleaning of the Jewish cemetery in Tuzla [8]

2.3. Stećak

Stećak monumental medieval tombstones that lie scattered across ex-Yugoslavia are mainly located in Bosnia and Herzegovina, and at the borders with Croatia, Montenegro, and Serbia. An estimated 60,000 are found within the borders of Bosnia and Herzegovina and the rest 10,000 are found in Croatia (4,400), Montenegro (3,500), and Serbia (2,100),

at more than 3,300 abandoned sites with over 90% of all of them being in poor state [9, 10, 11].

Stećak's appeared in the mid 12th century and they reached their peak in the 14th and 15th century, before disappearing during the Ottoman occupation in the very early 16th century [12]. They were common among all religious, amongst Bosnian, Catholic and Orthodox Church [13], they are usually connected to the autochthonous Vlach population [14]. Until now, the original ethnic and religious affiliation has not been determined [15]. The epitaphs on them are frequently written in the now-vanished Bosnian Cyrillic alphabet called Bosančica. The tombstones named Radimlja (Fig. 5), west of Stolac in Bosnia and Herzegovina are one of the best-preserved collection of these tombstones [16].



Fig. 5. Stećci at Radimlja necropolis

It was only in 2016 that Stećci were inscribed as a UNESCO World Heritage Site. It includes a selection of 4,000 stećci at 28 necropolises – of which 22 from Bosnia and Herzegovina, two from Croatia, three from Montenegro, and three from Serbia [12].

However, a photo taken in august 2019 was unbelievable (Fig. 6), people having a picnic and sitting on the monumental medieval tombstones. If this is not vandalism what is?



Fig. 6. Stećci at Radimlja necropolis

3. Conclusion

The paper gives three examples of cultural heritage that has been a subject of neglect in Bosnia and Herzegovina. Lacking cultural heritage protection can be seen all around us. It is evident that manmade disasters can even exceed natural disasters in their harmful effects on cultural heritage. Additionally, sometimes the natural hazards cannot be predicted so leaving the cultural heritage unprotected due to insufficient information, but human vandalism can be stopped and should be prevented in all cases. It is clear that the awareness of the importance of cultural heritage is very low. In order to preserve cultural heritage and the existence of history in these areas, adequate measures have to be taken and this has to be done immediately, otherwise, we may lose a value that may never be retrieved. In this way, we as a society are depriving future generations of their history and their heritage. Are we allowed to do this?

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BRIDGES ON THE RIVER NISHAVA AS HISTORICAL STRUCTURES – NISH TRILOGY

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Abstract: *The river Nishava is not a long or particularly big river but it crosses border between Bulgaria and Serbia and it runs through landscape of exceptional beauty, along ancient routes. That distinguishes it among other rivers in central Balkans. It starts in Bulgaria and confluent in Juzna Morava, at the territory of city of Nis, Serbia.*

In this paper we explored bridges over Nishava in and around Nis, focusing primarily on its relevance as historical structures, but also partly examining current state and maintenance.

Key words:

1. Introduction

The river Nishava is not a long or particularly big river but it crosses border between Bulgaria and Serbia and runs through a gorge of extraordinary beauty, along ancient routes in the direction East to West. That distinguishes it among rivers of central Balkans, as one of the most memorable. It starts in Bulgaria and runs into Juzna Morava at the territory of city of Nis. Juzna Morava runs into Velika Morava, and consequently to Danube near Smederevo, which confluent in Black Sea at Bulgarian/Romanian border.

In this paper we explored bridges over The River Nishava, in and around city of Nis, focusing primarily on their relevance as historical structures, but also examining current state and maintenance where it was considered relevant.

2. The river Nishava

Nisava starts at Ginci, in Stara Planina (The Old Mountain), north from Sofia; in its upper flow it is known also as The Ginska River. It runs through municipalities of Godech, Dragoman and, after 67km, it crosses the border at Kalotina – Gradina, which is the major border crossing between Bulgaria and Serbia. In Serbia it runs through numerous villages and several towns and cities: Dimitrovgrad, Pirot, Bela Palanka and Niš (Fig. 1.). On its way, it passes through scenic 17km-long Sicevo gorge (Fig. 1). The total length of the river flow is 218km. Finally, it becomes the longest tributary of the South Morava at the western fringe of administrative territory of Nis, which owes its name to this river. The amount of

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water significantly changes during the year, which makes Nishava sometimes wild, fast and deep river, and sometimes slow and shallow. Occasionally, it becomes so shallow that it could be crossed on foot.

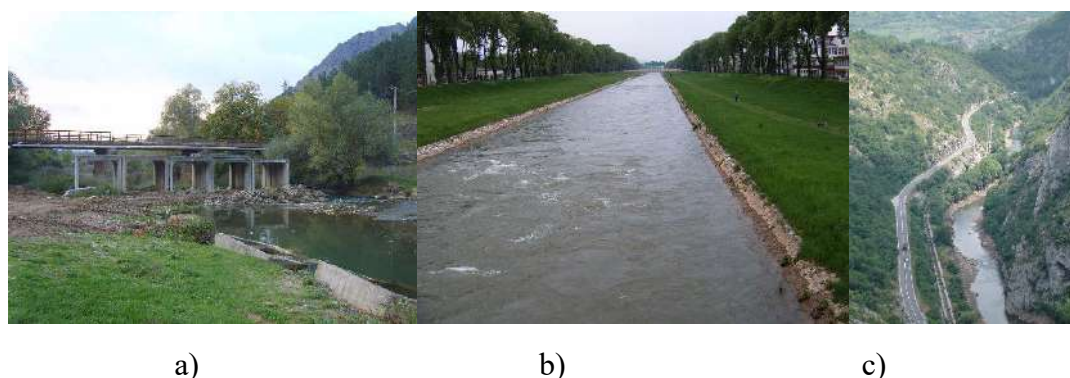


Fig. 1. Images of Nisava along its route from upper to lower Right to left: bridge near Ginsko, Nišava in Pirot, Aerial view through Sićevo gorge (W, 2019)

The Nišava valley is part of a major natural route, the one connecting Europe and Asia from ancient times; the route follows the valleys of the Morava, Nišava and Marica and onwards towards Constantinople, present-day Istanbul. Both the Belgrade-Sofia-Istanbul road and the railway follow this route, as well. (W, 2019)

3. The bridges in and around Nish

3.1. From East to West

Considering that the River Nišava is not particularly wide, most of its bridges are less than 40m long.

Consequently, construction of bridges is not demanding or expensive, which allows great number of them (Fig. 2).

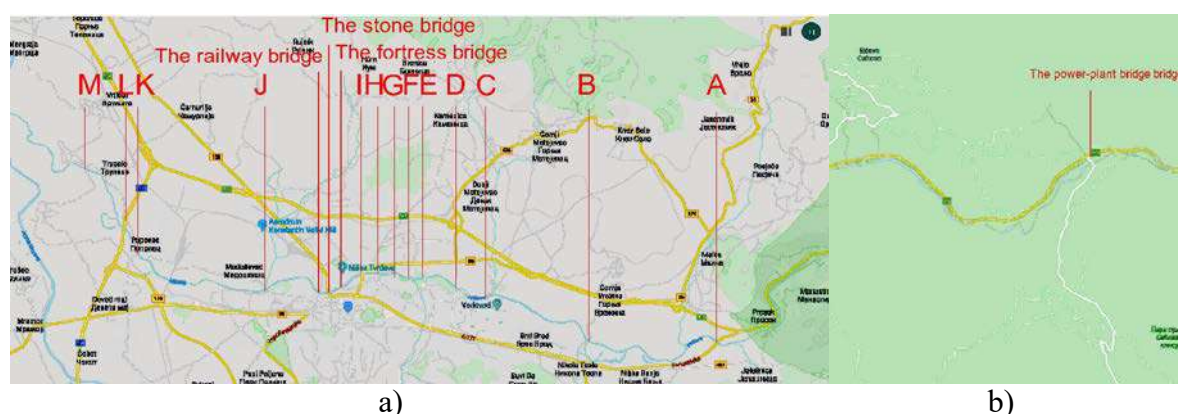


Fig. 2. Location of bridges mentioned a) in the city of Nish b) around city of Nish

3.2. The power-plant St. Petka

From East to the end in the West, closest to the eastern border of administrative area of city of Nis, within Sićevo gorge, near village Ostrovica, there is hydro power plant – the structure that incorporates a bridge (Fig. 3). It dates from 1908.



Fig. 3. The power plant MHE „Sićevo” (1931) with a bridge. (PP, 2019)

The power plant was named after Saint Petka, the protector of women, to whom a monastery was dedicated. The monastery was endowed by Royal military unit in name of fortunate survival of Serbian king in an accident in France. It was built only 13 years after Tesla's famous power plant on Niagara falls (1895). The power plant was designed by mechanical engineer Aćim Stevović, and powered by machinery produced by Siemens Schuckert Werke. Eventually, it works well ever since due to regular maintenance, without any reconstruction, and in meantime it has got a status of cultural monument.

It has massive structure, with fortress-like appearance and elements which have certain resemblance with numerous other structures in Euro-centric zone at turn of the century which were inspired by revival of Egyptian architecture i.e. its most characteristic feature - wall dominance.

3.3. The East string of contemporary bridges

The first two among East string of contemporary bridges over Nišava are located near loop called Malčanska, not far from village of Prosek (Fig. 4).

One of them is common concrete structure well-chosen considering climate and availability of cheap construction materials and workers. The other, parallel, bridge is reused steel railway bridge.



Fig. 4. “A”The Prosek bridges a-d



Fig. 5. “B” The Gornja Vrežina bridge (Mapio, 2019)



Fig. 6. “C” Brzi brod suspension bridge - before and after refurbishment and partial reconstruction (Mapio, 2019) (Wikipedia, 2019) a-e



Fig. 7. “D” The Donjovrežinski bridge (in the process of refurbishment/replacement)



Fig. 8. “E” The Boulevard Mediana Bridge

The “F” bridge (Fig. 9) was one of the last bridges built in 1980s, during so-called “socialist times”. Its construction was followed by several reconstructions (visible in the layers of concrete over original structure), needed because cracks appeared on several occasions.

After socialist period, democratic city governments built many bridges. For example, one of them in 4-year period built as many as 6 bridges including 2 of them on the river Nišava and reconstructed one of them – pedestrian cable-stayed bridge “C” with A-pylons (Fig. 10).



Fig. 10. “G” Pedestrian Bridge



Fig. 11. “H” Chez-Tonic-gas-station bridge

The bridge “H” (Fig. 11) is one of newest bridges, and it is located near huge archaeological site, making it more accessible for the visitors in the future, once when heritage is presented and the site open for the public. The bridge “I” (Fig. 12) is one of rare bridges with “a name”, well-established as a spatial reference. Not only age, but its shape also indicates it was built “in different times” - in second half of 20th century. It is one of six steel bridges on Nišava in the city area, out of 17 total.

3.3. The bridge ahead of main gate of city fortress

The central position and most attention of all city bridges gets the one located in front of the main gate of the city fortress, known as Stambol-gate (showing direction of Imperial city of Constantinople, nowadays Istanbul). When Ottoman Turks occupied the city, they demolished old Roman/Byzantine bridge, and built their own. After liberation, Prince Milan had it replaced by a wooden bridge, which stood there until 1900, when the new steel bridge was constructed (Fig.13).

The type of the arch bridge was widely used in Germany and it is known as "German arch". The construction consists of a two-hinged truss arch. The struts are falling to the middle. The roadway which worked as a tie band is suspended on narrow vertical steel profiles, the hangers. It was bombed and sank in both WWs, and on 29.11.1961 it was replaced by bridge which stands today, which got nick name “Gillette bridge”, for its narrow bearing structure (Fig. 14). During its construction, numerous, very valuable, archaeological artifacts were found on site, including famous head of Constantine the Great.

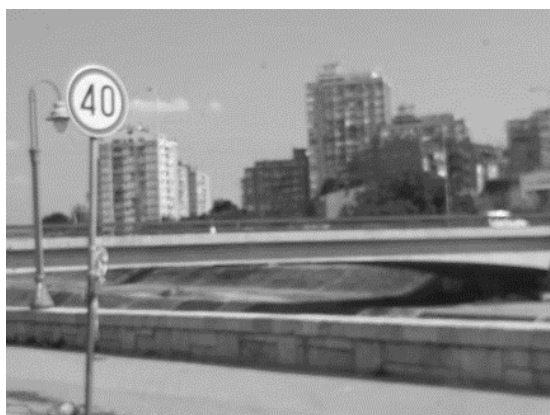


Fig 12. “I” The Youth Bridge (Mladost)

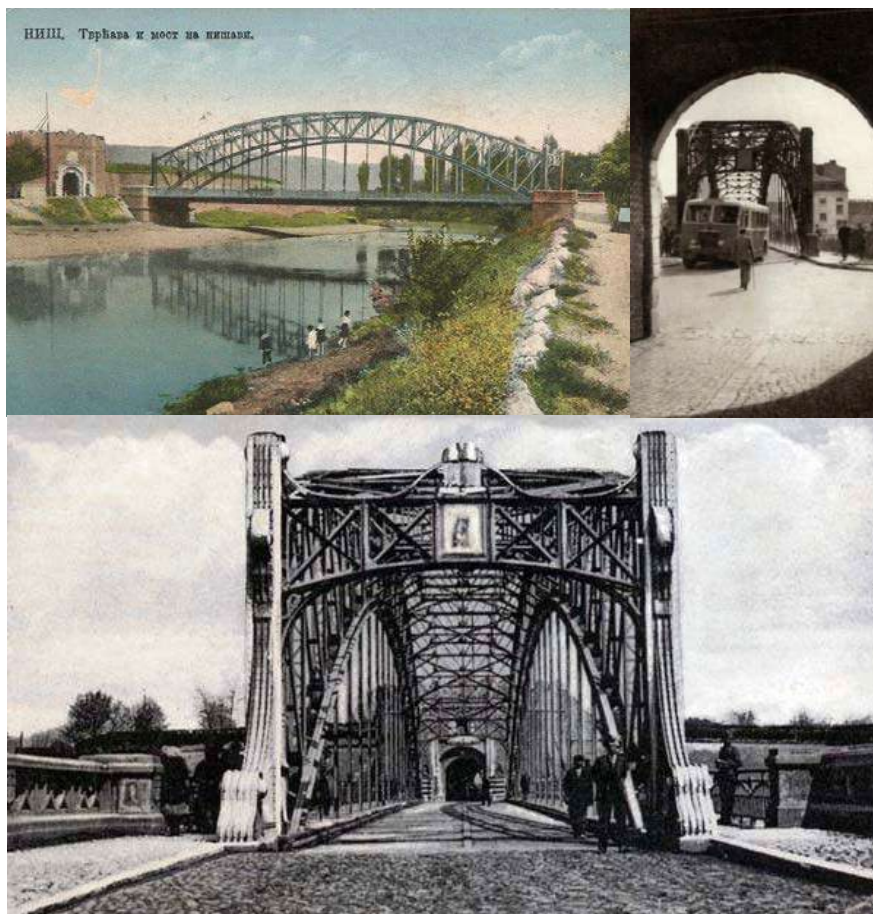


Fig. 13. The fortress bridge once (source: WEB)



Fig. 14. The fortress bridge nowadays

The bridge that is nowadays called The fortress bridge was once known as Iron bridge among local residents (although it was made of steel). It shows significant signs of aging and requires regular maintenance. (Fig. 14).

In line with tradition of wrong nicknames, so-called the stone bridge (Fig. 15) is not made of stone. It was heavily bombed during the last war in 1999. because was the strongest of all and considered most adequate for military purposes.

The railway truss bridge was destroyed several times in the Second WW (Fig. 16.), and it marks the historic border between central residential and business and industrial zone of Niš (Fig. 17).



Fig. 15. The Stone Bridge

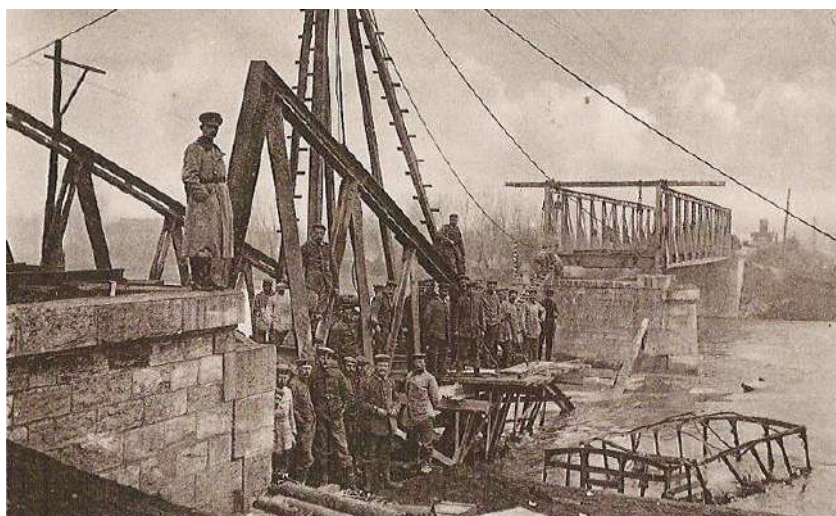


Fig. 16. The railways bridge during The Second WW (Wikipedia, 2019)

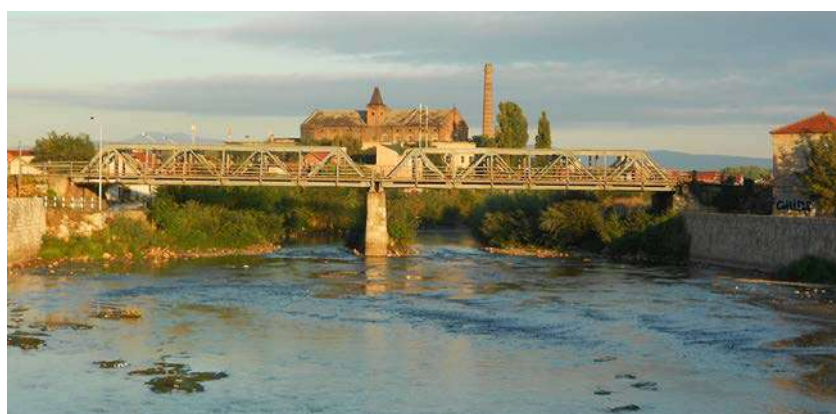


Fig. 17. The railways bridge and old gum factory (WEB, 2019)

3.4. The West string of contemporary bridges

Bridges “D” and “J” (Fig. 19) are built according to the same design, and both show signs of aging which question further use. Even more, both have problems with the adequate flow due to design, and nowadays, collapsing pillars. The three remaining bridges in the West string of contemporary bridges are common concrete structures, which are recently built (Fig. 20, 21, 22).



Fig. 20. “K” The Popovac bridge



Fig. 21. “L” The highway bridge (incomplete but operating)



Fig. 22. “M” The last bridge on Nišava in Trupale, Niš

4. Discussion: state, maintenance, comparison

Construction of bridges is often implication of political will or lack of it. All democratic city governments, after 1996 and in the first decade of millennium were (passionately) dedicated to building bridges. As part of their populist policy, they built

non-expensive but durable bridges, which would mark progress, and at the same time remain “available”, in challenging years after the last Serbian war of 20th century in 1999. In favor of previous, another common characteristic of those bridges were that they were “no-name” and “no-author” bridges. Lack of authorship is very indicative, because it meant bridges had “corporate authorship”, which marks entire period of Serbian industrial development. As consequence, they are mostly named after landmarks nearby (e.g. shopping centers or gasoline stations), which also means that they change their popular names when e.g. the shopping center changes its brand.

Aesthetic requests did not have high priority in most cases: most of Niš bridges are not memorable, and do not stand out for their aesthetic values, however their careful analyses may lead to decoding thumb rules of times and people who raised them. In addition, they often do not differ from many other bridges in other European countries, as shown in Fig. 23., which is valuable testimony from historic point of view.



Fig. 23 Bridge over Seine, Paris

The strong link with history which justifies that they are considered historic structures is the most obvious in case of the fortress bridge which regularly served the purpose of “**damnatio memoriae**”, a principle which literally means "condemnation of memory" in Latin, i.e., that a person is to be excluded from official accounts and which was extensively used in wars throughout history of the Old World.

5. Conclusion

In Niš and its vicinity, there are three bridges which already deserved status of cultural monument based on historic significance which they have. The forth one, most significant for history of electrical power supply development and legacy of Tesla – very close to heart of every Serbian, is formally outside of city administrative area, and therefore we called the tale of Niš bridges on Nišava a trilogy.

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All photographs except 1,3,13,16 and 17 were made by the N. Zivaljevic-Luxor

ARCHITECTURAL RECONSTRUCTION OF THE MAIN ENTRANCE OF THE MEDIEVAL FORTRESS RUSOKASTRO. PROSPECTS FOR CONSERVATION, RESTORATION AND ADAPTATION.

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Abstract: *Rusokastro is a Late Antiquity and Medieval fortress, situated on a rocky ridge in Kameno Municipality, Burgas, Bulgaria.*

The contemporary archeological research of the site has begun in 2006 and the results include: significant parts of the main western medieval fortress wall, the entrance with two gates and two adjacent towers, fragments of late antiquity fortress wall with two towers, etc. The findings provide comprehensive evidence about the plan, function, building materials and stages of construction. The comparatively well preserved architectural substance, dating mostly from 13th-14th century, defines the site as an outstanding example of the fortifications from the time of the Second Bulgarian Empire. Despite the significant destruction, there is sufficient evidence to virtually reconstruct the plan and overall architectural appearance of the main entrance and its towers.

The detailed study and the proposed architectural reconstruction should serve as good starting point for future architectural design of the site as main tourist attraction for the Municipality.

Key words: *Rusokastro, fortress, conservation, restoration, adaptation, cultural heritage*

1. Introduction

Rusokastro is a Late Antiquity and Medieval fortress, located in Southeast Bulgaria, 35 km away from the Black Sea city of Burgas and 3.5 km away from Rusokastro village, Kameno Municipality.

It is built on a rocky ridge 108 m above sea level which provides a panoramic view from Emine Cape to Yambol. This hill top is protected by sheer cliff faces from north, east and south and is accessible only through a flat rocky terrace from the west. The Rusokastrenska river flows west, north and east of the almost vertical 25-30m high crevices. The site was chosen because of its natural defensibility and suitability to observe a wide angle of the surrounding flat area.

2. Late Antiquity and Medieval fortress Rusokastro

Rusokastro was a fortified city with several satellite settlements, expanding over an area of more than 50 acres with mighty defensive system and served as an important road station and border outpost of the Medieval Tsardom Bulgaria. In its vicinity the troops of Tsar Ivan Alexander have decisively overtaken the army of Byzantine Emperor Andronikos III Palaiologos in 1331, thus placing the whole South Black sea region under Bulgarian rule for the last time in the Middle Ages.

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2.1. History

The earliest traces of a human settlement on the hill top date from the 1st Millenium BC (evidenced by Thracian ceramics from the Iron age, fragments of Hellenistic amphorae, a bronze coin from Mesembria, etc.). In the near vicinity is the cave Rusina Cave/Rusa's Hole with its hand shaped triangular entrance used through this period as a holy site.

The area is fortified in the 6th century. Chronologically the development of the Rusokastro fortress can be divided in two stages:

First (Late Antiquity/early Byzantine) – beginning of 6th century – end of 6th/beginning of the 7th century: fortress wall with two adjacent rectangular towers by the main gate. It was abandoned after a fire at the beginning of the 7th century (right after the end of the rule of Emperor Flavius Phocas Augustus in 610 AD). During 10th-12th century the fortress was settled again, but it is not clear if the Late Antiquity defensive features were still in operation. The first findings of Bulgarian origin on the site date from this period and among them are coins, early medieval ceramics with various decorations, bronze buckles, etc.)

Second (Medieval/Bulgarian) – end of the 12th – beginning of the 14th century: new fortress facilities have been built including a new entrance with two semicircular flanking towers, new fortress wall and additional outer western wall, citadel, etc. In the second half of the 14th century the main fortress wall was modified. Without any scientific evidence of slighting or burning, the city was most presumably abandoned by its population at the end of the 14th century.



Fig. 1. General site plan

The name “Rusokastro” is first used by the Arab geographer El Idrisi in his work “Geography of the World” (1153), describing Rusokastro as “big and crowded city”. It is also mentioned in various Byzantine sources from 13th-14th century (Manuel Philus, Georgius Pachimer, John Kantakouzenos, Nicephorus Gregoras, etc.). As an archaeological site the fortress is documented in the 80s of 19th century consequently by

prof. Konstantin Jireček („thick stone wall with preserved wide foundations and traces of a tower“) and Karel Škorpil. [2].

2.2. Archeological survey

The contemporary archaeological survey is being undertaken since 2006 from a team of Regional Historical Museum - Burgas under the supervision of Dr. Tsonya Drazheva (2006-2011) and Dr. Milen Nikolov (2014-). After nine archaeological seasons the results include: significant parts of the main western Medieval fortress wall; the entrance with two gates and two adjacent towers; fragments of Late Antique fortress wall with two towers; additional forward fortress wall; significant parts of the citadel; stone pavement road; Medieval church and necropolis; two buildings inside the city; fortified passageway with a well-tower etc. [2] The findings give comprehensive evidence about the plan, function, building materials and stages of construction of Rusokastro fortress which serves as solid base for architectural analysis. The essence of the excavated and surveyed architectural substance dates from the 13th-14th century, which defines the historical and cultural value of the archaeological site as an outstanding example of the fortifications from the time of the Second Bulgarian Empire.

2.3. Architectural appearance

The functional and zone planning of the fortress defense are defined by the natural settings. The rocky ridge, surrounded by abyss and the river meanders, dominates the broad flat landscape. The location of the mighty fortified city on this hill is identical to the big and thoroughly studied Bulgarian medieval strongholds Tarnovo, Lovech, Cherven etc. [3] The fortified area is divided in three sectors: southern (between the two southern walls); central (between the inner southern wall and the other walls); citadel (on the highest point of the hill), surrounded by its own inner fortress wall. They altogether shape a carefully planned and very hard to attack and pierce defense system.

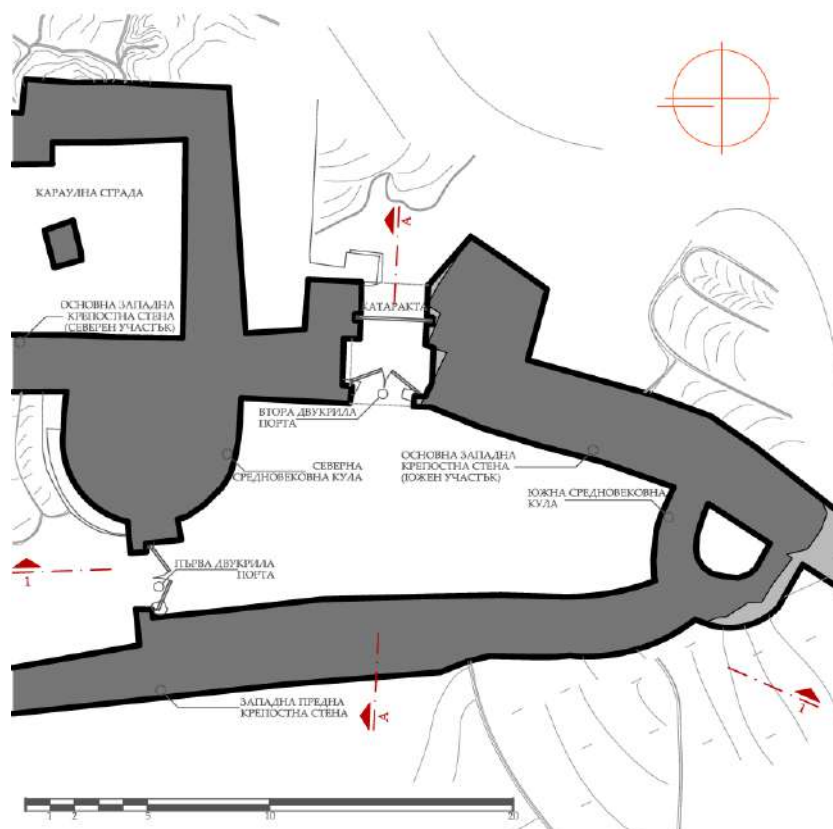


Fig. 2. Main entrance plan (Ideal reconstruction – V. Donchev)

The only potentially vulnerable direction is from east, guarded by a fortress wall and the northern U-form tower. It leads through the first gate to an additionally fortified area, surrounded by the main fortress wall, the outer wall and in the range of the two (northern and southern) U-form towers, located asymmetrically to the entrance. Perpendicular to the first gate, right in the main fortress wall, successively located are the second (bi-fold) and third (porticullis) gates.

The dividing of the fortified area in sectors is a practice on many similar Medieval facilities and its objective is to hinder the potential attackers of the stronghold main entrance. [4]

It is important to mention that this common defensive system at the main entrance, the so called Propugnaculum/barbican (the two U-form towers; the front yard; the stone paving; the outer western wall with its front gate), has been built at once at the very end of the 12th century until the first decades of 13th century. [2]

The stone paved road is flanked from the west by a single-faced supporting wall, and from the east it borders the natural solid rock. In the northern sector of the outer western fortress wall is the side face of the first gate, built altogether with the northern Medieval tower. The gate is bi-fold and its axial stones are still intact. The northern tower is solid up to its preserved height of approximately 4 m and has a filling of stone and soil, without inner wall face. It has been renovated in the last decades of 13th and the very beginning of the 14th century by strengthening and increasing the northern wall thickness. The southern tower has massive walls of stone and mortar. The outer western fortress wall has a face from stone and mortar and filling of stone and soil. It is built in two stages (2.6 m thick in 12th-13th century and 3.5m in the second half of 13th-beginning of the 14th century) and its foundations lay directly in the soil at its northern end. [2]

The plan of the entrance area of the Rusokastro fortress is an illustrative example for adept use of the natural settings and their skillful integration with defensive features.

There are other examples from the Medieval time of Bulgarian strongholds with outer fortress walls and adjacent towers: Shumen (much greater additional fortified area); Tarnovo – main entrance of Tzarevetz fortress and northern entrance of the palace complex (modified plan of the first central entrance from 6th century). [3] Similar settings can be found in the fortresses of Ohrid, Vidin, Žrnov near Belgrade, etc. Very much identical is the southwestern entrance of the fortress of Dimotika/Didimotichon, Northern Greece. Its plan is almost completely identical to this of Rusokastro fortress and it dates exactly from the period 1359-1369.

The second and third fortress gates are located in the main western wall, which is preserved up to the height of 5.05 m (+104.53). In this sector its thickness is 3.34-3.50 m. It is built by stone blocks of various sizes in rows, cemented with grey and yellowish mortar. Currently from the main entrance excavated and surveyed are: northern part of the gate high up to 1.90-2.00 m (+100.52) from the stone pavement (+98.53) and preserved several rows of the foot of the brick vault; the southern part of the gate up to 0.5 m in height; side face, axial and threshold stones of bifold gate; side face and rabbet of the third porticullis gate. [2]

2.4. Ideal reconstruction

Despite the high grade of destruction of the south part of the main entrance, the comparatively well preserved northern side provides sufficient evidence about its plan and constructive features. We have complete information about the contour, building materials, width of the two doors of the second gate, the way they were opened and locked. The same is valid for the parameters of the third (porticullis) gate: its exact location and thickness is traceable through the preserved gutter for lifting the grid. The most valuable information lies in the discovered first rows from the brick vault, starting at the height of approximately

190 cm. Being aware of the vault's radius, the starting level and building material, we are able to provide a completely justified hypothesis about the overall appearance of the main entrance. [4] Additionally, the wall height up to the start of the brick arc provides evidence about the minimal height of the fortress wall when the porticullis grid is fully hoisted. Without having definitive evidence, but analyzing analogical examples, it is presumable that the entrance to the space above the gateway housing the hoisting equipment for the porticullis was from the south. On the upper level is the wall walk, used for movement from north to south and reverse between the two semicircular towers and beyond them across the fortress wall. [4] All of the above mentioned archaeological data and conclusions serve as scientific basis for the graphical reconstruction of the overall architectural appearance of the main entrance with its second and third gates. [1]

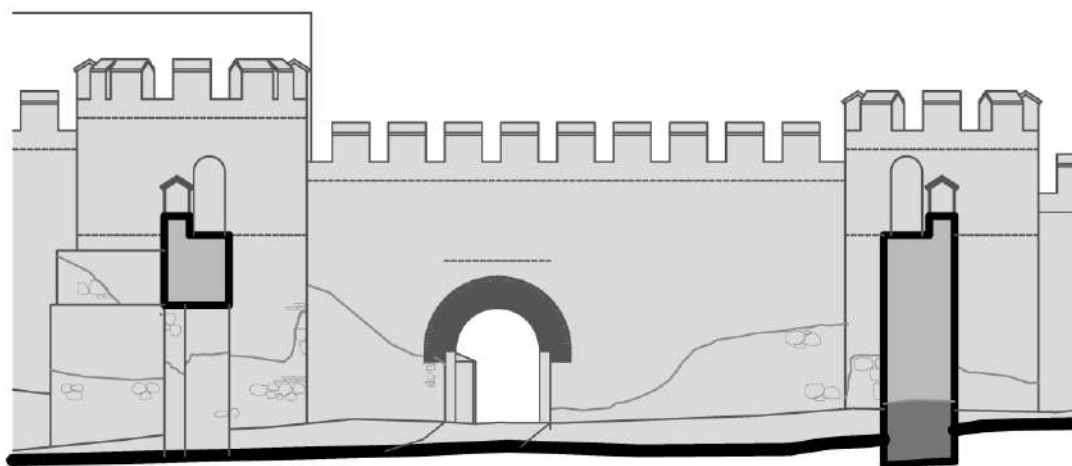


Fig. 3. View 1-1 (Ideal reconstruction – V. Donchev)

In the presence of so much essential preserved original substance and after the comprehensive and years-long archeological excavations, the future process of conservation and restoration will be based on precise scientific documentation and will exclude any conjecture. Significant advantage is the huge pile of the original building material on the slope and inside the fortress, which ought to be reused in the conservation and restoration process. [5]

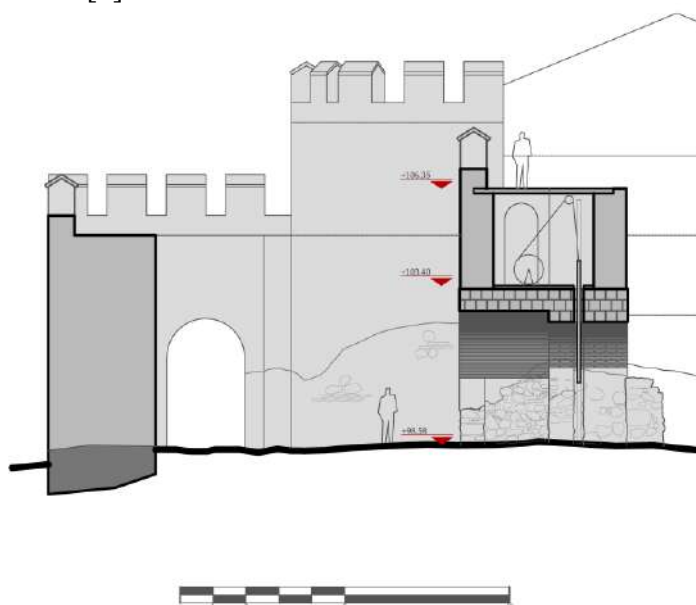


Fig. 4. Section A-A (Ideal reconstruction – V. Donchev)

3. Prospects for conservation, restoration and adaptation

In 2016 the new authority of Kameno Municipality decided to organize and fund intensive archeological excavations with the clear purpose to proceed with the preparation of architectural design for conservation, restoration and adaptation of the already surveyed parts of the fortress. [2] The awareness of the need to safeguard and maintain the cultural heritage and the long and consistent work of the scientific team make possible the preservation of the site as an historical evidence for its time. The authority's vision encompasses assuring employment for the poor local people, establishing recognition, feel of communion and pride of the valuable heritage amongst them and the future visitors. The rebirth of Rusokastro fortress is already a dream and a hope for the whole population of the Municipality.



Fig. 5. Perspective view of the main entrance (Ideal reconstruction – V. Donchev)

3.1. Conservation and restoration

There are no conservation and restoration activities undertaken until this moment. During the years other issues are being solved as the plots ownership and the road, electric and water infrastructure planning and building. In 2019 the archaeological survey has completed the excavation of the main entrance with three gates, two Medieval towers, two late antiquity towers; the main fortress wall; the outer wall; the stone pavement; fragments of the citadel fortifications including fortress walls and towers; fortified passage with tower-well on the northern side of the ridge. After several archaeological seasons it is time for architectural design.

As part of the design team, the author of this study has the clear vision for the proper conservation and restoration methods to be used. Following the extensive archeological and historical study, including the detailed graphical reconstruction and considering the summary of the scientific, spatial and aesthetic settings, it is logical to plan the main entrance and the flanking towers as future natural accent in the general concept for developing the Medieval fortress Rusokastro as a cultural heritage tourism site. The high grade of preservation and the substantial known details about the plan and the overall spatial appearance of the entrance area demand a more recognizable restoration approach, which should contribute vital visual and sensual information to the visitors. [5] Considering the presence of so much undisputable evidence about the specifications and the geometry of the brick vault, when it comes to the design of the future conservation, restoration and adaptation, the rebuilding with similar to the original building material is

justified. The leading principle should be the minimal intervention in the original, which should match entirely the scientific definition for restoration – to preserve and reveal the aesthetic and historic value of the monument which is often hidden, misshapen or damaged. In future interventions, the conservation works by creating superstructure using adequate traditional building techniques with the original and available building material is completely justified and the design team believes this is the best option when possible.

3.2. Adaptation

In addition to the forthcoming conservation and restoration, for the proper socialization of the excavated areas, it is necessary to provide accessibility infrastructure, tourist guides, info tours and other forms of information. In the near future the old tradition of celebrating the Feast of Saint George on the terrace in front of the „St. George“ chapel should be restored, as well as the conduction of ritual meal offering for health, folk wrestling, folklore dances, etc. Other forms of social use include interactive types of entertainment such as: horse races, martial arts, tourist orienteering, extreme climbing, spaleology, etc.

In 2019 the Municipality has applied for two Interreg A (Cross-border cooperation) projects: construction of complex recreation zone next to the fortress and construction of a road to the site. The first one will set up new attractions: mini model of the fortress; thematic space with an open-air classroom; a training board; amphitheatrically placed seating benches for the trainees; thematic outdoor playground; archery site; a boulder and rock climbing site. Proper park furniture will be installed: benches, waste bins, information boards. The realized reconstruction and socialization activities will develop new tourism services for the visitors and will increase the attractiveness and popularity of the archeological site. The results will include increased awareness of local people, tour operators and especially of children for the rich historical heritage of the region. The planned road will provide transport and pedestrian access to the site.

After finishing of this project we expect an irrefutably high cultural impact – both on local population of the Municipality and the whole region, as well as amplifying the foreign tourist impressions, who are already well acquainted with the famous and long recognizable ancient and medieval towns of Sozopol and Nesebar.



Fig. 6. Aerial photo as of Summer 2019

4. Conclusion

Taking into consideration the surveyed characteristics of cultural value, the Rusokastro fortress possesses all the necessary preconditions to fulfil its socially useful purpose. Using the proper conservation, restoration and adaptation methods it will become a first-rate site of the Bulgarian cultural and historical heritage. The acquired scientific data and the forthcoming conservation and restoration architectural design will contribute to the better studying and safeguarding of this very well preserved site, bearing witness of the height of the Second Bulgarian Empire and its material culture in the Middle Ages with significant historical value.

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**MİMAR SİNAN,
THE ARCHITECT OF SÜLEYMANİYE CAMİİ, İSTANBUL, TÜRKİYE**

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Abstract: *Mimar Sinan, who had a life time, nearly for a century, did build very important structures and buildings of Ottoman Empire, till the end of his life in 1588.*

In the construction of the structures and buildings, Mimar Sinan tried novel techniques and solutions in his every next construction with success.

For he traveled a lot and often with the Ottoman Army to everywhere over the continents, he could be able to meet with lots of built examples in the world.

Through his visits to such kind of real structures and also through his experiences about building and constructing, he had a very professional and advanced decision system how to construct buildings and structures, correctly and still in service for centuries.

Süleymaniye Camii, is a very important landmark, having a very clear structural system, easy to follow the loads, starting going down from the top of the dome to the end point of the building, where the foundations are in the earth.

In the paper, the main principles of how Mimar Sinan did construct the structures and how he did solve the structural systems of the buildings, all compose the architectural heritage of Türkiye, still in use today's conditions, will be explained through Süleymaniye Mosque, built in 1550-1557, in İstanbul, by Mimar Sinan.

The aim of the paper is to give an idea about the way how Mimar Sinan designed his proposals, in 16th century, to let others know the secret of him to support a better environment today, in 21st century.

Key words: *Mimar Sinan, Süleymaniye Camii, architectural heritage, novel techniques, İstanbul*

1. Introduction –

Istanbul as the busiest city of Türkiye, which is over two continents, Asia and Europe at once, has lots of architectural heritage, built by Mimar Sinan. As the Great Architect of Ottoman Empire, Mimar Sinan did build and construct so many buildings and structures, having different functions and also all of them are in urban scale, to compose the city and then the country. In his every building and structure, he did try an advanced technology to support novel techniques. The masonry structural system reached to its peak, to pass the large spans at once, by domes and arches.

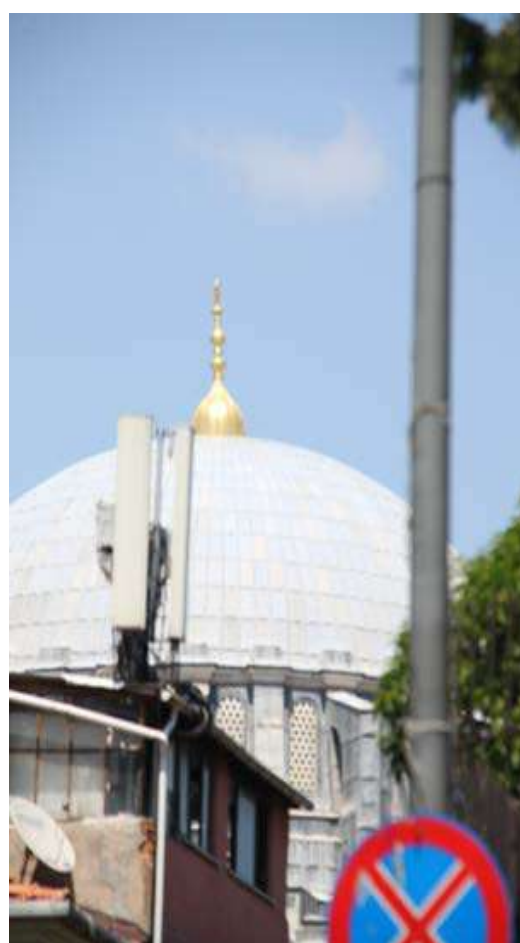
Mimar Sinan did manage to design holistic total spaces, by challenging with loads to down through correct paths, starting from the top of the domes or arches and ending in the foundations under the earth.

In the paper, Süleymaniye Camii (Fig.1.a), Fig.1.b)), which was built in 1550/1557 [1] in the mid of the Süleymaniye Külliyesi, in Istanbul, Türkiye, by Mimar Sinan will be examined through its magnificent structural system solution to let it be a light for the Mimar Sinan's building and construction technology[2]. The Süleymaniye Külliyesi has also other buildings, surrounding Süleymaniye Camii in the mid of the Complex as schools, kitchen, baths, hospital, and more to compose a campus area to support the education and healthy development of the people living in the Ottoman Empire, in the name of Kanuni Sultan Süleyman, who was the tenth Sultan of the Ottoman Empire.

The Structural System of Süleymaniye Camii is very important to create a total space under a main dome.



a)



b)

Fig. 1. While getting closer to Süleymaniye Camii, through Süleymaniye Street, by walking: a) the view of the main dome; b) the main dome; (photos by YK Aktuglu, on 8th of June, 2018)

2. THE STRUCTURAL SYSTEM OF SÜLEYMANIYE CAMİİ

Süleymaniye Camii was constructed with the stone masonry structural system, as stone perimeter walls, stone columns, main dome, semi domes, arches and flying buttresses to support the base of the main dome, not to be damaged due to the pressure of the main dome (Fig.2.a), Fig.2.b))



a)



b)

Fig. 2. While getting closer to Süleymaniye Camii, through Süleymaniye Street, by walking: a) the view of the total top structure; b) the ending wall where the mihrab is, with supporting walls to get the full stability of the perimeter wall; (photos by YKAktuglu, on 8th of June, 2018)

Main Dome above the base of dome, dome pulley, which has serial window openings to get daylight in, has flying buttress at both sides of the main axis, passing through the entrance door from the courtyard to mihrab, at roof level. Roof structure of the mosque has a main dome, above a square plan, having four huge columns at the corners and four huge arches between columns. At roof level, according to main axis, at right and left sides, the arches are supported by itself, having side walls under the arches, with window openings at three levels, to get daylight in. At the main axis, the arches, carrying the main dome are supported by two semi domes at both ends. At the lower level of these semi domes, there are smaller semi domes to support the larger semi domes, through arches.

By arches full with windows, the unique space under is becoming full with daylight. By semi domes, and smaller semi domes, the unique space under is getting larger.

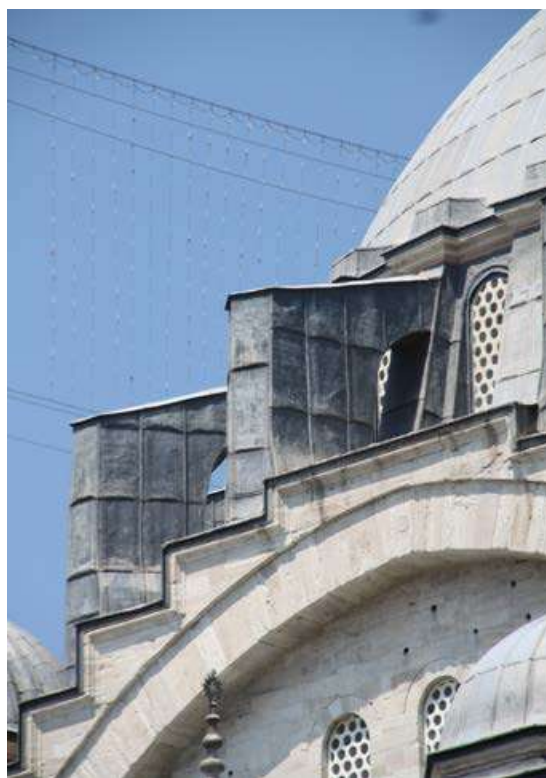
Fig.3.a) shows the main dome, with windows and flying buttresses, main arch, top of huge column, coming up, and the main pathway for loads, going down. Fig.3.b) shows flying buttresses closer, over the main arch, full with window openings.

All window openings are having double window frames, here outside, and also inside. There are voids between two window frames, to protect the weather temperature and also a perfect barrier for sound isolation.

At the top double window frames, there is a solid iron bar section, passing inside the void to surround the dome to protect it by getting the tension loads in safety.



a)



b)

Fig. 3. Main Dome structure : a) it is easy to follow the pathway for the loads going down through the dome, pulley, column, arch, flying buttres, and stepped wall; b) outer window openings together with the whole structure; (photos by YKAktuglu, on 8th of June, 2018)

While looking closer towards roof structure, the whole structural elements are seen clearly in Fig.4.a) and in Fig.4.b). While loads are going down from the top point of main dome, the whole roof top is looking like a pyramid. In other words, the top point indicates the sky. The whole outlook of the mosque is in the service of the loads to be carried in safety. What is really interesting, nearly all walls and dome walls are having double wall layer due to the double window frames over. From one side, this solution makes the structural system lighter and from other side, the structural stability of the mosque gets more importance to last till now along more than 460 years.

The 4 columns have domes at the top of the columns, to indicate the columns from outside. It is easily understood, that while some area in the section of the column is getting the loads from the arches, some area goes on holding the dome stable.



a)



b)

Fig. 4. Total view of the top structure: a) Main dome with other domes; b) Main Dome with 6 flying buttresses at one side; (photos by YKAktuglu, on 8th of June, 2018)

The southwest view of the mosque (Fig.5.a), Fig.5.b)), the texture of structural system could be seen very clearly, where the loads are coming down through the structural elements, both at roof level and also of the building as they are at ground floor and first floor.

The main dome and semi domes and smaller domes together with arches are composing the roof levels, while arches with iron bars are composing the ground floor and first floor.

There are two entrance doors, under the porticos from the southwest side of the mosque.



a)



b)

Fig. 5. Southwest view of the mosque: a) Main dome, main arch, smaller domes, arches to carry the slabs where smaller domes are transferring the partial loads on; b) southwest view of the building after the three arches to carry the slab above, with eaves and arches, connected with iron bars to get the tension; (photos by YKAktuglu, on 8th of June, 2018)

One of the entrance doors at the southwest façade, which is closer to the starting perimeter wall, where the mihrab is on (Fig.6.a)) is having three arches to let the people pass under them to enter in. Over this entrance portico, there are three domes to get the attention for entrance to the mosque. And this part is being carried by another arch, having three windows over the wall under the arch, to get the daylight in. The iron bars are for the entrance arches to let them stay in stable.

At the first floor, nearby terrace of the entrance, composed by arches and columns, the roof structure is a sloping structure with eaves to get the human scale for the prayers outside (Fig.6.b)). There are arches, connected with iron bars, at the first floor also

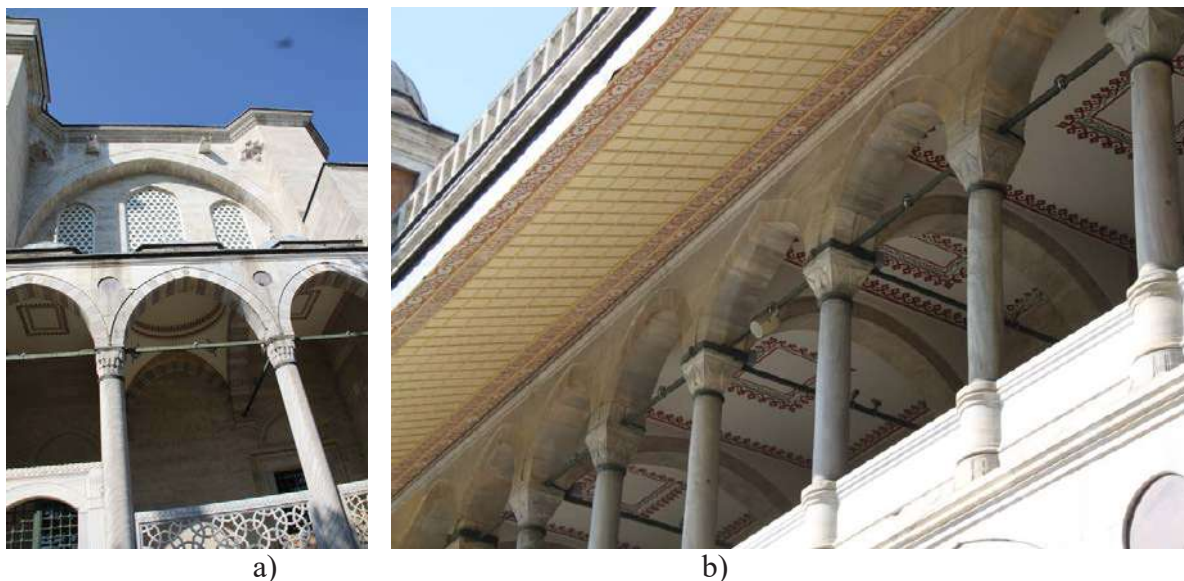


Fig. 6.: Details of southwest side of the mosque: a) Entrance canopy from the southwest side of the mosque, with three arches and three domes; b) first floor of the southwest side of the mosque, with arches, connected with iron bars, having a sloping roof with eaves; (photos by YKAktuglu, on 8th of June, 2018)

The courtyard of Süleymaniye mosque has a rectangular plan, surrounded with arches with dome structures (Fig.7.a)). The composition of the domes in front of the courtyard entrance from garden has a special architectural design as a three storey-high building is welcoming the prayers in the courtyard, to get the stability of the archway at four sides of the courtyard. Also the mid dome, just above the entrance door to the courtyard (Fig.7.b)), is at a higher level than the other 8 domes at one row, as the mid dome, just above the entrance door to the mosque, is at a higher level than the other 8 domes at one row. And also there is a height difference at a higher level, between the row in front of the entrance side to the mosque and also the side dome rows.

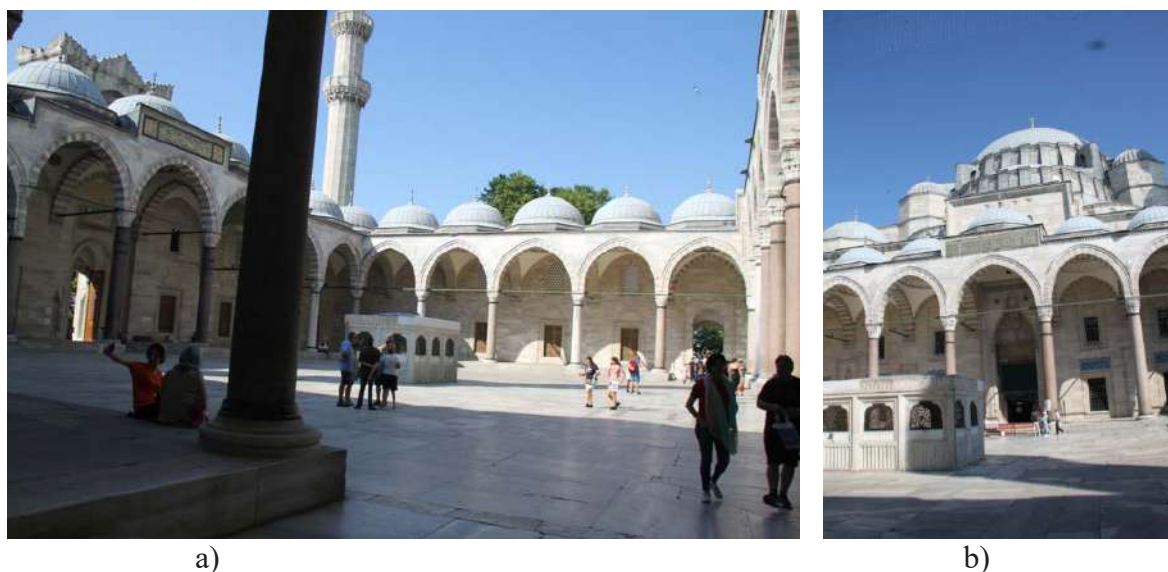


Fig. 7. Courtyard of Süleymaniye Camii: a) the entrance from the garden to the courtyard, surrounded with arches over columns; b) the entrance to the mosque from the courtyard, with a main entrance dome, in front of the main entrance facade of the mosque; (photos by YKAktuglu, on 8th of June, 2018)

In the inner view of the mosque, there is a lamping system, hang down from the main dome, which creates a human scale in the name of the height till to the candle lamping, kandil in past. Behind the lamps, the main structural system, to carry the loads of the main dome, can be seen, with main arch, pendentives [3, p.329] between arches, three arches to carry the semi dome, supporting the thinner arch, columns and balkonies at two different levels as they are in Fig.8.a). The better view of the total space can be understood in Fig.8.b

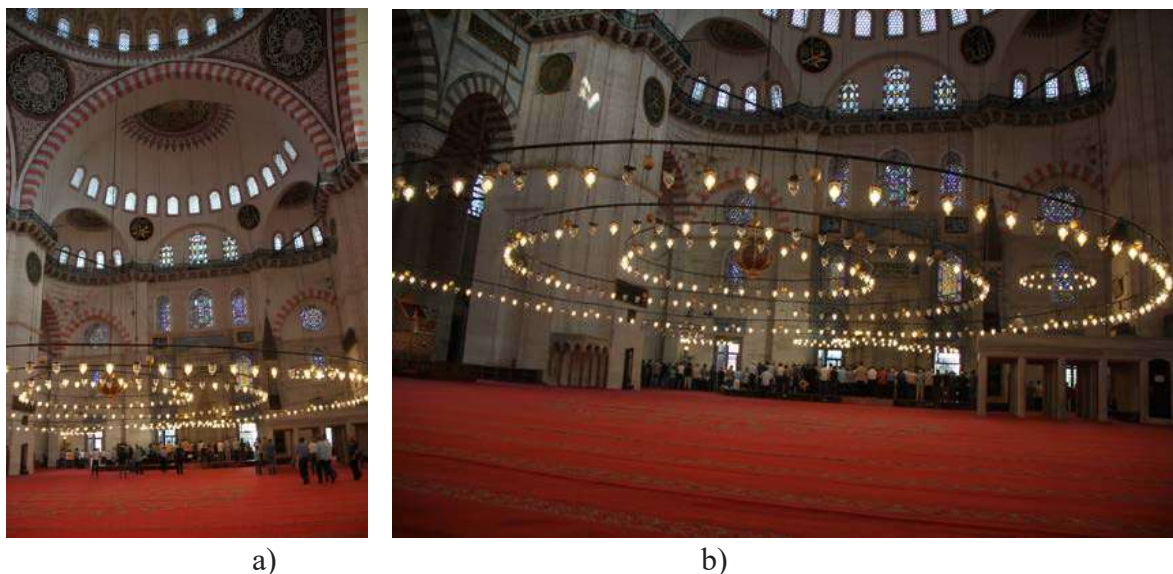


Fig. 8. Inner view of the mosque towards mihrab, to southeast direction: a) the view is from the end level of the main dome till ground floor, between two columns; b) the inner view with the left side arches and columns; (photos by YKAktuglu, on 8th of June, 2018)

In Fig.9.a) and 9.b), the sacred main dome and semi domes, arches and smaller semi domes how they do span over the total holistic space beneath.

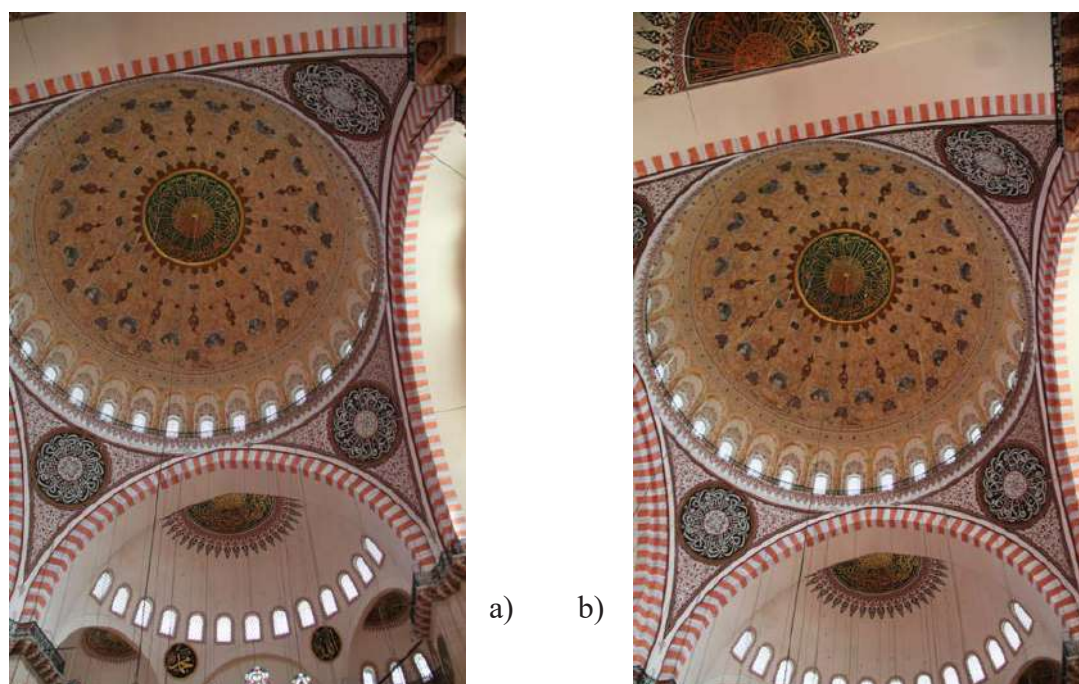


Fig. 9. Inner view of main dome, semi domes, smaller semi domes: a) together with four arches to support the main dome at the top; b) with semi domes also; (photos by YKAktuglu, on 8th of June, 2018)

Under the main arches, as it is seen in Fig.10.a) left side of the mihrab and in Fig.10.b) right side of the mihrab, there is a double section spaces to enlarge the inner space of the mosque.



a)



b)

Fig. 10. The composition of main arches and windows and smaller arches under: a) northeast side composition; b) southwest side composition; (photos by YKAktuglu, on 8th of June, 2018)



a)



b)

Fig. 11. Main columns, closer to mihrab, with the total structural system: a) northeast main column; b) southwest main column; (photos by YKAktuglu, on 8th of June, 2018)

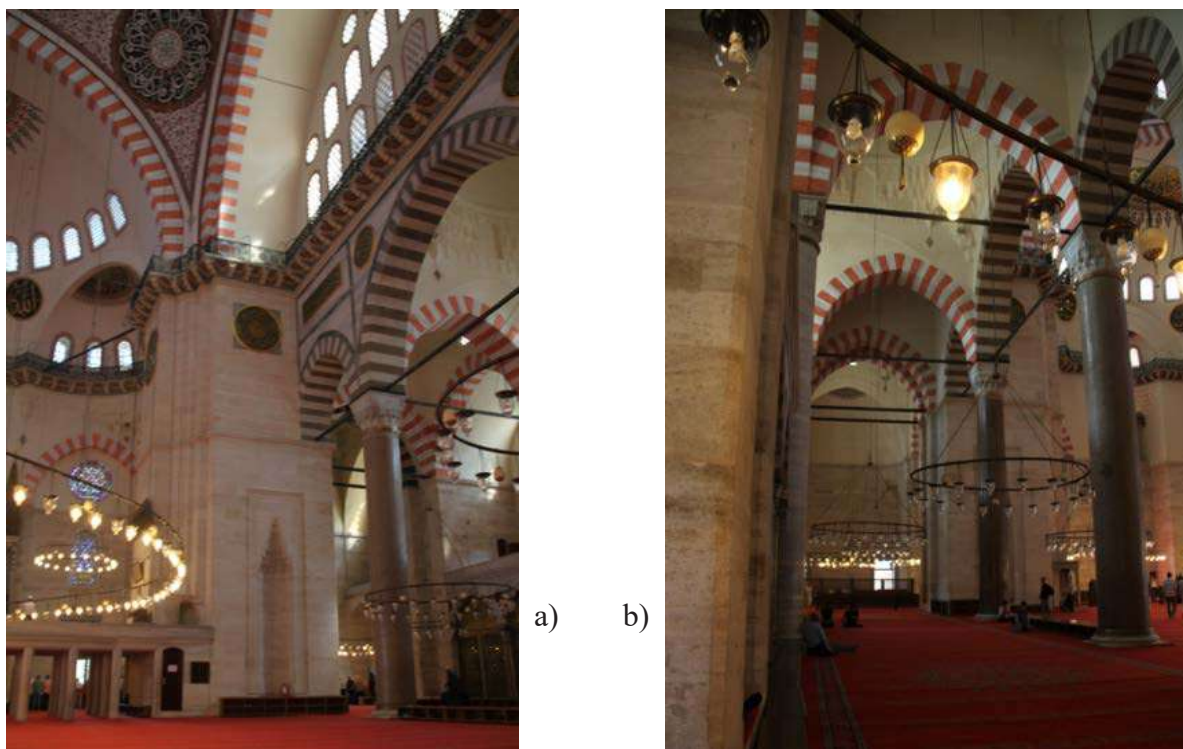


Fig. 12. The composition of the arches and columns under the main arches to carry the main dome: a) the structural composition to design an additional space to the main space to make the main space be enlarged; b) the view of the additional space behind the three arches; (photos by YKAktuglu, on 8th of June, 2018)

The main columns are in fact very fat, but also there are tricky designs of the main columns to indicate the main columns thinner than their real dimensions, as it is seen in Fig.11.a) and in Fig.11.b).

Pendentives between the two arches and also the base of the main dome, are adding additional value to the architectural design quality of Suleymaniye Camii. Arches with iron bars, are enough strong the get the upper loads.

In Fig.12.a) and Fig.12.b), the additional spaces at both sides of the main dome area, are helping the environments enlarge more.

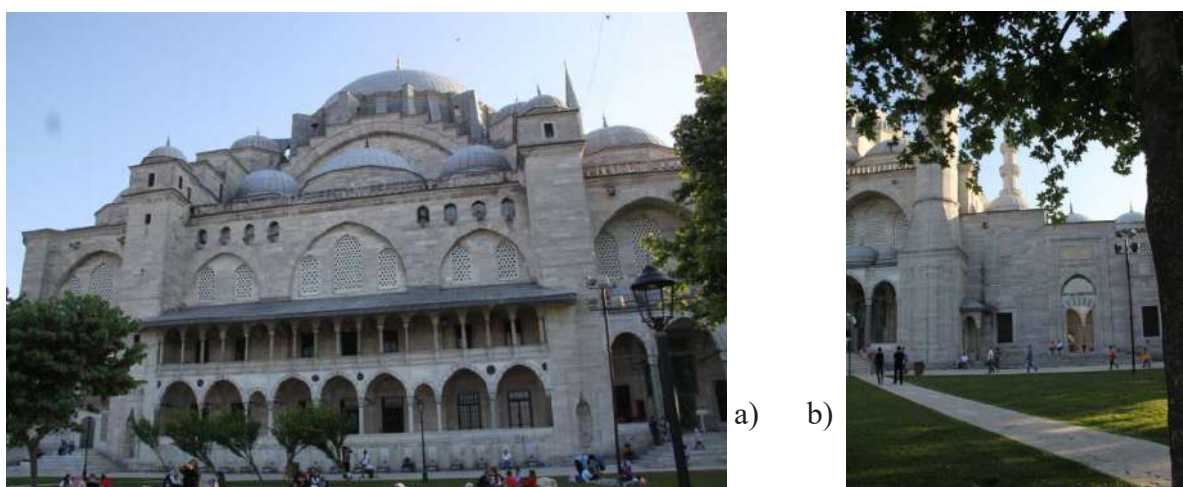


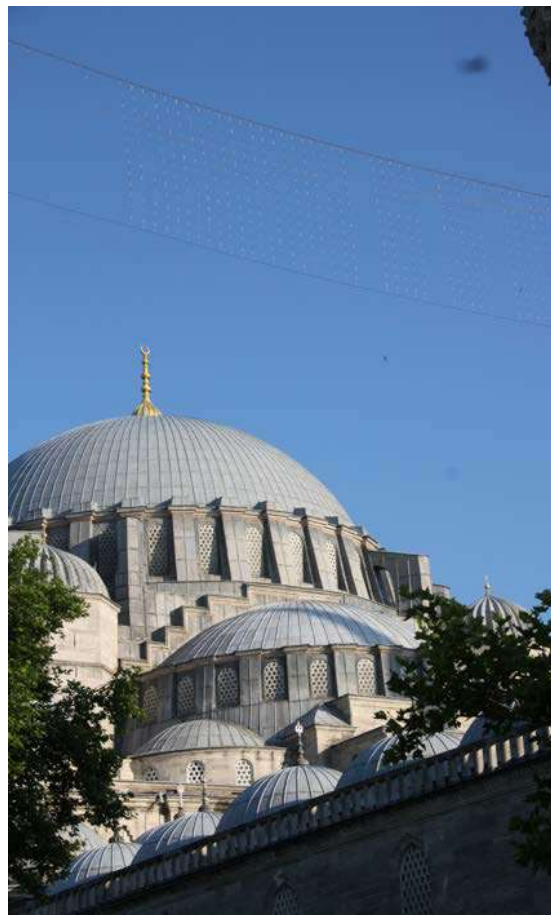
Fig. 13. The northeast view of the mosque: a) all structural texture, composed by main dome, flying buttresses, semi domes, smaller domes, arches, columns are altogether; b) the entrance gate to the courtyard from garden of the mosque; (photos by YKAktuglu, on 8th of June, 2018)

In the Northeast facade, the arches, compose a rectangular base for the dome structures, as well as the arches at the ground level, compose the first floor slab carriers. In Fig.13.a), this can be seen. In Fig. b) gate to the courtyard can be seen.

In fact there are 4 minarets [2, p.297] at four corners of the courtyard. All these minarets can be expected also as the stability elements of the courtyard. In Fig. 14.a) there can be seen 3 minarets at once. In Fig. 14.b) the total roof structure at the Northwest façade can be examined.



a)



b)

Fig. 14. The view of the mosque from the north corner of the garden: a) the minarets, 3 of 4 are standing up at the corner points of courtyard; b) northwest view of the roof structure of the mosque; (photos by YKAktuglu, on 8th of June, 2018)

Mimar Sinan preferred a simple area to sleep, and maybe it is the best place, for it is really at a very real city centre of Istanbul.

Süleymaniye Camii has a huge garden area around the mosque and its courtyard. The wall surrounds the garden area lets the streets go around the mosque. Just across the street corner, the Great Architect of Süleymaniye Camii, Mimar Sinan, rests at his place, seen in Fig.15.



Fig. 15. Mimar Sinan's sleeping place (photo by Y.K.Aktuglu on 8th of June, 2018)

3. Conclusion

Süleymaniye Camii is one of the best mosques of Mimar Sinan to represent the successful outcome of mosques having main dome with semi domes and arches to support the main dome, to create a total space under. Also by remembering that it was built according to the rules of how to build a stone masonry mosque building, it may be clearly understood that how deep knowledge exist in the buildings and structures of Mimar Sinan, mainly in Türkiye and also in the world.

Acknowledgement

I am very thankful for the motivation of Prof. Dr. Doncho Partov about preparing a paper about Mimar Sinan. Thank you very much Prof. Partov.

I am very thankful for the partnership of my colleague, came from DC to visit Istanbul. We have visited Süleymaniye Camii on 8th of June, 2018.

Note

Before this paper, there were,

[1] several technical visits to Süleymaniye Camii with architectural students, colleagues and by myself, in past.

[2] several scientific papers about Mimar Sinan and his 7 mosques, written by a group, including me and my 6 colleagues.

[3] A research project about in the name of the sustainability of Mimar Sinan's 7 Mosques in Türkiye, supported by TÜBİTAK, Turkish National Scientific Research Institution, prepared by me and 6 colleagues, at the same time with COST Action C25, Sustainability of Constructions, which all of us (7 team members), were team members of C25.

This paper, is prepared after a visit to Süleymaniye Camii on 8th of June, 2018. During the visit 469 photographs were taken by Y.K.Aktuglu, on 8th of June, 2018. Through 469 photographs, the results were gained, and explained with photographs.

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MARKET BRIDGES IN EUROPE AND OTTOMAN EMPIRE

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Abstract: *The work deals with one of the specific directions in bridge construction, that of constructions built with commercial buildings, with an emphasis on architecturally unified design. It is analyzed how from the chaotic construction with buildings stepping on one or both sides of the roadway, then in the 15th century goes to the architecturally unified type of the market bridges, consisting of closed commercial or commercial residential blocks, on both sides of the roadway. This typology is mainly the work of Italian architects. Indicative in this area is the work of Fr Giovanni Giocondo da Verona in Paris from the early years of the sixteenth century. However, a key moment in clarifying the idea is the competition for the Rialto Bridge in Venice. Among the several projects proposed distinctive are the grand ideas of Palladio. The latest West European market bridge designs belong to the Scottish architect Robert Adam (1728 - 1792), who was his follower.*

So far, the question of covered market bridges in Eastern Europe, Asia Minor and Iran in the period from the last quarter of the fourteenth to the end of the nineteenth century has not been analyzed in the scientific literature.

There are only individual publications on more significant facilities, mainly from Bursa in Asia Minor, Lovech in Bulgaria and Isfahan in Iran. The architecture of these bridges, which, unlike the West European ones, are entirely covered, is influenced by the Bezisten typology, which is a continuation of the development of the eastern covered market streets. And this seems to be starting to happen around the end of the fourteenth century. The earliest example of a covered bridge (over the Maritza River south of Adrianople) in the Ottoman Empire is only known to me from an image dating from 1388 to 1395. Further, a series of specimens from the 15th - 19th centuries are examined in the work, which is mainly found in the cities of the Balkan Peninsula - Edirne, Nis, Ser, Edirne, Pazardzhik, Dupnitsa, Malko Turnovo, Bitola, Prizren, Lovech, Drama, Gumurjina. etc. in present-day Bulgaria, Serbia, Greece, Kosovo, Turkey and northern Macedonia.

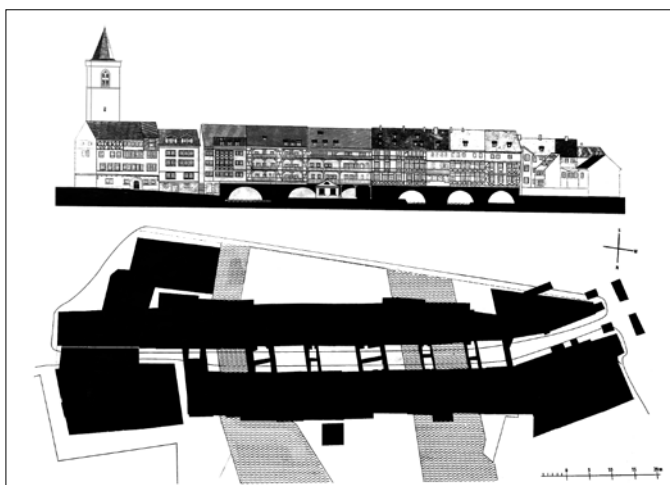
Key words: *medieval bridges, covered bridges, Balkan bridge builders, architectural history, medieval Europe, Balkan Peninsula, Ottoman Empire*

During the first half of the 15th century, the Irgandi (Irgandı köprüsü, 1442) market bridge appeared over the Gökdere River in Bursa. It was built by another Islamized architect of Minor Asia - Timurtash bin Abdullah¹. It is one of the earliest Ottoman covered bridges that will be built throughout the coming centuries until the late nineteenth century.

At the same time, in the western half of the European continent, the construction of bridges with chapels, shops, workshops and even residential buildings dates back to the XI-XII centuries, but then it was mostly a chaotic, time-consuming practice rather than the realization of complete architectural ideas.

Such architectonically thought out solutions emerge and develop only in the typology of covered bridges in front of fortress gates, a fortification idea designed to create narrow, easily defendable spaces, comfortable for concentrated direct fire and limiting fronts, which makes easy the crushing of attacking forces with tumbling rollers, balls and other large shapes with spikes. In German-speaking lands, covered bridges continue to be built due to the poor climate, without being directly related to defense functions.

It was not until the beginning of the fifteenth century that the first thoroughly conceived bridge construction solutions would emerge, sometimes combining in one both ways of building on bridges. Initially, this was done under the old schemes, which formed an open street, surrounded by two longitudinal sides with single or concluded residential and commercial buildings. A typical example is the history of the Kremerbruck (Commercial / Shop Bridge) in Erfurt (Thuringia), where over the repeatedly rebuild wooden bridge shops seem to have always been built, or at least since the beginning of the XII century, because in 1156 it was referred to as the "Pons rerum venalium" (I.e. Market Bridge).

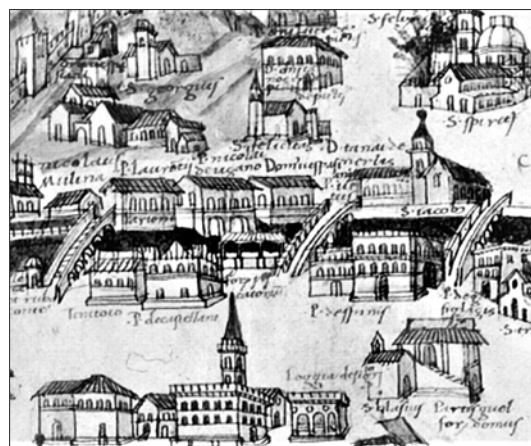


Erfurt, Thüringen, Germany. Krämerbrücke over the Gera River. View from the perspective map of Merian (1650); Summarized plan of the bridge in its present condition; Archival photo views

¹ In the Ottoman name system the personal name and the fathers name are indicated with the prefix 'son of'. It is a medieval practice to adopt a "son of Allah" in the form of "bin Abdullah" or "bin Abiddin" instead of his father's name for the adoption of Islam by a non-Muslim.

The bridge is owned by the local Benedictine monastery, but after its continuous burnings, which continued into the 13th century, the Erfurt City Council purchased its remains, once again burned in 1293, and began construction of a new stone structure. It seems that for the first time the bridge was conceived as a single whole with a commercial street with residential structures for the owners, and in 1325, when it was completed out of stone, there were already uninhabited timber structures on it, confirming the existence of a unified design concept. There are stone tunnel portals on both entrance sides of it, together with a church of the Benedictines and a second one dedicated to St. Egidien. In this form, the bridge has six arches and its 79 m long, with a width of 19 to 22 m. After the buildings burned down in 1472, by 1486, 62 new, this time stone-wooden buildings were re-created. Of course, after that there have been other rebuilds and demolitions.

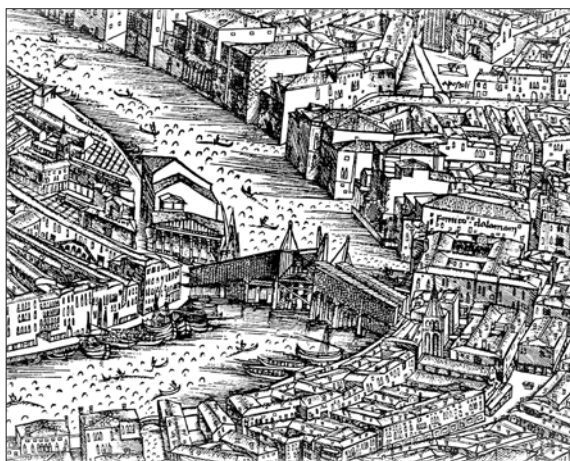
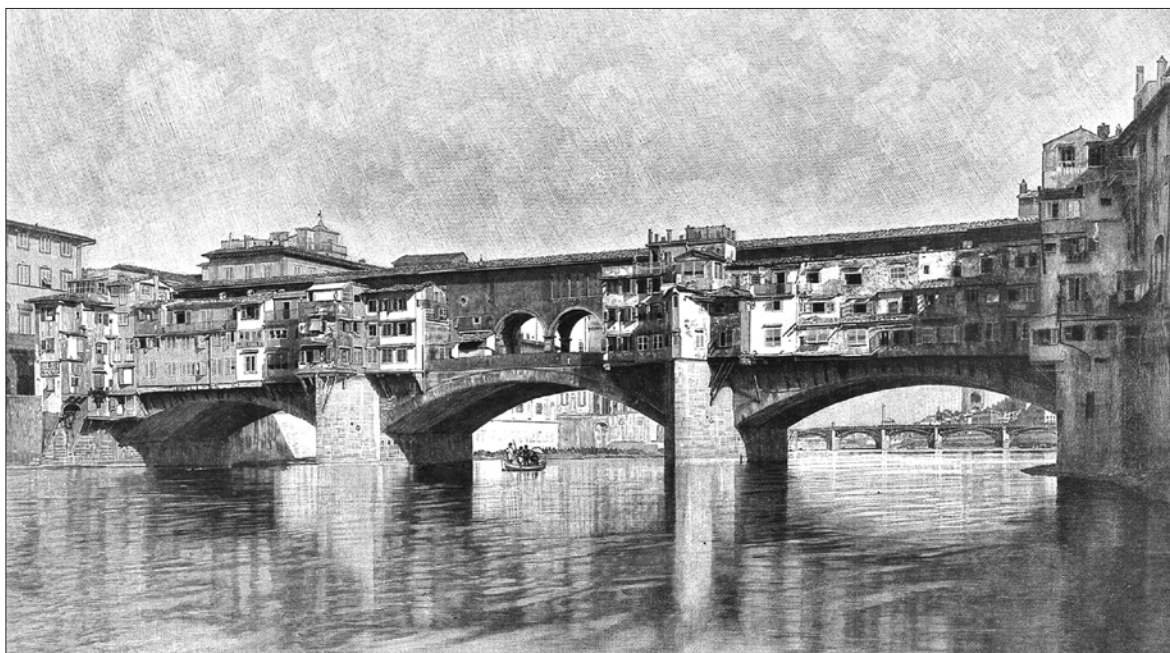
Undoubtedly in Western Europe this line of building market bridges continues to be realized, but more architectonic appearances will appear in the fifteenth century. An example of development in this direction is the Ponte Vecchio in Florence, which was restored as stone after the previous stone-timber one was swept away in the great flood of 1117. There is preserved information that there were twenty stores on it, which were destroyed during a fire on 23 June 1331². In 1333, it was demolished and only two river bases survived, on which later the construction of a new facility began. This new bridge was completed in 1345, with Giorgio Vasari (1511–1574) attributing his authorship to Tadeo Gadi (1290–1366), but nowadays it is also argued that the architect is Neri di Fioravanti (unpublished - 1366), and Gadi is just his associate. Anyway, these excellent bridge builders created together a bold solution of a three-arch structure with segmental arches in the proportion of 5: 1, the central of which exceeds about 30 m. However, it seems that initially two shop buildings corpuses were being built on the roadway, and only on one of its sides.



Bridges of Florence with Ponte alle Grazie (originally Ponte di Rubaconte, 1237) and Ponte Vecchio (1470-1471) over the Arno River. Views of the Charta della Catena (1470 - 1471, Francesco di Lorenzo Rosselli) and of a map of the Geography of Ptolemy (Geografia di Tolomeo, 1472, Francesco di Lorenzo Rosselli)

² For the early history of the bridge is of great value the information in the chronicles of the Florentine chronicler Giovanni Villani (La Nuova Cronica, ca. 1322 - 1348), and is entirely true for the years 1265-1348, because except as seen from him it is also based on eyewitness accounts, preserved archives and written testimony.

This is evidenced by perspective maps of fifteenth-century Florence, the earliest of which is the famous *Sarthe della Catena*, created in 1470 by Francesco di Lorenzo Rosselli, and a miniature in a 1471 book on the geography of Ptolemy, where the bridge is drawn from another angle³. In all of them the market buildings are shown as two-storeyed. Old photographs show a preserved part of these facades, but then over time they were repeatedly partially demolished, reconstructed and upgraded. Subsequently, buildings were also constructed on the other side of the roadway, but the front was only partially covered by shops, mainly above the ruts and on the sides of the central arches of the bridge. In 1565, the corridor of architect Giorgio Vasari, commissioned by the Duke of Florence Cosimo I Medici, will pass over them, which will give a monumental appearance to the facility⁴.



Florence. Ponte Vecchio (1470 - 1471) with the corridor of architect Giorgio Vasari (1565) commissioned by Duke Cosimo I of Medici. Views of the woodcut from 1893, the perspective map of Paolo Forlani (1569) and predecessor of Ponte di Rialto – Ponte della Moneta, by the perspective map of Jacopo de Barbari (1500)

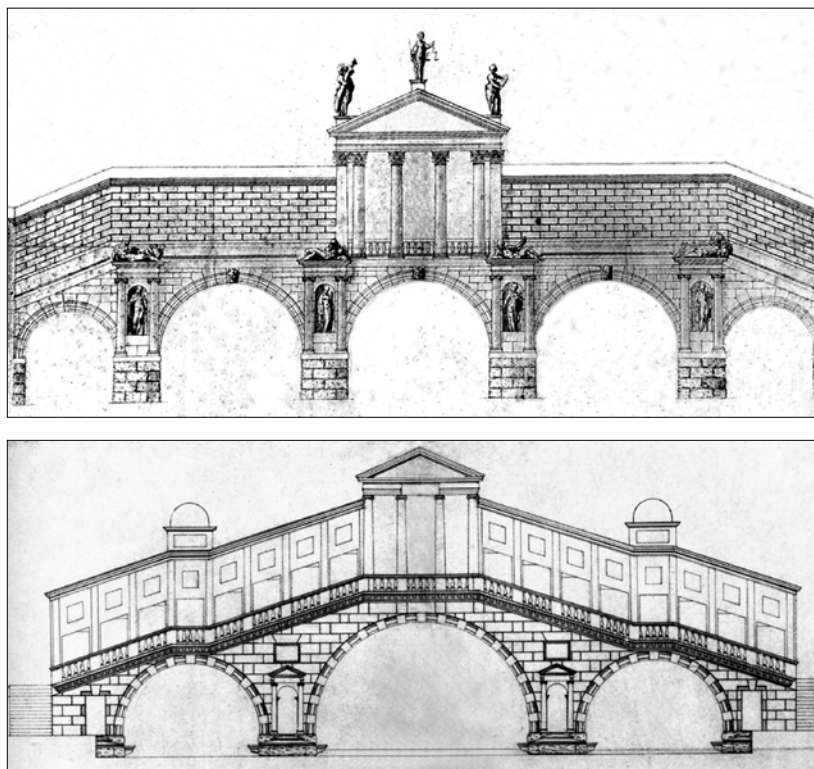
³ Mappa di Firenze. - In: *Geografia di Tolomeo*, 1472, Bibliothèque nationale de France, Paris.

⁴ The Vasari Corridor connects the Palazzo Vecchio administrative center through its south extension - Uffizi, to the residence of the Medici, Palazzo Pitti. It is long in combination with its coastal and bridge sections over 850 m.

The real beginning in the area of architectonic unity of a bridge structure with store buildings seems to be set in motion as construction intentions began for the creation of a stone bridge over the Grand Canal in Venice of the Rialto to replace another, already damaged wooden one, Ponte della Coin. The earliest proposal for this stone facility dates back to 1503 (it looks like Fra Giovanni Giocondo da Verona, who also made a project in 1514), and the first decision by the city government for its creation is in 1507. Following a lengthy deliberation in 1525, a tender was announced for the project, and a little later, the Venetian Doge Pasquale Chiconia held a competition. All of the proposal stages involved several of the most famous architects of the era - Andrea Palladio, Jacopo Sansovino, Vincenzo Scamozzi, Jacopo Barotzi da Vignola (maybe some project had Michelangelo Buonarroti) as well as some almost unknowns like the Swiss from Lugano Ponte, who will unexpectedly receive the order after the last round of 1587-1588. According to some sources, however, the original version of the winning project was submitted by Alvise Boldù ("dal Nobil Homo Alvise Boldù"). The final choice is mostly based on a project that is the only one created with a single large segmental arch.

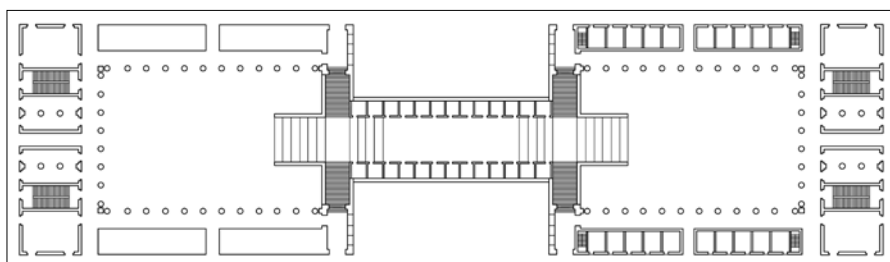
All of the preserved project designs created by the various authors have been resolved in the spirit of mannerism, based on the free interpretation of classical Vitruvian architecture.

Skamozzi's project made in 1587/8 is for a three-arch curved bridge with stairs going down to the shores, which greatly complicates the normal functioning of the store buildings. Only at its uppermost part above the main arch it had a broader area beneath colonnaded gates on both of its sides, but it is not a market area instead it's intended as a recreational area with river views. Skamozzi uses Palladio's scheme from 1551, which provides one central lane and two side promenades with shops.

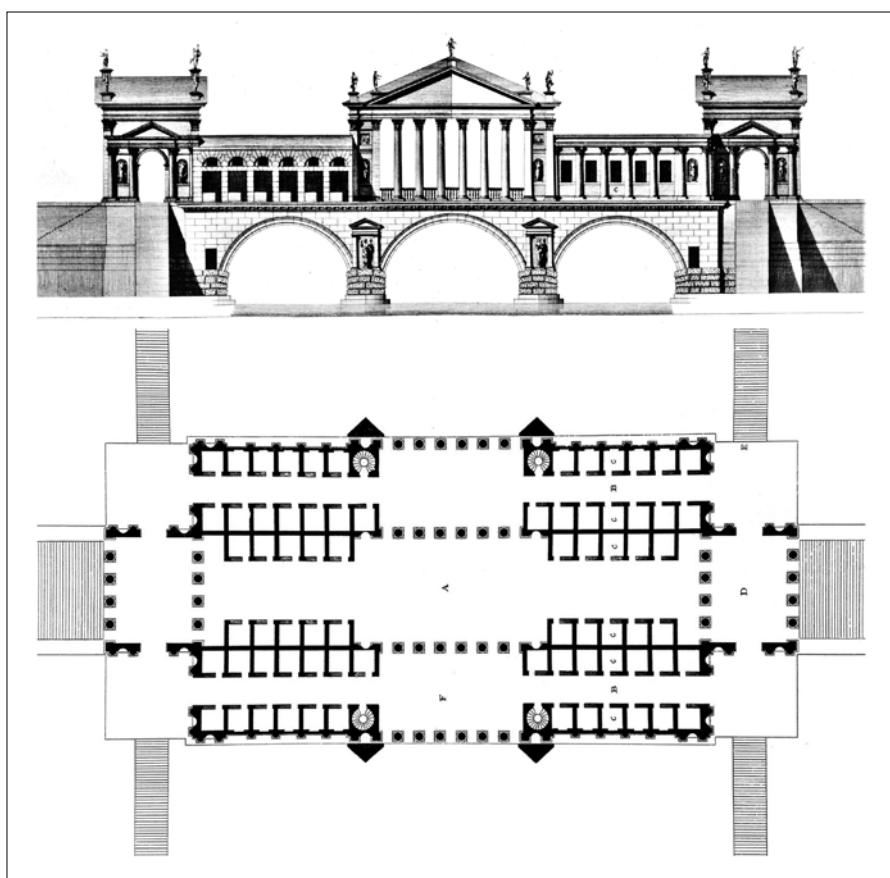


Andrea Palladio's first competition project for Ponte di Rialto (1551)
and the competition project of Vincenzo Scamozzi (1588)

This first of the two projects, created by Palladio, is much better suited than Skamozzi's idea which was perhaps based on it, because it offers embankments with long side stairs from the shores to the flat road with shops. Particularly pompous is the second of his projects (1566), which also has three parallel longitudinal shopping streets with three staircase approaches to them at the two opposite ends of the bridge, but the sideways were built with shops on both sides. He also developed the idea of a central space-marquee, offering a monumental transverse ship with colonnades and triangular pediments on both sides, but also added frontal, as well as colonnaded, porticoes on either side. Naturally, this super-heavy superstructure steps on three identical arches, lying on two mighty river bases with breakwaters and antique niches with statues above them. In fact, for the commercial needs of the city, this is functionally the best project, but obviously the very high cost of construction impedes its acceptance.



Andrea Palladio's first competition project for Ponte di Rialto (1551) – floor plan



Andrea Palladio's second and most extensive project for the Ponte di Rialto, in the original drawing (1569, published in *Quattro Libri dell'architettura*)

Antonio da Ponte's final project that won the tender, for which it is not clear whether and how much it has anything to do with the one proposed earlier by Alvis Baldou, also has central and lateral stairways inclined toward the shores, but through differential staircase approaches to them both shore climbs receive a slightly more moderate percentage of excesses⁵. In addition, there are narrow access areas at each store's entrance. This bridge also ends at its highest point with a panoramic landing with single arch porticoes. Its length is 48 m, from which the arch exceeds 28.80 m, with a hull width of the considerable 22 m. The foundations of the coastal bases are grounded deep below the bottom on 6000 wooden piles, followed by hydrophobic mortar-covered grates and lying on them masonry of gradually bending inwards rows of bricks, followed by stone construction, thus becoming perpendicular to the tensile forces of the vaulted structure.



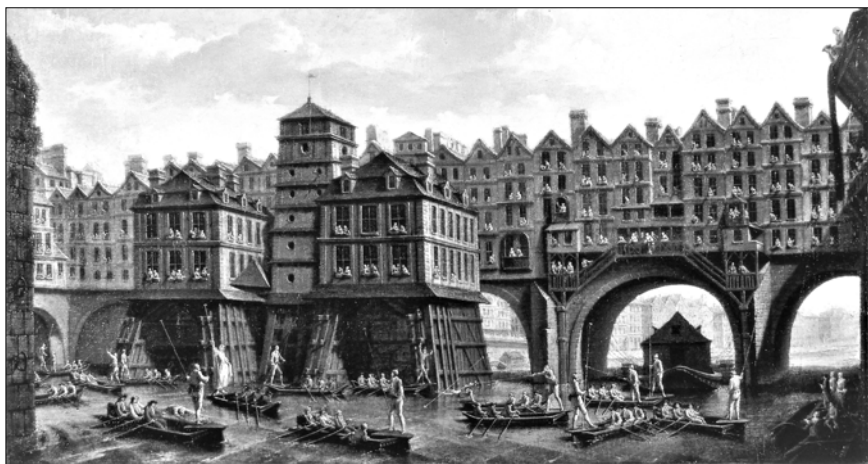
Perfectly realistic painting by Giovanni Antonio Canal-Canaletto (ca. 1727, Parma, Galleria Nazionale) of Ponte di Rialto by Palladio. Photorealistic views from the south of Canaletto (1727) and from the north to Michele Marieschi (1735) by Antonio da Ponte's realization

⁵ In 1590, the Venetian Senate granted to Ponti a patent for bridge building innovation, under which no one was allowed to sell views of the bridge for 20 years. Skamozzi, however, objects, considering that he is in fact the author of the architeconic scheme, though his is not based on a single-vault but on a three-arch construction, but also borrows ideas from Palladio's first project. And also Skamozzi, probably angry with his loss at the last of the competitions, predicts that his bold arch will inevitably collapse - something that never happens.

The construction began on June 8, 1588 at 6 pm and continued until July 1591, led by Antonio da Ponti, but in his team he included with no doubt his 20-year-old grandchildren Antonio and Tommaso Conti as journeyman.

Despite the creation in the sixteenth century of this progressive new line in bridge construction, it finds almost no continuation elsewhere because of the extremely high cost of this type of construction. Instead, the chaotic construction on top of bridges continues to be widely practiced, especially in the German-speaking territories of Europe and partly in France, Italy and England. In countries with harsher climates, especially in the German states, many covered, purely pedestrian bridges are still being created, sometimes only with added chapels.

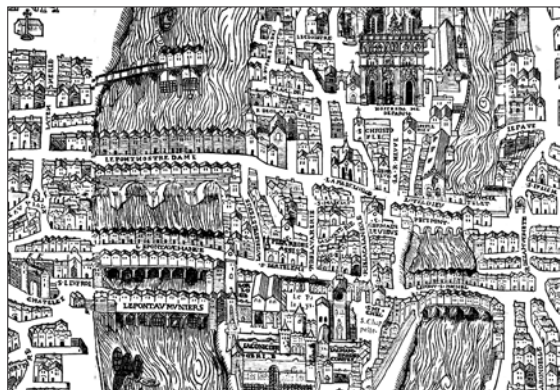
Among the exceptions are some of the bridges over the Seine along the streets of Paris, passing through the island of Saint-Ile-de-la-Cite, which were periodically rebuilt with their housing and commercial upgrades. Of these, the longest life had the Pont Notre Dame, which rolls over the large arm of the river at Sita. Built as a wooden one during the Celtic period, it was rebuilt as a stone one by the Romans and once again rebuilt as a stone-wooden one on the ancient bases. In 885 or 886, it was burnt down by the Normans besieging Paris and was therefore abandoned. Shortly thereafter, downstream another one was constructed to replace it, known as the Pont des Planches de Milbray. How many times after that it was repaired and rebuilt, is not very clear, but there are reports that, during the time of Charles VI Le Fall (1380-1428), it was destroyed in the great flood of 1405, its restoration this time was on its original location in front of Notre Dame Cathedral, which is why it began to bear its name. The new 115-meter-long structure was again wooden and includes 65 houses with shops on the ground floor. The idea is to achieve a unified image that serves to "decorate and increase the city's income." Poor maintenance, however, led to self-destruction in 1499. So one year later, Dominican architect Fra Giovanni Giocondo da Verona, working at that time in the city, was designing a reconstruction with a six-arch stone structure. The construction of the building, which was carried out by the city master Jean de Fellin, was completed in 1507, and the envisaged 68 residential buildings with shops on the ground floor - in 1512.



Paris, Cité Island. Pont Notre-Dame painting by Nicolas Jean-Baptiste Raguenet (1751, Musée Carnavalet in Paris) and by engraving (XVIII century, anonym)

The symmetry and architectural qualities of this construction make it a benchmark for the construction of shopping streets and other covered bridges in the city. According to

Merian's perspective map of 1615, this type architectonics is also owned by the Little Bridge and the Saint Michel Bridge over the small arm of the Seine, as well as a pair of adjacent bridges over the big arm near Pont Notre Dame. Of this type is the building along Magdelen Street, located between the Notre Dame Bridge and the Little Bridge.



Paris, Cité Island. View of all bridges built on perspective maps of Truschet & Hoyau (1550) and Merian (1615)

Pont Notre Dame was repaired along with part of the buildings on it in 1660, but 126 years later, in 1786, the depreciated and becoming dangerous structures were destroyed and in 1853 it was rebuilt on the old foundations and the stone hull.

An identical method of construction also appears on the Bristol Bridge over the Avon River in England. It was built with stone in 1245–1247, along with the built on top timber-framed houses with shops, the rents of which are intended to provide the means for its maintenance⁶. In the following centuries, due to the not durable construction of the buildings, they were undoubtedly rebuilt and upgraded, and in the 17th century it gets to the point where they were marked as four-storeyed, crowned with fifth attic levels. We also see them like that in engravings dating back a hundred years later. In the center of the bridge in 1361 a large two-storey chapel “St. Assumption of the Blessed Virgin Mary” was built, with lower level crypt and a bell tower. It was destroyed along with more than 20 other buildings in a fire in 1647.

Because the roadway was only about 6 m wide, the building, although console-mounted above the river, became in places a dangerous obstacle for passers-by, and in 1760 it was decided the facility is to be demolished and a new one to be built.

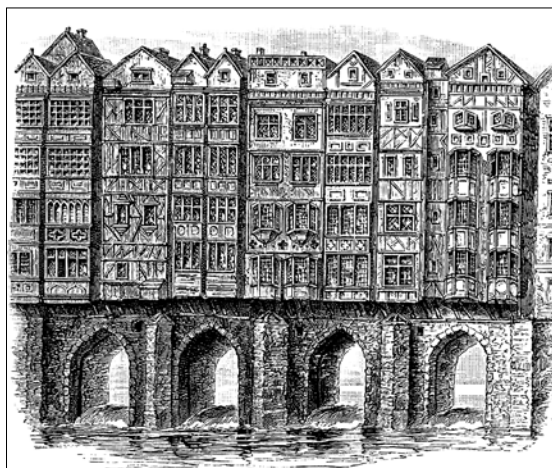
In a similar way goes the construction history of the London Bridge over the Thames River. Built for the first time between 1176 and 1209 (Protomaster Peter de Colechurch) as

⁶ According to the “Adam's Chronicles of Bristol”. Written by William Adams between 1623 and 1648.

See her digitalization at:

https://archive.org/stream/adamsschronicleo00adamuoft/adamsschronicleo00adamuoft_djvu.txt https://archive.org/stream/adamsschronicleo00adamuoft/adamsschronicleo00adamuoft_djvu.txt

Under the year 1245 notes: “... the Bristol Bridge began, and the inhabitants of Radclay, Temple and Thomas were united (through him) into the common town of Bristol, whereas before they were in two (separate) cities and there were two markets, one at the Bristol High Cross and the other at Staleng Crosse’s Tempell Streat. And the land on the Augustan side of the river was given and given to the monk of Bristol by Sir William Bradstone, abbot ...”. That means that the bridge is a construction work of the monastic order in Bristol.



Bristol, England. The bridge over the Avon River (1245 - 1247, chapel - 1361).
Views on engravings from the seventeenth century



London Bridge (1176 – 1209). View by a painting of Anton van den Wyngaerde (1545)
London Bridge (1176-1209). A general view on an engraving by Claes Jansz Visscher (1616)
and of the Bridge Street (eighteenth century)
London Bridge (1176 – 1209). View by a painting of Claude de Jongh (1632)



a stone multi-vaulted structure, which is what was customary for the time of The Late Middle Ages, it was gradually and chaotically built up with residential and commercial buildings along its 273-meter length. In the oldest engravings of the 15th - the beginning of the 16th century, the construction in the sections between the tower gates was loose and made of one-storey and two-storey multi-format buildings. In the first half of the next century, the first blocks appeared, consisting of uniformly designed party walled three-storeyed buildings. We can see it, for example, in the 1545-year drawing of Flemish Antonis van den Weininger, where a block of three-storey buildings is only in the section to the north of the bridge's chapel, and the rest of the bridge is still with the old lax construction of small buildings. Undoubtedly, by the end of the same sixteenth century, the newer type of building construction covers the southern part of the bridge too, because in engraving from 1616, Claes Van Visscher will create a panoramic view of London, with the bridge, the hull of which is already covered by four large blocks of four- and five-storey buildings, between which a shopping street is sought along the axis of the bridge lane. Probably this dense building has often suffered from fires, and therefore in the cavalry lane of 1632 by another Dutchman, Claude de Jongh, one can see destroyed parts of these blocks restored to different heights. A more significant reconstruction took place at the end of the same century, when the architecture of the buildings was once again modernised.

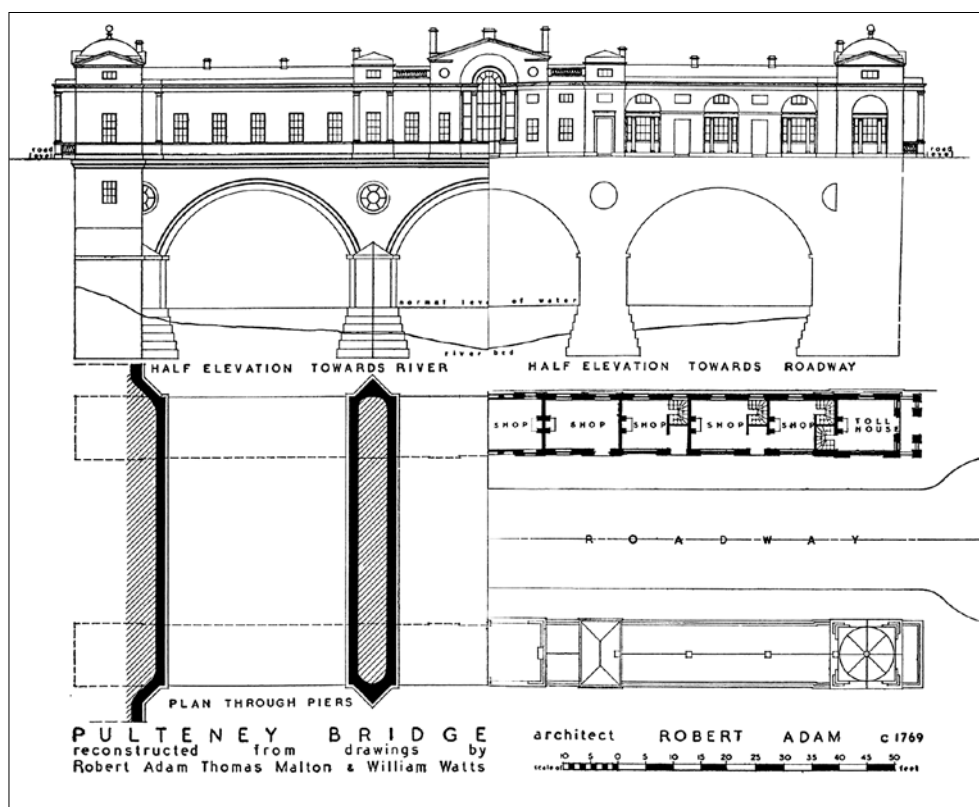
It may be added that during the Late Middle Ages, and afterwards, some palace buildings were built on bridges, as if mostly in France. Such a bridge wing over the Cher River has the Chenonceau Castle in the Indre-et-Loire department, designed by arch. Filiber Delorm and built in 1580 by Arch. Jacques Andrew Dusserso.



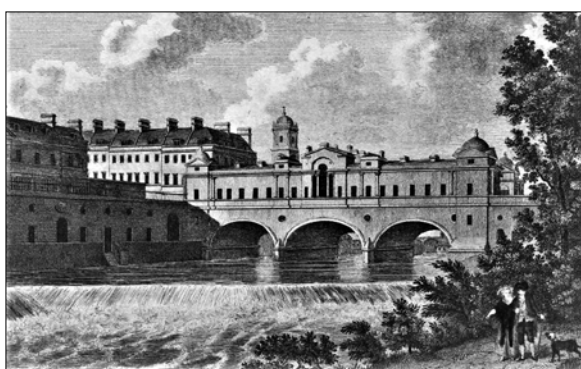
Department of Indre-et-Loire, France. Bridge wing of Chenonceau Castle over Cher River (1580)

The architectural unity of bridge structures with market buildings on them has its unexpected renaissance in the eighteenth century in the work of the great Scottish architect Robert Adam (1728–1792), the creator of the specific interior style “Adam” as a part of English neoclassicism. Working with his brothers James, John and William, among his many projects and realizations, he also has about 10 bridges, two of which stand out especially in this particular architectural area. These are the bridges in Bath, England, and

in Edinburgh, Scotland. Undoubtedly, they were influenced by what he saw and learned during his specialization in Rome between 1754 and 1758, when his mentor was the famous architect and architectural historian Giovanni Batista Piranesi, and when he specifically studied the work of Palladio, which underlies part of architectural visions from the seventeenth to eighteenth centuries, known as Palladian style. Of the two bridges with commercial streets, only the one in Bath (Pulteney Bridge) was built, built over the Avon River by Arch. Adam between 1769 and 1773 commissioned by the famous lawyer, farmer and politician Sir William Plutney. It was intended to connect the agricultural lands of the contractor to the city. Sir William assigns the work to his friend and compatriot Adam, who, impressed by the Italian designs, offers their structure as lucrative. It was designed and built as a bridge shopping street with shops on both sides of the roadway, solved in the neo-classicistic Palladian architecture of Adams, with dominant structures at the center of the building on both sides and at the ends at the entrances to the bridge.



Bath, Somerset County, England. Pulteney Bridge over the Avon River (1769 - 1773, architect Robert Adam). A reconstructive view of the project from the original drawings of Arch. Robert Adam (1769) General view of the bridge by Thomas Malton (1788) and the bridge street by Joseph Mallord William Turner (1810)



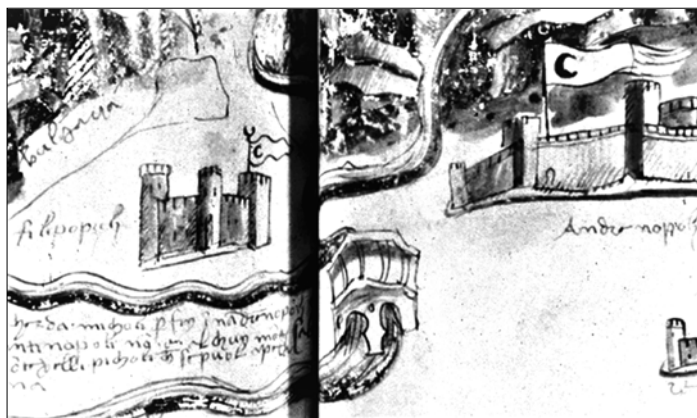
The second of Adam's commercial bridges was developed in 1790–1791 as a grand structure connecting the city along Princess Street and across the suburban Low Calton Hill to Leith Harbor. It was intended that a trace for a road would pass beneath it, now called Calton. It is a huge bridge structure, reaching to eight floors above the level of the road, made in Adam's Palladian style of neoclassicism. The design is extremely large and expensive, so this bridge was never realized.



Edinburgh, Scotland. Unrealized project for the so-called South Bridge (1790 - 1791, architect Robert Adam). General view of a watercolor by the author

So far, the issue of covered market bridges in Eastern Europe, Asia Minor and Iran from the last quarter of the fourteenth to the end of the nineteenth century has not been analyzed in the scientific literature. There are only partial publications on some of the more important facilities, mainly from Bursa in Asia Minor, Lovech in Bulgaria and Isfahan in Iran.

Until recently, there was no known archaeological or written source from the fourteenth century for the construction of covered bridges on the Balkan Peninsula too. I was recently impressed by an image of an anonymous Italian military map of the Balkans, dating it by the rulers' flags on the fortresses from before 1396, but not earlier than 1388, when the city of Sofia was Ottoman.



Adrianopolis (today Edirne, Turkey). Covered bridge over the Maritza River south of the city (14th century). View of an anonymous Italian military map (French National Library)

It is positioned after the big bend of the Maritza River and its merge with the Tundzha River, which means - at Adrianopol, although the city is marked rather northwest of it. However, which according to the realities of the Middle Ages is true, it is not by chance then that the approach to the main city gate is after the bridges across the island of

Tundzha. And the image itself is of a massively-built vaulted covered bridge with a colonnade upper structure that steps with its middle foundations on an island in the Maritza River. Where, then, should this facility be sought after it has been established for the time being that, by the end of the fourteenth century, the only existing bridge pair was the one across the island of Tundja - known today as the Gazi Michal Bridge and the Yaldaram Bridge, the first of which was later renovated in 1502 (or 1520). Of course, there is the possibility it might be either one of these two bridges crossing the road through Tundja Island, assuming that there is an inaccuracy in the image. Even with this hypothesis, the city would still be east of it. At the same time, in 1672, Parisian Antoine Galan saw large-scale remains of a bridge 7 km south of Edirne, near the Bulgarian village of Bosnakoy (now Bosnia, Turkey). "Walking along the Maritza riverbed," he writes, "I noticed remnants of a stone bridge there and, as it seems, quite long ..." As a location, this bridge completely corresponds to the location marked on the map after the river bend. It lies on the main route from Antiquity, connecting Via Ignatius of Traianopolis (Thracian Dorisk, today Banya, Ladzhaki, Lutra) through Dimae (today Feres) and Plotinopolis (now Dimitika) with Adrianopolis (day Edirne and Odrin) Via Militaris. In fact, it is also the direct connection of Edirne to the nearest seaport, which is extremely important for trade during the Middle Ages. It is possible that this bridge is a key trading and customs point on the Belorussian coast for the medieval themes of Macedonia and Thrace, as well as for the Kingdom of Bulgaria⁷.

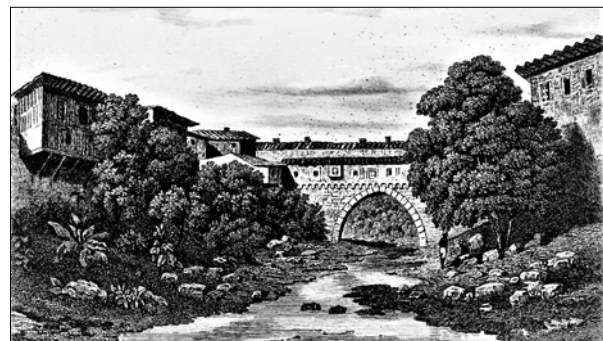
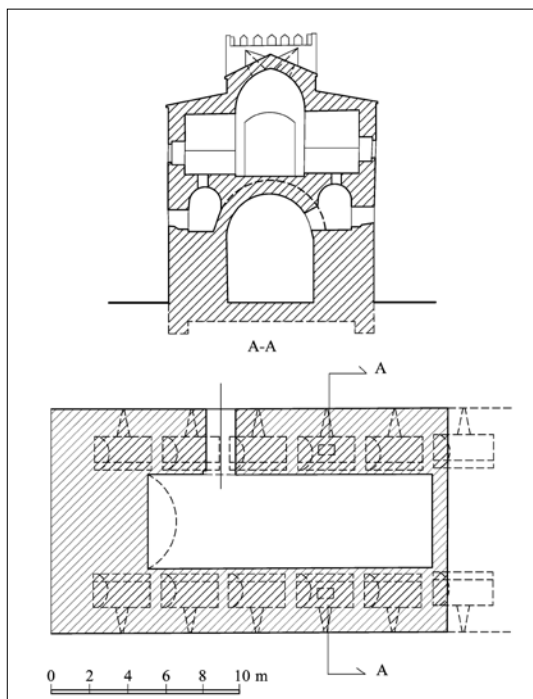
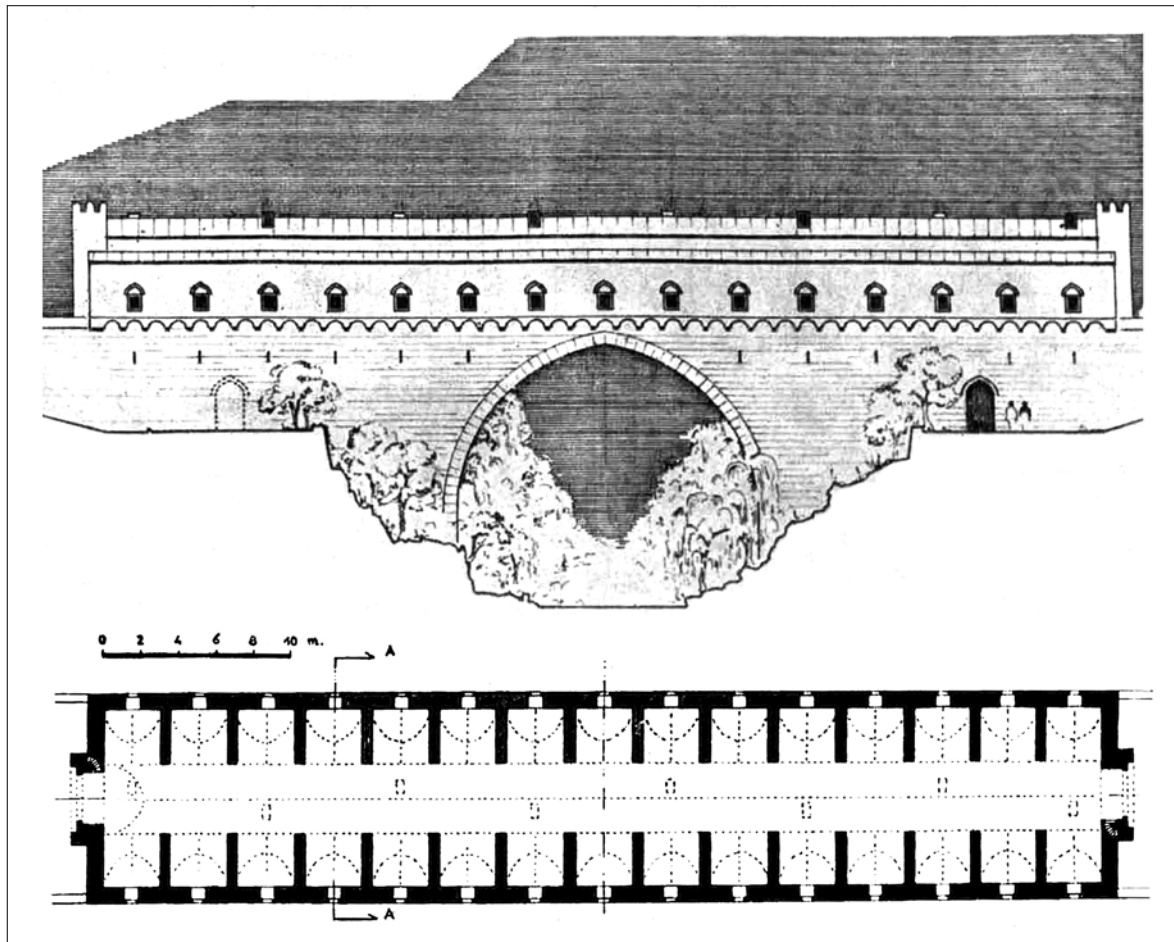
If the legend of the creation, told by Evliya Chelebi, is believed to be true, then from the 14th century dates the Irgandi Market Bridge over the river from the Gökdere Gorge in Bursa dates back. According to her, in the capture of the city in 1326, one of the participants in the battle finds gold coins scattered in the creek. He takes them to Sultan Orhan Bey as booty, but he tells him in charity to build a bridge with them in the same place, which was fulfilled.

However, according to the Kadi register of Bursa, the bridge was built by a Hajji Muslihiddin bin Ali al-Irgandi in 1442 who was killed in 1492 in Bilecik⁸. The same registers (Defter, no. 72, p. 114) state that in 1559 the grandson of the donor, Ahmed Chelebi, planned to create 31 shops and a masjid with the legacy bequeathed to him by his father. In 1855 the stores were already 33, ie. either a larger one is split in two, or the masjid has disappeared and two new shops have been formed in its place. Dr. Yilmaz Yonge, in his excellent scientific bridge studios (studies), has made an architectural restoration, in which the shops are 30. He furthermore believes that it has been built as a market bridge by Muslihiddin. It cites an in-depth architectural analysis, according to which some of the premises built into the hull are warehouses that can only be connected to upper structures erected above them, and therefore suggest that the initial shops may have burned down⁹.

⁷ Unfortunately, the electronic copy of the map that I have is poorly scanned and with insufficient resolution for me to read the detailed four-line inscription next to the image of the bridge.

⁸ Bursa Kadi Registers, Defter, No. 13, p. 11. The reference is to Irgandi Köprüsü, Bursa'da Gökdere suyu üstünde XV yüzyılda yapıldığı sanılan köprü. - In: İslam Ansiklopedisi.

⁹ Onge, Y. The Original Architecture of the Irgandi Bridge and Bursa. - In: Vakıflar Dergisi, XIII, 1981, pp. 425-448.



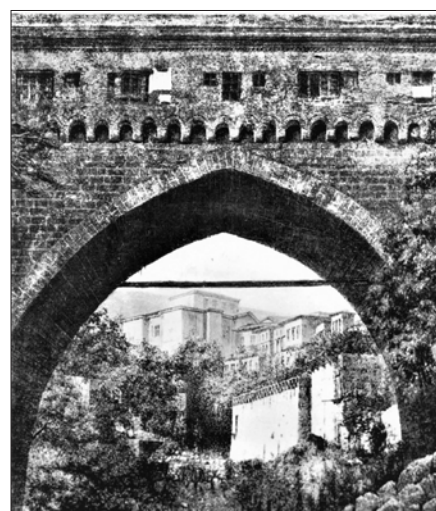
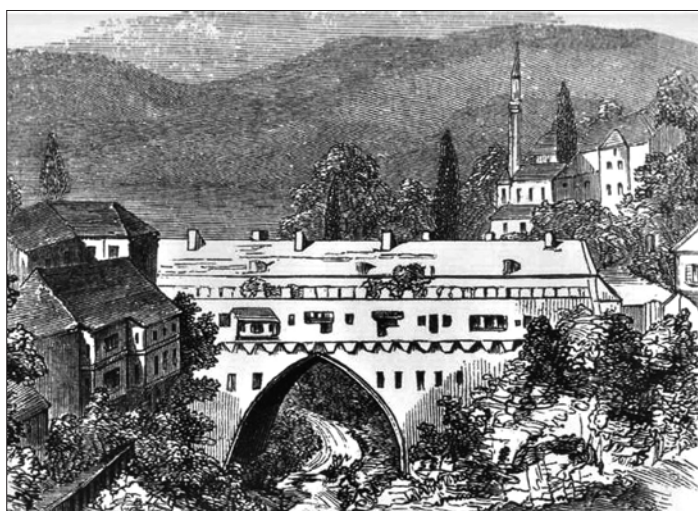
Bursa, Asia Minor Turkey. Irgandı Bridge (Irgandı köprüsü, and Çarşılı Köprü, 1442).

Reconstruction of the plan with the upgrades with stores and the facade by Onge (1981)

Sections through the bridge housing and the building above it on the restoration of Onge (1981) and views of the holes in the housing in a photograph taken after its destruction by the Greek Army in 1922.

Views of the bridge on drawings by Julia Pardoe (1838)

Indeed, this bridge has two long, vaulted caravanserais (14.85 x 4.50 m) built on its hull on both sides of the bridge vault, and longitudinally on the sides of them - with a series of 12 small, chain rooms that are without any connection to them. Which naturally means that they are warehouses of commercial premises built above the level of the roadway. This architectonic really reveals that the bridge was built and then in 1559 and rebuilt at its top as a completely massive covered structure. On either side of the street, there are stone gates, closed at night with iron doors. Engravings by Julia Purdy (1836) and French archaeologist architect Charles Texier (1835) show the covering of the market street as rising basilica like over the roofs of shops, with a number of ventilation and chimney overhangs. It is also seen that both the upper build stores and their warehouses below them are illuminated with rectangular windows - almost square in the upper structure and narrow as battlements (0.75 x 0.43 m) on the facades of the bridge housing. Dr. Yonge suggests that the initial ones are sharp pointed, but he does not actually state any details. Only the bridge arch is sharp pointed.

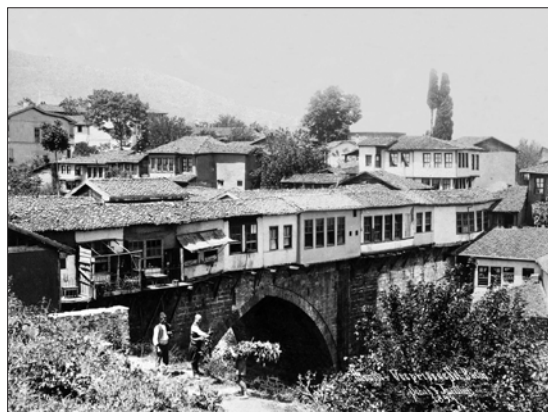
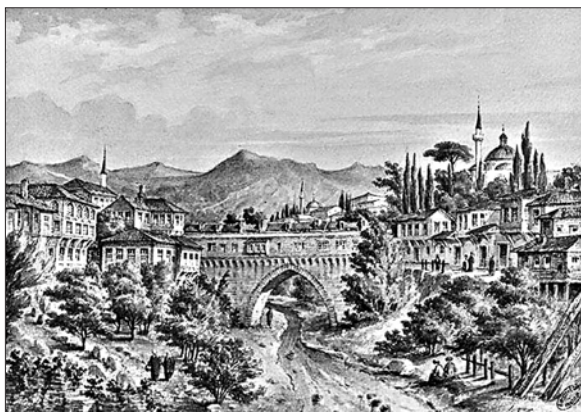


Bursa, Asia Minor Turkey. Irgandı Bridge (Irgandı köprüsü, and Çarşılı Köprü, 1442). Views of the bridge on drawings by Charles Texier (1832, published in 1862 and 1882, *Asie Mineure*) and archive photo view (1854)

According to the Kadi registers, the whole superstructure is covered with lead sheets, which were repaired in 1567, 1573, 1576 and 1632. Pardo's engraving shows that in the early nineteenth century, some of the sheets have disappeared and the roof was overgrown with shrubs, meaning that the rooms were massively arched. From the engravings and one photo from 1854, we find that the long outer walls of the store superstructure are cantilevered by shallow Lombard fittings, and that the entire superstructure with them is made of bricks. The facades are topped with a powerful, intricate cornice resting on a wolf-tooth style frieze. The body of the bridge (11 m wide) is stone, lined with large slabs whose surface hangs slightly above the forehead of the vaulted structure. There is a 16m wide point arched breakthrough, formed by quadras - whole and fitted with two shorter ones, which is an Armenian technique. By the way, the name of the Islamized mimar (architect) Timurtash oğlu (son of) Abdullah¹⁰, who is much more likely to be Armenian rather than Greek, is recorded as the author of the bridge.

¹⁰ Baykal, Kazim. Bursa ve Anıtları - Bursa et ses monuments. Bursa, 1950.

And by the time of the twentieth-century genocide, the neighborhoods with the bridge were populated with Armenians, as were the shop owners.



Bursa, Asia Minor Turkey. Irgandı Bridge (Irgandı köprüsü, and Çarşılı Köprü, 1442).

Watercolor view (before the 1855 earthquake)

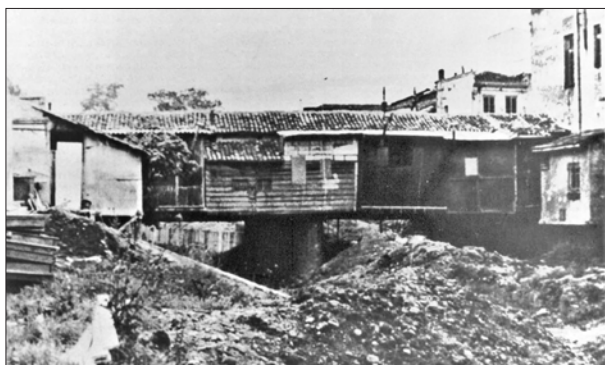
View of an archival photography from 1894 (Sébah & Joaillier)
of the restored after the earthquake look of the upgrades

Between 1573 and 1589, the bridge was visited by Reinhard Lubenau, who states that its length is 300 meters, and considers it to be Byzantine before the conquest of the city. In 1836, when it was thoroughly examined and drawn by Julia Pardew, it was perceived as Roman. During an earthquake in 1885 the market superstructure of the bridge collapses, and from photographs from the very end of the 19th century it can be seen that from the Lombard arches only some of the stone brackets on which they stand are left. On top on the two sides of the arch are built new, orieled timber structure shops, but the street between them is no longer covered. In its late appearance in 2004, it was completely rebuilt after its destruction by the retreating Greek army in 1922 and the partial reconstruction of the remains of 1949. However, the arch is built as a semi-cylindrical, and not sharp pointed.

It should be noted that in the Asia Minor medieval Islamic world, bazaars representing shopping streets, closed on both sides with solid gates and covered with rooftops, appear quite early. There are written records of such dating back to the X-XI centuries. Undoubtedly, they are at the heart of the architectural typology of Bedesten, which had a strong development in the fourteenth and fifteenth centuries and throughout the cities of the Ottoman Empire¹¹ - insofar as they were also classified as cities with or without bedesten. In the Seljuk Sultanate there are reports of bedestens since the beginning of the 13th century. In Kahramanmaraş they date from the XI-XIII centuries, and from the XIV century are those in Lozengrad (Kırklareli, 1383), Manisa and others. From the nineties of the fourteenth century is also the bedesten in Yıldırım in Bursa. Functionally, the typology of the bedesten is thought to develop on the type of three-ship basilica, widespread in ancient and early medieval Syrian architecture. It can be seen that this type of architectonics is present at the superstructure of the Irgandı Bridge, which in fact repeats that of the three-ship bedestens.

¹¹ The word bedesten (tur. Bezesten, Bezestan) is composed of the arabic "bez" - clothing, with the Persian suffix "istan" - for a place.

In climatically warmer areas of the Ottoman Empire, it is often practiced to cover the whole or part of the street with light wooden roofs and even to close them with gates on either of the outer sides. Also, in the presence of rivers and gullies passing through the settlement, its eventual expansion, similar to what is happening in other territories of Europe, begins the construction of shops on top of the transfer bridges. In many cases, they are directly rebuilt as covered markets. It is clear from the descriptions of travelers and Kadis and tax registers that in the 15th-19th centuries many market bridges were built on the Balkan Peninsula, for example in Nis, Thessaloniki, Ser, Edirne, Pazardzhik, Dupnitsa, Malko Turnovo, Bitola, Prizren, Lovech, Drama, Gumurjina and others, in Bulgaria, Serbia, Greece, Kosovo, Turkey and Northern Macedonia¹².



The Covered Bridge in Gumurjina (now Komotini, White Sea Thrace, Greece). Views from archival photographs from the 1960s

In 1611, Lefèvre saw in Edirne a large wooden (or stone-wooden) bridge with workshops and shops. He describes it as "... the mosque bridge... where the shoemakers are. It is as new as the mosque."¹³ It was therefore built around 1568–1574 as a waqf of the then building Selimie Mosque by mimar Sinan. But as early as 1555, Hand Dershwam would note that "there is a stone bridge in the city opposite the Sultan's palace over the Maritza River (actually Tundzha), with many craftsmen around it: they also have a wooden bridge."¹⁴ Which means that the market bridges in Edirne in the sixteenth century are more than one. In this case, it is probably the Sarachi Bridge, which was almost duplicated at the same time by the Sarachhane stone (in 1853/4) near the Fatih Bridge, also above Tundja, leading to the Sultan's palace.

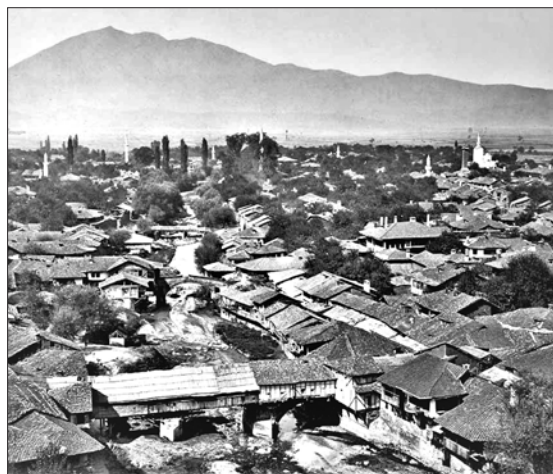
Evliya Chelebi also wrote about a wooden bridge in the middle of Drama's market in the middle of the seventeenth century, with the river sometimes flooding and dragging the shops. In the 1990s, Armenians Hugas Inejian and Stepan Agontz published a "Geography", which states that in Dupnitsa "there is a mosque, a bath and a market through which the gully passes", i.e. establish the existence of a market bridge¹⁵.

¹² Tuleshkov, N. Protomaster Nikola Fichev - Life and Activities (1800 - 1881). - In: Protomaster Nikola Fichev - Creator of the Bulgarian National Revival (sometimes called Bulgarian Renaissance), S., 2000, 78–79.

¹³ French travelogues about the Balkans XV – XVIII in..., p. 193.

¹⁴ German and Austrian travelogues about the Balkans XV-XVI in..., p. 259.

¹⁵ Armenian travelogues about the Balkans in the 17th-19th centuries S., 1984, p. 110.



Covered Bridge in Drama (Eastern Macedonia, Greece)

Prizren. Panorama of the city, foreground Sozi Bridge over the Bistritsa River. Photo by Jozef Szekeli (1863)

In September 1863, Hungarian photographer Dr. Josef Szekely, accompanying Dr. Johan von Han on his expedition through populated with Albanian areas, took a series of photographs in Prizren (Kosovo), one of which shows a large market bridge. Two years later, it was described by Henry Tozer: “The bridge that crosses this part of the river, with its vaulted roof and the pavilions (shops) on both sides, reminds us of Ponte Vecchio in Florence, though it is entirely made of wood and is much smaller in scale. The exceptionally picturesque bazaar of which these pavilions are part has a colorful appearance, with brightly colored towels, rugs and cotton garments hanging in front of them...”¹⁶

The bridge is known as Sozi (Ura e Soziut), as it is reportedly built by the famous Ottoman poet Sozi Chelebi (1455-1524/5, born and died in Prizren) as a sign of his great love for his wife. According to local studies, it dates back to 1508. Later, in 1513, a mosque would be built on the shore in front of the Sozi Bridge, and a library next to it, considered one of the earliest on the Balkan Peninsula.



Prizren. Sozi Bridge. Photo of Austro-Hungarian consul Oskar Prochazka (1906)

¹⁶ Tozer, H. F. *Researches in the Highlands of Turkey*. 335–338.

In a photo from 1906 by Prochazka it still exists, but in 1912, during the Balkan War, after the city was conquered by Serbs and many people were killed, Commander General Jankovic demolished and detonated many public buildings and mosques, and also burns the bridge down. So next year, photographer August Leon will shoot a panoramic view of the city with the bridge for the Albert Cannes collection, on which it is already without his storefront structure.



Prizren. Panorama of the city, in the foreground is the burned Sozi Bridge over the Bistritsa River.
Photo by Auguste Léon (1913)

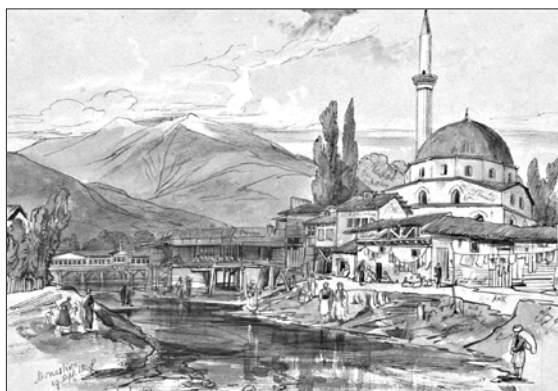
According to the old photos, the bridge was built out of stone and had three-vaults, undoubtedly curved, with powerful high breakwaters. However, we can see formwork imposts around them and on the breakwaters with large long squares, which indicates the construction is of the period from VI-VIII centuries, if one also takes into account the presence of a single-stage overhang of the hull lining above the forehead of the arched construction. So in this case it is most likely a restoration, made in 1508, of a ruined ancient or early medieval Byzantine construction. By the beginning of the sixteenth century, only the smallest arch from the shore with the tabakhane (the leather workshop) survived, part of the one on the opposite bank and one of the river bases at some height above the breakwater.

But whether this restoration also included the market upgrade is unknown. Assuming that the missing on all pictures next two vaults are in its current form during the reconstruction, then undoubtedly the new construction is a market, stepping in large part on the wooden road construction.

The photo by Szekely clearly shows two stages of construction of the upgraded part. The left half is lower, fronted with vertical boards and covered with wooden shingles, while the right half is taller, timber structure with a brick fill and a tile roof. It also continues on the

coast with taller store buildings with the same architectonics. Therefore, it can be assumed that the left, longer part is from an older bridge, dating from the seventeenth to eighteenth centuries, while the right is undoubtedly from the nineteenth century.

In 1836, the French scientist Amy Bue would see in Bitola (Monastir, today in Northern Macedonia) another market bridge and write: "The bazaar with its shops... occupies on both banks of the river a vast area connected by a wooden bridge, along which it also has shops. The bazaar has a wooden roof ..."¹⁷ Twelve years later, in 1848, Edward Lear will depict him in one of his Balkan watercolors as an architectonised, all-wooden structure with pediments and a semi-cylindrical kyoshk (sitting area for eating, meetings etc.) in the middle of the hull¹⁸.



Bitola, Northern Macedonia. The Great Bridge over the Dragor River between Pekmez Market and Ishak Celebi Mosque. Watercolor Views of Edward Lear (1848)

The bridge, called "The Grand", crosses the Dragor River along the market street (Pekmez Market, part of Shirok Sokak) between the city's Bedesten and Ishak Celebi Mosque (Ulujami, 1506) on the other bank. Near it, along the road of the bazaar, a city clock tower was built. There is no information as to when the market bridge was created, but the mosque waqnam (the document for establishing the waqf) dated June 3, 1508, records that 105 shops are provided for its maintenance, so it can be reasonably assumed that some of them are from The Grand Bridge near it. And this means that its appearance dates from the beginning of the sixteenth century. Of course, it was then inevitably rebuilt several times until 1853, when it was swept away by a catastrophic river. In January of the following year, Jordan Hadzhikonstantinov-Dzhinot wrote about the incident: "Down in the middle of the Monastery (Bitola) there is a river called Dragor. It has 6 bridges, and on them there are rich shops. This past year, Dragor ran in and, with strong and terrible water, destroyed the bridges and shops, which would cost them up to 5 million Groschen in damages."¹⁹

We also learn from this information that in the first half of the 19th century, there were five more covered market bridges over the Dragor River in Bitola besides The Grand Bridge. For the rest, however, no data is available. Most of them are probably part of the existing bridges of the twentieth century, for which there are preserved memories of previously wooden ones.

¹⁷ French travelogues about the Balkans XIX c., 1981, p. 374.

¹⁸ Edward Lear. In the Levant: Travels in Albania, Greece and Turkey in Europe, London 1988, p. 79.

¹⁹ Jordan Hadzhikonstantinov-Dzhinot. Monastery (Bitola). - Constantinople newspaper, January 29, 1854.

After the demolition, The Grand Bridge is no longer rebuilt as a market bridge. Soon after, a stone one was erected in its place, but it did not have a long life and no longer exist in photographs from the beginning of the twentieth century.

For the rest of the bridges, except for the one preserved in the Drama and those from archival photographs from Gumurjina, there are only brief references in travelogues and other old notes.

The most famous of the market bridges on the Balkan Peninsula is the "Covered Bridge" near Lovech, over the Osam River. He is referred to in the 1890s as a "large and very solid stone bridge with several arches"²⁰. I have found that some authors of the sixteenth to the nineteenth centuries classify stone-wooden bridges as 'stone' and their bridgings as 'arches'. For example, James Baker in 1877 would write about the one near Lovech: "The fast Osam, about a hundred yards wide, crosses the city beneath the arches of the new stone bridge, which would be an honor for every country."²¹ At that time, it was actually with a stone-wood construction. Therefore, without hesitation, it can be considered that the bridge, described at the end of the eighteenth century as "stone", is actually a well-built stone-wooden one. This is also the case with the earliest, more specific, information belonging to Ami Bue, who in 1836-1838 will see in the city a "covered stone bridge with shops"²².

It also appears that this one of the bazaar bridges was also quite old, possibly even from the sixteenth to eighteenth centuries, often smashed in its wooden parts by incoming river waters²³. Afterwards, most probably restored on the surviving stone foundations, finally in 1871 Felix Kanitz welds in such condition, which made him classify it as a "pitiful bridge connecting Mustafa and Dolna (Lower Krai) neighborhoods to the left bank of the Osam River. Even the most undeveloped and poor German village - he adds to this finding - would be ashamed of such an ugly bridge, especially since it, like the Ponte de Rialto (in Venice), is also used as a closed bazaar. The rotten boards and the holes drilled on this bridge were dangerous and fatal to my horse's legs. "Kanitz goes on:" In 1874 it was completely demolished due to the danger of collapse and a new one was erected in his place, built by Master Nikola (Fichev) from Dryanovo."²⁴

In connection with this construction, three Ottoman-Turkish documents were put into scientific circulation a quarter of a century ago²⁵. It is understood from them that at the beginning of 1874 (and perhaps even at the end of 1873) Nikola Fichev was preparing a project and a quantitative account for a wooden bridge bazaar. Later, the people of Lovech demand from him to offer a construction option for a massive bridge structure. In a letter dated July 20, 1874, to the Lovech Kaymakam, it was noted:

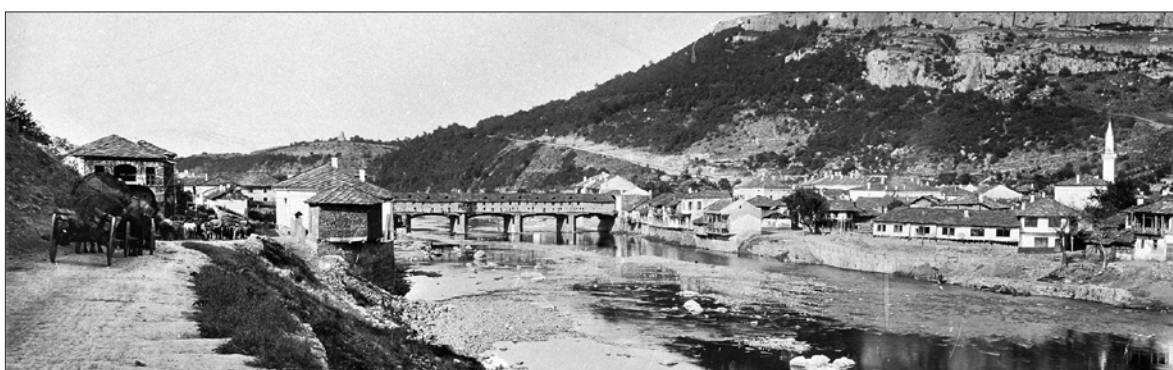
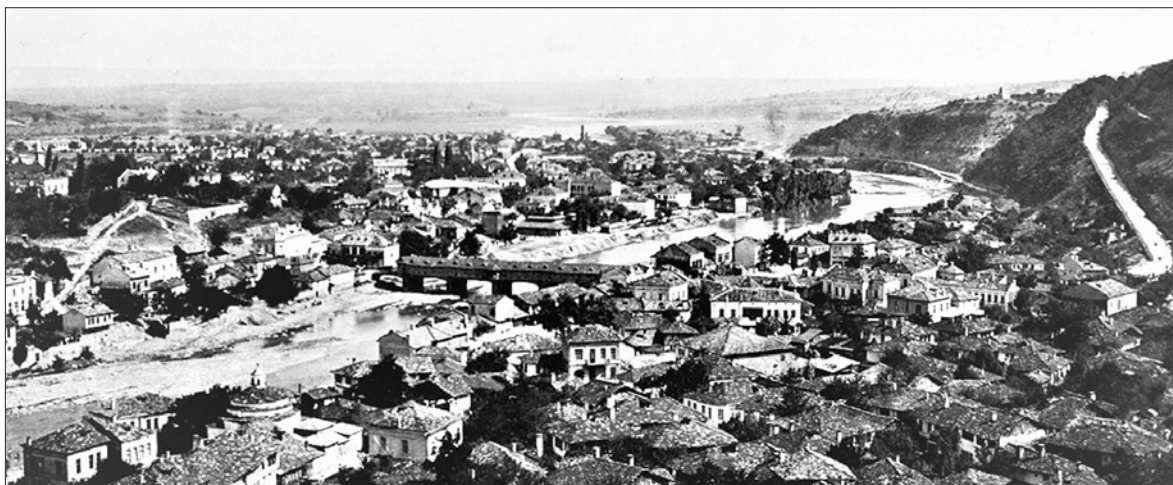
²¹ Baker, James. Turkey in Europe. London, Paris & New York, 1877.

²² French travelogues about the Balkans of the nineteenth century ..., p. 241.

²³ In a note from the book "The History of Alexander the Great" (Lovech Museum), it is noted that in 1848 "the Osam came and carried the bridge along with the shops and the goods". In another note published by Geno Ivanov, this is confirmed - "1848 June 25: the water carried the bridge". (Ivanov, G. Floods in Lovech and Caused Mischief - Nineteenth Century. - In: Lovech and the Lovech area).

²⁴ Felix Kanitz, Danube Bulgaria and the Balkans. T. II, S., 1995, p. 27.

²⁵ Maria Mravkarova. Kolyo Ficheto and the Covered Bridge in Lovech. - Journal of the Ages, vol.1, 1976, 49-53.



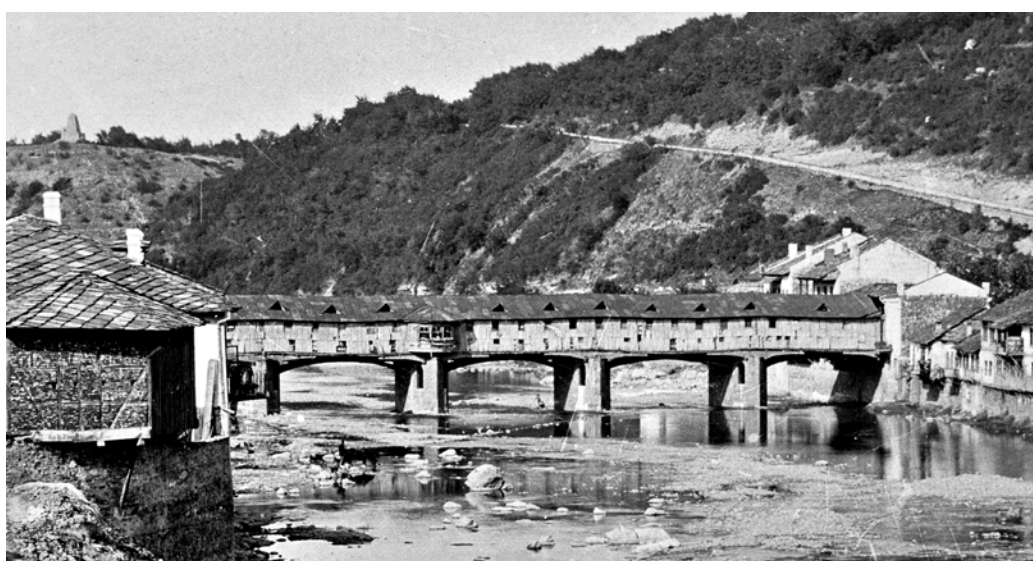
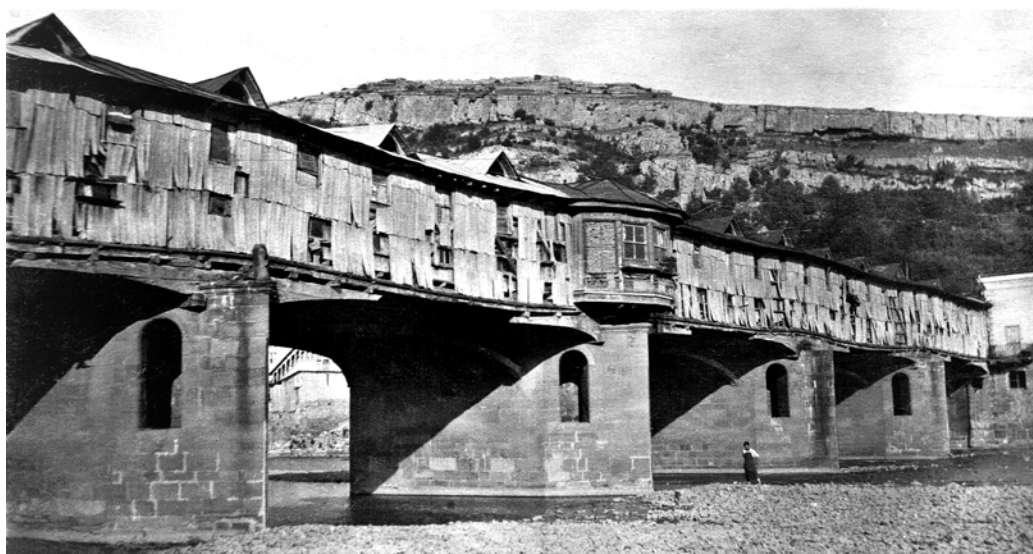
Lovech, Bulgaria. The Covered Bridge over the Osam River (1874).
Panoramic view of the fortress (1910s) and road level view (early twentieth century)

"In connection with the request to the master Kolyu, who returned from there (Lovech - B.A.) to Tarnovo, whether materials were prepared (ie projects and bills), for the big bridge in Lovech ... whether it can be of stone or not, according to the enclosed copy of the written account sent by him ... its value will be increased by 73,800 Groschen." But, because as can be seen from the text below, there were stones donated by the local population, and if allowed to use the "old ruins" (of the fortress of Lovech - B.A.), the cost of construction will go up only by 20,000 Groschen. Let us note in passing that Nikola Fichev, like all the masters of that time, were mindlessly demolishing the abandoned ancient buildings and fortresses for the needs of new construction²⁶.

From the third document (November 11, 1876), we learn that the old bridge was not deliberately demolished, as Kanitz claims, but that "last year (1875) it was completely destroyed when the river came". It is also confirmed by correspondence, published by Geno Ivanov: "1871 June 25: the water carried the bridge."

²⁶ Unfortunately, this practice destroys a great deal of ancient and medieval Bulgarian construction. For example, the fortress of the capital Pliska was preserved until the sixteenth and seventeenth centuries together with the crenels, but in the next three hundred years, in addition to the demolition for building materials, but also hundreds of furnaces smelted its limestone quadras, columns and decorative plastic arts for him to witness it at the end of the nineteenth century as pitiful ruins. It was not until 1890 that a royalty decree prohibited this practice, which, later on did not prevent Alexander Stamboliiski from officially allowing it again.

This bridge, which serves the traffic of the "Constantinople postal road leading from Tarnovo to Vidin", is an old waqf property managed by muteveliia (inheritor of the waqf), and therefore the whole of its funding from the state was denied. So it was built mainly with funds from donations, loans and personal labor, as evidenced by the same document. It costs about 500,000 Groschen. In its completed form, there were 46 shops, bringing 170 000 Groschen each year, which are serviced by the loans and which, after their repayment, should be used to support primary schools, repair mosques, repair and build small bridges and fountains.

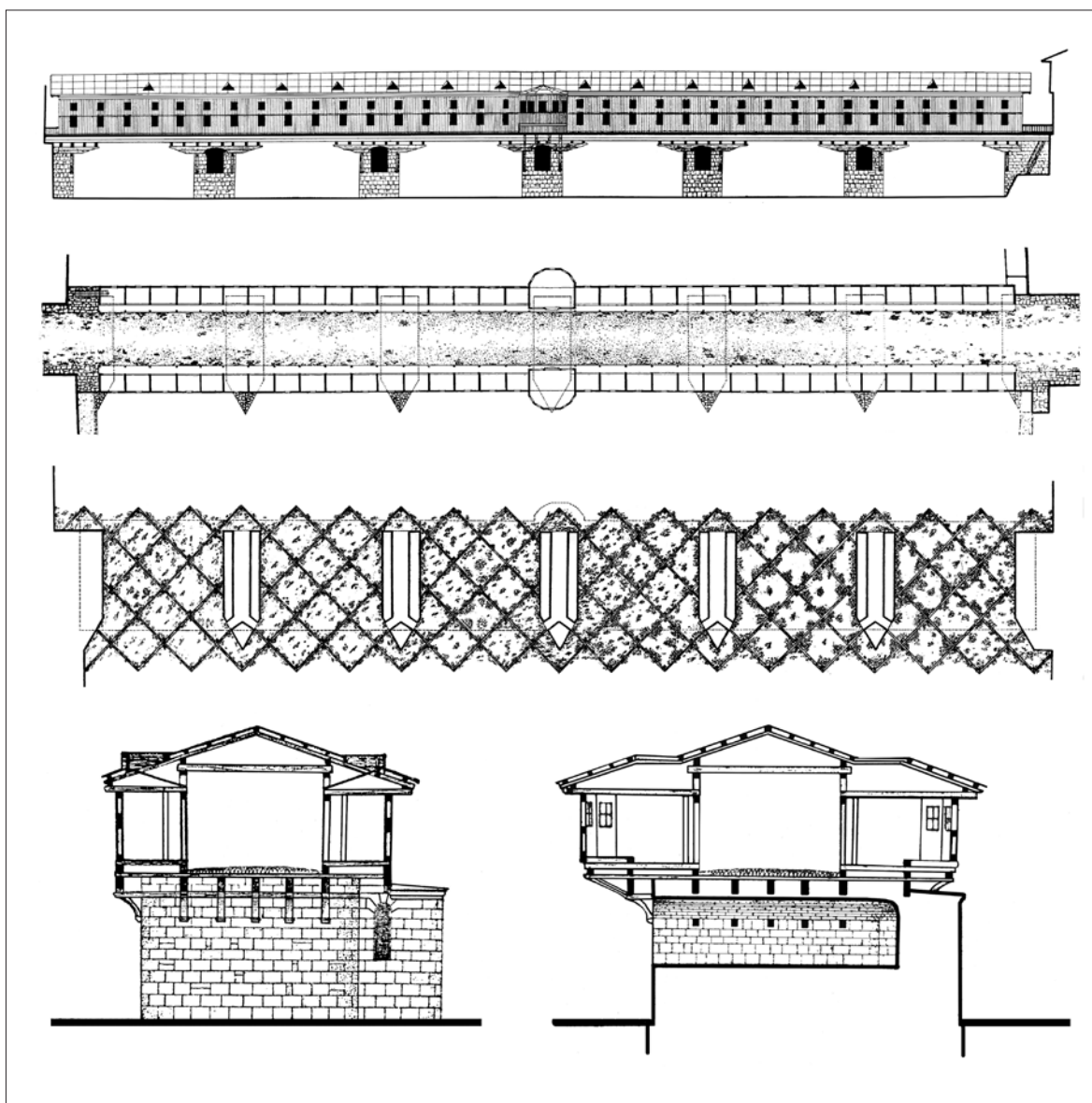


Lovech, Bulgaria. The Covered Bridge over the Osam River (1874).
General views of photographs from the early twentieth century

These three documents show the complete chronology of this construction, which has so far been referred to as being carried out from 1874 to 1876. It turns out that during the first of these years only projects and bills are drawn up, and the construction itself takes place from 1875 to 1876. Arch. Georgi Kozarov learns from the local people that projects and a wax model have been made for the bridge.²⁷

²⁷ Kozarov, G. Master Nikola Ivanovich Fichev (life and activity). - In: Master Nikola Fichev (Kolyu Ficheto) 1800 - 1881. S., 1953, p. 40.

According to Felix Kanitz, "the new bridge rests on seven limestone stone pillars ... decorated with lions and other sculptures." ²⁸ From archival photographs and some paintings taken before it burned in 1925, we know its architecture in greater detail. His description in Kozarov's writings is also quite detailed. A relatively successful attempt at reconstruction is made by Arch. Emil Momirov, but in the drafting it was no detailed that according to the Ottoman-Turkish documents cited above, the shops built were only 46 in number, not 68, as the author thinks, based on the visible axes in the façade. This means that not all of them are created equal in size, but as small and large stores. That is why, as Kozarov points out in the same book, each shop has "one or two small windows", i.e. it covers one or two planning axes.



Lovech, Bulgaria. The Covered Bridge over the Osam River (1874). Planning reconstruction of the bridge by arch. Momirov (1954). Foundations plans with reinforcement at the bottom around them and the main level, facade and sections

²⁸ Felix Kanitz, Danube Bulgaria and the Balkans. T. II ... p. 26.

However, the question is unclear whether the shops are built as one-storey, with two rows of windows above each other, or two-storeyed. In the famous etchings of Peter Morozov it is clear that the central kyoshk on the side of the stream is two-storeyed. There is also an intermediate structural division that runs horizontally between the two rows of windows. And all this speaks of two floors. But at the same time, it is evident from the archival photographs of the bridge that there is a single storey kyoshk on the other side. Having two-storey shops here would not be strange considering their small area at the bottom (2.5 m x 2.5 and 2.5 x 5.0 m). Moreover, the traditional shop at the time was mostly two-storeyed throughout the Balkans, for example the Hadzhikonov shop in Sevlievo and the Turnovo shops, again built by Fichev. So the presence of an upper storage level is quite logical. The third row of openings, raised in dormers above the roof, illuminates and ventilates the street lane in the same way as in Bursa's Irgandi.

In this bridge-bazaar Nikola Fichev demonstrated not only virtuoso construction mastership and original ideas in detail, but also highly artistic views. The architectural image is remembered for its vertical and horizontal articulation, with colorful bay windows and stone-cut cornice on the breakwaters. The pantheon of beastly images, similar to those of the bridge to Byala, has not only security functions in the sense of popular cultural beliefs, but also includes encoded messages, among which the symbol of the Bulgarian revolution - the lion - is central. Saturnino Jimenez in 1877 puts it this way: "Before completing his grandiose work, the artist placed on the central vault a sculptural symbol of patriotism - the Bulgarian lion. Representatives of the Ottoman authorities tried to oppose it, based on either the political significance of this emblem or the Muslim belief not to paint or draw figures of living beings. But the architect succeeded in proving to the Lovech Kaymakamin that in this case the lion is a symbol of strength and that, therefore, in the interests of strength, the bridge cannot be passed without a lion."²⁹ Also, this text confirms the authenticity of the identical one, recorded by Georgi Kozarov 40 years later, already a legendary story-dialogue between the Protomaster and the Lovech authorities.

Contemporary historiography considers this to be the last building of Nikola Fichev, with which he discontinued his architectural practice, but has several of his churches, which were then built until 1880³⁰.

²⁹ Saturnino Giménez, *Mis viajes en la Peninsula de los Balkanes y el Asia Menor*. - In: *Boletín de la Real Sociedad Geográfica*, vol. XIV, 1883, p. 248.

³⁰ Much of the text on the Lovech Covered Bridge was published in: Tuleshkov, N. *Protomaster Nikola Fichev Life and Activities (1800–1881)*. - In: *Protomaster Nikola Fichev Creator of the Bulgarian National Revival*, S., 2000, 77–80.

FIELD STUDIES ON A GROUP OF HERITAGE BUILDINGS IN KAZANLAK, BULGARIA - PILOT ACTIVITIES

Eng. Tihomira Kracheva¹

Foundation "Heritage (re)discovered", in process of establishment

Abstract: *In Bulgaria there are 39 476 heritage sites, and the large amount implies difficult administration and monitoring of the technical conditions. Subsequently, many of the buildings no longer exist, are badly maintained and thus dangerous to the public or will become dangerous within few years. The institutions in charge of maintaining the heritage sites are struggling with many obstacles, preventing them from ensuring the upkeep and even survival of many of the cultural heritage buildings. First and foremost, no action can be taken without updated information regarding the status of each site, and with the current data collection system, it is physically impossible for the relevant institutions to ever achieve an actionable level of knowledge in this regard. By the time they are done examining half of the sites, the information for the first quarter will already be outdated. Thus, the "Heritage (re)discovered" project was born with the objective to achieve an acceptable level of knowledge on the status of the close to 40,000 heritage sites throughout the country. Due to the shortage of financing, a volunteer model for data collection was chosen with a pro-bono technological partner. To test the viability of the project, a small sample on-the-ground study was conducted, encompassing 47 sites.*

Key words: *Cultural heritage, pilot project, data collection, ownership, emergency measures, town of Kazanlak*

1. Introduction

Cultural heritage encompasses the intangible and tangible immovable and movable heritage as a set of cultural values that bear historical memory, national identity and have scientific or cultural value. [1]

According to the public register of the National Institute of Immovable Cultural Heritage in Bulgaria there are 1 385 heritage sites with world and national importance [2]. According to the Audit Report of the National Audit Office [3] in our country, the heritage sites of all categories of importance are 39 476, of which 19 438 are architectural and construction works, including 355 of national importance. Fewer than ¼ of the heritage sites have been granted status and the remaining 14,780 have only been declared.

This presents an insurmountable challenge for the institutions in charge taking care of cultural heritage sites, starting with insufficient human resource to ensure proper data collection on the current state of the buildings and continuing with challenges with funding and ownership when attempting to secure, salvage and restore badly maintained sites.

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2. Aim and Scope

2.1. The “Heritage (re)discovered” Project

As a first step towards resolving the larger issue, the project “Heritage (re)discovered” aims at collecting data on the current status of immovable cultural property and promoting cultural heritage in the community. To reduce the cost structure of the study, and considering the tremendous enthusiasm with which the idea of preserving Bulgaria’s cultural heritage is met, especially among the younger demographics, we have chosen to follow this data collection framework: 1) All data – including photos and questionnaire-based information - will be collected by volunteers across the country; 2) Each volunteer will be encouraged to examine cultural heritage sites within the settlements that s/he is familiar with in order to facilitate the work of proper identification of the sites and reduce transport costs; and 3) Data collection, analysis and support will be facilitated by digital tools, developed cost structure of the study by the Technological partner at no cost to the project.

Considering that the project will be based on volunteer work, a key condition to its success is simplicity. The objectives, collection tools and process and the end result have to be easily understood by people with varied educational and professional backgrounds so as not to exclude the young non-engineers/architects, who are the main target demographic for the volunteer base.

2.2. Pilot Project: Aim and Pre-Launch Work

For the purpose of the pilot project we selected an ensemble group of heritage buildings in the city of Kazanlak. Often single heritage sites caught up in the contemporary urban environment cannot maintain their artistic and psychological impact. In the design of a group of heritage buildings, it is observed that even small and secondary architectural elements gain special value in the ancient street space. Creating a binding and unifying environment helps to emphasize the qualities of individually valuable single heritage buildings. [4]

The main objectives of the pilot activities can be summarized in the following points:

- Preparing and validating on the ground questionnaires for single and group heritage buildings
- Creating and validating an information system for collecting up-to-date data for the cultural heritage sites
- Creating a map of the chosen group of heritage buildings in Kazanlak based on the collected GPS coordinates
- Collecting a enough sample data to help inform and direct the roll-out of the project country-wide

After several meetings, our team received the support of Sofia Municipality, Kazanlak Municipality, the Chamber of Architects in Bulgaria, ICOMOS Bulgaria and numerous specialists from different economic fields.

The city of Kazanlak was chosen to carry out the pilot activities for three main reasons: 1) ease of collection for the pilot team, 2) the town’s rich history and 3) acceptable number of heritage sites clustered together. The choice of this specific ensemble was not only motivated by the fact that it contains a large enough sample of heritage sites without the number being unattainable within the scope of the pilot project; but is also supported by the fact that this group of heritage buildings was the cause of inspiration for a prominent architect like Le Corbusier [5].

In October 2018 after a meeting with the chief architect of the Kazanlak municipality, Arch. Stoev, the pilot project was launched. The field surveys were conducted in the period 11.2018-07.2019.

3. Presentation of the Sites

3.1. Location

The heritage group “Knyaz Svetoslav Mirsky” is located in the city of Kazanlak. The architectural and construction ensemble is locked between “Nikola Petkov” Blvd. and “Knyaz Svetoslav Mirsky” Str., “Konstantin Bozveliev” Street and “Tiulbenska” Street. The range of the ensemble is represented graphically of Fig. 1.

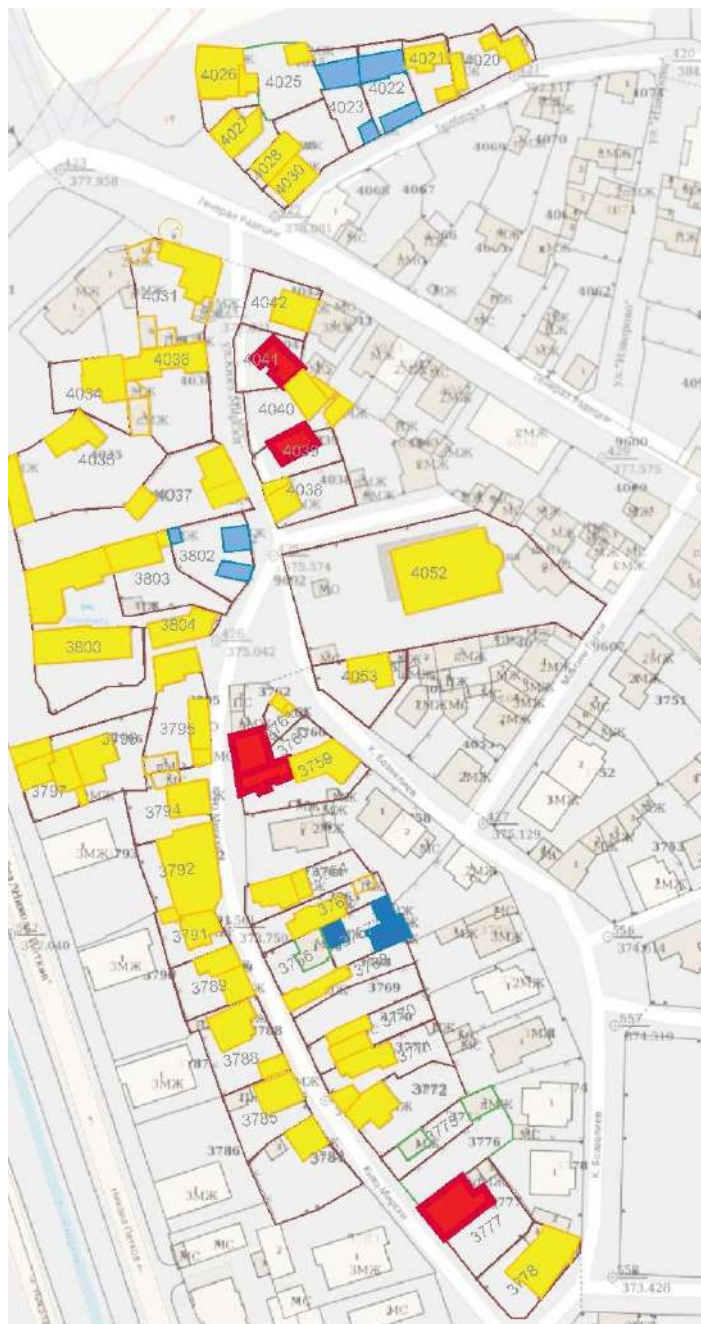


Fig.1. Map of the ensemble group “Knyaz Svetoslav Mirsky”

Colour legend of Fig.1:

yellow – heritage sites

blue – heritage sites which are no longer in the official register

green outline – heritage sites that we couldn't reach or even see because of fences

red – dangerous or endangered heritage sites

3.2. Administrative Status and Origin of the Name

The ensemble was created in the 1960s, and was officially announced in the State Gazette No. 34 of April 30, 1974.

The heritage group "Knyaz Svetoslav Mirsky" gets its name from the main street within its boundaries. The historical personality the street is named after is extremely important to the city. The hereditary Russian prince with the military title of Major General Nikolai Ivanovich Svyatopolk-Mirsky (July 17, 1833-27 October 1898) fought during the Russo-Turkish War of Liberation as commander of the left column of Lieutenant General Fyodor Radetsky in Kazanlak in December 1877.

3.3. Composition

The ensemble includes 47 regulated land lots, including a church, three museums, two restaurants, a craft workshop and an affiliate of the city library. The spatial interconnection of the sites is realized with the streets "Knyaz Svetoslav Mirski" and "Tulbenska".

The following photos illustrate the main categories of heritage buildings according to the technical condition they were in the period of the field research.

3.3.1. Safe and Preserved as Cultural Heritage

This category describes well-preserved buildings of both public and private ownership, posing no threat to the public and with key cultural heritage elements in visibly good shape. This includes well-restored or original architectural elements, and facades which are either well-preserved or properly renovated in the spirit of the historic context.



a)



b)



c)



d)

Fig. 2. Buildings in Good Condition: a) general view of the building, private property; b) well preserved facade ornamentation; c) general view of an art museum, public property; d) general view of an ethnographic museum

3.3.2. Safe but at Risk

This category describes buildings with no major structural issues, but which have been poorly or insufficiently maintained, resulting in partial loss of heritage value or demonstrating a trend towards such loss in the coming few years.

The below example captures the original house of a local priest which later became the property of a well-known local military personality. The property's garden has been maintained for more than a century and has been declared part of the heritage [7]. The building is private property.

The Kazanlak municipality was informed about this category of buildings in an interim report and the provided information was sufficient to enable them to start contacting the owners and requesting for renovation works to start. The below building is one of the success stories of the pilot project, where the condition of the building was tangibly and properly improved as a direct result of the gathered information.



a)



b)



c)

Fig. 3. Safe, at Risk: a) general view of the building; b) falling facade plaster and loss of ornamentation; c) renovation works started (photo from July 2019)

3.3.3. Dangerous

This category describes 1) buildings which – due to bad maintenance – have major structural issues, making them dangerous to the general public, including passing pedestrians, street-parked cars and curious citizens, trying to gain entry; or 2) building which – if immediate action is not taken – are at risk of being permanently lost within the next few years.

During the pilot project Kazanlak Municipality was continuously informed of the most endangered buildings and they started to contact the owners asking them to take measures. This process was met with multiple challenges which are documented as they

arise and as solutions are attempted, with the intention to facilitate the search for solutions outside the scope of this project.

A mini-case study of a dangerous and endangered building is the house where the artist Ivan Enchev-Vidio (1882-1936) lived. He is the founder of the art Kazanlak gallery, which opened doors in 1901 [8].

The building was described in a letter to the Kazanlak Municipality as one of the most dangerous of those examined:

Translated excerpt from the report to the municipality:

The roof is heavily collapsed and it is out of plane. There are damaged and near to collapse structural elements. Part of the turret to the adjacent building has already collapsed. The timber elements on the front facade are in very poor condition. The facade plasters are cracked and flaking, as pieces of them have already fallen. Facade is located in the immediate vicinity of "Knyaz Svetoslav Mirsky" Street and is a real danger for pedestrians. The building is visibly abandoned and has no inhabitants. It is private property and is situated within the boundaries of two separate plots, which do not belong to the same owner.



a)



b)

Fig. 4. Dangerous: a) street view; b) part of the roof almost collapsed

The complex ownership structure is likely to make the salvage of this heritage site close to impossible. The Heritage (re)discovered team intends to keep track of the administrative and legal progress on the "rescue" of this building, so as to assist in applying key learnings in the future to similar sites within the rolled-out project.

3.3.4. Full Loss of Cultural Heritage

This category describes cultural heritage which is beyond saving, where intentional or unintentional forces have led to the complete loss of the building and/or its value as a cultural heritage site. In these cases, there is no real urgency to act and the relevant institutions will need to devise an appropriate course of action.

For context, the current legislative framework requires that such buildings are rebuilt following the original designs and photographic evidence, but implementation of this rule has been largely unsuccessful throughout the country, in part because for many of these buildings there is insufficient information about design and few or no photos of the original building exist. [1]

An unintended benefit of documenting the current state of non-lost cultural heritage buildings is that the availability of the photographic evidence might in some cases help deter the buildings' destruction in the future.

The pilot project helped identify two categories of fully lost cultural heritage buildings, although the list might expand as a larger percentage of the national network is being examined:

- 1) Buildings with irreparable damage, empty plots or parking lots



a)

Fig. 5. Figure caption: a) view of an empty plot where there was a heritage building with local importance. According to the chief Architect of Kazanlak Municipality the building is missing long before he takes the job of chief architect. The municipality still investigating when this happened, how and why it is allowed.

- 2) “Renovated” buildings with full legal documentation, which in reality have been completely altered – most likely demolished and replaced by new structures



a)



b)

Fig. 6. Figure caption: a) view of a new building from the street; b) an old photo of “the same building”

4. Next Steps Towards Preservation

Although the current project with its primary goal of data collection and analysis is only one step towards achieving real-life results in the conservation and restoration of cultural heritage, even this small-scale pilot project has been successful in bringing positive change to the state of the examined buildings. This was already displayed through the example from the “Safe but at Risk” category, and can be further confirmed with the following example from the “Dangerous” category.

The following excerpt from the file of a privately-owned building demonstrates the power this project has to aid in conservation efforts. It also shows that – at least in some

cases – private owners might be willing to fund the restauration of the cultural heritage sites they own.

Translated excerpt from the building's file:

The building is private property and the owners live there. Except for the roof, the structure displays an acceptable technical condition. The roof is in dangerous state, and the supporting structure is badly collapsed. The coverings are bared, and as a result leaks have appeared in all rooms.

At the request of the owners, administrative assistance and consultation were provided. After discussion with the chief architect of Kazanlak, the Heritage (re)discovered gave them information about the procedures for performing repair work at heritage buildings. The owners have stated their wish to repair the roof structure from their own pocket after permission from the municipal and state institutions.



a)



b)

Fig. 7. Next Steps Towards Preservation: a) general view of the building; b) bad condition of the roof structure

5. Conclusion

The current study encompasses 47 distinct sites in the city of Kazanlak within a group of heritage buildings and uses a proprietary information system to facilitate data collection and analysis. The field research is the pilot phase of larger project aiming to cover all remaining sites and serves to provide insights into the overall condition of the heritage sites in the country. Furthermore, it allowed to test the information system and data collection tools, which are also meant for use in the large-scale project.

The analysis of the date collected through the pilot study shows that 6% of the sites no longer exist, 13% are in dangerous or very poor condition, 43% are conserved and well maintained and we couldn't reach 8% of the properties. In general, the private properties are in worse condition with some noteworthy exceptions.

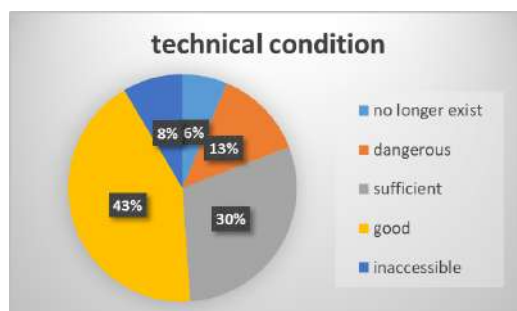


Fig. 8. Analysis of the collected data

The pilot project shows that the information system is adequate and has all the necessary functionality for measuring and analyzing data. In addition, the need to roll out the project countrywide is demonstrated. The pilot also brought the realization that it is vital to prioritize private ownership properties for two main reasons: 1) they are statistically more likely to need emergency measures and 2) data collection and the next step of preservation efforts are more cumbersome and time-consuming due to administrative obstacles.

Finally, it is urgent to conduct the research on the remaining 39 429 sites using the tested technology and data collection tools.

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**MODERN SUSTAINABILITY APPROACHES IN TRANSFORMATION OF
PROTECTED LANDSCAPES INTO LEISURESCAPE: RUSSALKA
HOLIDAY VILLAGE, BULGARIA**

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independent scholar

Abstract: *Details of establishment and construction history of “Russalka Holiday Village” in the context of mass tourism, including its present state following the years after the regime collapse in 1989 contextualize application of environmental strategies implemented in its original modernistic urban, architectural and landscape design.*

Highlighting the influence of nature and environment in its architectural and horticulture agenda, the discussion emphasizes the polarities between the modern architecture’s approaches and the contemporary sustainability discourse of designing a resort within a wild protected area on one hand and the quality of comfort and the tourist services addressing the modern paradigm for “leisure for all” on the other.

Purged from the regime ideology, the research opens the debate about evaluation and heritage protection within the national legislative framework and preservation of “Russalka Holiday Village” in the context of the Bulgarian post-war modern architecture.

Key words: *leisure era, modern architecture and sustainability, natural reserve, sustainable approach, symbiotic architecture, heritage at risk*

1. Introduction. Modern architecture and the era of leisure and mass tourism

The ideological basis for the development of mass tourism was set up in the pre-war years on the 5th International Congress of Modern Architecture (CIAM 5, 1937) held in Paris with the proclamation of leisure that had been already defined as one of the four functions of modern urbanism for “an obligation of the community for all”. Thus the post-war optimism envisaged leisure as a social attainment of modernity and postulated the right for holidays and access to recreation for everyone. The new social-life model of the leisure era² claimed the onetime pre-war elite-reserved privileges for the middle working class addressing at the same time the potential of the landscape for relaxation, pleasure and healthy living. [1] [2]

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² Focus of the 5th International Congress of Modern Architecture (CIAM 5) held in Paris from June 28 to July 2 of 1937 was precisely on the consequences of leisure in the design of the functional city demonstrated by its topic Logis et Loisirs [Dwelling and Leisure] and Le Corbusier’s (1887–1965) proclamation of housing and leisure as essential goods that should be guaranteed as public services, “an obligation of the community for all”. [2]

2. Establishment of “Holiday Village Russalka” operated by “Balkantourist” and part of the „Club Méditerranée“

Ironically, establishment of the Bulgarian state monopolist tour operator “Balkantourist” that later played a major role in Bulgarian touristic policy for development of international tourism was founded by the Communist government in 1948 as a self-sustaining enterprise of the Ministry of Railways in order to provide barter vacations for Czechoslovakian citizens as compensation for the nationalized Czech enterprises in Bulgaria.³[3]

Within a short time the mass tourism on the Black sea became a leading business sector in Bulgaria, attracting many tourists not only from the Czech Republic but also from the whole former Eastern bloc - Soviet Union, East Germany, Poland, Hungary, Romania and even tourists from West Germany. Gradually “Balkantourist”'s services expanded from predominantly seaside to include also mountain and cultural tourism. By launching the construction of the Bulgarian mega Black sea resorts in the mid 50-s – “Sunny beach” (1956-66) and “Golden sands” (1957-74), inspired by other countries such as Greece, Yugoslavia and Romania for development of own seaside resorts, the period of major international tourism in Bulgaria was initiated. [4]

Although founded as a part of the governmental programme for attracting foreign tourists in Bulgaria and operated by the state monopolist “Balkantourist”, the exclusive services of “Russalka” were not accessible for all but only for western tourists. Since its establishment in 1968 until 1990 Russalka Holiday village used to served exclusively foreign tourists, members of „Club Méditerranée“ – predominantly French, but later also Italian, Belgian, Spanish and Austrian tourists. Access to the holiday village was prohibited for Bulgarians, exceptions were made only for the resort personnel and administration.

In contrast to the tourist concept of the voluminous and also operated by the monopolist “Balkantourist” Bulgarian Black sea resorts “Druzhba”, “Golden Sands” and “Sunny Beach”, the small-scale, located in the wilderness “Russalka” followed the model of the headquartered in France all-inclusive vacation „Club Méditerranée“. Establishment of “Russalka holiday village” in 1968 pioneered about two decades the construction of resorts of the type “Duni” and “Elenite” in the mid-1980s. [5]

The innovative touristic agenda of “Russalka” which followed the model the French „Club Méditerranée“ vacation club provided all-inclusive packages. Besides food and accommodation the service package also included various ultimate entertainment and sport services and facilities, that in general the other Bulgarian mega resorts were deprived of: diving, riding and yachts clubs, tennis and children’s playgrounds, a shopping center, pelloid and mineral baths. The ancient and prehistoric rock-dwellings and wineries, as well as the Byzantine archeological remains in Yailata (Kamen briag) along with the natural underwater museum accessible by the divers contributed for the high quality of the provided cultural touristic product.

In fact, the first attempt of setting up a „Club Méditerranée“ in Bulgaria in 1966 within the “Sunny beach” resort failed. The secluded location of the present “Russalka holiday village” situated close to cape Kaliakra, North to Varna and respectively its airport, was carefully chosen by the French tourist managers as a result of investigating the whole length of the Bulgarian Black sea coastal line by helicopter. [6]

³ The idea for the favourable for Bulgaria cash-saving barter was suggested by the Czechoslovakian leader Klement Gottwald to the prime minister of the burdened with heavy war reparations Bulgaria Georgi Dimitrov and it included free vacation for his fellow citizens on the Black Sea in exchange for the nationalized by the communist authorities of the Czech industrial enterprises in Bulgaria. [3]

A team of Bulgarian architects, landscape architects and civil engineers prepared the master plan, the architectural, landscape and horticulture design of the holiday village under French guidance and counselling. The architecture team responsible for the architecture design and the masterplan was led by Marin Marinov and also included Simeon Dimitrov and Venelin Zhechev, Krastan Karakashev was responsible for the landscape design as well as the horticulture. [7]

Construction of "Russalka" started in the beginning of 1968 and lasted only several months as the resort was opened in the summer of the same year. "Russalka holiday village" became very popular in Europe, attracting annually between 6000-7000 foreign tourists during its long-season operation from May to October. Until today it stays quite unpopular on a national level among Bulgarians and is a favourite place for holiday due to the well preserved wilderness for tourists from Romania, Russia and Central Europe.

3. Modern sustainability approach and the concept of symbiotic architecture of "Russalka holiday village"

"Russalka Holiday Village" pioneered establishment of the specific type of leisure architecture in Bulgaria and distinguished itself among the portfolio of the Bulgarian state monopolistic tour operator "Balkantourist" by its unique touristic and architectural agendas due to the involvement of „Club Méditerranée“.

Outstanding features of its architectural and landscape design are the implementation of innovative sustainable strategies such as the organic masterplan, acupuncture landscape and horticulture design long before they were commonly used in 21st century architecture.

The masterplan of "Russalka" follows organically the terrain and consists of sea-facing bungalows or villas of different types carefully grouped in mosaic volumes set within the existing forest frame in order to save as much as possible of the existing trees. For the same reason the sport facilities, the shopping centre and the panoramic-terrace restaurant are situated on the bare coastal cliffs.

The concept of symbiosis between architecture and nature of "Russalka Holiday village"'s masterplan and landscape design was preconditioned by the exclusiveness of its location within the Kaliakra natural reserve of steppe, cliff and marine habitats, the local mineral-spring and peloid resources. The secluded coastal spot of rather Mediterranean character features a cut rocky coastline, picturesque caves, small tucked away inlets and coves, limited fine golden sand and pebble stripes framed by a century-old oak forest alternated by abundant steppe vegetation. The wilderness of the Birds' wharf on Via Pontica migration bird highway provides feeding, nesting and wintering of numerous waterfowls such as little bitterns, small loons, cormorants, hoopoes, thick-billed larks, black-backed wheatears, kingfisher, ducks, waders, gulls, etc., various steppe grass inhabitants and reptiles. [8]

Since nowadays natural reserves are prohibited for construction areas, the idea for situating a holiday village within a natural reserve is at least disputable from contemporary point. Construction of "Russalka" in the second half of the 20th century addressed the claim for collective happiness and the right to holidays proclaimed by CIAM 5 in 1937 on the assumption that "the environment forms the individual".

The design team tackled rather successfully the architectural and landscape design challenges concerning transformation of the natural reserve into a modern leiscapescape implementing innovative sustainable strategies providing for its guests literally fulfilled the modern paradigm for "direct contact with nature".

The innovative landscape design of Krastan Karakashev implements afforestation of the bare seacoast and gentle for the existing wild verdure micro interventions such as

saving as much as possible of the existing wild verdure and oak forest and supplement of the removed trees with Mediterranean coniferous and deciduous species, preservation of the indigenous vegetation in both the micro-horticulture and macro-masterplan scale instead of designing the ubiquitous flower parterres, stepping-stones pedestrian promenades leading from the villas to the seashore and a breakwater protection of the central cove used by the yacht club.

The unique characteristic ring seashore terraces of “Russalka Holiday Village” were designed by Krastan Karakashev for enlarging the limited sand stripes and serve both as sand pools and micro swimming pools.

The original masterplan of “Russalka” includes measures as prohibited for motor vehicles resort area, a few main cobble-stone pedestrian and low-velocity vehicles alleys for maintenance and direct access from the lawn of the bungalows.

The modernistic urban and architectural agenda “Russalka holiday village” consists of 525 mainly one- and two- but maximum three-storey villas, each with own bathroom and provided accommodation of simple yet high level of comfort for about 1000 tourists.

The minimalistic, human scale architecture of “Russalka” villas features traditional materials such as white lime coating, wood and stone cladding and wooden banisters in combination with modernistic flat roofs. Repetitive modular design mimics the rocky terrain and interprets the terraced architectonics of the traditional settlements from the Bulgarian Revival period such as Veliko Tarnovo, Nessebar and Kovachevitsa in a modernistic way, providing panoramic view for each villa.



a)



b)

c)

d)

Fig. 1. The modular villas/bungalows of “Russalka” Holiday Village of various types are enclosed by an abundant verdure and forest frame a) b) c) d) © R. Kirova, 2019

The archeological remnants of a fortress’s wall were integrated in the panoramic seaside restaurant designed by Venelin Zhechev who intentionally incorporated the idea of a shipwreck on the cliffs in its design.

“Russalka”’s architectural appearance characterizes of the aesthetic of clarity and utility of the modern architecture but also features of contemporary sustainable strategies unusual for the second half of 20th century such as maximal reversibility of the concrete

plots and structures, white lime coatings and light colour of the original flat roof coverages, adequate-orientated rooms protected by semi-opened terraces and verandas and big eaves for advanced sun protection and climatic sustainability.

Interesting comparison could be made with the modern architecture approaches in construction of “Golden sands” where the existing small swamp inhabited by water turtles was removed for the erection of the high-raise hotel “International” that was possible only due to the constant work of the water pumps installed in its basement.



a)



b)



c)



d)

Fig. 2.

- a) The seaside panorama restaurant “Russalka” designed by Venelin Zhechev © R. Kirova, 2019
- b) The virgin cliffy cape before its afforestation and construction of “Russalka”’s panoramic restaurant © Rashev, S., Die Bulgarische Schwarzmeerkuste, Sofia Press, 1968, p. 21 [9]
- c) The renovated villas of “Russalka” were added veranda appendixes © R. Kirova, 2019
- d) Part of the originally designed characteristic ring seashore terraces of “Russalka Holiday Village” were removed © R. Kirova, 2019

Finally, despite of the delicate and adequate design approach of “Russalka” still the local virgin ecosystem was negatively affected by its construction and rare protected species such as the ruddy shelduck (*Tadorna ferruginea*) and the monk seal (*Monachus monachus*) eventually became extinct.

4. Preservation of “Russalka holiday village” as an outstanding piece of modern architecture heritage in Bulgaria

Soon after the regime fall in 1989 “Balkantourist” has become a private enterprise and its property including “Russalka holiday village” was sold.

Owned by a private owner “Russalka” is managed today as less than 20% of the 522 villas of “Russalka” are renovated and function and enjoy touristic attention due to the unique virgin-nature environment.

Renovation of the situated close to the sea part of the holiday village includes enlargement of the villas by utilization of the verandas' volumes and adding of new verandas, maintenance of the flat roof details, installation of roof solar water heaters, replacement of the existing decrepit furniture and replacement of the shabby wooden banisters of the verandas with metal railings.

Although left in deterioration with decrepit cladding and isolation details, the rest of the villas still keep the original interiors from the late 1960s.

After “Russalka” had become private enterprise it turned out that there were certain misses in its inherited from “Balkantourist” construction papers concerning part of the originally designed sea shore infrastructure which was difficult to stay concerning the profound changes in the eco-legislation.

Still, except from the partial removal of the originally designed characteristic ring seashore terraces and the central-cove pier of the yachts club together with the later constructed large beach swimming pool in 2010-11, in general the original masterplan is still intact. [7]

Regardless the alert need for overall conservation and overhaul of exterior and interior spaces, the acupunctural, wilderness-preserving landscape design and masterplan as well as the architectural authenticity of the oldest Bulgarian holiday village, the already half-century old “Russalka” demonstrates the highest degree of architectural authenticity and is the best preserved among the “Balkantourist” resorts today.

4. Conclusion

“Russalka Holiday Village” is an outstanding sample of modern architecture in Bulgaria which represents the successful yet adroit and acupunctural implementation of the bold and extraordinary idea for incorporating a resort into a natural reserve and the dextrous transformation of a wilderness into a modern leisurescape.

Architectural and landscape agendas of “Russalka” are of outstanding value for Bulgarian modern architecture heritage as the oldest Bulgarian Black sea holiday village is undoubtedly a product of modern architecture and embodies its principle for “direct contact with nature” born on CIAM 5, but at the same time is a precursor of various contemporary sustainable approaches.

Regardless of or namely owing to the poor management of “Russalka” which embodies the modern credo from the era of leisure for “direct contact with nature”, its architectural, urban, and landscape authenticity are preserved to a practically utmost level.

Since in 2019 “Russalka holiday village” is expecting to change soon its owner, it is important the public attention for its preservation and conservation as valuable example of modern architecture in Bulgaria to arise: a balanced and ideologically devoided debate for the legacy of modern holiday architecture in Bulgaria from the second half of 20th century,

a discussion about the preservation, maintenance and re-use of modern buildings and sites in accordance with a responsible evaluation of the landscape in environmental and sustainable terms.

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MODERN ARCHITECTURE IN HISTORICAL PLACES

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Abstract: *With the emergence of new building materials and technologies, the architects around the world, at the turn of the century, started experimenting and eclectic combining of the building styles, erasing their history and origin. The result of such activity has been a drama in numerous urbarchitectonic environments, where the significant historical places obtained shockingly wrong hybrid physical structures, for the sake of modernity. Experimenting with the coarse, new design of architecture, along with a very diverse sensibilities of designers, brought about a stigma of nonsustainability, erosion of the spirit of the place, and esthetic decline of geometrical forms and rejection of historical references for something new, entirely unexplored. Insufficiently conceived interpolations of new architectonic forms into the existing urban fabric disrupted the conceptually clear compositional versions of the past and opened the door to a "parasitic architecture". They gave rise to the disruption of characteristics of micro-ambient entities. This paper focuses on the issue of newly designed "modern buildings" on the historical places, which exhibit conceptually declining designing and construction. The research of new additions and interpretations of famous physical structures whose potency is in the considerable cultural-historical heritage, which neither can nor must be denied or ignored, is the logic of a low creativity. From this perspective, "explosion of modern architecture" progressively causes historical degradation, drastic artistic-esthetic contrasts in space, mark of suppression of building values of the past and demonstrates a lack of vision of a identity of a future urbarchitectonic conceptualization of houses, streets, settlements, squares and plazas.*

Key words: *historicity of a place, experimenting, parasitic architecture, building values, hybrid structures, spatial degradation*

1. Introduction

Disrespect of the historically valuable architectonic heritage and interpolation of new physical structures in urban space brought about a number of improper designing interventions where we recognize a brutal approach and endorsement of historical-cultural imbalance in ambient entities. The urban drama is amplified by new city-building materials and technologies which pay no heed to preventive conservation potential and protection of the existing structures. New iconography of cities is created by inauguration of transformed physical structures under the guise of: reconstructions, revitalizations, restorations, additions, renewals, alterations of facades etc. There are city-building changes in the space which neither feature an interaction of building-architectonic structures, nor the necessary sensibility of their creators. Such philosophy brings about a conceptual imbalance and progressively present changes which tend to render worthless the old,

inherited, patinated buildings. We are facing degradation of historical values, where completely new engineering-designing standards are imposed; also vandalism, negligence and ignorance, disrespect of authorship rights, basic social and legal norms, etc.

2. Research

This paper presents ten town planning and architectonic examples from all around the world which show failed city-building interventions. It particularly shows those physical structures in the urban area which created a chaos in architecture, culture and art of micro-ambient entities. It points out to the loss of the city memory and loss of its historical and esthetic consistency which makes the urban future progressively less certain.



Fig. 1. Park Associati Milan, Italy, Filippo Pagliani, Michele Rossi

<https://designalog.wordpress.com/2012/01/15/architecture-the-cube-by-park-associati/>
<https://www.archdaily.com/196951/the-cube-park-associati/50173abd28ba0d77a800026c-the-cube-park-associati-photo>
<https://www.archdaily.com/196951/the-cube-park-associati/50173ac128ba0d77a800026d-the-cube-park-associati-photo>
<http://modulo.net/en/realizzazioni/the-cube>

In his wish to abandon conventional rules in ecourbarhicture, Italian designer and architect Ettore Sottsass¹ realized a very utopian, visionary and radical architectonic design under the title "Planet as a festival", imagining a better architectonic world. A portable pavilion structure having surface area of 140m² and a terrace of 50m² with a dangerous aggressive idea in which town planning and location conditions and inherited situation of structures in the environment are ignored, confirmed a non-artistic approach and lack of sensibility for organic connection to architectonic historically and culturally important physical structure in space. Milan is the second stage of the European tour of this portable "capsule", restaurant pavilion which can be assembled and disassembled. The building² saw its debut in Brussels on Parc du Cinkuantenaire in April 2011, where it remained until June when it was taken to Milan. Since 19th of December until 26th of April 2012 CUBE exclusive restaurant for 18 users with an outstanding view of Piazza del Duomo, only a few meters from the cathedral is turned towards Palazzo Reale and Arengario, in which new Museo del Novecento is located. Interpolating this extremely polemic and contrasting structure generated an impermissible and worrying chaos in space.

¹ <http://www.sottsass.it/>, Ettore Sottsass 1917-2007

² Architects: Park Associati, Filippo Pagliani, Michele Rossi. Client: Electrolux Home Appliances Emea N.V



Fig. 2. Roof extension on the stock exchange. Börsegasse 10, Wien, Austria

<http://www.schiener-architects.com/projekte/dachausbau-am-borseplatz/>

<https://www.bgks.at/projekte/dachausbau-boerseplatz-1010-wien/>

<https://www.avest.at/portfolio-item/1010-boerse-gasse-10/>

The idea for this design³ of addition of a two-floor attic featuring luxurious housing units in Vienna, of 2010, represents an alternative to the conventional design of roofs under the angle of 45 degrees. The designers designed a new volume of physical structure with very up to date contemporary materials. It is set-back from the frontage line in order to alleviate the drastic contrast with the historically valuable building⁴, Gnd floor + 4 floors, built in the 19th century. New foundations at the depth of 15 meters were constructed to meet the static requirements. The front glazed façade is inclined and behind it are terraces. Even though the Vienna Town Planning Consulting Board approved realization of this⁵, what transpired is a drastic architectonic contrast in the city center. The historical-cultural value of the existing, inherited building was ignored, and the new composition of the attic indicated disruption of an ambient entity in the city and gave rise to impermissible esthetic and artistic, visual tension in the area.

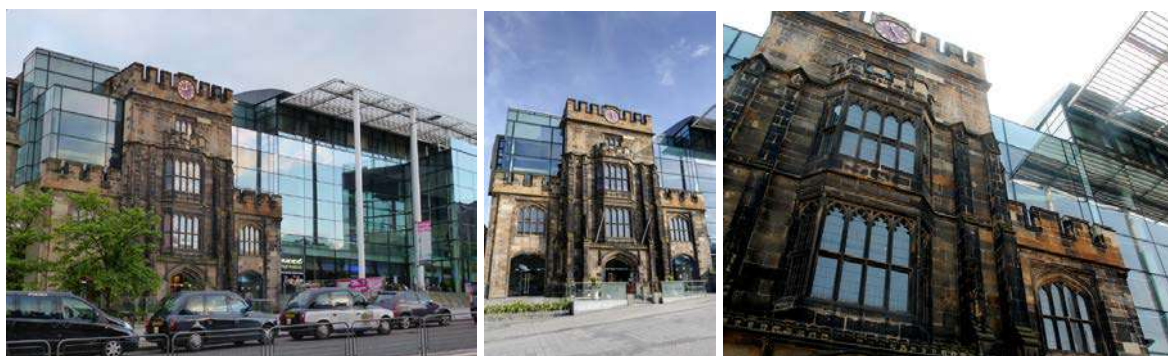


Fig. 3. The Glasshouse Hotel, Edinburgh, Scotland. Glasshouse hotel Edinburgh incorporating old church architecture facade

<https://mosaic-ad.com/project/the-glasshouse-hotel-edinburgh/>

https://c1.staticflickr.com/6/5677/21498372326_a32c561dbd_b.jpg

http://www.justluxe.com/community/edinburghs-glasshouse-hotel-introduces-special-rooftop-picni_a_1966146.php

<https://www.alamy.com/stock-photo-glasshouse-hotel-edinburgh-incorporating-old-church-architecture-facade-3798319.html>

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⁴ Nummer 10: Wohnhaus M. Mandel (erbaut 1872/1873 von Julius Dörfel)

⁵ Bauherr: ÖVB-Immobilien GmbH, 1080 Wien. Adresse: 1010 Wien, Börsegasse 10. Jahr: 2010. Architekt: Hans Schiener, Christoph Schiener.

The idea of a hybrid physical architectonic form which unites a 160-year-old Lady Glenorchy Church and contemporary sharp-lined architecture of the luxurious Glasshouse Hotel⁶ with five stars, 77 rooms and apartments, was realized back in 2003 in Edinburgh. The integration of the gray stone gothic church façade with a reflective glass façade at the frontal, entry section brought about a visually striking contrast. Grotesque clash of old and new material on the façade is an indicative landmark symbol of the city. The designers renounced respect for the historicity of the place and its iconic character. One may observe a cultural-historical imbalance, brutal marriage of materials on the façade, uncoordinated language of building structure and a non-artistic intervention in space. Also prominent is the discrepancy of geometrical forms on the façade and disrespect for the approach the designers of the bygone era. The newly created ecourbarchitectonic quality has specific, contradictory dimensions of value, with a removed inherited multiple decade long patina.



Fig. 4. Montreal Museum of Fine Arts - Claire and Marc Bourgie Pavilion of Quebec and Canadian Art

<https://www.archdaily.com/176526/new-pavilion-of-quebec-and-canadian-art-and-concert-hall-provencher-roy-associés-architects>
<https://yandex.ru/collections/card/590c5260acbcf68f025ce211/>
<https://i.pinimg.com/736x/76/1b/83/761b83ea8f027617e07db1ff8f10c387.jpg>
<http://design.trsty.com/wp-content/uploads/2015/05/montreal-museum-of-fine-arts1.jpg>
<http://www.aappq.qc.ca/projets-des-membres/pavillon-claire-et-marc-bourgie-musee-des-beaux-arts-de-montreal>

Despite the recognitions and prizes won the architects⁷ for the design of the Montreal Museum of Fine Arts (MMFA), which celebrated 150th anniversary in 2010, a general question remains about the metabolic marriage of two physical urbarchitectonic forms in space which do not stand in formal-historical and esthetic-artistic dialogue. The church created in 1894 is by the new design transformed, and it will be extended and restored, and its nave area is transformed from the former Victorian Erskine and American church into a concert hall with 444 seats. This historically significant place and structure obtained a new function in 2011 with a 20% larger gallery surface area of the Pavilion - 18.953 gsf and a total of 59.000 gsf. Claire and Marc Bourgie Pavilion from Quebec and Canadian Art and Bourgie concert hall were opened on 14th of October 2011. This case is indicative, from the point of view of theoretical town planning and architecture. It raises essential, strategic, city-building topical questions: to what limits and how one should extend the inherited

⁶ Client: The Glasshouse Hotel Company Ltd., 2 Greenside Place, Edinburgh, EH1 3AA, Scotland. Area: 120,000 sq ft. Status: Completed. 2 Greenside Place, Edinburgh, EH1 3AA, Scotland

⁷ Architects: Provencher Roy+Associés Architects. Architects Claude Provencher i Matthieu Geoffrion. Recipient of the 2010 Canadian Architect Awards of Merit and the 2011 Award of Excellence from the Urban Development Institute of Quebec. Location: Montreal, QC, Canada. Area: 59000.0 ft². Project Year: 2011.

architectonic edifices and whether it is necessary to join together valuable historical heritage and modern physical structures into one complex volume?



Fig. 5. Rahola Vidal - Còrsega housing, Barcelona 2010

<https://www.pinterest.com/pin/90986854943103873/>

https://www.archdaily.com/391782/30-houses-building-rahola-vidal/51c35f51b3fc4b581f0000bf_30-houses-building-rahola-vidal_220-01-jpg/

<https://www.archdaily.com/391782/30-houses-building-rahola-vidal/51c35f59b3fc4be6fe0000a5-30-houses-building-rahola-vidal-photo>

By adding three floors on the existing housing building Gnd floor + 2 floors on a limited corner location of Corsega street and Caputkins Passage, in Barcelona, with a maximum occupation of the lot volume, a conflicting, polemical urbarchitectonic situation was created. Disregard of the height of adjacent structures and of the historical heritage in the immediate neighborhood caused a noticeably prominent esthetic-formal irreconcilable drastic micro-ambient spatial disharmony. Cultural and social context of the place was changed. The windows on the facades in the upper and lower part of the building have an irreconcilable scale and geometrical-artistic discrepancy and ill-conceived material surface finishing. Metallic mobile surfaces in dark brown color affect the visual effects of possible change of appearance of façade cladding. In the newly constructed part of a parallelepiped, rigid-angled structure, on the facades is applied designing orthogonal modular matrix as opposed to the adjacent buildings which have a creatively conceived plastic with multitude of interesting details and a different geometrical logic.

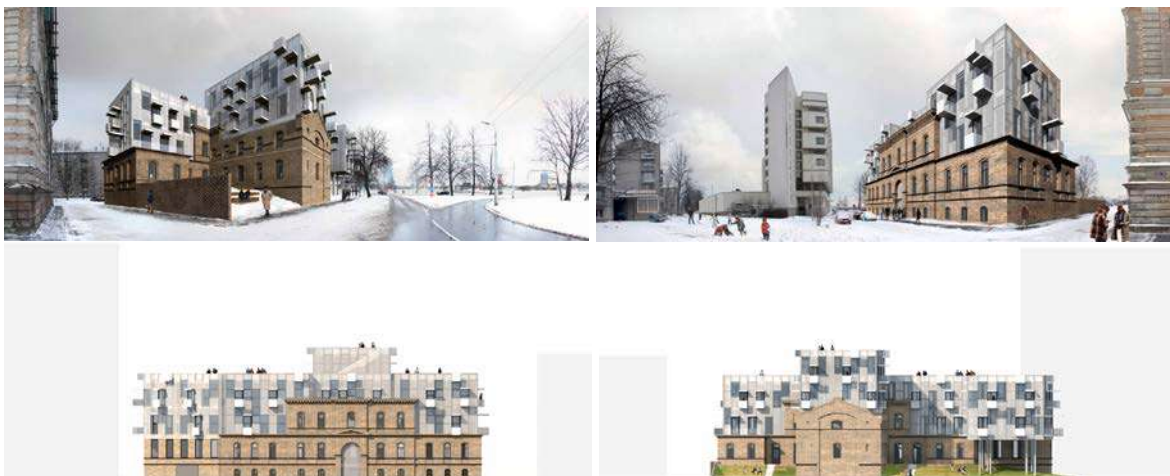


Fig. 6. Reconstruction of Former Police Station Apartment Building / NRJA. Riga, Latvia

<https://www.archdaily.com/207257/reconstruction-of-former-police-station-to-apartment-building-nrja>

https://www.archdaily.com/207257/reconstruction-of-former-police-station-to-apartment-building-nrja/pol_viz3

Local town planning administration of the city of Riga, in Latvia decided to convert the former police station into a housing building. The concept planned for retaining the physiognomy of the existing building with a brick façade in the lower part and addition of new three floors of modern architecture and new reinforced-concrete structure inside the existing volume. The designers⁸ designed balcony areas for the new housing units and a façade cladding with uniform modular pattern and glazed surfaces, in contrast to the inherited physical structure which has dominating brickwork and small windows on the façade. A car lot with 18 parking spaces, sport clubs and technical rooms are designed on the ground floor. Above the newly added volume is a public terrace facing the Daugava river. Offices, restaurant and an entrance zone for the apartment are designed on the first floor. The other floors contain 24 apartments. What is lacking is a historical respect and understanding of the character of the inherited place, material-textural continuity as well as the necessary geometrical-coloration and organic harmony.



Fig. 7. Szczecin Philharmonic - Filharmonia im. Mieczysława Karłowicza w Szczecinie.

National Museum in Szczecin, Poland by Robert Konieczny/KWK Promes

<http://bustler.net/news/search/award/5309/national-museum-in-szczecin-crowned-as-2016-world-building-of-the-year>

<http://www.zakladpodrozniczy.pl/szczecin-i-5-powodow-dla-ktorych-warto-go-odwiedzic/>

http://1.bp.blogspot.com/-Ndc5nbY9Xs4/VnHAKu8MBZI/AAAAAAAAAMOU/JkhxyWNkBW4/s1600/DSC_0986.JPG

<http://projektyrpo.wzp.pl/content/rpzp060201-32-00209>

The idea for construction of a new Philharmonic building in Szczecin on the location of the Concert house emerged in 2004. The opening ceremony was at the beginning of the art season of 2014/2015. The designers⁹, with the new town planning-architectonic conceptualization of space with more than 12000m² of useful area on four floor and the hall capacity of 953 seats, created an extremely functional and top musical interior ambient. They won a competition of 44 designs from all over the world with symbolic ice-like, white archisculptural building shape. The building volume has a square floor plan, and it is adjacent to the Royal Presidium of the Police Force, currently the building of the Voivodeship Police Headquarters Szczecin on a historically important place. The white façade of Philharmonic hall can in daytime have various colors. The structures defined in stark contrast do not have a common formal synthetic continuity of appearance within cityscape, nor an architectonic language which could testify of respect of the historical identity of the place.

⁸ Architects: NRJA Location: Kugu street 15/17, Riga, Latvia Team: Uldis Luksevics, Ieva Lace, Linda Leitane, Martins Rusins, Oskars Kotello Type: Competition entry: Land Plot Area: 1471sqm Floors: 5 Building Intensity: 219.8% Total Area: 2123.3sqm

⁹ <http://barozziveiga.com/contact/>. Bailén 36, 1º 2ª, 08010 Barcelona. Spain



Fig. 8. Bellefield Towers at University of Pittsburgh

http://3.bp.blogspot.com/_PnT6fOkhWyg/TSNyREeU8vI/AAAAAAAAAErM/cyr7HoRNLe0/s1600/5324048731_4fcc786052_b.jpg

<https://commons.wikimedia.org/wiki/File:BellefieldTowersPitt.jpg>

<https://upload.wikimedia.org/wikipedia/commons/f/f7/BellefieldTowersPitt.jpg>

Bellefield Tower¹⁰ belfry, at the corner of the Fifth and Bellefield avenues in Oakland, is an indicative town planning example where inherited and modern architecture are confronted. The belfry goes back to 1889, when it was a part of the former Bellefield Presbyterian Church, and it is all that remained in front of the building of in front of the building of Bellefield Tower University of Pittsburgh. The attractive location was used by the local town planning services for construction of a physical structure, Gnd floor + 6 floors, in the immediate vicinity, with a very contemporary material conceptualization of a facade plane, while noticeably ignoring the cultural-historical and urbarchitectonic value of the belfry in the process. One can observe a clear town-planning and designing attitude towards certain cultural, esthetic, functional or technical specifics. The newly designed functionalistic building is left without details and ornaments. It contains information about the architects' attitude towards architectonic heritage and styles in architecture. It exhibits the cultural standpoint of the building commissioner, his eccentricity, esthetic-artistic attitudes, cancelling of significant historical traces of urban past and lack of understanding for urbarchitectonic contradictions in a city development.



Fig. 9. Eight film theatres with a total of 1380 seats, ticket hall, atrium space, offices

<https://www.architecturelab.net/cinema-alesia-manuelle-gautrand-architecture/>

The Gaumont-Pathe group decided in 2011 to renovate the existing building¹¹ in Paris, built in 1921 on an attractive location, in order to build on the cinema theaters and improve comfort of the users. The focus was on an innovative transformation of an old interpolated building between a Mc Donald's outlet, Gnd floor+1floor and a housing

¹⁰ <https://journals.psu.edu/wph/article/viewFile/2805/2637>

¹¹ Project Details: Location: 73 Boulevard du Général Leclerc 75014 Paris, France. Area: 3,600 sqm. Program: Eight film theatres with a total of 1380 seats, ticket hall, atrium space, offices. Architects: Manuelle Gautrand Architecture

building Gnd fl.+6 fl + Attic into a modern high-quality functional architectonic space. The frontal wave façade, 25 long, was designed with spectacular LED flexible animation screen facing west towards the wide Boulevard du General Leclerc. Lack of sensibility of the designer for valuing historical inherited urbarchitectonic value created a critical, esthetic-artistic, cultural-decadent situation in urban space. At work here is the building philosophy where it was more important to possess than to understand. What happened is the loss of the authentic identity of the place, abolishing of iconography of past times and instead consolidation, and image of the of valuable spiritual heritage was deleted. The emphasis was on contemporary technologies for favoring of film excerpts with motion pictures and informational jigsaws running for 24 hours.



Fig. 10. Tower of Vilharigues before and after restoration, Vouzela, Portugal by Carlos Quevedo Architects

<https://weburbanist.com/2018/01/03/architecture-as-the-phoenix-13-modern-structures-borne-from-rot-and-ruin/>

<http://www.medievalhistories.com/matrera-castle-vilharigues-tower/>

https://www.facebook.com/pg/pacodatorre/photos/?tab=album&album_id=568805986476653

https://commons.wikimedia.org/wiki/Category:Torre_de_Vilharigues

The medieval Tower of Vilharigues in northern Portugal was built by the end of the ninth century as a military installation. It is located on a hill, with a beautiful vista towards Vouzela town and Lafoes valley. After restoration in 2006, the Tower of Vilharigues obtained a new appearance and function of panoramic vantage point. Parts on the important building on the cultural heritage site suddenly collapsed in 2013 because of the land slide. The architect Carlos Quevedo¹² used steel and cement to recreate the original dimensions of the building, which made this “recuperated” and structurally reinforced ruin again available for the public, in spite of the fact that a little is left of it. The local residents were not satisfied with the restoration result, since their expectations were not met. They asked for the authentic, original appearance of the Tower it had prior to devastation. There were harsh judgments of this failed intervention. Some local residents called this move a “massacre of heritage”. De facto, the renewed Tower considerably change its original appearance. This modern physical structure did not satisfy the people who are professionals in cultural heritage protection. This hybrid of glass and steel profiles and centuries-old stone walls brutally disrupted the spirit of the place and users’ feelings of valuing of a cultural-historical space.

3. Conclusion

Dramatic changes in the cities with modern architecture on historically important places, in a number of cases, degraded the usage of space to the level where historical

¹² Carlos Quevedo Rojas. Cádiz (Spain), 1980 graduated from the E.T.S. Arquitectura of Seville, Master’s Degree in Architecture and Historical Heritage (Seville)

identity of the place becomes unrecognizable and permanently lost. A new architectonic geometry with essentially different building materials prevailed, especially in design of façade planes. New urban philosophy is emphasized, in which there is no organic, metabolic relation of the adjacent buildings and where integrations of old and new, often very contrasting structures, are allowed. Investors do not see, or do not wish to see the inherited cultural heritage in its original form, but advocated a profiteering logic, inadequate, irregular architectonic interventions in space, insisting on the tensions in dramatic dynamics of cities. Nowadays, more than ever before, we need a more selective and more careful approach to a different strategy of preservation of inherited ecourbarchitectonic structures. We endorse a firmer cooperation of architects and conservators in conceiving a better, more stable ecourbarchitectonic iconography in order to prevent haphazard and conflicting activities in cities.

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LESSONS FROM HISTORY ABOUT METROPOLITAN GENOME – FROM NAISSUS TO SERDICA AND FROM SOFIA TO NIŠ

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Abstract: In rapidly changing world, growth of population causes sublimation of urban areas to cities, metropolitan areas and megacities. “Bigger” means more efficient and stronger. Therefore, concern about size means concern about economy, social progress and vitality. In this paper, we discuss lessons from Roman times about socio-economic development between Naissus and Serdica and their relevance for contemporary urban area between Sofia and Niš. In other words, we discuss metropolitan genome and relevance of historical structure along this axe, which is approximately axe of VIA MILITARIS, for well-being of inhabitants of designated area, nowadays.

Key words: Naissus, Serdica, metropolitan development, socio-economic prosperity

1. Introduction

The works on Corridor 10, which is the working title of highway from Niš to Bulgarian border (Fig. 1), led to discoveries of many archaeological sites (Fig. 2).



Fig. 1. Location of East branch of Corridor 10

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DEONICA AUTOPUTA E-80	LOKALITETI
Prosek – Bancarevo	Bare 1, Jelašnica
Prosek – Bancarevo	Bare 2, Jelašnica
Prosek – Bancarevo	Bare 3, Jelašnica
Prosek – Bancarevo	Česma Moralijs, Bancarevo
Bancarevo – Crvena Reka	Toplik, Glogovac
Bancarevo – Crvena Reka	Latinska Crkva, Glogovac
Bancarevo – Crvena Reka	Selište, Glogovac
Bancarevo – Crvena Reka	Polje, Glogovac
Bancarevo – Crvena Reka	Kladenčište, selo Špaj
Crvena Reka – Čiflik	Livade, Moklište
Crvena Reka – Čiflik	Slatina, Moklište
Crvena Reka – Čiflik	Gladno Polje, Bela Palanka
Crvena Reka – Čiflik	Rimski Most, Bela Palanka
Crvena Reka – Čiflik	Latinska grobišta, Dol
Crvena Reka – Čiflik	Sv. Car Konstantin i carica Jelena, Do
Čiflik - Staničenje	Selište, Sinjac
Čiflik - Staničenje	Crkvište, Sinjac
Čiflik - Staničenje	Kod Česme, Crnoklište
Čiflik - Staničenje	Mađilka, Staničenje
Staničenje - Pirot	Sarlah (jug), Pirot
Staničenje - Pirot	Tursko groblje (Tri krsta) Sarlah sever, Pirot
Pirot - Dimitrovgrad	Obrenovac Selo
Pirot - Dimitrovgrad	Obrenovac Srečkovo, Obrenovac
Pirot - Dimitrovgrad	Gojindolsko Kale (Malo Kale), Obrenovac
Pirot - Dimitrovgrad	Rupa, Veliki Jovanovac
Pirot - Dimitrovgrad	Zid pored puta, Veliki Jovanovac
Pirot - Dimitrovgrad	Lazinje, Vojnegovac
Pirot - Dimitrovgrad	Belo polje, Sukovo
Pirot - Dimitrovgrad	Pored železničke pruge, Činiglavci
Pirot - Dimitrovgrad	Selište (Kndina bara – Via militaris), Dimitrovgrad
Pirot - Dimitrovgrad	Crkvište sa krstom, Gradinje
Pirot - Dimitrovgrad	Voćnjak, Gradinje
Pirot - Dimitrovgrad	Stara petlja, Dimitrovgrad

Fig. 2. List of archaeological sites discovered along Corridor 10 from Nis to Serbian border (Source: Archaeological Institute of Serbian Academy of Science and Art)

This route has been in use since Roman times. The network of Roman roads started being constructed in 2nd c. B.C, and by 2nd c. AD it became the biggest transportation network that ever existed. The route remained essential during Late Antiquity and Byzantine period, as well as in later periods, until nowadays. It ends in Istanbul, the Imperial city ("Carigrad" or Constantinople) (Fig. 1.).

The Corridor 10 accidentally overleapt the route of VIA MILITARIS, while contemporary spatial planners decoded landscape for optimal highway route. The landscape line remained essentially unchanged over centuries, and common sense in decision-making process led to similar outcome in many segments. In Roman times, villages were located along the route for practical reasons: for efficient travel, it was necessary to change the horses after 10 Roman miles (14.81 km) and lodging for travelers was available approximately after every 25 miles (in fact, usually 20-30 miles i.e. every 30-45km). That rhythm was uncompromising – and the rule serves nowadays for prediction of new archaeological sites. For example, starting from assumption that there must exist a station for changing horses, archaeologists discovered a heritage site in Nishevac, 34km from Nish.

2. VIA MILITARIS

VIA MILITARIS (or VIA DIAGONALIS) was built in 1st c AD. Serdica (nowadays Sofia) was proved to exist much earlier, and in 1st c. it was conquered by Romans. Naissus (nowadays Nish) was mentioned in Roman documents much later, in 3rd c., as military campus. The major Roman roads were approximately 6-9m wide; they were paved by stone and laid on several layers of gravel and sand. The construction of The Corridor 10 revealed well preserved section of VIA MILITARIS, well preserved chariot (a light type, designed for fast travellers) (Fig. 3.) and 2 milestones, out of 3 discovered on the territory of Serbia by now (Fig. 4). It is known that contemporary roads are constructed based on similar concepts of those of Roman roads (Fig. 5, 6 and 7.)



Fig. 3. VIA MILITARIS Up (1) and Down (2)



Fig. 4. Milestones along Roman roads (left) and milestones discovered at Corridor 10 (right and down) (3) (2)

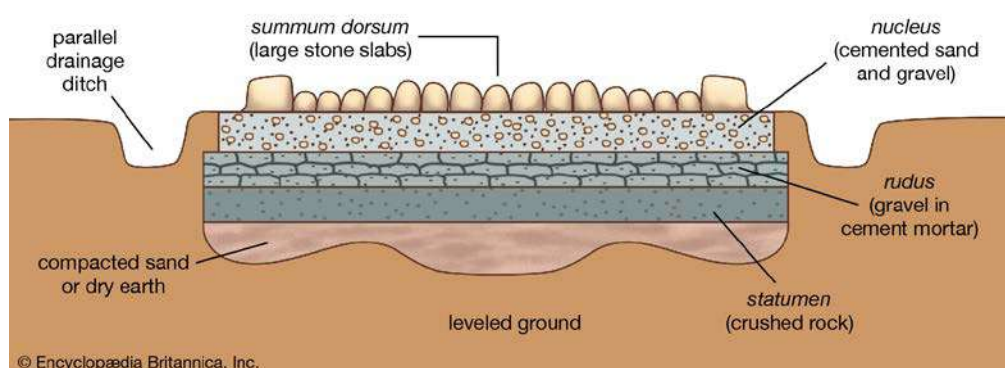


Fig. 5. Structure of Roman roads in Antiquity (4)



Fig. 6. Roman road section compared to contemporary (5)

3. Lessons from Roman times about socio-economic development between Naissus and Serdica

Soon after the development of Imperial Roman state reached its peak in 2nd c. AD, the cities started to decline. Signs of decadency of urban areas were numerous, e.g. abandonments of huge villas, division of big houses between several families, quick relocation of families from countryside to cities, bringing livestock and countryside lifestyle with themselves while looking for asylum in better protected cities, using debris for repairing buildings etc. Those trends appeared earlier in the West than in the East of Balkans. Many Emperors originated from Eastern parts, which brought prosperity during their reign at least locally. Only reforms of Diocletian and Constantine brought period of prosperity across provinces, and later also those of Justinian (6) (Fig. 7. and 8.).

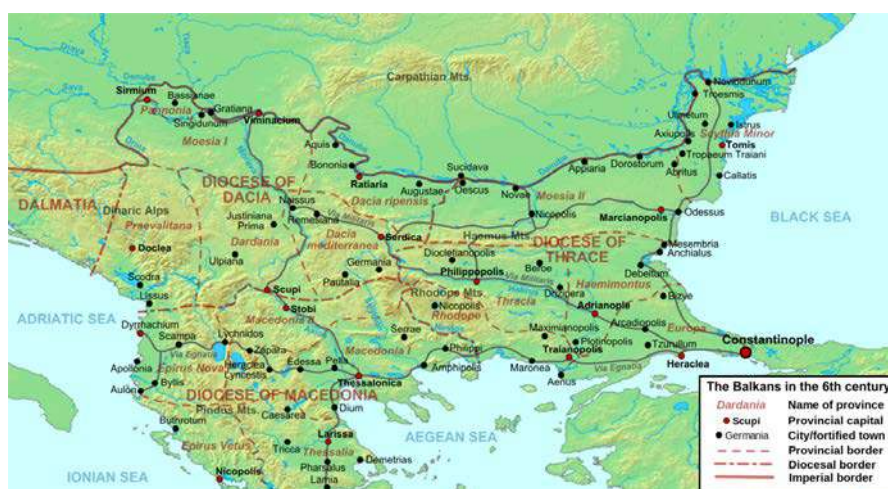


Fig. 7. Provinces (Source: Wikipedia)



Fig. 8. “Map of Illyricum with marked prominent archaeological sites...” (6)

Naisuss and Serdica benefited more than other cities in some periods due to a fact that Constantine was born in Naisuss, and St. Helena, the Emperor's mother, is said to have close ties with Serdica (she was even said to be born there but Procopius claimed differently). The road, which connected two cities, was intensively used in peace and war times which was another reason for benefit.

4. Development challenges of the area between Sofia and Nish

In contemporary terms, the area between Sofia and Nish is an example of transit-orientated development (TOD). Villages and towns are located along the route, which raises some safety issues, but nevertheless encourages trade and bring certain prosperity.

In the past, the prosperity was badly influenced by state borders, which implied firm borders of political and military alliances. After the end of The Cold War, political circumstances changed, but not for better in all terms. Bulgaria joined EU and NATO, while Serbia faced civil wars and consequently a short war with NATO on 1999.

Both Serbia and Bulgaria passed from state run economy to market system, which also means trough a necessary gap in transition(Fig. 9.), and that gap is what is considered in daily life "economic and political turmoil" of recent decades.

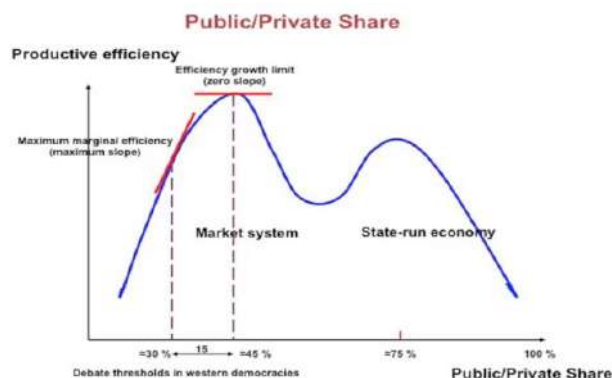


Fig. 9. Transition gap passing from state run economy to market system (7)

The prosperity brought by transit was commonly not considered sufficient for good quality of life of local inhabitants in designated area. General trend were not favorable: global trend of relocation from rural to urban areas, and impoverishment due to transition in both countries in 1990s.

The challenges of socioeconomic development nowadays are mainly: poverty, demographic aging and depopulation.

5. Metropolitan genoma

Urban centralities develop usually around historic cores. They include social facilities and further housing development growth. In their vicinity, emerge new developments. Later, at some distance, appear additional infrastructure networks and utilities, large regional facilities, interurban road network, industrial areas, periphery commercial centers etc. (Fig. 10). If such urban centralities interact among themselves in what-is-called here *metro-matrix balanced urban development*, a metropolis emerges. Alternatively, lack of balance in urban centralities leads to their decline and consecutive abandonment.

It is obvious that historic core can be demolished after the urban centrality is fully defined (which sometimes happens with excuse of land efficiency in favor of more commercial purposes) however it is hardly recommendable, for numerous social reasons.

Furthermore, one of the most efficient ways of preventing any development of urban centrality is demolishing its historic core at the very begging.

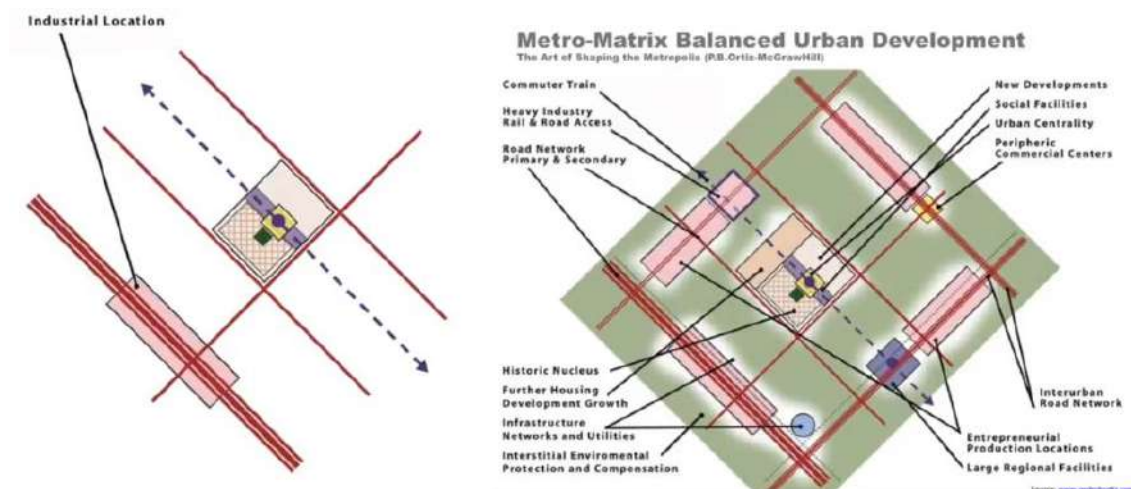


Fig. 10. Urban centrality (7)

Development of metropolises matters for a simple reason: in contemporary world, size of urban area matters. The analyses reveal that socioeconomic prosperity is concentrated in huge urban areas. There are very few examples where socioeconomic benefits are spread all over a state, in a balanced way (Germany being one of them). Cities are „hardware + software“, and that means, in different words, that prosperity requires both **Knowledge** i.e human resources (skills) and social capital (governance), and **Finance** (construction and infrastructure) (Fig. 11).

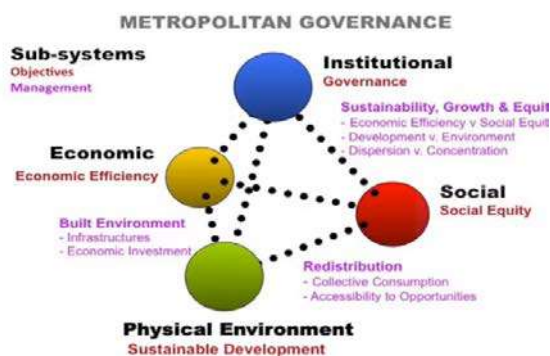


Fig. 11. Metropolitan governance (7)

6. Discussion: significance of built heritage for well-being of residents nowadays

As commonly known, built heritage management advanced significantly since 1980s, and there are numerous models for built/natural heritage based urban development. Culture acts as “a glue”, or “a catalyst” both for development of urban centralities and for generating of metro-matrix. That is why *culture* should be added to a metropolitan governance triad *society, economy and environment* (Fig. 11), as forth element.

Although, experience proves that heritage sites help socio-economic development, the archaeological site in Crnokliste has become sad example of what happened to historical structures along the Corridor 10(Fig. 12.).



Fig 12. Basilica discovered in Crnokliste near village Stanicenje (8)

Metropolis implies growth in a way which brings welfare to local people, on both sides of the border in this case. In realization of such scenario, recently discovered archaeological sites along the Corridor 10 have much greater importance than it seems at first. Development of metropolis requires – as rule of thumb – high capital and low risk, however, neither of that exists in area between Sofia and Nish at this time. That is why it is most important to preserve what there are: valuable heritage sites.

One of the lessons from Roman governance is that a road is as efficient as each and every horse-exchange station along it. Nowadays, it practically means that each and every heritage site matters, as constitutive element of urban centrality and furthermore metro-matrix.

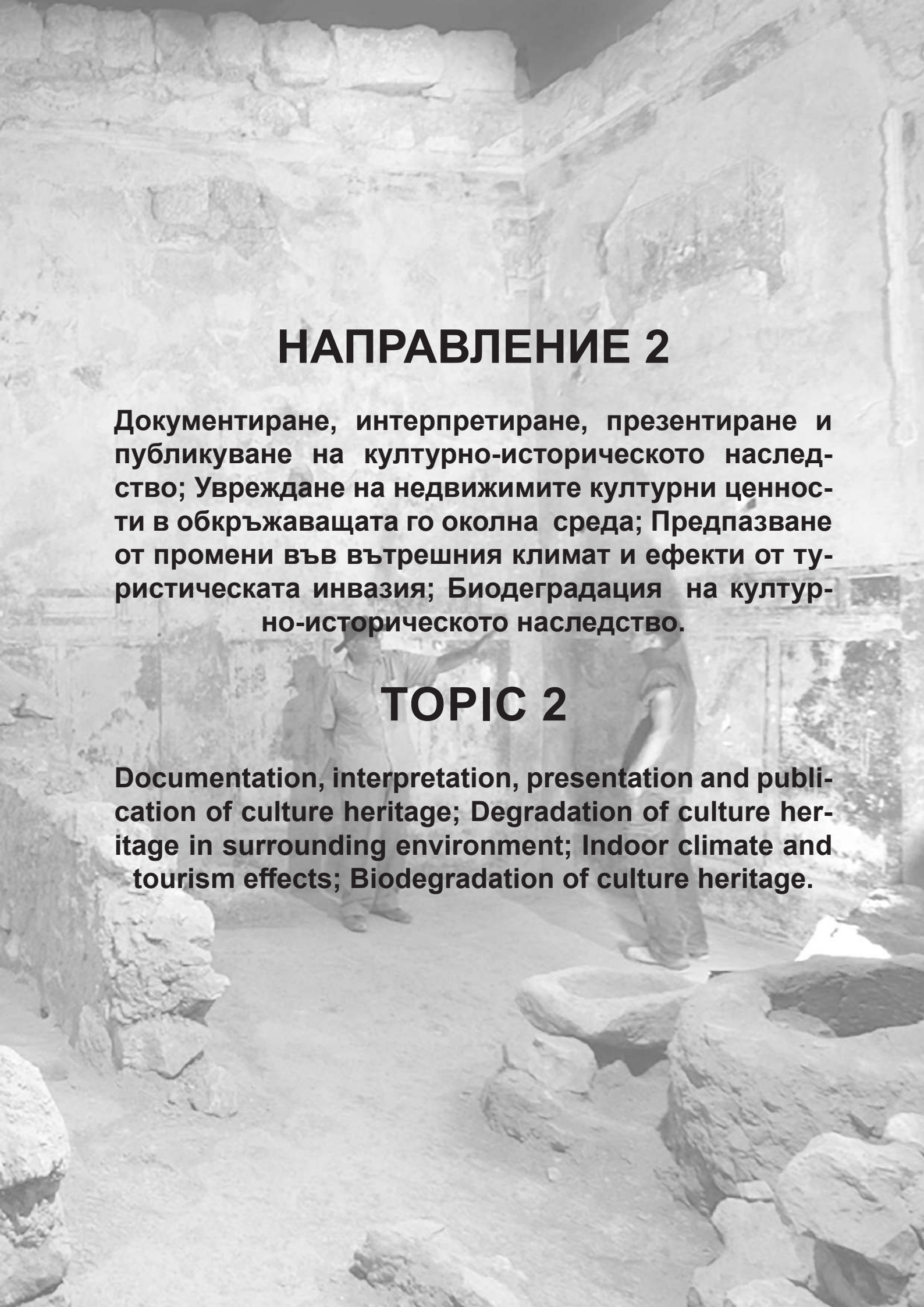
7. Conclusion: a journey of a military road through time

In development of the area along East branch of The Corridor 10 between Sofia and Nish, heritage sites could become “hearts” of urban centralities, which are elements of metro-matrix. If resources (both knowledge and finances) are used wisely, they could lead to development of metropolitan area, implicating highly needed increase of quality of life, changing decline into prosperity. Geographically, central position in this scenario belongs to a historical structure – VIA MILITARIS.

Neglecting heritage sites and postponing public presentation for “better” times is wrong, implying fundamental misunderstanding of urban and metropolitan development nowadays.

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The background image is a grayscale photograph of an ancient stone structure, possibly a ruin or a historical site. Two people are visible inside the structure, one pointing towards the wall. The structure is made of large, irregular stone blocks.

НАПРАВЛЕНИЕ 2

Документиране, интерпретиране, презентирание и публикуване на културно-историческото наследство; Увреждане на недвижимите културни ценности в обкръжаващата го околна среда; Предпазване от промени във вътрешния климат и ефекти от туристическата инвазия; Биodeградация на културно-историческото наследство.

TOPIC 2

Documentation, interpretation, presentation and publication of culture heritage; Degradation of culture heritage in surrounding environment; Indoor climate and tourism effects; Biodegradation of culture heritage.

**УСТРОЙСТВЕНИ ПРИОРИТЕТИ ПРИ БЛАГОУСТРОЯВАНЕТО НА
МАЛКИЯ ГРАД В БЪЛГАРИЯ. НА ПРИМЕРА НА ГРАДОВЕТЕ
КЮСТЕНДИЛ, САМОКОВ, КОСТИНБРОД, ДОЛНА БАНЯ И ДР.**

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**SPATIAL AND TERRITORIAL PLANNING PRIORITIES IN THE
DEVELOPMENT OF SMALL TOWNS IN BULGARIA. UPON THE
EXAMPLE OF TOWNS LIKE KYUSTENDIL, SAMOKOV, KOSTINBROD,
DOLNA BANYA, ETC.**

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***Abstract:** At the present stage of economic development in our country many different business interests have come about, as they quite often give rise to a conflict in the development and the planning of the central urban parts of a small town, which is also related to the general vision of its development and the policy pursued by the local authorities. The issues concerning planning regarding the improvement and renovation of the central urban parts including their cultural and historical heritage is determined by the complex relationships incurred by the different status of the property ownership, the cultural monuments in these parts, and the various personal desires stated by the owners concerning their function in the future. The paper examines available possibilities of an exemplary renewal of a so called Central Town Area related to the general conditions and policy of the European requirements on this matter, as well as the willingness and intended policy of the local government with concern for improvement of the living conditions and qualities of the central parts of these cities. With regards to the European forums having been held, as well as to the Leipzig Charter for Sustainable European Cities drawn up in 2007, and the 2010 Toledo Declaration on the Development of Small and Large Cities, the actuality of the topic may be deemed relevant.*

Key words: *urban planning, urbanism, sustainable development, central urban parts*

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1. Въведение

На съвременния етап на стопанско развитие в страната настъпиха много и различни бизнес интереси, които доста често пораждат конфликт в развитието и планирането на централните градски части на малкия град, свързано с общата визия на развитието им и провежданата политика от органите на местната власт. Проблемите и решаването им в устройствен аспект на благоустрояването и обновяването на централните градски части се обуславя от сложните взаимоотношения, породени от видовете собственост на имотите на тези територии и посоченото многообразие от желания на собствениците за тяхното предназначение в бъдеще. Видно от нормативните документи в центровете на малките градове са съсредоточени почти всички видове дейности на комплексното обществено обслужване, терените за рекреация, съществуват паметници на културно-историческото наследство, които са с повсеместен характер. От тук произлиза и конфликтът на разнородни интереси, породени от статута на частната собственост върху недвижимите имоти от центровете на градовете в желанието на бизнеса за честа промяна на предназначението на същите и не в редки случаи на намеса в статута на защитени паметници на културата. В устройствен аспект централните части на малкия град са богати на публични пространства, често оформяни в различни етапи на обществено развитие, понякога без връзка помежду си по отношение на мащаб, градски дизайн, зелена система и благоустрояване.

Обект на изследване са централните градски части на малкия град с предмет проблематика и устройствени мерки при благоустрояването им. Целта на изследването е да се създаде теоретичен модел, който да реши въпросите, свързани с обновяването, реконструкцията и благоустрояването на публичните пространства от тези градски центрове, както и решаване на проблемите с паметниците на културно-историческото наследство и зелената система. Обхватът на изследването обхваща някои стари градове на страната като гр. Кюстендил и гр. Самоков, както и по-нови, гравитиращи край столицата – гр. Костинброд, гр. Божурище и гр. Долна баня.

Като задачи за решаване в изследването стоят публични пешеходни пространства, площадът на малкия град, комуникационни проблеми, достъп до сградите на общественото обслужване, културно- историческо наследство и връзка с историческата памет и ролята на зелената система при благоустрояването им. При решаването на задачите да се създаде оценъчен модел за подобряване жизнената среда на населението от малкия град, както и постигане на градската идентичност.

2. Град Кюстендил



а)



б)

Фиг.1 - Примерно обемно- устройствено проучване с ръководител доц. д-р арх. Власарев по научно- изследователски проект на ВСУ „Любен Каравелов“ на

централната градска част на гр. Кюстендил. а) изглед към културно- исторически паметник „Дервиш баня“ от 16-ти век; б) обемно проучване на пространствата около „Дервиш“ баня с възможно експониране на археологията от Древна Пауталия – крепостната стена;

Целта на обемно- устройственото проучване, показано на фиг.1, е да се създаде пространствена рамка, оформяща кръглия площад на Дервиш баня, възможност за експониране археологията- крепостната стена на древна Пауталия и интегриране на пространствата с зелената площ на градината пред художествената галерия, както и възможност експониране на част раннохристиянски базилики.



а)



б)

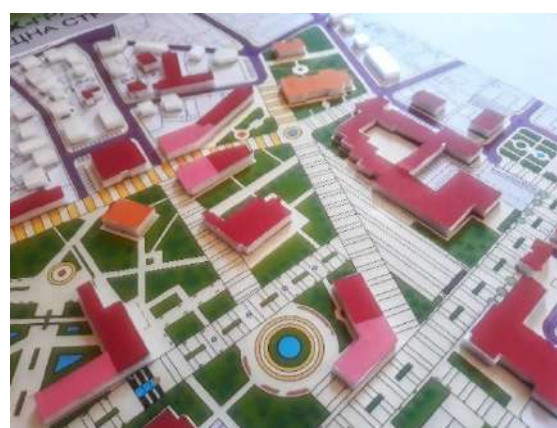
Фиг. 2- Примерно обемно- устройствено проучване с ръководител доц. д-р арх. Власарев по научно- изследователски проект на ВСУ „Любен Каравелов“. а) Изглед от културно- историческия паметник „Фатих Мехмед“ джамия; б) Обемно проучване на пространствата по бул. „Цар Освободител“ и „Фатих Мехмед“ джамия, богати на културно- исторически паметници.

Целта на проучването, показано на фиг.2, е да се създаде оптимално устройствено решение на пространството около „Фатих Мехмед“ джамия, касаещо изграждане на нова пешеходна зона по бул. „Цар Освободител“ и ново решение на зелените площи и прилежаща зеленина към културно- историческия паметник – „Фатих Мехмед“ джамия. Търсено е запазване мястото на сергийния пазар, като са отредени нови площи за поставяеми обекти и освобождаване на съществуващите около летния театър. Създадена е възможност за експониране на археологията като подземен урбанизъм под съществуващия площад на градския пазар.

3. Град Самоков



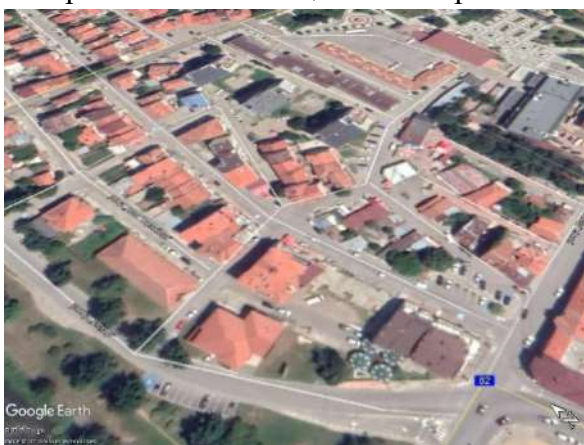
а)



б)

Фиг. 3 - Примерно обемно- устройствено проучване с ръководител доц. д-р арх. Власарев по научно- изследователски проект на ВСУ „Любен Каравелов“ (9/2019г.), показващо съществуващото положение на рамката на централния градски площад на гр. Самоков, сградата на общинската администрация, сградата на бившата община и банка ДСК, както и триъгълния площад с „Голямата чешма“. а) сателитна снимка; б) обемно проучване на площада и градската градина от ЦГЧ на гр. Самоков;

Проектотпредложението на обновяването на посочените площадни пространства включва подмяна на настилката, оформяне на нови зелени ивици с подчертаване на пешеходната ос по улица „Цар Борис III“, богата на културно-исторически паметници от българското възрождане.



а)



б)

Фиг. 4 - Примерно обемно- устройствено проучване с ръководител доц. д-р арх. Власарев по научно- изследователски проект на ВСУ „Любен Каравелов“. а) сателитна снимка; б) обемно проучване на застрояването на старите търговски улици („Житна чаршия“) от центъра на града;

На фиг.4 е показано изграждане на нова пешеходна зона на мястото на сергийния общински пазар, оформяне на пространството улиците от старата част от центъра на града, включваща „Житна чаршия“ и прилежащите пешеходни улици. Създаване на акценти на кръстовището пред жилищна сграда- паметник на архитектурното културно наследство. Обновяването тази стара градска част от центъра на Самоков предвижда застрояване с максимална плътност 100 на сто и височина на сградите от 10м, включваща надстрояване и престрояване със запазване характера и историческия облик на сградите. Тази част интерпретира някогашните дюкяни, обновени като малки търговски обекти, бутици, ателиета и обекти на общественото хранене в партерните части от застрояката.



а)



б)

Фиг. 5 - Примерно обемно- устройствено проучване с ръководител доц. д-р арх. Власарев по научно- изследователски проект на ВСУ „Любен Каравелов“, 2019г. по улица „Търговска“, гр. Самоков. а) изглед на културно- исторически обекти по ул. „Търговска“; б) оформяне на пространствената рамка на двата площада, триъгълен с „Голямата чешма“ и площада пред общината;

Целта на проучването, показано на фиг.5, е създаването на нова пешеходна зона по ул. „Търговска“, включваща пространствата около „Байракли“ джамия, „чешмата с обичата“ и триъгълния площад към нея. Пространството около читалището, паметник на архитектурното културно наследство, също се обновява като пешеходна зона. Запазена е формата на градския площад пред Общината. Градската градина, като зелени площи, обвързва сполучливо в композиционно единство паметниците на културата, „Байракли“ джамия, читалище, музей и „Голямата чешма“, като алейна мрежа, материала на настилките, както и удачно решение на денивелацията на двете нива от градската градина. Възможно е и експониране на бившата часовникова кула на града като втори акцент към рамката на триъгълния площад с „Голямата чешма“, по съществуващи архивни данни за местоположение и архитектурен образ.



Фиг. 6 – Реализация на обновяване на градската градина с подчертаване на единството на настилката, иглолистната растителност и паметниците на културно-историческото наследство – „Байракли“ джамия- гр. Самоков. Настилката е с материал, подчертаващ местния ландшафт. а) изглед към „Байракли“ джамия; б) изглед към алеината мрежа;

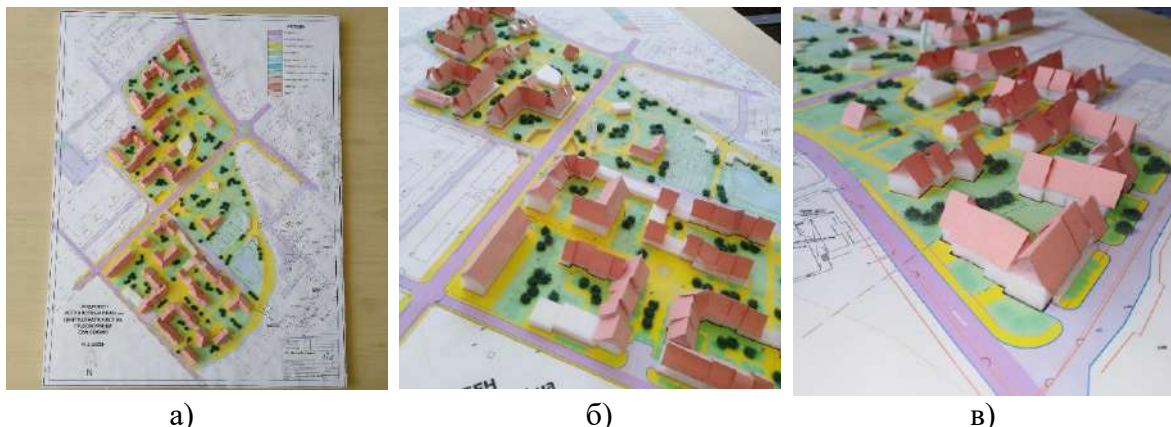
4. Град Костинброд



Фиг.7 – Възможни рекреационни и туристически маршрути, включващи културно-историческия туризъм, относно късноримската резиденция „Скретиска“ и късноримски пътни станции. а) рекреационна ос; б) рекреационна ос до резиденция „Скретиска“

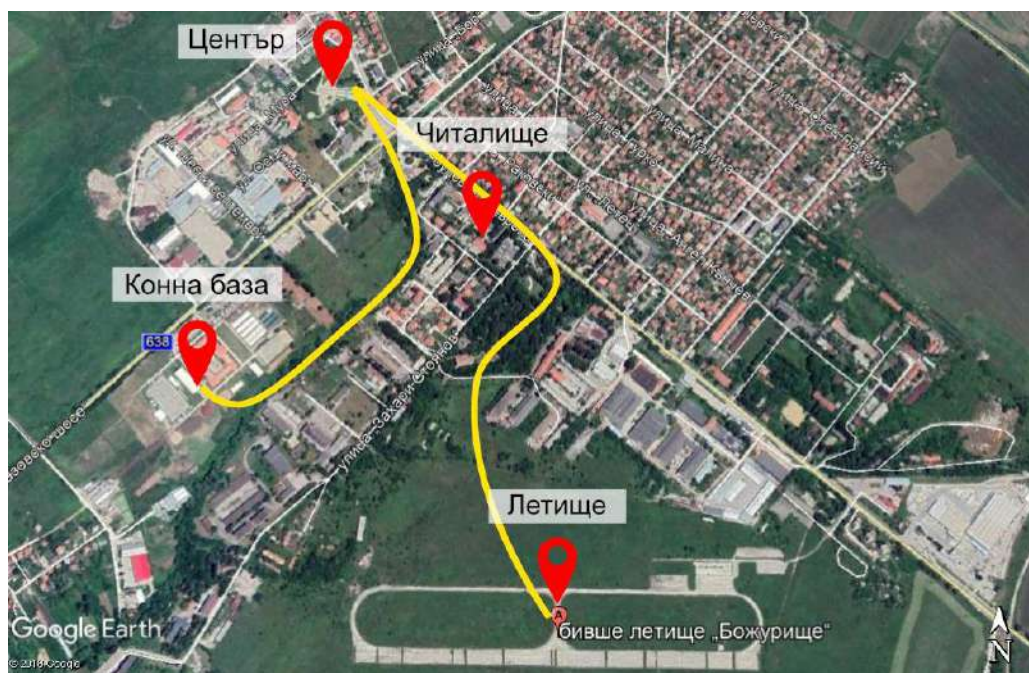
Не е решена възможността за създаване на устройствен маршрут, приобщаващ резиденция „Скретиска“, като културно- исторически паметник в обновяването на централната градска част на гр. Костинброд. В проекта за обновяване на централната градска част следва да се зложат и възможностите, които дават културно- историческите маршрути с оглед устойчиво устройствено решение на същите.

5. Град Божурище



Фиг. 8 - Примерно обемно- устройствено проучване с ръководител доц. д-р арх. Власарев по научно- изследователски проект на ВСУ „Любен Каравелов“ 2019г. на централна градска част на гр. Божурище. а) цялостен макет на проучването; б) изглед от юг; в) изглед от север, характерът наподобява стар възрожденски център на малък град;

Решението от фиг. 8 предвижда застрояване с жилищни и обществени сгради, обособяване на квартали със склучено застрояване и по- висока плътност на застрояване. Центърът е обновен на база запазване на зелените площи, изграждане ново площадно пространство с подчертаване въздействието на съществуващите обществени сгради без да бъде допълнително застроен. По този начин се създава естествена връзка за изграждане на културно- исторически маршрут към комплексите с културно- историческо значение- конна база, читалище и летище.



Фиг. 9 - Примерни културно- исторически маршрути, интегриращи централната градска част с нейната периферия, включваща обекти на културно- историческото наследство- конна база, читалище и летище.



а)



б)

Фиг. 10 – Реализация на обновените обществени пространства от ЦГЧ на гр. Божурище. а) изглед към обновено площадно пространство; б) изглед към площада с нов архитектурен дизайн- пейки, фонтан и осветление;

Създадена е възможност за пространствено- функционална връзка с обектите на културно- историческото наследство. Използвани са нови екологични настилки, пейки с интересен дизайн, както и подчертаване сградата на общинската администрация с монументално декоративно пано, символизиращо името на града.

6. Град Долна Баня



а)



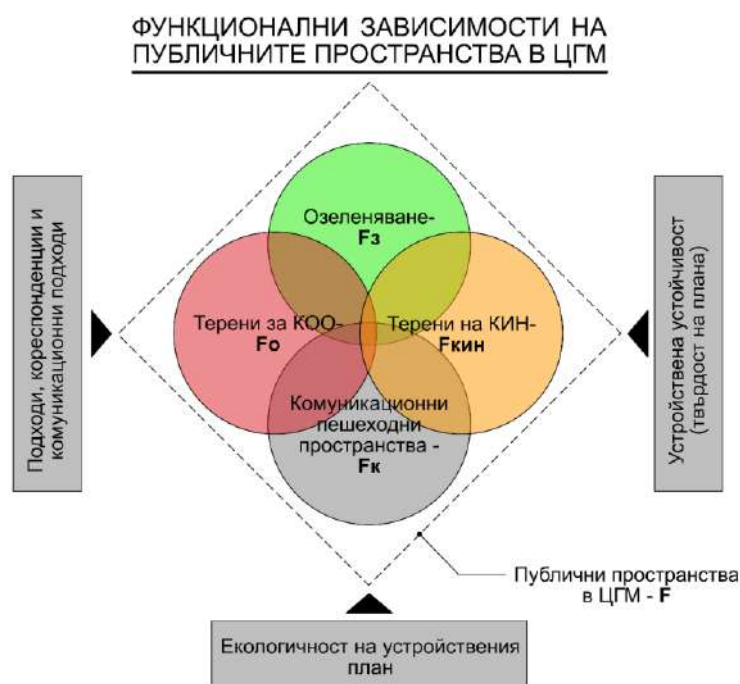
б)

Фиг. 11 – Изгледи от централни градски части на гр. Долна Баня. а) изглед към градския площад с читалище; б) изглед към редови къщи паметници на културно- историческото наследство;

Град Долна Баня има удачни възможности за обновяване на главната улица като пешеходна зона и преустройство на централния градски площад с читалището и парковата зона към него (показани на фиг.11). Обновяването се изразява с пешеходни улици с нови настилки, възстановяване уличната рамка от склучено застрояване със сгради на културно- историческото наследство и обновяване на обществени сгради и обекти. Проблемите са сходни със застрояването на старите квартали от централната градска част на гр. Самоков, като има и достатъчни

възможности за развитие на градската градина с историческата сграда на читалище „Рила- 1898“.

Извод: Средните и малки градове съставляват значителната част като брой от градовете в България. Обновяването на центровете им е належащ и целесъобразен устройствен похват за цялостното им устойчиво развитие. Интеграцията в устройственото решение между зелена система, сградите на комплексното общественото обслужване и тези на културно- историческото наследство обуславят качествено и устойчиво реализиране на публичните пространства в централните градски части на малките и средни градове с подчертаване на историческата памет на населеното място.



Фиг. 12 – Схема на функционалните зависимости между различните видове терени в ЦГЧ на малкия град, представляваща графично функционалните зависимости между различните видове терени и площи в обхвата на централната градска част на малкия град и тяхната интеграция при обновяването на територията. Основни структурни елементи са зелената система, нейното изграждане и обновяване, както възстановяване и обновяване на паметниците на културата. Тези зависимости обуславят устройствената устойчивост на градоустройствения план, както и неговата целесъобразност на решението му.

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NURTURING INDUSTRIAL HERITAGE IN AREA OF THE CITY OF NIŠ (SERBIA) - ITS IDENTIFICATION AND VALORISATION AS INITIAL STEPS FOR CULTURAL URBAN (RE)DEVELOPMENT

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Abstract: *Industrial heritage as a part of cultural heritage, piecing together the remnants of lost industrial activities, can be of significant interest for the future generations. Its importance has been recognized in making the connections between the present and the past while creating identity of an urban space. Due to the lack of the rigid procedures, and despite its widely recognized importance in terms of future sustainable redevelopment, in Serbia, this kind of built heritage is been neglected and out of the focus of the institutions and the society as well. Considering the area of the city of Nis, this paper examined the heritage and the industrial residues of the two periods as of the major historical importance — before and right after the WWII; with the aim to make a detailed insight into their current statuses. Comparing two epochs, we have identified the determining characteristic of the examined periods of industrial development. While it is generally acceptable that the older structures could be of the greater importance for the architectural historians and conservators, this paper tends to highlight the importance of nurturing and managing the full scope of the industrial heritage regardless the historical distance.*

Key words: *industrial heritage, industrial architecture, Nis, modern architecture, socialistic architecture, heritage management, architectural conversions*

1. Introduction

Industrial heritage is an element of history of an urban space that has recently become an important element of protection and nurture. In fact, the importance of preserving the architectural heritage was recognized very soon after it became clear that

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insensible changes in the modernized urban space could lead to inconsistent consequences due to forever lost values. Industrial heritage is mentioned as part of the cultural and architectural heritage in the ICOMOS's, UNESCO's charters, of importance and value to society. It is also recognized as part of the sustainability strategies of development and dynamics of contemporary urban. Therefore, industrial heritage is not the focus of exclusively narrow-minded bodies, institutions of culture, but this segment of human heritage is also recognized as an integral part or instrument for achieving the goals (economic, environmental, etc.) that are of global importance for the whole society. Built primarily as utilitarian objects, they do not enjoy a high degree of appreciation and admiration as some other categories of objects and urban entities. However, industry in cities, especially when it becomes only a part of the history and memory of society, is assessed as an important part of the social factor in both spatial, social and economic terms. The reasons for this are based on the physical scale of the space and objects they occupy in cities, then on the impact on the lives of people and the changes they have caused in the lives of people and the entire social community, as well as the global society. For this reason, industry has found an important place in the history of human civilization, and therefore nurturing this historical narrative becomes a justifiable goal.

Given that urban identity can be of the great help in the city branding, while contributing to its historical and cultural development, the initial step includes recognition of the values of cultural heritage. Contemporary concepts of managing cultural heritage, within the sustainable development agenda, include wide ranges of flexible formal and informal approaches in activating the areas of this kind, and they are the basis for its evaluation.

The paper deals with the industrial heritage of the city of Nis. By identifying and systematizing the sites and complexes that represent the heritage of this territory, this research tends to make an assessment and defines the current status, position and future prospects of the industrial heritage of the area. The aim is to give a detailed and precise insight into the trends of industrial development in the city throughout the history, as well as the development of modern society in the context of the challenges that come with the new times and new socio-political context.

2. Industrial heritage – current status in Serbia

Industrial heritage is defined as a set of entrepreneurial and engineering buildings, accompanying buildings of residential, national, religious and public architecture, sorted out in groups and types with associated landscape, as follows: infrastructural facilities (bridges, railway complexes, etc.), rural agricultural buildings and spaces as part of traditional architecture (barns, watermills, mills, etc.) and conventional industry and industrial complexes in urban areas. Mining complexes and energy facilities can be singled out as separate units of industrial heritage which are specifically integrated into natural landscapes (mines, mines, hydro power plants, etc.). It is also very important to note that the valorisation of industrial heritage usually happens by exploring firstly the oldest epochs of industrial development, so it can be said that the industry of 19th and first half of the 20th century was satisfyingly considered and virtually all industrial and entrepreneurial buildings that are considered as cultural assets belong to this period. However, the most significant period of Serbian industrialization, by the size of industrial development and the impact on society and lifestyle, the post-WWII industrial development has not been sufficiently explored to the date.

Serbia's industrial heritage is part of Europe's scientific and cultural heritage. Industrial facilities represent a significant testimony to the development of a society and are an integral part of industrial heritage, which in total implies the material remains of an industrial culture that has historical, technological, social, architectural, cultural and

scientific value [9]. Kurtovic-Folic points out that as symbols of growth and power of the economy, industrial buildings tend to look striking, to give the impression of strength and durability, so that in the process of industrialization, factory chimneys began to become symbols of a new age, a reference point in the city's landscape [7]. The protection of industrial heritage is carried out in the process of so-called integral protection, which implies the protection of movable and immovable cultural property by a single legal act guaranteeing the protection of an immovable property (industrial building) and the movable property contained therein. Also, industrial buildings can be separately valued as immovable cultural property without movable property within them. The legal framework in the field of cultural heritage protection, both movable and immovable, is defined by the Law on Cultural Property of the Republic of Serbia. [10] As the industrial heritage also includes a part of the movable cultural heritage, where the Museum of Science and Technology in Belgrade maintains jurisdiction over that heritage and the integral protection of the movable and immovable industrial property. Museum also maintains a register of these properties and takes care of the artefacts that are part of it, within the museum's properties, as well as goods outside them, in original locations or privately owned or owned by other institutions. In this way, the general framework was created that would further enable Serbia to continue on the work of designing and planning of integrated protection, promotion and popularization of scientific, technical and industrial heritage and to join and closely collaborate with international and European organizations such as ERIH, TICCIH and E-FAITH et al. Therefore, one industrial complex has more possibilities to be placed under the status of heritage protection. However, in the valorisation of architectural (immovable) heritage within the industrial heritage as a whole, attachment to the aesthetic component, the concept of "beautiful-ugly", can only be understood and discussed as a handicap or as a result of incomplete research in an industrial heritage valorisation project. It should be kept in mind that industrial development was neither beautiful nor pleasant (exploitation of workers, exploitation of children as labour, strikes that were stifled in blood), but these negative phenomena are part of the identity of an industrialized society [14].

Generally, the multiple lines of dealing with heritage can be traced. On the one hand, there are institutions of heritage protection that deal with the studding, processing, evaluating and prescribing protection measures. On the other, the factors of active heritage management can be also identified through strategic planning and decisions making institutions that deals with planning processes, urban dynamics, and economy, polices and politics, etc. Also, real-estate property owners have certain mechanisms and point of view for management of their own assets, which can vary from case to case, and depends largely on the economy and economic capacity of the owner. All these stakeholders do not necessarily have to be separated or opposed in the process. They should actually be integrated and/or confronted at the planning level creating a single strategy of operation and management.

3. Qualitative analysis of industrial heritage in Nis

The first hint of a solid economic modernization of Niš is the construction and opening of a railway line that occurred in 1884, after the liberation of these territories from the Turks, when the first train to Niš arrived from Belgrade with this newly constructed track. In more than a century of developing industry within the city of Nis (Serbia), there are a lot of evidences of this human activity. This history of developing industrial activity in Nis could be divided into three major periods: period before WWII, socialistic period and period after the collapse of social regime. Upon the political shifts, there were always great changes of the way the industry was developed, financed, supported and physically planned.

The development of the industry in the city of Nis started upon the liberation of the Turks in the late XIX century. Political development of the state influenced the development of the industries. In this context, it is possible to recognize two distinctive periods in modern history of the area. First one is characterised by monarchical ruling of the state, while the second one is characterised by socialist, communist rule. Different types of the state regulation have the consequence in industrial development, we well. Industrial development of this area is characterised by various industrial branches that have been founded over time. While the first period is characterised by capitalistic society and dominant private investment in industry, the second period is marked by the state governance of the economy and industries as well. Nevertheless, there was never open and developed market for industrial products and competing for the customers was never the case.

Although a relatively stable branch of the economy, industry is highly dependent on many factors that contributed to its increase to enormous heights during the second half of the 20th century, but also decline sharply and steeply. Given the negative economic situation in Serbia and the transformation processes in recent decades that have not been accompanied by stable political prospects, but on the contrary, the industry has faced a steep decline. The challenges of various political transformations have definitely contributed to the fact that the industry does not survive challenging periods, which, even without political pressures, would be questionable. From this perspective, industrial heritage and sites is predominantly treated in Serbia as an economic task, a brownfield investment, and only secondarily as a cultural task of protecting the heritage. In this respect, several significant factors can be identified: the inertia of planning policies, the lack of interest in local policies, the inertia of heritage protection institutions, as well as their limitations in resources and models of actions. This has all left a vacuum space, unregulated period of time, within which life has happened, meaning real events and situations that happen spontaneously and recklessly. This is the context within the evaluation of the existing industrial heritage sites was carried out.

3.1. Defining framework

A framework for the analysis of the industrial heritage and architecture in the city of Nis is defined by historical, urban and architectural parameters with the aim to create a general scope of overall architectural industrial heritage of the city. The main focus is on defining relation between qualitative characteristics of the buildings and other industrial facilities and their current status and destiny. The aim is to find out potentially a determinant factor for positive outcomes, or at least known (evident, obvious) outcomes, of industrial heritage conservation and transformation. The defined parameters for the analysis are not necessarily unrelated and this kind of relations will be also discussed. In this way, conditional generalizations that lead us to conclusions that may be globally applicable can be determined from a single examination of specific examples, locations. Survey of the area that covers the territory of a city aims to reduce the influence of all external factors in the given examples to a constant, referring to geographical, climatic, economic, cultural, etc. In this sense, generalization can be introduced at city level, while conclusions can be applied to other areas, provided that there is a real comparison of conditions in Nis and that other territories.

Analysis included identifying: type of industry, date of construction (construction period), size of site, morphology of urban form and buildings' type, type of construction material, current status in terms of heritage, current status in terms of use; disposition within urban environment – integrated/disconnected/isolated; current status in terms of strategy in use.

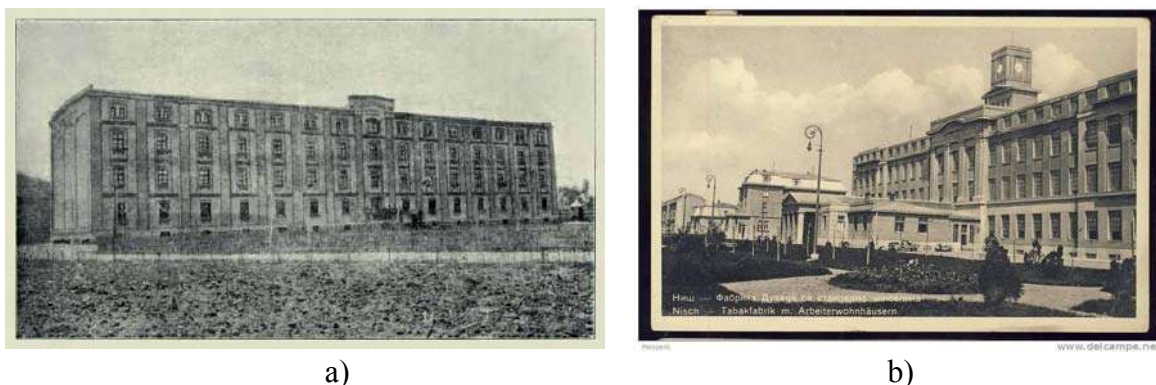


Fig. 1. a) Tobacco warehouse (Old Monopole) in Nis – end of XVIII c.; b) Tobacco factory in Nis (the photo dates from mid-Wars period)

3.2. Analysis data and results

The results of the examination and the analysis of industrial heritage in the city of Nis are systematized and given in Tab.1 and Tab.2. This paper used the archived materials that documented the decades of entrepreneurial life of these companies that have been in the focus of social historians [2,3,7,8]. The urban and architectural analysis of the industrial complexes have been done within this research according to the archival documentary and the field research of the industrial remains in the present days.

The analysis of the industrial heritage on this territory has shown that there is no specialization and concurrence within the industrial branches, and the industry has been developed by expanding the spectrum of industrial branches represented in the area. This points to an underdeveloped industrial product market and industry development in the capacity only to meet local needs. On the other hand, this means a great diversity of industrial heritage, since each complex is a unique witness to the development of industry in Nis.

Таб.1 Industrial heritage of the city of Nis – qualitative analysis – summary

Name of the industrial complex	Type of industry	Construction time	Size	Morphology of the building type	Construction & material type
1. Leather factory “ <i>Djuka Dinic</i> ”	light processing industry	since 1910	5.6ha	multi-story building; concrete hall; auxiliary low-rise buildings	masonry building, wooden & concrete structure
		I period – before WWII			
2. Textile factor “ <i>Niteks</i> ”	light processing industry	since 1886	10.2ha	multi- & single story buildings, shed building	masonry building, steel & concrete structure
		I period – before WWII			
3. Old Monopoly – Tobacco warehouse	light industry warehouse	1885	0.50ha	multi-story building	masonry building, wooden structure
		I period – before WWII			
4. Tobacco factory Nis	light - agricultural processing industry	since 1930	23ha	multi- & single story buildings	masonry building, concrete structure
		I period – before WWII			
5. Brickyard	heavy –	end of 19.c	32.5ha	multi- &	masonry

“Čele Kula”	construction industry	I period – before WWII		single story building	buildings
6. Brewery Niš	agricultural processing industry	1884-1972	6.2ha	multi-& single story building	masonry building; wooden & concrete structure
		I&II period – before & after WWII			
7. Machine industry Niš – MIN (Šumadijska street)	heavy - machine industry	since 1884	33ha	great hall; auxiliary low-rise buildings	steel structure; glass façade
		I&II period – before & after WWII			
8. Machine industry Niš – MIN (12. Febreuar street)	heavy – machine industry	since 1913	23ha	great halls; auxiliary low-rise buildings	steel structure; glass façade
		I&II period – before & after WWII			
9. Pump factory “Jastrebac”	heavy – machine industry	since 1949	20ha	single-story industrial halls	concrete structure
		II period – after WWII			
10. Electronic industry – EI	heavy - electro-industry	1948-73	65ha	single-& multi-story buildings	steel and concrete structure
		II period – after WWII			
11. Aluminum processing plant “Nissal”	heavy industry; metallurgy	since 1955	11 ha	single-story industrial halls	steel structure
		II period – after WWII			
12. Bakery industry “Žitopek”	light agricultural processing industry; warehouse	since 1947	10ha	multi-story buildings; silos	masonry building; concrete structure
		II period – after WWII			
13. Printing house “Prosveta”	light processing industry	1961	0.56ha	single-story industrial hall	concrete structure
		II period – after WWII			

Табле 2 Industrial heritage of the city of Nis – qualitative analysis – summary (continue)

Name of complex/ building/site	Disposition within the city area	Relation with surrounding	Herit age status	Current status (in use or not)	Redevelopment strategy in use
1. Leather factory “Djuka Dinic”	central city zone (within 1km in radius)	closed complex	no/yes *	closed, no activity on site	sale, privatisation
2. Textile factor “Niteks”	inner city area	closed complex	no	renewed factory activities	sale, privatisation

3. Old Monopoly – Tobacco warehouse	central city zone (within 1km in radius)	semi-closed complex	no	reused, converted	sale, privatisation
4. Tobacco factory Niš	industrial zone – “North”	closed complex	yes	renewed factory activities	sale, privatisation
5. Brickyard “Ćele Kula”	outskirts of the urban area	open	no/yes	ruined & closed, no activity on site	sale, privatisation
6. Brewery Niš	inner city area	closed complex	no	renewed factory activities	sale, privatisation
7. Machine industry Niš – MIN (Šumadijska street)	old industrial zone	closed complex	no	closed, no activity on site	partial sale, privatisation
8. Machine industry Niš – MIN (12. Febreuar street)	industrial zone – “North”	permeable/ semi-closed	no	converted & renewed factory activities	partial sale, privatisation
9. Pump factory “Jastrebac”	industrial zone – “North”	isolated/closed complex	no	closed, no activity on site	sale, privatisation
10. Electronic industry – EI	industrial zone – “East”	permeable complex	no/yes	partially reused, converted	partial sale, privatisation, plan of detailed regulation
11. Aluminum processing plant “Nissal”	industrial zone – “East”	isolated/closed complex	no	renewed factory activities	sale, privatisation
12. Bakery industry “Žitopek”	old industrial zone	closed complex	no/yes	renewed factory activities	sale, privatisation
13 Printing house “Prosveta”	inner city area	closed complex	no	closed, no activity on site	sale, privatisation

Note: * all complexes market with “no/yes” contains at least a building with heritage status or in the process of decision making regarding the status

4. Discussion

As can be seen from the presented data in Tab. 1 and Tab.2, the old industrial complexes in Niš have an indefinite and unclear status in terms of protection as a cultural heritage. In fact, for a number of buildings, there is a prior assumption of a heritage status, but not the operational results of such activities. There are no initiatives directly targeting the protection of industrial heritage. Actually, local Institute for heritage protection that is in charge of management of heritage building within the city area, have been indolent

towards the industrial heritage, buildings and sites. On the other hand, there are rare examples of careful inheritance at the initiative of private users and owners. Also, it cannot be said that a brutal devastation of the inheritance is taking place through an aggressive approach. Still, this is also not sustainable in the long term, as well, especially as some changes that go unnoticed, while certain qualities disappear permanently. It can be noticed that there are not many initiatives on the subject of promoting this space beyond the boundaries of the commercial, but towards public and cultural uses. On a contrary, the value and relevance of the old industrial sites have been evaluated in the practice strictly according to market-related principles. There is a very little interest for developing public policies that may be comprehensive. There is a single exception for complex of Electronic Industry (EI), in which case a local authority adopted a Plan for detailed regulation (PDR) [1] which is a step forward towards strategic and institutional planning of redevelopment schemes.

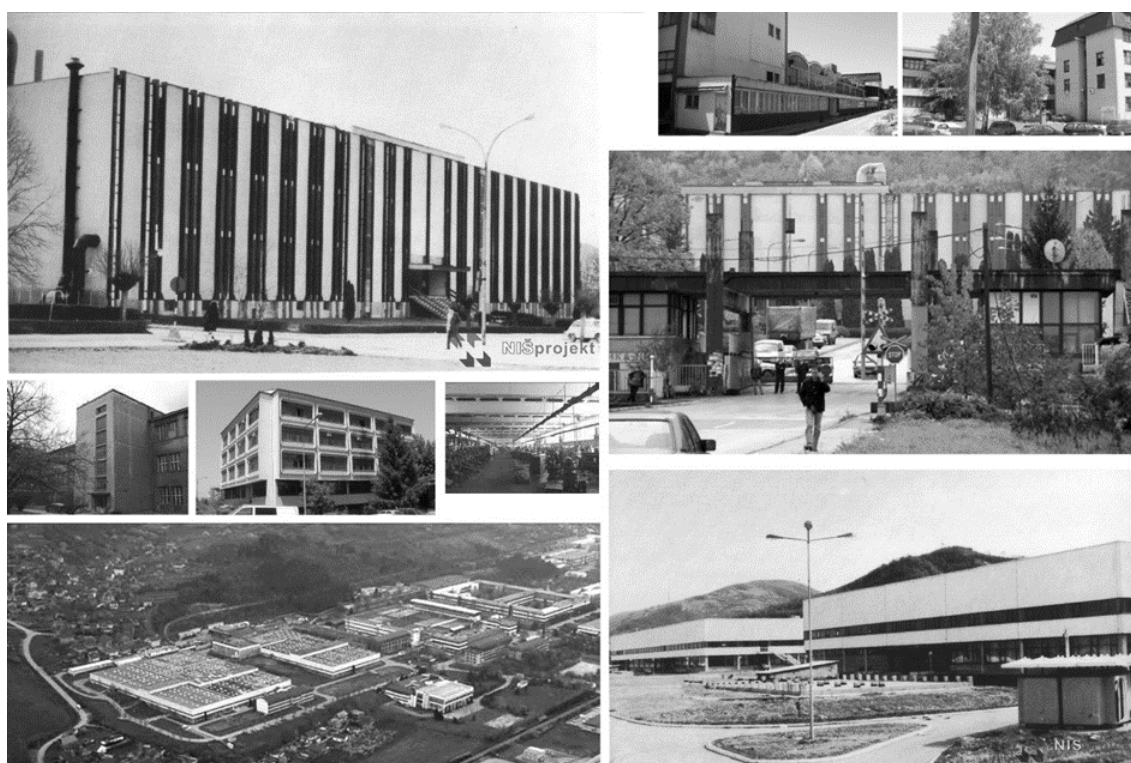


Fig. 2. Electronic industry Nis (EI Nis) – A collage of photographs

Older complexes are better integrated into the environment, and functional conversion and adaptation for the new uses have already occurred in some cases several times. (Fig.1) Industrial complexes built after WWII (Fig.2), in the era of social-communism, are far greater problem for conversion. Closeness and morphological disconnection with the surrounding areas as well as cheap materials and dull façade articulation, make them inadequate for the new attractive uses. In the context of the quality of materials and the type of industries, it can also be concluded that the heavy industry has more problems in conversion than light, processing and electronic industry, at least the experience here shows. In doing so, the heavy industry (here, the machine industry) has impressive proportions of structures that are true representatives of industrial architecture and engineering. (Fig.3) However, these aspects are not critical to the redevelopment, as the use of such facilities generally faces serious challenges in finding new functionality.

However, the practice of reusing and redeveloping old industrial sites in Serbia, in Nis is far from a standstill status. What does that mean? As industrial buildings are primary

rational and utilitarian buildings, the focus is given on their functional status, and they are usually being considered in this context. Even in the case of unused or underused complexes and buildings, there is a little interest for the protection measurements in advance as long as those buildings and artefacts are not in direct threat of disappearing, decaying or there is some kind of ecological threat. At that moment, it is expected to devise additional measures and activities to be activated in order to find a sustainable solution for specific situations, and these solutions are generally in a wide range between economic wishes and the protection (conservation) of heritage. It is expected, to some extent, that all sites analysed in this paper will be on the “scanner” of all stakeholder institutions, in order to balance the expectations and possibilities in more sustainable and balanced way.



Fig. 3. Machine industry Nis (MIN) – A collage of photographs

5. Conclusions

It can be concluded that industrial heritage in the area of the city of Nis has been neglected. There are quite big differences between, on one hand, formally defined goals and the potentials and on the other, real situation on the field, as it has been presented in this analysis. There is a general impression that all mechanisms and instruments for a development of a sustainable solution for these areas have not been exhausted. While there is an evident lack of cross-sectorial cooperation and synchronisation, the industrial heritage sites within the area of Nis is predominantly low-profile commercially-led re-developmental schemes. Also, there is a minimal level of the initiatives and the investment that originates from the local government, which implies that these sites are not in the focus of the local authorities and the officials. Additionally, it is evident that in these circumstances there are a minimal level of real-estate demands that could be settled by reusing and converting existing buildings and sites. It is especially devastating the fact that industrial heritage of the city that once has been called the city of electronics (after EI Nis), did not face the serious research activities about this kind of heritage. While the lack of commercial demands may be related with the level of economic development of the country, this does not abolish the fact the research and planning activities has been skipped as well. Still, it is not expected that such trends must be permanent and in the future it is possible to expect all kind of demands and all kind of social configurations.

The most important conclusion of this analysis is necessity of detailed research and documentation of the heritage that exists in this area in which it is necessary to thoroughly explore and evaluate this heritage as a whole individually. While the older structures are at

risk of deterioration due to wear and tear, and non-maintenance as well, especially the empty ones; the newer buildings are at risk of total transformation, which is not a problem in itself, as long as some valuable architectural pieces, not recognized as such, disappear in this process. Also, it is concluded that the tendency to reuse these facilities belongs to the ranges between industry, warehouse and business premises, which all belongs to the same type of urban use. This type of uses, in addition to having a generally aggressive-negligent attitude towards the heritage, does not contribute excessively to its promotion and appreciation. It is overall impression that the opportunities and potential for the renewal and revival of these sites remain undiscovered or being missed. The greatest ground for any form of intervention is in the assets and the economy, but these resources can only exist if there is also knowledge and information about the possibilities and potentials, etc.

In this context it is necessary to promote the capacities, potentials and possibilities of the existing industrial heritage cites no matter of the current market demands. In some cases may be a carefully developed strategy that will take a decisive role instead of an economic interest. Industrial buildings are identified as urban places that can equally provide as they require. The attention in preserving and nurturing social memory and culture is necessary, while the same places can offer unique experience of history and the ambience that goes beyond the limits of conventional buildings.

Acknowledgement

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SPECIFIC STRUCTURAL FEATURES OF THE BULGARIAN CHURCH ST STEFAN IN ISTANBUL

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Abstract: *The Bulgarian church St Stefan (St Stephen) in Istanbul is built at the end of the XIX century. The church was produced and assembled by the Rudolph Wagner Company in the period between 1895–1896. The churches made of cast iron and steel were an outcome of the technological development and the mastering of new industrial technologies. Such churches were erected in places where the footing did not allow the construction of heavy-weight buildings or when opportunities for development were absent and the circumstances were such that only the functional side of architecture was paramount, e.g., military garrisons, development of ore mines, development of new technologies in distant places, re-settlements of large Christian communities or missionary activity. In this sense the aesthetics of the industrial architecture and the latest developments in the field determined the simple design of the church buildings, among other things. Analysis and understanding the structure is relevant for the future of the church and the support of the building in good conditions for the future generations. The steel structure of the church is not unique but is an excellent example of this type of structure in the world heritage.*

Based on the preserved drawings of the church, the paper aims to present the basic concept of the structure and to make comments on some basic details. Some final conclusions and recommendations for the preservation of the building are given.

Key words: *church St Stefan (St Stephen) in Istanbul, heritage structures, preservation, rehabilitation, strengthening*

1. Introduction

The St Stefan's Iron Church (Fig. 1), as it gained popularity, is one of the most significant Bulgarian monuments of architecture and culture. The preservation of the identity of the Bulgarian nationality within its ethnic boundaries after the Liberation of Bulgaria is a major task of the Bulgarian Church, whose headquarters was established in Istanbul in 1870 and remain there until 1916. This is the reason why the Church of St Stefan played an important historical role. It is a symbol in the history of Bulgaria, but also a symbol of a very interesting building construction. The renovation of the building in 2018 marks the beginning of a new phase in its life (Figs. 2, 3).

The beginning of the initial project is complex and full of many problems and unforeseen situations that accompany the construction work to the very end. What is

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valuable in the structure is that it has posed a really serious challenge to structural engineers, using the available information and the technical details, to go further to a future deeper analysis of the structure and to one new contemporary interpretation of its behavior based on different numerical models. All this will make possible to elaborate the best plan for the future of the church, as well as to implement various new technological solutions that will guarantee the safety of the structure and its preservation for future generations.



Fig. 1. Actual view of St Stefan church [3]



Fig. 2. Actual constructions view of the church –details [3]

Fig. 3. Actual constructions view of the church –details [3]

The possibilities and aesthetics of metal in architecture during the 19th century is a novelty. The metal is undoubtedly replacing cast iron in structural solutions at this particular time, and this puts the final structure of St Stefan's Church in the group of some of the most advanced design projects for the period. We are witness of the application of new material to address the construction and mastering of spaces and retaining distances, thus the church expressing an innovative trend in the use of metal in a new way. And while metal as a whole is the priority of architecture for industrial buildings so far, in the Iron Church it already has a certain aesthetics, which puts it on another level in the design and application of metal in structural solutions. In view of the particularities of the terrain, the resources and the facilities available, the metal structure turns out to provide all the desired conditions for stability.

A team of Bulgarian experts in 2012 analyzed the problems of the church and offered a list of measures. According to this project a special attention should be provided to the seismic vulnerability of the structure, the settlements and the temperature changes. Analysis of the vulnerability of the church structure, taking into account the simultaneous effect of seismic impact and fire is important to be analyzed as well. The non-structural elements and their behavior and their contribution to the overall performance during the earthquakes are one part of the problems to be solved in the future numerical models.

The proposed research in the paper is based on the available historical documents in the Central State Archive [1] and the monography presented in "The Bulgarian architectural complex at the Golden Horn" [2].

2. Short historical review

The short history of the construction of the church of St Stefan is based on the documents stored in the Central State Archives. They are written in Bulgarian and French, the official international language in the second half of the 19th century. Some of them are specialized and others are the result of observations of non-specialists. For that reason, their interpretation was a complex task. The Steel Church of St Stefan represents the third stage of construction on the land of the Bulgarian Stefan Bogoridi. He donated his land to Bulgarians living in Istanbul to help meet their religious needs under the new Tanzimat legislation (started in 1839) in the Ottoman Empire. The creation of religious opportunities for Christians is the result of state reforms that give the Christian people the right to greater autonomy and religion. In the aftermath of the reforms, churches may be affiliated with or belong to individual Christian peoples.

The land that Stefan Bogoridi donated to Bulgarians living in Istanbul is problematic. It is an embankment between the Byzantine fortress wall, which cannot be loaded with heavy buildings. Most of them in this area are wooden. Stefan Bogoridi's private and farm buildings did not burden the loading area as much as a masonry church. The landslide problem arose when the construction of a large-sized masonry church began in 1856. The famous architects Gaspare and Giuseppe Fossati were invited to design it. Due to poor cohesion of the soil and short piles which strengthened the terrain, the masonry substructures are cracked. This feature becomes a signal for the problems that lead to many future field surveys.

The studying of the terrain began in 1870 with studies of the reasons for the breaking of the substructures of the masonry. Once they realized that the compromised foundations can not be used, it is the engineers' primary task to find a new place for the future temple. The question of where the church was built and the place of steel one, which was also built in the 1890s cannot be clarified by the documents. Perhaps this fact is not so significant because the terrain is strengthened with new piles. They are longer and larger in diameter, and a system for their placement has been developed. This creates the conditions for the construction of a new temple.

In order to lighten the load on the ground, engineers and architects, Italians, Greeks and French, who operate Istanbul, proposed to use new materials and structures. Similar examples exist in the world, thanks to the designs of Gustav Eiffel's desk and Belgian steelmakers. The proposals of the Istanbul architects were agreed with the head of the independent Orthodox Church Exarch Yosif at that time. His initial secular education (he graduated Law in Paris) made him open to European innovation. At that time, various purpose-built cast iron and steel buildings were being built for churches as well as pavilions for world exhibitions. They are made of steel construction and steel or cast iron without any details. It is essential for them to be quickly assembled and their materials to be easily transported. Such temples are erected in military garrisons, inaccessible or fire-prone areas and in places with new settlers. Of such character are the regions of Latin America and the Philippines, where Gustav Eiffel's office supplies prefabricated elements for prefabricated elements.

Some of the most famous steel production and supply companies were invited to design the Bulgarian church. The tender was won by the Viennese company Rudolph Philipp Waagner, which at that time was very famous in Bulgaria. The reason for its success is rooted in the development of Bulgarian architecture after the Liberation. There was a large number of Austrian architects working in the country, who brought their ideas into the look of buildings in cities like Ruse and Sofia. Waagner owned its own foundry and offered the lowest bid at the auction. The decorative and structural elements it produced found a place in the construction of buildings in Bulgarian cities. Knowledge of the quality of the steel of the company Waagner gives security to the Bulgarian government, which provides a trust fund in the Bulgarian National Bank for the payment of design, production and installation.

The architect of the church is Hovsep Aznavour. He initially studied at the Armenian Catholic School of Armenian Catholics - mechtarists on Saint Lazar Island in Venice. He then received the best education in his time, completing a degree in architecture at the Roman Academy of Arts. His Catholic views and Academic Education in the Heart of Catholic Europe – Rome, shaped his creative views. When he returned to Istanbul, he designed a lot of public buildings. The Bulgarian Church was a great challenge for him. He participated in the field survey and, along with other engineers and architects, came up with the idea that the new church should be lighter in order not to burden the landslide.

Hovsep Aznavour also created two projects for masonry churches. The second was adapted for steel structures. His drawings were recalculated in Vienna. He worked according to the European norm of French standards. The Bulgarian Ministry of Construction allowed the Austrian company to produce steel parts according to the Austrian standard. Heliographic copies of a part of Hovsep Aznavour's projects have been preserved, which now are a main source to learn peculiarities of the steel structures. Another part - already lost – was a verbal explanation in the construction assignment, which is the second very detailed source of structural information.

Until the opening of the drawings in the Central State Archive, there was no clarity on the specifics of the structures. They were visible and accessible in the western part of the emporium when one uses the staircase to the bell tower. The pictures above show a semivault and trusses.

The church was planned as one apse latin basilica with semivault with a transept to the east. Vertical structures were lined with cast iron panels. The structures were not filled with masonry because the architect suggested that the air circulating between the outer and inner walls will create better climatic conditions. The steel structures and the unfinished lining caused problems for the temple. After the project was finished, leaks through the roof appeared during the warranty period. Another reason shown by the documents from

the time of construction was that the steel structures were outdoors. The corrosion on them was not removed before their final painting. In the humid climate, they became particularly vulnerable to the waters of the Golden Horn. Numerous misunderstandings on the performance of guarantee period lead to new problems that developed over time. No drainage has been done and the horizontal layout around the church was not completed.

The reason for the poor condition two decades after the completion of the assembly in 1898 was the lack of quality construction supervision during the assembly. In the early 20th century, many unprofessional and poor quality repairs were carried out. In the 1970s and 1980s the church was monitored by Bulgarian and foreign experts and regulations were given but they were not comprehensive enough. A problem in its preservation is also its interstate status. The church was built with the funds of the Principality of Bulgaria, but is currently owned by a Turkish foundation which consists of ethnic Bulgarians, descendants of the old Constantinople Bulgarians, who settled in the 18th and 19th centuries in the capital of the Ottoman Empire. Since its construction, it has a budget for the Bulgarian government as well. The problem with its preservation is that the area is operated with the permission of the Istanbul Municipality and under the supervision of its specialists. That is why restoration activities started by Turkish specialists started in 2011. The archival documents, and especially the drawings that were provided to the Turkish specialists prior to the restoration, make it possible to carry out specialized monitoring.

3. Basic concepts of the structure, specific details

Sixteen drawings of the Central State Archives have been identified, systematized and described. The presence of the authentic assignment (in French) and the drawings are the only original project documentation [1] available at this time. They are a valuable source that can be used in future studies of construction and its behavior.

3.1. Assignment for the design

The document “Cahier des charges” (in French) gives a very detailed information concerning the construction of the church. The 33 articles give the information about the general requirements and the specific requirements for the structure as well.

3.2. Characteristic of the construction materials

In “Cahier des charges” the article 7 gives the general characteristic of the steel. They should be from the best quality and protected by corrosion.[1] Concerning the bearing capacity, they should possess at least minimum capacity of 15 kg/mm² in compression.

The galvanized sheet with thickness of 0,0015 mm is the material for the facades according to article 8 [1].

An interesting point in the project is the replacement of the steel structure profiles from the original French standard with the Austrian one. The presence of a metal foundry Wagner is the probable reason. Another significant point in relation to the profiles used in the structure is the guarantees for the quality of the metal. Details of its certification are provided. The certificate was issued in Vienna in 1894 by the Royal Imperial Technical Museum of Craft Technology [1], and four pieces of tensile-tested steel are the basis for this certificate. Attached are two tables for profiles and flat metal (probably considered steel sheets). The length of the specimens is 30 cm for the standard test and 20 cm for the test for the ductile behavior. The results shown (yield strength, fracture limit, relative elongation, etc.) give rise to the definition of the steel type as well as its classification as manganese steel (with manganese alloying element), subsequently confirmed by X-ray analysis.[4] The certificate is one of the most important documents concerning the

characteristics of the materials. Four bars are tested in the laboratory for grading of construction materials and machineries.

3.3. Basic concept of the structure

The available protocol N 1/1890 signed by the architects Markov and Hovsep Aznavour provides the following details: 1) The soil has no enough bearing capacity and until 23 m in depth the required bearing capacity of the soil is not reached. 2) The old foundations from the previous building are in bad condition and they are not suitable for a brick masonry structure. That is the reason to recommend the steel structure as a lighter solution. [1]

The plan of the structure according to the original Aznavour's project is given in Fig.4.

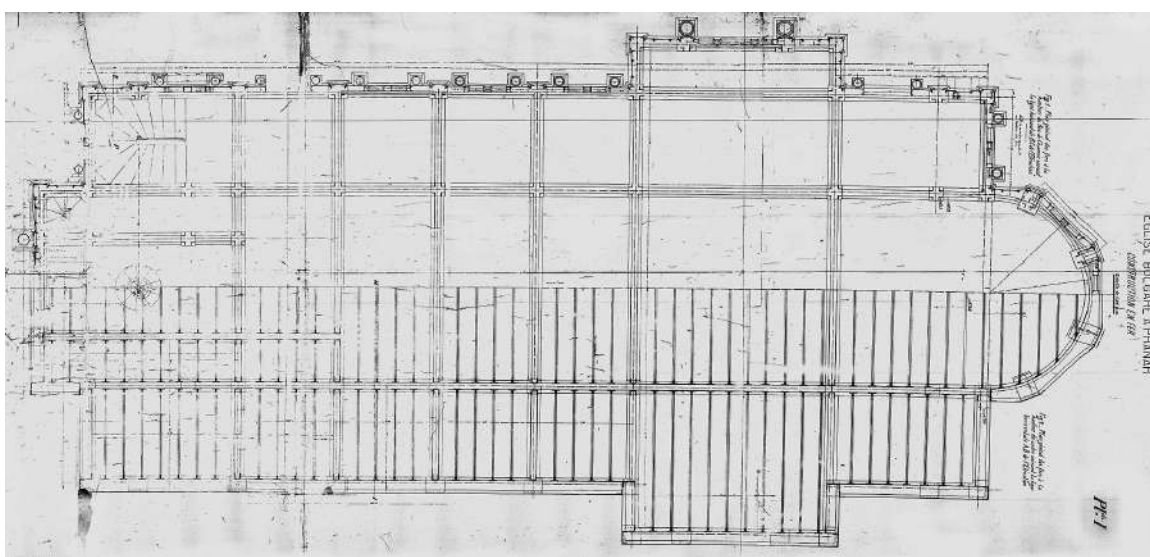


Fig. 4. Plan of the church [1]

The article 3 in “Cahier des charges” is mainly dedicated to the description of the structure. According to this article the church has a steel frame structure with longitudinal and transverse steel beams, vertical elements connected to steel plates with thickness of 12 mm. The connection of the top structure with the marble plinth is realized by bolts anchored in lead plates. All columns (interior and exterior) are assembled by steel profiles. The steel plates for the facades are supported by steel profiles. The roof structure represents steel trusses spaced in 3,00 m. The ground floor (Fig.5) is a system of beams. The design permanent load of the ground floor is 1000 kg/m². The connection between the elements is realized by bolts and rivets.

The article 4 gives the information for the coating of the facades, executed with sheets of metal, with thickness 4 mm.

The article 5 is dedicated to the bolts and the rivets

In the analysed documentation a table of the different profiles used for the building is attached (Fig.6).

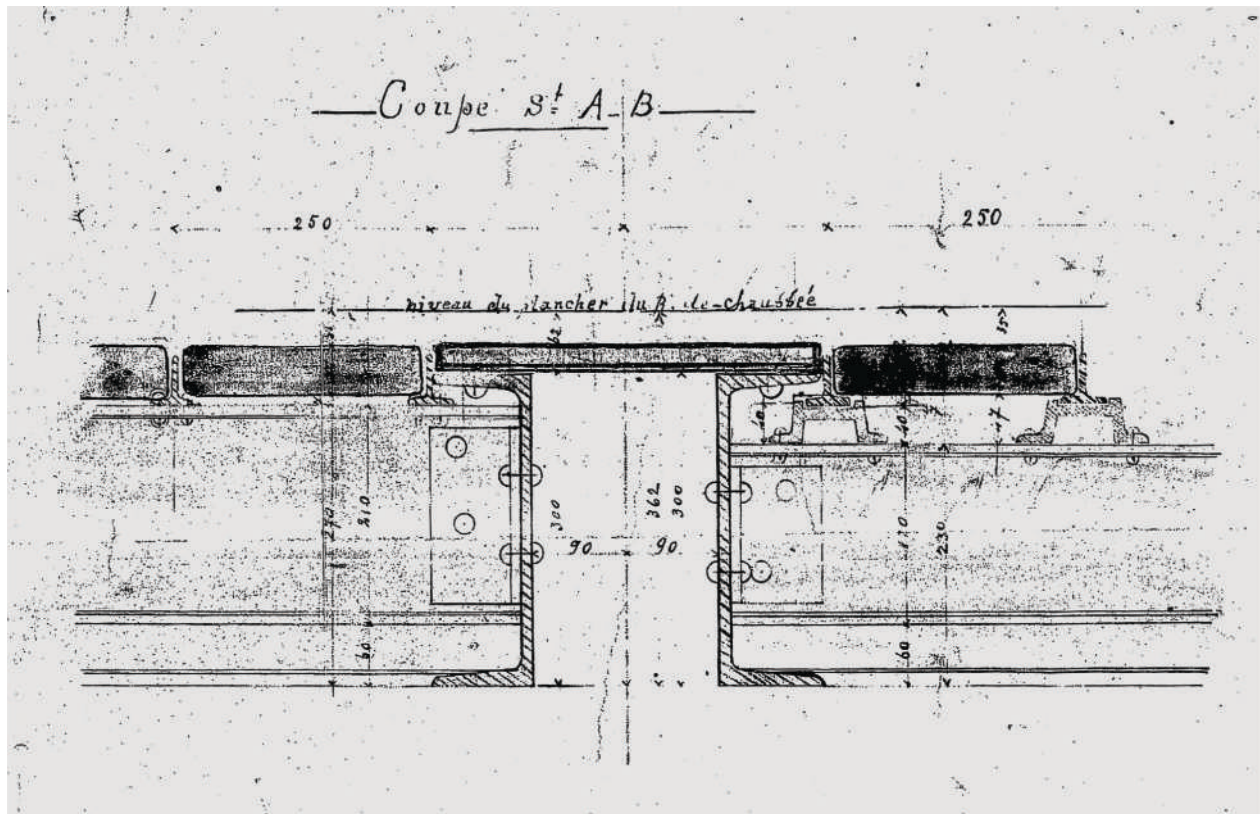


Fig. 5. Floor detail [1]

Designation des fers	Longueur complet en mètres	Surface en m ²	Poids en Kilos	Designation des fers	Longueur complet en mètres	Surface en m ²	Poids en Kilos
Cornières à cotés égaux				Cornières sèches			
1	275,14	18,80	479,21,45	13	82,40	3,32	83,45
2	35,34	2,44	484,22	14	81,30	3,30	83,45
3	275,14	2,34	524,31,48	15	82,40	3,32	83,45
4	163,17	3,23	4747,37	16	338,20	3,70	4773,44
5	167,14	2,31	5848,43	Cornières fermes			
6	166,70	3,84	589,24	17	41,40	3,34	834,19
Cornières à cotés inégaux				Fers T			
7	5,84	12,35	819,24	18	47,70	16,85	822,52
8	116,81	19,45	2249,37	19	118,00	18,80	2197,87
9	211,00	17,64	4229,30	20	118,00	18,80	2197,87
10	77,00	8,44	511,57	21	118,00	18,80	2197,87
11	23,80	1,30	241,71	22	118,00	18,80	2197,87
12	31,00	1,81	273,21	23	118,00	18,80	2197,87
				Fers à L			
				24	47,70	16,85	822,52
				25	201,00	35,19	3341,22
				26	141,14	19,39	4083,19
				27	416,00	4,84	1771,75
				28	416,00	18,80	2197,87
				29	217,20	7,80	1994,27
				30	81,00	4,79	93,84
				31	141,20	3,34	331,92

Fig. 6. Table of profiles [1]

It is important to pay attention to the analysis of the terrain for the Aznavour's project. The survey of the old foundations of the previous construction continued throughout the year between 1888 and 1889. A proposal for strengthening was made. Important and significant architects and engineers in Istanbul provide expert judgment on the causes of damage, the nature of the soil and the depth of the groundwater. A very special point is the description of the pile test of the future construction - an approach very close to the concept of some modern deep foundation design solutions. The initial scheme available to piles and their full-scale testing "worries" architects. This leads to the optimization of the position of the piles and the decision on their number, their length and diameter. The terrain was finally strengthened several times until April 1892.

Particular attention should be paid to the casting of the different non-structural elements that give the appearance of the church, especially cast iron details for the bases of columns, capitals, friezes, etc.

4. Conclusions and recommendations

Based on the proposed in the paper analysis the following conclusions and recommendations could be formulated:

1) Preservation of historic buildings is a demanding task, especially in seismic zones, where vulnerable constructions can suffer severe damages and losses.

2) Multidisciplinary collaboration and experimental research are fundamental to acquire and increase the knowledge base of any theoretical or practical solution in order to pursue rehabilitation of building while respecting at the same time preservation criteria.

3) Selection of right materials, techniques and procedures to be employed for the repair of a given structures have been major challenges.

4) Development of a system for monitoring displacements, speeds and accelerations from dynamic external influences in the structure. Development and installation of a monitoring system for identification of structural deviations caused by soil conditions, as well as seismic impacts.

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RELATION TO THE TRADITIONAL ARCHITECTURE – CASE STUDY OF SERBIA AND ITS ENVIRONMENT

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Abstract: *There is increasing global awareness about the importance of cultural heritage and about creating conditions for its preservation in the future. It represents the moral role of the entire contemporary society, not just the obligation of the competent institutions. The concept of a traditional house is emphasized in the paper as a separate part of the cultural heritage of a country. The paper deals with typical examples of a traditional house in Serbia, Romania and Bulgaria. The aspects of preservation, current condition and purpose of the buildings are examined, and whether the objects are in active use or are completely neglected. Through these examples, positive and negative treatments of a cultural heritage of a country were observed. The subject of this paper is the relation to traditional architecture and the case study of selected examples of a traditional house in Serbia and the surrounding area. The aim of this paper is to review and demonstrate the current state of preservation of vernacular architecture and the attitude to the cultural heritage of the area. The methods used in the paper are analysis, synthesis, comparative analysis, modeling method and case study.*

Key words: *cultural heritage, traditional house, preservation, vernacular architecture, traditional architecture*

1. Introduction

Cultural heritage represents the unique and irreplaceable cultural value of a nation. It means inheriting physical artifacts and intangible attributes of a group or society that constitutes the legacy of past generations, which is carefully preserved in the present in order to be left as the legacy for the benefit of future generations [9]. Current understanding of cultural heritage is covered through two UNESCO conventions: the Convention for the Protection of the World Cultural and Natural Heritage (1972) and the Convention for the Protection of the Intangible Cultural Heritage (2003). Although the

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definitions of cultural heritage are not the only ones in these conventions, they are the most extensive and, as such, most affect the attitude to heritage [11].

Preservation and attitude to cultural heritage are very important aspects of the sustainability of a country's culture and tradition. This paper deals with the problem of attitude to vernacular architecture in Serbia and its surroundings in more detail, with a special reference to Romania and Bulgaria. As the Balkan countries have a long and rich history, they abound in many examples of traditional architecture. The aim of this paper is to review the current state of preservation and protection of vernacular, i.e. traditional architecture. The aforementioned problem has been analyzed through examples and the case study of traditional houses in these areas.

Traditional house belongs to the area of vernacular architecture. Vernacular architecture is based on the craftsmanship of master builders and craftsmen with no formal training, gained through experience and refined over time. It represents the architecture of the area and traditional knowledge, and depends directly on the materials available in the immediate environment, as well as on the land configuration and climate of the particular area. It represents a significant part of the architectural heritage and provides a special dimension to the immovable cultural heritage and the possibility of a layered analysis of the concept of architecture. The very concept of architectural heritage, approach to its preservation and protection, will be discussed in the next chapter.

2. Architectural heritage – active approach and its protection

The term architectural heritage comprises immovable cultural property created by human work from prehistory to contemporary architectural creation. This term covers historical cities, settlements or parts thereof, old buildings and parts thereof, archaeological sites, as well as areas of historical, cultural, artistic or environmental value. One of the classifications of the architectural heritage is in the architectural entities, historic buildings and archeological sites [6]. The paper deals with the notion of vernacular i.e. traditional house which belongs to a group of historic buildings. These structures reveal to the modern man and to society as a whole the entire range of values that derive from their characteristics and functions.

Since the very process of construction, every building is exposed to certain influences. They can later mar the original appearance and characteristics of the building, both in esthetic and structural terms. The causes of degradation are numerous and are reflected in the complete or partial demolition of the building, but there may be of a different nature, due to extensions and additions of floors, and conversions of their function. They can be divided into long-term and temporary ones [6]. They include the effect of natural and climatic factors, but also the effect of man, as well as conscious degradation or deliberate destruction of the building. Particular emphasis is placed on the unconscious form of degradation, which is caused by negligence in the maintenance of the building causing the deterioration, or inappropriate use of the building that is adverse to the original values. This problem is present both in Serbia and in the surrounding countries. The cause of the problem is primarily related to changes in the social structure of the population and the economic crisis, and the departure of the population from rural areas. There is a sudden dilapidation of houses, both of their exterior and structure; they become unsafe for dwelling.

Throughout history, individuals and communities took certain measures to preserve their cultural heritage, and therefore their architectonic heritage. Protection means the systemic implementation of legal and professional protection measures, aligned with the regulations of the conservation and restoration profession, for the purpose of conservation[9]. Protecting a building requires a methodologically correct, logical and systematic approach; and certain principles must be observed. What is very important in

the attitude of one country to the architectural heritage is the organization of protection and regulation.

In many European countries, and so in the Balkans, until the end of World War II, the main protagonists of protection were exclusively conservation services; that is, experts within the institute for protection of monuments or regional institutions. Over time, the concepts of active protection emerged and developed, comprising the involvement of institutions and experts of different profiles, as well as the transfer of heritage protection competences to the authorities. Such a new organization was accompanied by the formation of legislations, international instruments and conventions. In addition to the large role played by the state itself, local authorities also play an important role in the process of preserving vernacular architecture, since a large part of decisions are made first at the local level. In addition to various national institutes, international professional organizations such as UNESCO and ICOMOS play a decisive role [7].

However, it is very important to emphasize that not only experts but the entire population is involved in the design and preservation of the built environment. Apart from the action of socio-political communities, the actions of individuals are very important. Therefore, in addition to research and conservation work on the study and protection of cultural heritage, the education of the population to recognize the value of heritage in their own environment, and to take active involvement in conservation processes is equally important, but not sufficiently developed and insisted on nationwide [3]. The aforementioned conventions and charters also support this view, and so the first Athenian charter indicated that "the best guarantee in the matter of protecting monuments and works of art comes from winning over the people themselves and from their respect" [5]. The population can participate in the active protection of the structures as a part of the local community, as individuals: owners, native people, visitors, neighbors; more specifically as part of different stakeholders. Also, residents can be part of active protection as volunteers. Volunteers and volunteering are a significant element of managing the architectonic heritage. However, cultural volunteering is not yet developed in our region, and there are no registers of such associations in the countries. The advantage of volunteering is that both youth, unemployed citizens and pensioners can participate. In general, there is a great need to train and educate the population and to learn about volunteerism in this area

3. Vernacular architecture in Serbia and surrounding countries

Culture can be defined as the totality of material and spiritual values that humanity, or a part of it, has created and developed over the course of its history; while tradition is a way of transmitting culture from generation to generation in speech or in writing. Traditional culture is most prevalent in rural areas, less accessible and mountainous areas. One of the hallmarks of traditional culture is vernacular architecture as a harmonious blend of material and spiritual values in their original form [13]. Vernacular architecture is characterized by the use of natural materials for construction, mainly from the immediate vicinity, local craftsmen, knowledge passed down from generation to generation, simple tools and aesthetic features focused mainly on the proportion of the building and less on the finish of details and decoration [2].

Vernacular architecture both in Serbia and Romania and Bulgaria is the result of the influence of numerous Old-Slavic cultures mixed with indigenous Roman, Byzantine and Oriental cultures. Austro-Hungary also had a great influence on the development of architecture, especially in the northern parts of Serbia. A large number of older buildings have been preserved, most often small and modest houses in rural and hard to reach areas. However, there are also examples of more developed and structurally complex houses in different parts of these countries, both in rural and urban areas. Most of the houses that have been preserved to this day were built in the eighteenth and nineteenth centuries.

According to a quite rough and conditional division, monuments of vernacular architecture can be classified into two larger groups: listed monuments in the city and listed monuments in the countryside [4]. In the next chapter some examples of "urban houses" and "rural houses" and their current state will be presented.

The types and characteristics of houses vary depending on the area in which they were built and developed. What is common to these Balkan countries is the basic principle of local construction model known as the "nature knows better". This model is based on the following principles: "materialization principle (material availability principle), coloration principle (availability of color choice) and mimicry-mimesis principle (relationship to the surroundings principle -"spirit of place")" [12]. Also, vernacular architecture does not represent a set of spontaneously constructed buildings. Everything a people builds is based on experience, and over time, certain habits, patterns, and rules have been created, that are common to the entire architecture.

However, due attention has not been paid to the monuments of vernacular architecture in the past. The very protection of cultural monuments was mostly focused on sacral monuments, mostly to churches, while other types of monuments were more or less ignored. This resulted in the destruction of national monuments or the adaptation of buildings to new needs, which thereby lost the spirit of vernacular architecture. Although the problem of heritage conservation and restoration has been increasingly addressed in recent years, there are still a large number of houses that need to be rehabilitated.

4. Examples of positive and negative practice – case study

In order to better understand the problem of attitude towards vernacular architecture in Serbia, Romania and Bulgaria, a case study was conducted. Examples of good and bad practice are selected, that is, buildings that were successfully preserved and revitalized, as well as buildings that are in poor condition or were inadequately treated are presented. The traditional house of this area was taken as the reference of this study. The buildings were built between the eighteenth and nineteenth centuries. Also, examples include both urban and rural houses.

4.1 Serbia

Master Vasa's Konak (residence) in Kraljevo, Figure 1 a), is taken as the first example of the attitude to cultural heritage. It is one of the many examples of residential and family houses that have been restored in Serbia, such as the Master Jovan's residence in Čačak, the residence of Prince Miloš in Topčider, the residence of Princess Ljubica in Belgrade, the residence of the musellim in Valjevo and the like. This cultural monument of great importance is located in the city park, across from the Church of the Assumption of the Virgin. Episcopo Janićije had it built in the mid-19th century. It was built in the style of the time of Miloš Obrenović, with elements of traditional Balkan architecture. Master Vasa's residence has been reconstructed several times and its function has been changed. Until the late 19th century, it was used for diocesan purposes. It then housed the Šumadija Field Artillery Regiment, followed by the boarding school of the Farming School. Between 1946 and 1951 it also served as a prison. For this reason, it has undergone significant changes. The porch on the floor was bricked up, it was planned for demolition due to dilapidation, purlins of the roof structure and eaves were shortened, the former wooden entrance staircase for the floor was replaced by a concrete one. The building was successfully renovated in 1951 with extensive and complex conservation and restoration work. After rehabilitation, the building became the National Museum in Kraljevo [10]. Nowadays, this building serves as the Spiritual Center, a bookstore is located on the ground floor, while on the first floor there is a large working hall and a chapel dedicated to Bishop Nikolaj, Fig. 1 b).



Fig.1. Master Vasa's Konak in Kraljevo: a) current condition of the building exterior; b) current condition of the interior, i.e. working hall [15]

Another example is the Katić house in Trstenik. It was built in the second half of the 19th century and it is a cultural monument of great importance. The original owner of the house was the merchant Stevan Katić [16]. The building basically belongs to the Moravska house type with influences of the Oriental type. The design itself is believed to have been brought from Lebanon or Syria. The building originally had a residential purpose with the Katić's business premises on the ground floor. Later, the basement of the house and much of the courtyard becomes a national restaurant. For a short period served as a gallery. Although protected by the state in 1947, it has not yet been adequately restored. It is currently abandoned and in a very poor condition, Fig. 2 a). The facade is dilapidated, while the structure is visibly damaged, Fig. 2 b). Inadequately executed works on the façade are visible from the period when it was used for catering purposes. It is currently privately owned, while the Municipality of Trstenik is planning to buy it off and begin to prepare design documentation for the restoration.



Fig. 2. Katić's house in Trstenik: a) Current condition of the building exterior; b) Visibly dilapidated façade and ceiling damage [16]

4.2 Romania

One of the most positive examples of preserving Romania's cultural heritage is the "Dimitrie Gusti" National Village Museum. This open-air ethnographic museum is located in Bucharest and extends over 100,000m². It was officially opened on May 10th, 1936 in the presence of King Carol II. The museum currently exhibits 346 houses, sorted by the place of origin, Fig. 3. The museum has expanded over time, houses have been transferred from different parts of Romania and have been adequately restored and repaired. The museum was damaged in the past by two major fires, in 1997 and 2002. However, with the assistance of the Ministry of Culture and National Heritage and Sponsors, all damaged buildings were successfully restored [17]. Museums of this type can also be found in Serbia - the Ethnographic Museum of Sirogojno, and in Bulgaria the Ethno Museum of Etar.



Fig. 3. Village museum in Bucharest: a) an example of a traditional house of 19th century from Trăisteni village; b) traditional village house of Maramureș region from Berbești village of 1775 [17]

On the other hand, there is a problem in rural areas where one can see many neglected traditional houses or inadequately restored ones, Fig. 4. Many buildings have been abandoned. Also, the locals, or the owners of houses that are inherited from generation to generation, are restoring them incorrectly and so they lose their original values. The examples given below are traditional Romanian rural houses in the Tara Motilor area. A comprehensive case study was conducted in 2012 exactly addressing the restoration and revitalization of these structures with specific proposals for renovation and new uses [1]. Similar examples can be found in almost all parts of Romania, mostly as a result of leaving the countryside. This problem is present both in Serbia and Bulgaria.

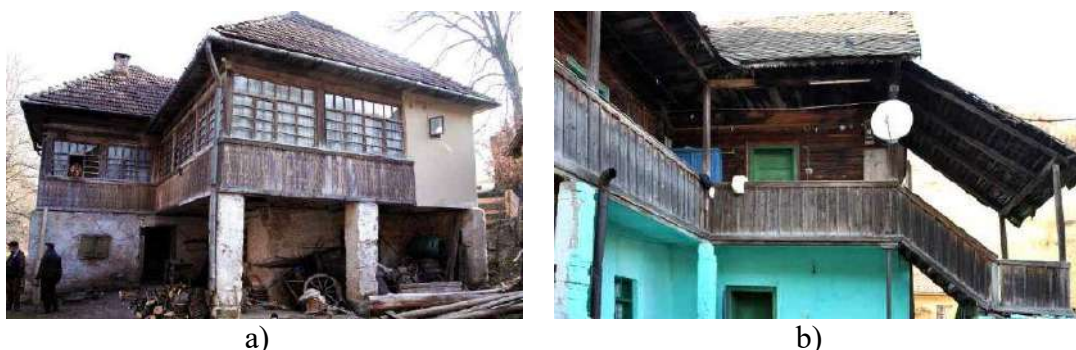


Fig. 4. Traditional houses in the Tara Motilor area: a) one of the houses requiring restoration; b) inadequate treatment of the buildings by the owners [1]

4.3 Bulgaria

In order to preserve Bulgaria's rich cultural heritage, numerous architectural reserves have been formed. These reserves include entire villages, districts, or parts of the cities, and are highly visited by tourists. Some examples are Koprivshtitsa, the Old Plovdiv, Kovachevitsa, Melnik, Arbanasi, the villages of Bozhentsi, Brashlyan Delchevo, Dolen, the Architectural and Ethnographic Reserve Etara, the villages of Zheravna, Stefanovo and Shiroka Laka. One example of one of the smallest cities in Bulgaria - Melnik, was especially highlighted. The city has a rich and long history, and is characterized by its well-preserved Revival period buildings. Some of the most important houses in Melnik are the Boyar's House, as one of the oldest Balkan houses, the Kordopulova House and the Pashova House, Fig. 5. The Boyar's House has been renovated and restored several times since the 13th century. The Kordopulova House was built in 1754 and is one of the largest houses of this period. The Pashova House was built in 1815 and currently serves as a museum of history. All three houses are protected by the law as cultural monuments [14].

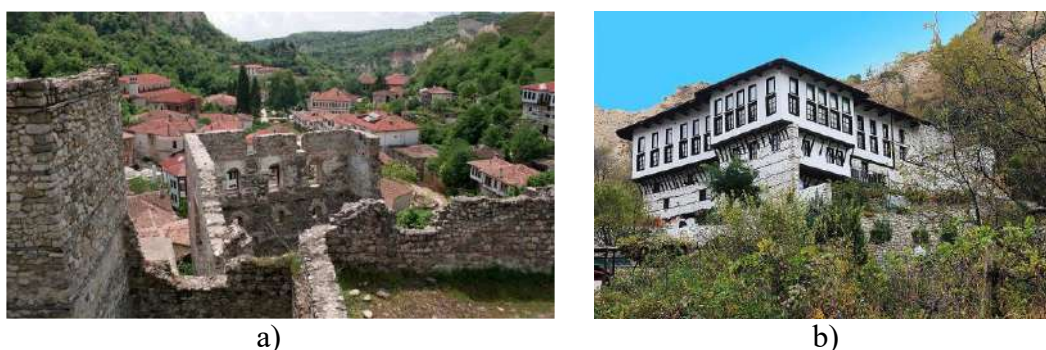


Fig. 5. Historical city of Melnik: a) remains of the Boyar's House; b) the Kordopulova House [14]

As in the case of Serbia and Romania, there are buildings that have been neglected despite their importance as part of the cultural heritage, Fig. 6 a). This is most often the case in rural areas. Also, the owners who inherited them increasingly sell these buildings. Their use is being promoted for the development of rural tourism, but there is no guarantee of how they will be treated by new owners. The house of Christo Karpachev is one such example, Fig. 6 b). It was restored many years ago and has until recently served as a museum [8].



Fig. 6. Examples of negative practice: a) Bogdan Bogdanov house, Karpačevo, completely dilapidated; b) Christo Karpachev house [8]

5. Discussion

Based on the examples presented above and a brief case study, one can better understand the current state of vernacular architecture in the studied areas. There is a number of well rehabilitated buildings that have been restored to their original shape. However, it can be concluded that in all three countries there is still a problem with the attitude to the architectonic. This comprises not only the problems of the attitude of the official institutions, but also of the citizens themselves. This includes various problems related to property ownership, inadequate use and attempted reconstruction by non-professional persons, as well as insufficient education of the entire population on the importance of preserving cultural heritage.

"In everyday life in Serbia, there is a gap between the theory and the wishes of members of the professional community concerned with the protection and preservation of immovable cultural heritage on the one hand, and the daily practices of a large number of Serbian citizens on the other" [13]. Expert wishes are based on theoretical postulates of protection, i.e. on preservation of the original appearance and function of the structure. While the practice in everyday life of ordinary people poses a number of challenges to achieve this "because monuments are being demolished, houses are being demolished, remodeled and altered according to the personal interests and interests of the people who live or in the immediate vicinity of the building" [13].

In the work of protecting the monuments of vernacular architecture, it is very important to solve the problem of their appropriate use in order to provide a long-term solution to the life of the monument. As can be seen from the examples above, many positive actions have been taken to re-activate the protected facilities. They are most commonly used as apartments, cultural institutions such as museums, archives, memorial houses, then cultural centers and galleries, restaurants and the like. The traditional architecture is also increasingly used in terms of tourism development, such as open-air museums, ethno villages, or historic parts of the city.

The aforementioned problem of population education is being successfully addressed in some parts of these countries, most often through projects, training programs and workshops for the renovation of traditional rural houses. Participants learn about traditional construction methods, how to properly treat buildings, and how to properly renovate them. However, mass participation in reconstruction and citizens' awareness of the importance of this problem are needed. Activities aimed at preserving the heritage of the past that conveys historical and artistic messages must, therefore, be prioritized as the community task [10].

6. Conclusion

The protection of cultural heritage is a topical issue both in our country and in the whole world. The paper briefly presents the current attitude to vernacular architecture in Serbia and surrounding countries, through the consideration of basic concepts and the case study. It can be concluded that great efforts are being made to preserve the cultural heritage, including traditional architecture. However, this problem has not yet been fully resolved and the formation of active conservation approaches in multiple fields is required. Also, it is necessary to raise the collective awareness of the importance of preserving our heritage in all its variety and integrity [10].

Acknowledgement

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PROTECTION OF THE IMMOVABLE INDUSTRIAL CULTURAL HERITAGE IN BULGARIA

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Abstract: *The number of immovable sites of cultural value in our country exceeds 40 000, seven of which are listed in the World Heritage List. In recent years, the conservation and preservation of the cultural heritage has attracted the attention of a wider audience. Issues related to the legal and physical protection of cultural sites are becoming subject to increased public sensitivity. The Cultural Heritage Act defines the intangible and tangible immovable and movable cultural heritage. The Act regulates the status of cultural sites and the state policy in the field of their conservation and protection.. The Act also defines the national system for conservation of cultural heritage, including the state and municipal bodies for management and control, museums, cultural organizations, the Holy Synod of the Bulgarian Orthodox Church and the central authorities of the other registered denominations.. Special attention is paid to the National Institute for Immovable Cultural Heritage. Specific mechanisms for the protection of movable and immovable cultural valuables have been put in place through concertation, authorization and registration procedures and proceedings. Despite considerable progress, the interaction between all participants in the process of protection is not yet sufficiently developed.*

Key words: *Protection; industrial heritage*

1. Historical overview

The cultural heritage has been the subject of protection in the form of legally established rules and restrictions since the very establishment of Bulgaria. The following periods can be distinguished in the development of the system of cultural and historical heritage conservation [1]:

- From 1888 to the early 1950s;
- From the 1950s to 1989;
- From 1989 to the present.

Legislative initiatives in the field of cultural heritage protection began shortly after the restoration of Bulgarian statehood. The first legal act Temporary rules for scientific and literary enterprises, adopted in 1888, regulates the responsibilities of state and local governments with respect to antiquities in Bulgarian lands. In 1890, the Act of Search and support of scientific and literary enterprises enters in to force, in 1911 the Antiquities Act

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is adopted, which provides a comprehensive definition of the term "antiquities" (in the sense of objects of cultural value). In 1927, a registration regime is introduced and the Antiquities Commission of the Ministry of Education publishes in the Official State Gazette a List of National Antiquities. In 1936, due to the need to preserve architectural ensembles from the Renaissance and to include them included in the new construction and regulation plans, the Ordinance-Law of Preservation of old buildings in the settlements is issued. In 1939, a bill for a new Antiquities Act is drafted, but it never comes into force.

The next period - from the beginning of the 1950s, is characterized mainly by the dominant role of the Bulgarian Communist Party, including in the field of policies for cultural heritage and values. Planning, creating rules and adhering to these rules is the responsibility of the Ministry of Culture (government) [2]. The rule-making approach that characterizes this period should not be overlooked - not through the creation of laws (by the legislature - the Parliament), but by issuing acts of the executive power - the Council of Ministers -, decrees, regulations, etc.

In 1951, a Decree of the Council of Ministers №1608 is issued [3], which places all cultural monuments within the borders of the People's Republic of Bulgaria under the protection of the state. A Council for the Protection of Cultural Monuments of the Committee on Science, Art and Culture is established to exercise direct control over cultural monuments. In 1952, an Instruction for the promulgation, registration and preservation of cultural monuments [4] is published, which examines in more detail the main provisions of Decree No. 1608 of the Council of Ministers. In 1958, a Decree of the Council of Ministers №165 [5] is adopted for the preservation of cultural monuments and the development of museum work in Bulgaria, and in 1959 Rules for its implementation are adopted. The Decree provides the obligation of each owner of a cultural monument to allocate funds for its conservation in its annual budgets. In the period until 1969, when the Cultural Monuments and Museums Act was adopted (in force until 2009), a number of regulations were elaborated and issued concerning certain aspects of the protection of cultural heritage.

The period after 1989 is a transitional one - the state structures, as well as all control, rulemaking and investment powers have been concentrated in the Ministry of Culture, which has not yet established relations with other agencies. At the same time, all structures at regional level have fallen apart. In practice, the situation is a concentrated power and financial resources in the face of Ministry of Culture, but without intermediate units to implement the state policy on monuments (using the terminology in force at that time) [6]. In 2009, following a heated debate and public discussions, a completely new Cultural Heritage Act was adopted. The 2009 Cultural Heritage Act provides a new framework for questions on cultural heritage and cultural values.

2. Headings Legal protection of industrial heritage in accordance with the legislation in force

In Bulgaria, the main normative act regulating the conservation and protection of the industrial immovable cultural heritage is the Cultural Heritage Act, in force from 10.04.2009. According to Article 6 thereof, the cultural heritage consists of 18 specific and general concepts of different order, including industrial heritage.

2.1. National system for conservation of the cultural heritage

Chapter two of the Cultural Heritage Act sets out the national system on conservation of the cultural heritage. It includes the state and social bodies for governance and control of the conservation of the cultural heritage activities, museums, cultural organizations in the meaning of the Protection and Development of Culture Act, as well as the Holy Synod of

the Bulgarian Orthodox Church and the central directorates of the other registered religions in cooperation with the Bulgarian Academy of Sciences, higher schools, creative unions, professional associations and other non-governmental organizations (NGOs) and in compliance with the objectives of this Act and the national strategy for cultural heritage, adopted by the Council of Ministers

The state policy in the area of the cultural heritage is governed and implemented by the Council of Ministers, which adopts plans for conservation and governance of the immovable cultural valuables and can create state cultural institutes upon proposal of the Minister of Culture

The Minister may make proposals for registering immovable cultural valuables in the World Heritage List, provide statute of the immovable cultural valuables, assign and adopt plans for conservation and governance of the immovable cultural valuables, coordinate engineering inquiries, plans for preservation and management, development plans, their amendments, specific regulations and standards thereof and investment projects – for single and group immovable cultural valuables in their borders and security zones etc.

In order to control the observation of the requirements of Cultural Heritage Act and the acts, issued on the basis of it, an Inspectorate for the Preservation of Cultural Heritage is established under the Ministry of Culture. The Inspectorate consists of a central management and regional inspectorates on conservation of the cultural heritage in every planning region as per terminology of the Regional Development Act

The policy on the conservation of the cultural heritage on the territory of each municipality is implemented by the mayor of the relevant municipality. For assisting the performance of the actions on searching, studying, conservation and popularization of the cultural valuables according to their powers, within the approved number of municipal administration staff, units shall be set up in the economic planning regions. These units can issue written opinions for endorsement investment projects for immovable cultural heritage which are not under the categories of “world” and “national” importance.

An important element in the system for conservation of the cultural heritage is the activity developed by The National Institute of Immovable Cultural Heritage (NIICH). It has the status of a state cultural institute of national importance with research expertise functions in the area of the immovable cultural heritage. With its actions, the Institute assists the Minister of Culture to exercise his/her competences in conducting the state policy in the area of conservation and popularization of the immovable cultural heritage. The main functions that the legislation regulates on NIICH are related to preparing complex assessments and justified proposals for declaration and for granting a status of immovable cultural valuables; proposals to the Minister of Culture for determination of their regimes of protection; written opinions for endorsement investment projects for immovable cultural heritage; producing draft programs of protection and management etc.

2.2. Conservation of immovable cultural heritage

Article 8 of the Cultural Heritage Act gives legal definitions of the concepts of conservation and protection of cultural heritage. It states that conservation is a systematic process of searching, studying, identification, documentation, registration, and that conservation means the restoration and adaptation, as well as protection of cultural heritage through a system of measures for providing its heritage in the interest of society.

According to Art.55 of the Cultural Heritage Act, the identification of the pieces of immovable cultural valuables is a systematic process of discovering, studying and preliminary evaluation of the piece subject to study as an immovable cultural valuable.

It is important to note that discovering and studying the pieces of immovable cultural valuables with the exception of the archaeological ones can be performed by NIICH, scientific organizations, higher schools, museums, natural and legal persons. The

preliminary evaluation, except for archeological pieces discovered during rescue field surveys shall be performed by NIICH, based on scientific assessment.

Declaring of sites, which may be defined as immovable cultural valuables, and also refusal to declare them, shall be done by an order of the Minister of Culture or an authorized deputy-minister upon a proposal of the Director of NIICH, based on the preliminary evaluation. By the order, the preliminary classification and category of the object of immovable cultural heritage, as well as the temporary regimes for its conservation shall be determined. The declared immovable sites have the status of immovable cultural valuables up to their determination as such. They shall be subject to final evaluation in relation with their registration as cultural valuables

Granting a status of immovable cultural valuable in the category "world significance" is implemented through their entry into the World Heritage List of the World Heritage Committee under UNESCO. The category immovable cultural valuables of "national significance" – is determined by an order of the Minister of Culture or an authorized deputy minister, following an approval of the Minister of the Regional Development and Public Works, and where within the boundaries of the immovable cultural valuable there are protected territories according to the Protected Areas Act or protected zones in the meaning of the Biological Diversity Act – also of the Minister of Environment and Waters. All remaining categories of immovable cultural valuables granting a status by an order of the Minister of Culture or an authorized by him/her deputy minister.

Every owner/concessionaries/beneficiaries of immovable cultural valuables is obliged to take the needed efforts for their conservation, protection and maintenance in good condition while observing the provisions of Cultural Heritage Act, in case of existing circumstances, threatening the immovable cultural valuable from damage or destruction is obliged to notify the authorities and to undertake immediate actions for its security. In case of non-fulfillment of these obligation will be punished by a fine.

Chapter 12 focuses on administrative penal provisions under which individuals and legal entities may be brought. The provided penalties (fines and property sanctions) are from 100 BGN to 100 000 BGN. It is important to point out that with the adoption of the Cultural Heritage Act, amendments to the Penal Code of Bulgaria were also adopted by creating Art. 278. For the first time, the conduct of an archeological site or sites that have not been identified and registered in the appropriate order is criminalized.

2.3. Territorial-planning protection

The territorial-planning protection of the immovable cultural heritage cover regimes of conservation; structural plans of protected territories for conservation of the immovable cultural heritage and specific rules and norms for them; plans for conservation and management of the immovable cultural valuables; design, coordination and approval of the structural plans and of the project documentations in the protected territories for conservation of the immovable cultural heritage and control on their application and implementation and financing and performing activities in the immovable cultural valuables and in their guarded zones for the purpose of their conservation and exposition.

3. Experimental results

One of the main criticisms of the "new" law is the punitive nature of many of the norms, including those providing for the seizure and confiscation of cultural property. To a large extent, this may be justified in view of the protection of the highest value as constituted by the objects of our cultural heritage.

If a comparison is made between Cultural Heritage Act and the repealed law on cultural monuments and museums shows, it will be clear that the repealed law is many times better not only in legal and technical terms but also as a substantive regulation of public relations in the field of culture.

The state policy for the protection of the immovable cultural heritage is currently lacking. Even though Bulgaria has ratified a number of international documents in the field of conservation, it has not yet created a single national equivalent. The lack of adopted strategic documents in the field of culture creates ambiguity about the vision, goals and priorities of the state policy in the field of management, conservation and protection of the cultural heritage.

More than ten years after the entry into force of the Cultural Heritage Act, the regulations laid down in the Act to ensure its implementation have not been issued. There is also no National Strategy for the Development of Culture. The territorial structures of the Ministry of Culture and the National Institute of Real Cultural Heritage provided for in the Cultural Heritage Act have not been created either. The non-functioning of the units in the administrations of six economic planning regions, the lack of a uniform methodology for their work and a certain order to implement the procedure for coordination of investment projects and requests to intervene in protected areas to conserve the cultural heritage of immovable cultural values does not allow the decentralization of the cultural heritage conservation system to be achieved.

There are weaknesses in the regulation of the procedures for discovering, declaring and granting a status - no deadlines have been set for the individual stages of the procedure. The regulatory requirements do not create conditions for an effective investigation of the state of immovable cultural valuables. The lack of clearly defined policies and procedures for monitoring objects immovable cultural valuables does not ensure receipt of timely and reliable information about their condition from the competent authorities in order to take adequate measures for their protection. There is no correlation between the number of employees in the NIICH/ the Ministry of Culture and the number of the immovable cultural values and the implementation of the statutory functions.

4. Case Studies

Only in the capital, the number of buildings declared as immovable cultural values exceed 1,700. Although the Cultural Heritage Act imposes clear obligations on municipal authorities to conserve and protect immovable cultural values buildings, several cases of loss or deliberate destruction of such buildings that have come under public scrutiny have sparked episodic debates on the conservation of immovable cultural heritage.

4.1. The “Zaharna fabrika” case

Undoubtedly one of the most discussed industrial sites in Bulgaria is the “Zaharna fabrika” complex - built in 1898 by the Belgian Solvay company. The importance that had the factory for our country is the fact that Belgian investors were exempt from customs duties on imported equipment.

The place where more than 1,000 people once worked seasonally is now empty. Although it has a status of immovable cultural value with a category of "national importance", as a result of the attitude of various owners over the years, the factory is about to remain a pile of bricks (Fig. 1). The previous owners were subject to three fines – one of 50,000 BGN and two of 100,000 BGN. Since the end of 2016, “Zaharna fabrika” has a new owner, who was fined BGN 200,000 in August 2018 and the fine has been appealed against at the moment.

Although many reports from the Sofia city Municipality claiming that it is beginning to impose mortgages on poorly managed buildings declared to be of immovable cultural value, no similar action has been taken so far with the property.



Fig. 1. Zaharna Fabrika – photos: <http://stara-sofia.blogspot.com>; „Save Sofia“;

4.2. The “Tram Depot” Complex

The “Tram Depot” Complex (Fig. 2) was built in 1900 by a Belgian tram concessionaire. For many years it is the only tram depot in Sofia. It also served as a workshop for the repair and maintenance of rolling stock. The building is part of a larger complex that includes an office building and a steam power plant that supplies electricity to the tram network.

In 2016, the Sofia city Municipality funded a project under the Europe Program aimed at developing a concept for transforming part of the tram depot into the Sofia City Transport Museum and combining it with other functions into the rest. In April 2017, at a meeting of the Municipal Committee on Culture and Education, a draft report was considered, which foresees that the landfill building will be rented for ten years and the tenant turned into a Museum of Transport Technologies and the Center for the Arts. The fate of the building is still unknown.



Fig. 2. “Tram Depot” Complex, photos: <http://stara-sofia.blogspot.com>; www.investbuild.eu;

4.3. The Royal Train Station

The Royal Train Station (Fig.3) was built in 1910 by King Ferdinand of Bulgaria. Few years later, King Boris III expanded it by adding side wings. A narrow linear train leading to the Vrana Palace started from it. The beautiful building once had a lobby lounge with two side rooms, arched windows and rich facade ornamentation.

Following attempt to demolish it, at the initiative of, the building was declared a real cultural asset in 2009. After few attempt to demolish it, at the initiative of the mayor of Kazichene in 2009 the building is declared immovable cultural value. Despite its status, today - 10 years later, the building continues to fall apart.



Fig. 3. The royal station, photos: <http://bnr.bg>; <https://www.dnevnik.bg>;

4.4. The Rope Factory “Ivan Vyzharov”, Krasno Selo, Sofia

The first rope factory in Bulgaria (Fig.4) was founded in 1902, and in 1924 it was transformed into a joint-stock company. It produced all kinds of rope products: ropes, threads, navy ropes and appliances, wires, scouring ropes, special ropes for wrapping tobacco bales; belts, transmission belts, all necessities for the army, such as: towages, hospital stretchers, belts for general use, upholstery belts and more.

The building does not currently have a status of immovable cultural value. Part of her former terrain is now home to multi-family residential buildings.



Fig. 3. The royal station, photos: <http://bnr.bg>; <https://www.dnevnik.bg>;

5. Conclusion

Activities for the conservation, protection and maintenance of the objects of immovable cultural heritage carried out by the Ministry of Culture and The National Institute of Immoveable Cultural Heritage are not effective. The lack of "encouragement" to conscientious property owners, the lack of strategic documents for the cultural sector, the lack of regulation of activities, the failure to provide the necessary resources to carry out the activities in full, and the poor coordination and interaction between authorities, create a real threat to the conservation and the preservation of the cultural heritage, including the industrial cultural heritage, for future generations.

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PERMANENT SHM FOR HISTORICAL KOSCIUSZKO MOUND IN CRACOW AND THE POSSIBILITY OF ITS IMPROVEMENT

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Abstract:

The permanent Structural Health Monitoring (SHM) system applied on the historical man made Kosciuszko Mound in Cracow is presented in this paper. A limited data gathering system applied after the revitalization of the mound in 2012 is described at the beginning, followed by the description of the comprehensive monitoring system which was introduced after 2014. It is shown, how the data on relative displacements and deformation of individual layers in the internal structure of the mound are obtained and constantly updated and how this type of information is associated with the corresponding meteorological data. At the same time the observed trends in changes as well as the correlations between individual parameters resulting from climate changes usually following the yearly cycle are indicated. Based on this background a novel data management system is proposed supported by alternative decision strategies. In the first of the compared strategies relatively infrequent actions are preferred, at the high risk of failure with potentially serious consequences, and thus relatively costly, while in the second strategy small scale interventions are preferred, initiated more frequently, but at much lower risk level.

Key words: *Structural Health Monitoring, historical geotechnical structure, revitalization, string sensors, piezometric sensors, displacements, deformations, meteorological data, decision strategies*

1. Introduction

The monumental Kosciuszko Mound in Cracow (Fig. 1) is an artificial hill of 34.1m relative height, heaped up by Poles in the years 1820-1823 in order to commemorate the national hero – Tadeusz Kosciuszko, in recognition of his merits. It is a geotechnical structure especially sensitive to deformation, mainly due to the unfavourable structural material and very steep slopes. In the past it failed several times. The most significant structural failure occurred after the flood of 1997. Then the state of the mound reached the level of building disaster, and this in turn resulted in closing of the mound to the public for

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about 3 years. The intense rainfall induced significant erosion of the slopes triggered the almost total destruction of footpaths leading from the bottom to the top of the mound (Fig. 2). Furthermore, the condition of the mound seriously worsened after the rainfall in the year 2010.



Fig. 1. Kosciuszko Mound in Cracow seen from above, current state.

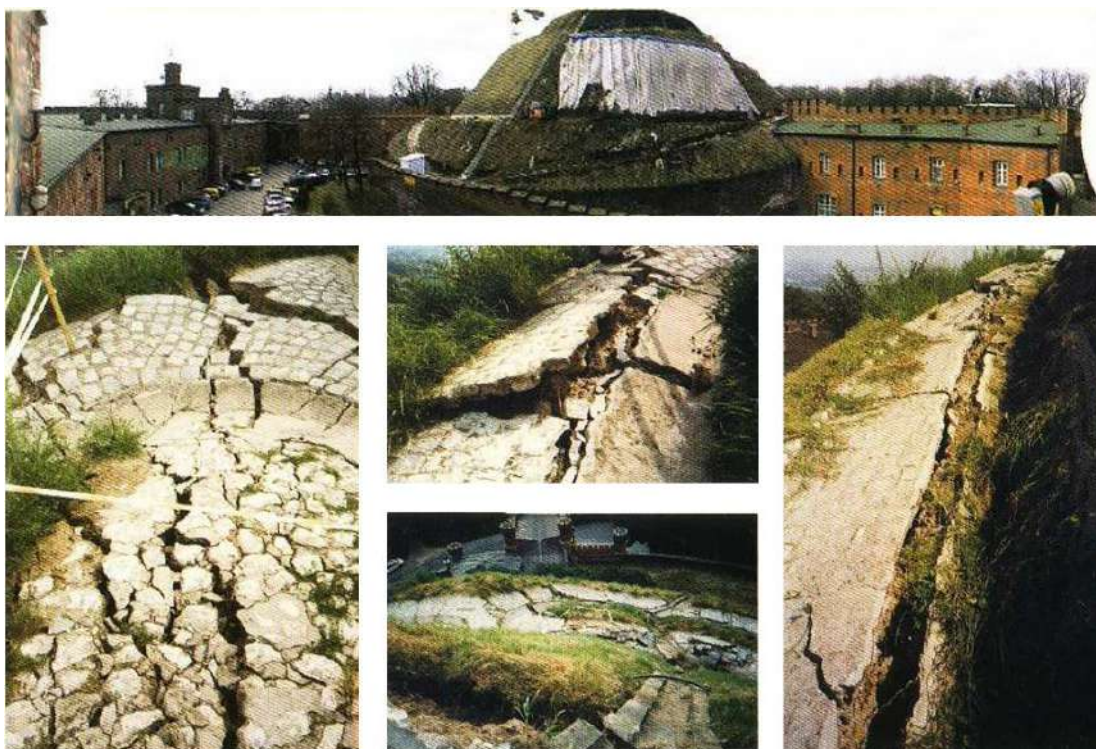


Fig. 2. Destruction of the mound in the year 1997.

The complex, very expensive renovation did not yield the expected result, and did not stop the destructive forces of nature in their tracks. Due to that fact, in the year 2012, the automatic monitoring system, based mostly on the string sensors, was installed on the

structure. The main purposes of this system were the identification of ground layers behaviour and observation of the temporal changes in the mound deformations, depending on the weather conditions. It was undoubtedly very costly, but the decision was made because of the historical significance of the object and its value to the national heritage. The important from the economical point of view problem of assuring the year round availability of the mound to the tourist traffic also played a role. It is assumed that the monitoring will constitute the basic, reliable and sufficiently precise source of information on all abnormalities occurring in artificially made soil mass, and thus will allow for immediate corrective action and will prevent serious damage.

2. Internal structure of the mound

Kosciuszko Mound is an artificial, man-made geotechnical structure erected on a sloped rock bed of indigenous limestone (Fig. 3). It was mainly made of loess type soils, generally in the form of silty clays and silts with a substantial addition of man-made dump ground. Soils of this type proved to be extremely susceptible to the environmental actions during the service time, and especially sensitive to the rainwater infiltration and multiple freeze thaw cycles. The way the mound was heaped up determined extremely unfavourable layered structure of the tambour, exhibiting heterogeneous and locally variable layer thicknesses. Extreme slope of the tambour side, reaching up to $46-51^\circ$ significantly affects the behaviour of the structure as well, as it substantially exceeds the angle of internal friction of soils used.

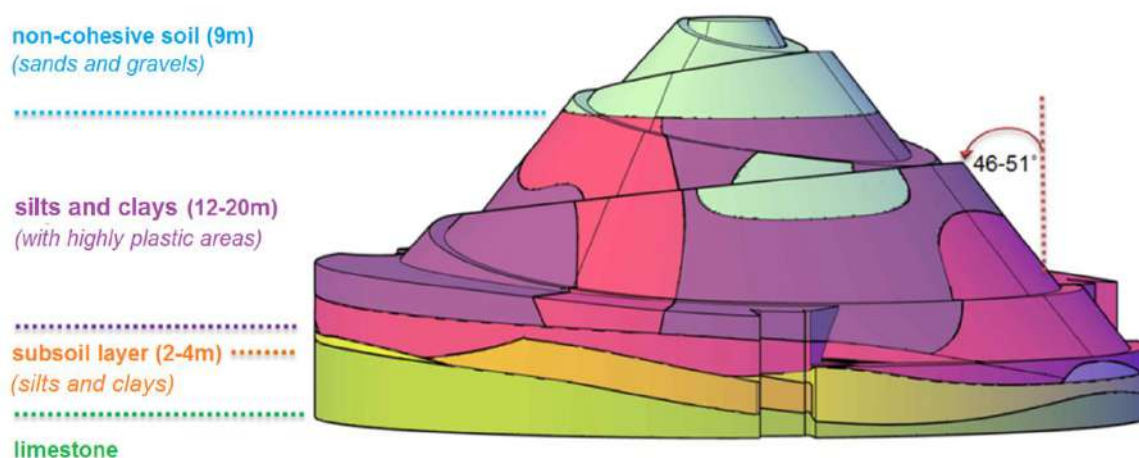


Fig. 3. Internal soil structure of the Kosciuszko Mound.

3. Description of the SHM system applied on the mound

The monitoring system applied in 2012 yields detailed information on the vertical displacements and hoop as well as radial deformations [1]. Location of sensors used to perform such measurements is depicted in Fig. 4. Vertical displacements are measured by the vertically oriented string sensors (Fig. 5) installed at five locations. The horizontal deformations are measured by another group of string sensors [2] installed at the perimeter of the mound and oriented circumferentially and radially towards the inside of the mound structure (Fig.6). The pore water pressure within the interior of the structure as well as the humidity of the top layer are monitored as well by piezometric sensors located in four measuring stations, at three different depths (Fig. 7). All the string sensors have been equipped with thermistors in order to measure the soil temperature at respective measurement stations. The obtained results are related to the geodesic measurements and

measurements of inclination as well. They are correlated with meteorological data provided by a weather station, constituting a part of the monitoring system.

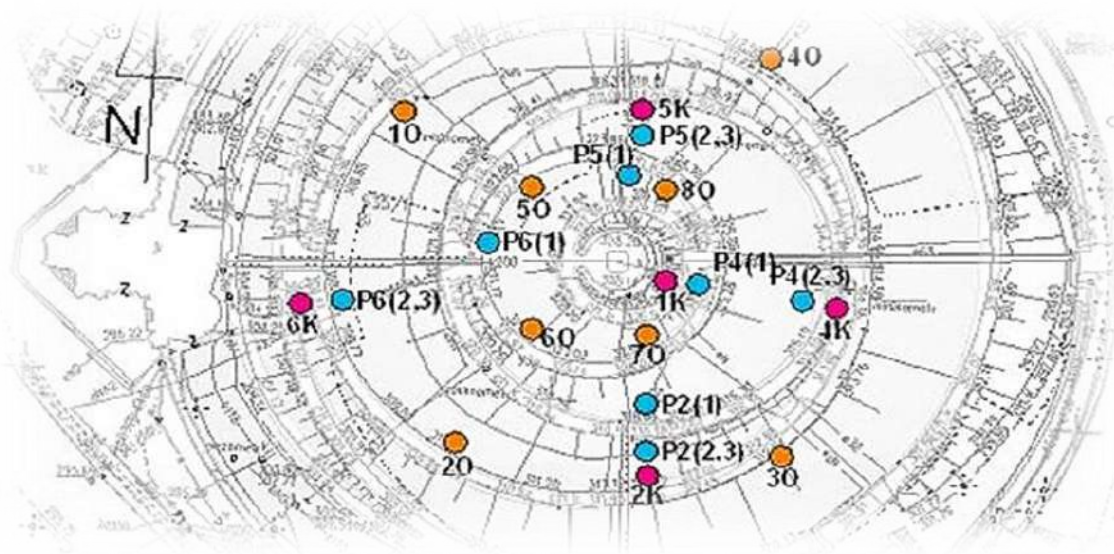


Fig. 4. Horizontal projection of the mound with indicated locations of measurement stations (denotations: K - sensors measuring vertical displacements, O - sensors measuring horizontal displacements (radial and circumferential) and soil humidity, P - sensors measuring pore water pressure and humidity of the external soil layer.



Fig. 5. Details of vertical displacement measurements.

Detailed geological analyses resulted in the installation of a permanent monitoring system. This action allowing for continuous observation, within the whole mound volume, of the very heterogeneous and mostly man-made, layered and water permeated soil structure was presumed to be the only possible technical solution warranting future trouble free service of the mound.

4. Implementation of VoI analysis

In order to more or less reliably estimate the Value of Information (VoI) for the considered mound and the monitoring system installed on it one should at first estimate the value of the mound itself, treated as a historical monument. It is difficult to come up with

an unambiguous value, as one must take into account above all its historical value related to the national cultural heritage. Therefore it is not only the value of the structure as such, built from a specific material at given expenditure of work effort. One should take into account contexts of various types, even the unquantifiable ones such as emotional value. If such approach is used this object may turn out to be priceless for many. One may also estimate the value based on the insurance premium the local and/or state authorities were willing to pay to insure the structure against complete loss. Whichever method one would prefer to use, these values would not be objective. It is also not the actual cost of installing the monitoring system described above on the mound in question and for its socio-economic determinants in order to see if such an operation would be profitable for society. This monitoring already exists, and one may only think about its improvement or extension.

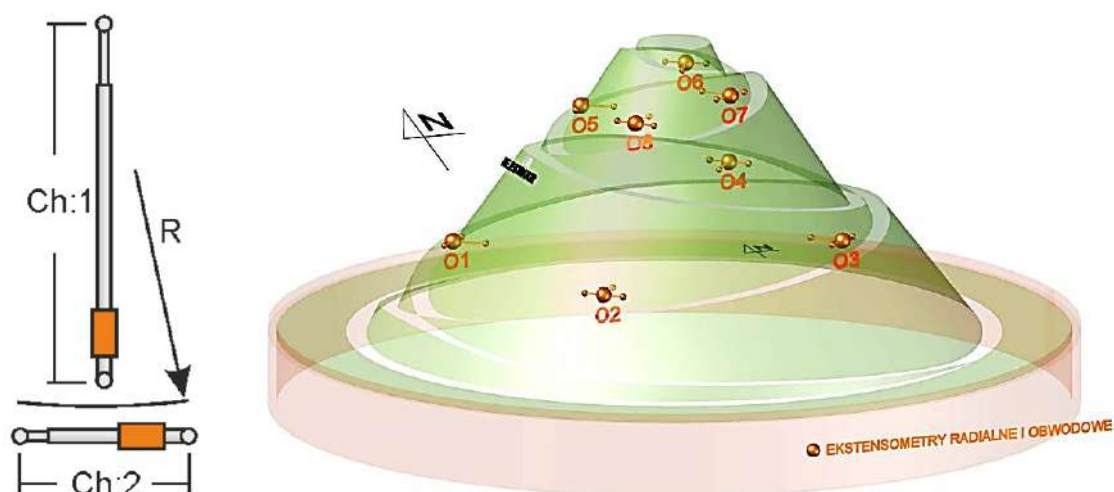


Fig. 6. Details of horizontal deformation measurements (along the radius and circumference).

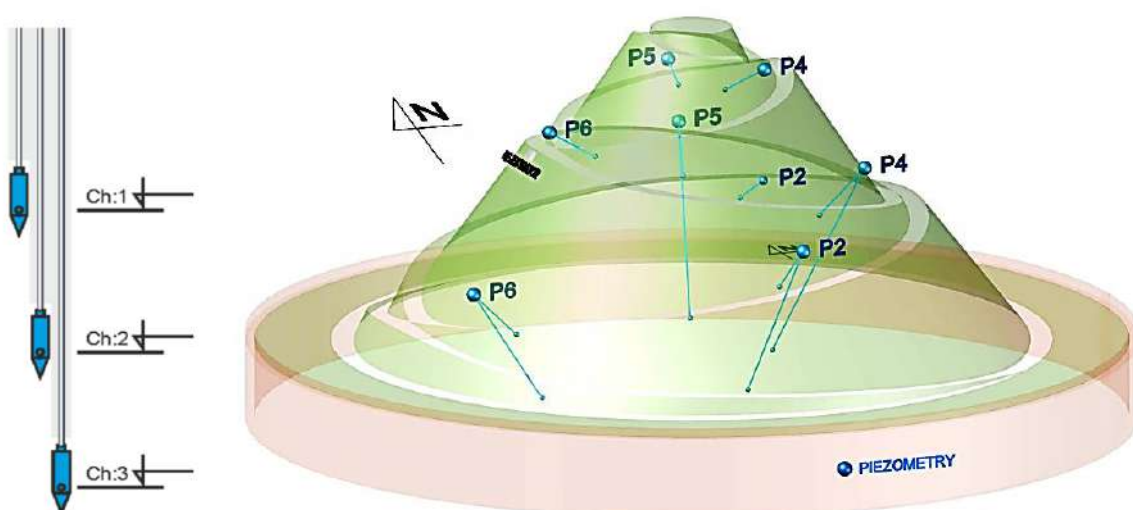


Fig. 7. Details of the pore water pressure and external layer humidity measurement stations.

In our analysis we suggest that the VoI analysis should be treated somehow conditionally, subject to the condition, that the results of monitoring applied are available

to the potential user, but some expenditures need to be borne to get these results. Thus the first stage in the procedure proposed by us would be the specification of various failure classes of considered structure, differentiated by the consequences of occurrence. Calculations of this type need to be accompanied by the qualitative and quantitative risk analysis. We propose at first to define and quantitatively describe a local failure mode, occurring rather on the surface and extending over a limited area. A small, but unequivocally determined failure consequence shall be assigned to such phenomenon. Subsequent failure types, defining increasing threshold consequence coefficients would denote increasingly global character of the observed destruction. These would be not only surface damage or deformations but also deformations extending inwards, such which may result in, for instance, loss of stability of the whole slope. At the end there remains the identification of global failure mode for the whole structure as an incident having the highest failure consequences by value. The monitoring results allow for calculation of time dependent stress levels in the soil at every measurement station based on the measured data. The time dependent mechanical properties of soil located in the vicinity of monitoring stations, and thus indirectly the effective soil strength, depend on the parameters measured at the same stations. A proper limit state condition (for instance pertaining to the slope stability) may be set and verified at any measurement station via the comparison of stress state determined at such point in the given moment in time with the corresponding value of material strength. Thus one may determine the probability of achieving such limit state or alternatively exceeding or not reaching it. At any moment of measurement, with proper data processing, such approach will yield a risk map specified in principle for the whole mound volume. Of course such 3D map will change in the subsequent measurement moment, as it will be built based on the updated monitoring data. Thus one deals in the proposed procedure with various failure levels, such that for each of these levels the cost of failure may be attributed. One has also at his disposal the probabilities of the occurrence of such failures at given measurement moment accompanied by the affected part of the total mound volume or only local surface area determined for considered probability. Such data set constitutes a sufficient basis for formulating the classical decision problem. Since one is able to attribute the probability of occurrence to each level of failure and one knows the costs of more or less comprehensive use of the available monitoring system, potential alternative scenarios for future strategies, including, but not limited to the two listed below, may be considered.

- **Strategy no 1:** at the determined and relatively low risk level it is suggested not to undertake any remedial actions as long as the monitoring would not indicate the local or global increase of this level to at least the threshold level arbitrarily assumed at a relatively high value. This strategy, if applied, results in the mound owner having to bear relatively high repair costs, but rather infrequently. Failures are infrequent but if do happen are of serious consequences.
- **Strategy no 2:** often initiated remedial actions of limited scope are preferred, i.e. actions are initiated every time the acceptable threshold risk level defined by the owner at relatively low level is identified as reached or exceeded even over a relatively small and insignificant area of the mound.

Subsequent possible strategies would in this case constitute combinations of the strategies presented above. The computational procedure proposed would allow the owner for, in our opinion, sufficiently justified planning of the future remedial actions, to be compatible with the real state of danger efficiently monitored by the professional measuring system installed on the mound [3].

5. The sample of data recorded by the monitoring system

The Authors of this paper consider the monitoring system existing on the mound in the middle of 2019 to be sufficient. Until 2014 this system was undoubtedly incomplete. It

allowed for observation and measurement of various tambour deformations, however the coincidence of these measurements with weather conditions, and especially with insolation changing in a daily cycle and with wind directions predominant in Cracow was completely lost. Therefore the installation of the system was completed only when the independent weather station comprising of pluviometer, anemometer, air temperature sensor, relative air humidity sensor, and pyranometer measuring the amount of sun energy reaching the mound was added to the sensor set. The sample of data changing in time and recorded by the monitoring system is depicted in Figs. 8 through 13.

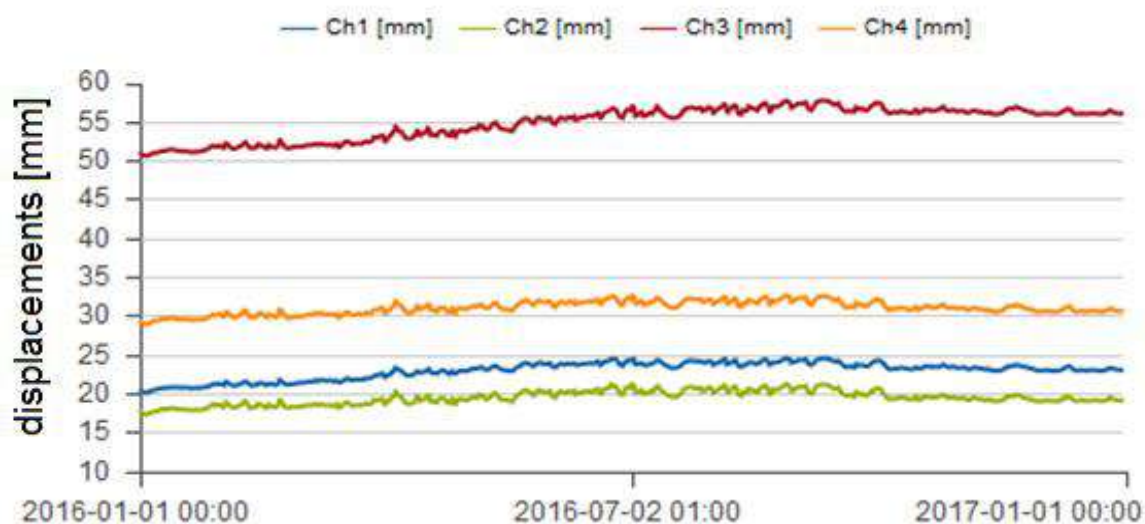


Fig. 8. A segment of the graph depicting monitored vertical displacements in the 1K measurement station at the boundaries of subsequent soil layers.

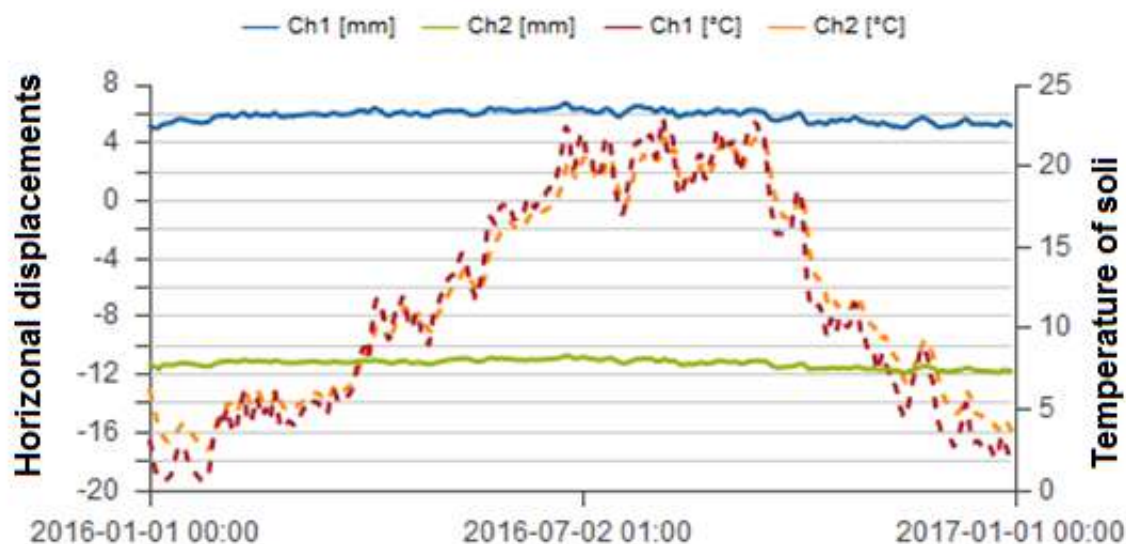


Fig. 9. A segment of the graph depicting monitored horizontal displacements in the 2O measurement station at the boundaries of subsequent soil layers accompanied by the soil temperature graph (yearly fluctuations of the soil temperature are clearly visible).

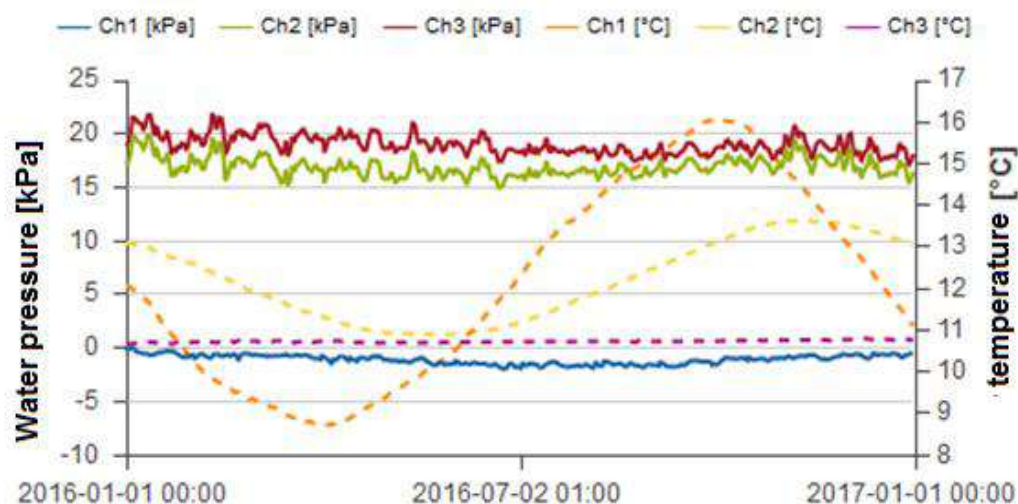


Fig. 10. A segment of the graph depicting monitored pore water pressure and corresponding soil temperature values measured at the 2P station (yearly fluctuations of the soil temperature are clearly visible).

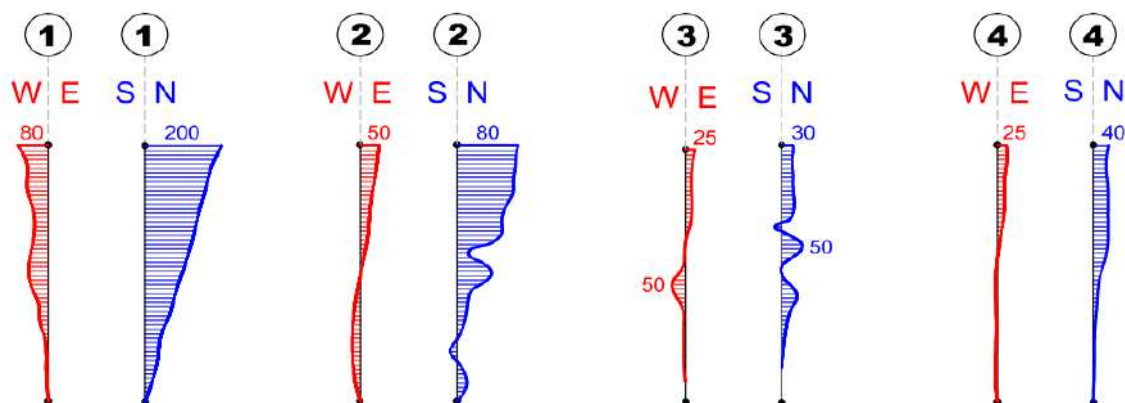


Fig. 11. Results of the inclination measurements at a given moment in time.

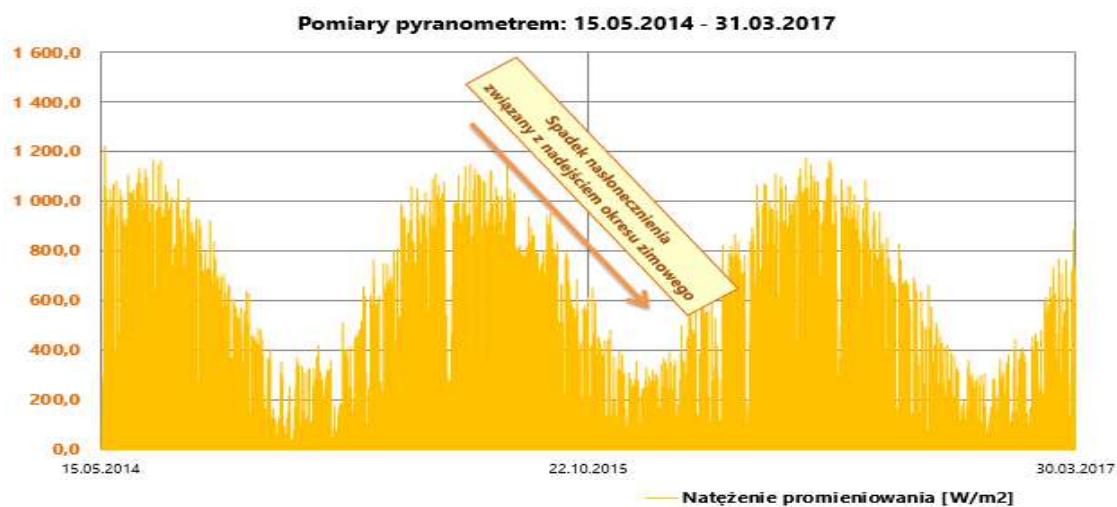


Fig. 12. Changes in the mound insolation in a yearly cycle recorded by pyrometer.

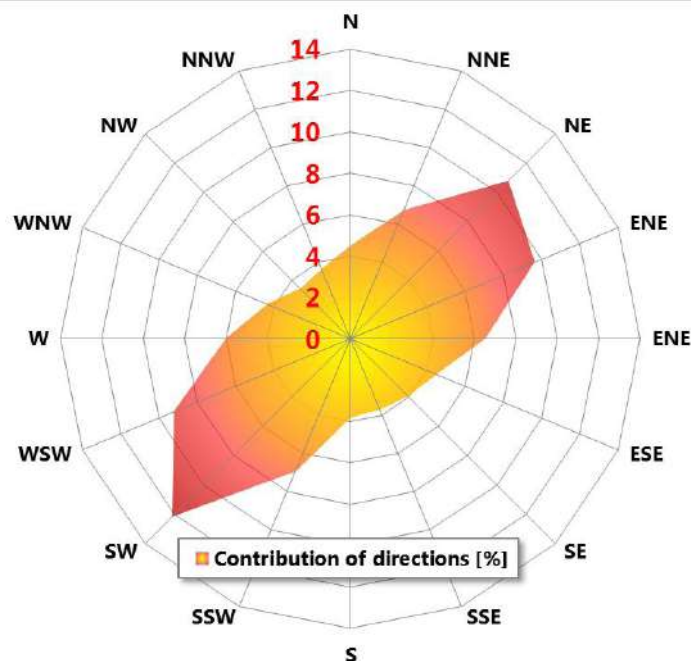


Fig. 13. Monitoring obtained wind rose for the mound location.

6. The future improvement concepts of the existing monitoring system

Until now the emphasis was laid upon the development of the monitoring system described by additional sensors and enrichment of the available data set. It seems, that the preparation of an optimised and unequivocal procedure allowing for efficient use of the gathered data constitutes the subsequent step, and this is undoubtedly expected by the mound owner. The point is that the various data types should be analysed in a complex manner in a single procedure taking into account the inherent intrinsic interactions and correlations present within the whole data set, instead of piecewise analyses performed on chunks of available data. It is also postulated, that the results obtained a posteriori, based on the measurements performed by the monitoring system sensors, should be used to improve the a priori assumed theoretical model. An extension of the user interface, and especially of the part on system “output”, would also constitute a significant improvement of the system as a whole. As noted above, the ultimate objective is to deliver to the evaluator a 3D risk map, showing the risk of soil reaching the ultimate limit state of bearing capacity or the mound slope stability, reproducing the whole volume of the monitored structure and accompanied by the risk level specified for each point on the map coincident with sensor location.

7. Concluding remarks

The man-made artificial mound described in this fact sheet is a very peculiar structure of very high historical value. Preservation of this mound in a state allowing for a year round tourist traffic calls for nonstandard actions assuring safe and reliable service in the future. Analysis of a structure of this type combines the problems of classical civil engineering (especially geotechnics), with problems of safety evaluation and systems engineering. The data available to the person appraising the technical condition of the structure of this type are characterized by the high variability of not only the statistical type but also due to the daily and yearly changes in the climate and weather conditions. The basic source of uncertainty is in this mound the layered structure of the hill, with very heterogeneous soil structure in all layers. Furthermore, the man made ground has its origins in many locations, thus its parameters fluctuate substantially. Finally, the soil

properties to a large extent depend on its humidity, and this in turn is affected by the seasonally changing weather conditions. This raises questions about the representativeness and reliability of the data collected. The limited accuracy of the measurements, due to the precision of the sensors used and their sensitivity to the weather conditions, is an additional source of uncertainty. The limitation of this type is especially important, as there is a risk of accumulating measurement errors, especially in the case of slope measurements. The uncertainty due to the limited credibility and random nature of the measurement data is aggravated by the inference uncertainty, based on the simplified model of analysis applied in practice. So far the inference based on the existing monitoring is supported by the statistical processing of the measured data and the analysis of the random processes describing the temporal evolution of the measured parameters. However, this variability is interpreted only locally in order to identify the possible trends and record the cases when the limit values are exceeded. It seems, that in order to qualitatively and quantitatively describe the deformation and mechanical properties of the mound structure, which change during the service time, it would be desirable to apply the measurement data gathered at discrete locations to develop and calibrate the 4D (three spatial dimensions and the temporal one) random field describing the soil behaviour in the whole volume of the mound. The 3D numerical model should also take into account the climate loads correlated with this field, and having the statistically determined values, based on the measurements supplied by the weather station.

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ИЗСЛЕДВАНЕ ВЪРХУ ИСТОРИЧЕСКОТО РАЗВИТИЕ НА ГРАДСКАТА (ПРИМОРСКА) ГРАДИНА НА ГРАД СОЗОПОЛ

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Градската (приморска) градина е разположена в източната крайбрежна част на провлака, свързващ черноморския бряг с бившия остров, на който е разположен античният град Аполония, като по такъв начин в миналото се е оформил сегашният полуостров.

Първоначално сушата, на която е ситуирано античното селище е бил остров, включващ и днешния съседен остров, известен с името „Св. Кирик и Юлита“. Началото на сегашният провлак е поставено след V век преди Христа, когато жителите на античния град, за да осигурят нормалното функциониране на селището, са свързали острова със сушата чрез каменен насип (по всяка вероятност с ширина няколко метра), който е играел ролята на пътна и снабдителна връзка с брега. Идеята за тази сухоземна връзка може би е дошла и от факта, че морето тук е било доста плитко, за което свидетелстват намерени, но слабо проучени следи за праисторическо наколно селище, съществувало на това място между IV-II хилядолетие пр. Хр. Новообразуваната суша (провлак), много скоро е започнала да се използва и за най- различни функции, обслужващи живота в селището. Според известните обичаи и традиции на жителите на античните селища, част от тях са погребвали мъртвите си извън, но в съседство със селището, където са живеели. По такъв начин, първоначално новообразуваната суша е започнала да се оформя и използва и като некропол (гробница) в продължение на 300-350 години. Извършените разкопки за проучване на некрополите около Созопол са показали, че най- старите и известни погребения се намират на терена на сегашната Градска (приморска) градина, намираща се на провлака. Процесът на естествено разширяване на провлака обаче е протичал доста бавно. На една фламандска рисунка на Созопол от XVII век се вижда, че провлакът вече е с ширина приблизително около 50 метра, което като визуална представа, представлява днешната ширина на най-тесната част на Градската градина. За средновековен Созопол е известно, че ограждането на града с крепостни стени и кули е оставяло провлака незащитен. Античните и по-късни крепостни стени обаче не са помогнали на езична Аполония и християнския Созопол да се опазят от нападателите и те са били многократно разрушавани. Няма много информация за живота на град Созопол (през 330 г. Аполония сменя името си и във връзка с приемане на християнството започва да се нарича Созопол) и съдбата на провлака през средните векове. Информация за значението на провлака за град Созопол са сведенията от 1786г. на Венцел фон Броняр, че в оформения залив -пристанище от провлака, е имало многобройни скелени (дървени пристанищни кейове), от които се изнасяло жито, дървен материал, дървени въглища, кожи, живи животни и риба.

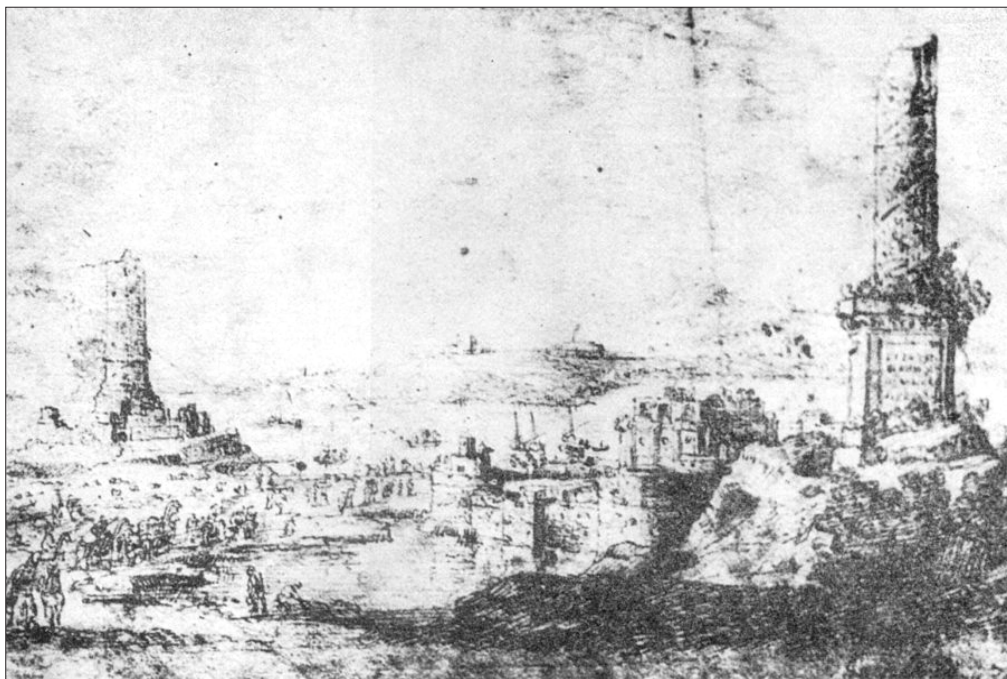
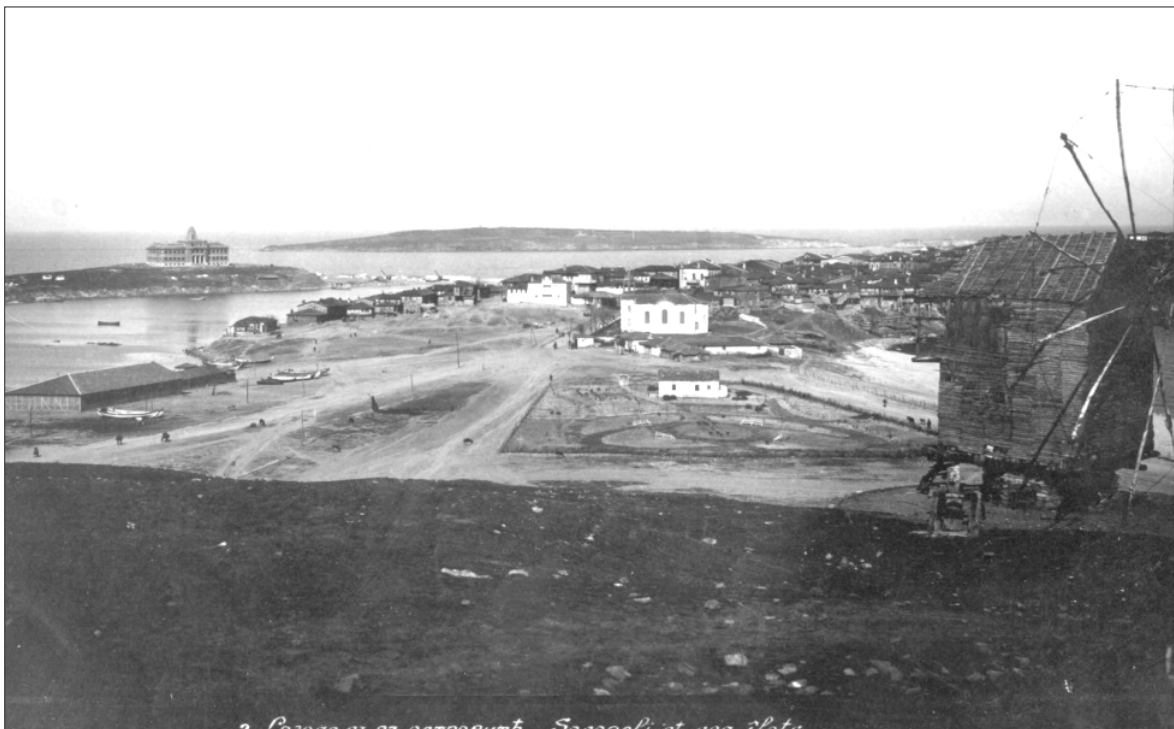


Рисунок на Созопол от фламандския художник Ян Петерс(1653г).

Традиционно, през последните столетия след приемане на християнството до 1934 г., част от провлака се е използвал и като гробище на Стария град. След 1934 г. с решение на кмета на града, то е било закрито окончателно. Вероятно обаче, ако се съди по архивните фотографии много по-рано – още в началото на 20-те години, извършването на погребения в това гробище е било преустановено и територията му започва да се оформя с алеи, дървесна и храстова растителност като бъдеща градина.



Общ вид на провлака в началото на 20- 30-те години с гробищната църква „Св. Зосим” на преден план и църквата „Св.св. Кирил и Методий” зад нея. Личи ограденият гробищен терен, в който вече започват да се оформят алеите на бъдещата градина.

След Освобождението през 1878 г. по сведения на Константин Иречек в произведението му „Княжество България”, провлакът е бил „нисък и пясъчен, с размери около 120 крачки широк и не много повече дълъг”. Площа му обаче много бързо почнала да се увеличава, когато след Освобождението созополската община е решила всички изкопани земни маси от Стария, новия град и отпадъците, да се изхвърлят на провлака, като по този начин неговото ниво е било вдигнато на 2-3 метра над морското равнище.



Повдигане нивото на провлака с насипване на земни маси и отпадъци в началото на XX век.

С цел да се спре движението и разпространението на пясъка върху останалата част от провлака, през 20-те години по източната му крайбрежна ивица е оформена пясъчна дига, която е стабилизирана със засадени върху нея храсти, устойчиви на екстремните екологични условия-бедна на хранителни вещества почва с ниска почвена влажност и силни зимни северни ветрове, носещи солен и влажен морски въздух. По такъв начин от една страна е била оформена източната граница на бъдещата Градска (приморска)градина и от друга – се е предизвикало разширяване на плажната ивица, а с това и общата ширина на провлака. Днес най- малката ширина на провлака е около 210 м. При входа на Стария град е около 250м, а най- голяма е на линията при кметството – около 370м. Успоредно с мелиоративните мерки по задържане разпространението на пясъците върху провлака и разширяване на източния плаж, по крайбрежната ивица, част от която е бившето гробище, съществуващата растителност започва да се допълва и с новозасадена. По всяка вероятност, основния дървесен вид, който се е самонастанил или е бил засаден от хората е бялата топола (кавак). Основание за това заключение ни дават както сведенията за растителността в градината от 60-те години на XX в. така и факта, че в съседство южно от провлака, е имало естествено насаждение от бяла топола, което е дало и името на местността – „Каваците”.



Оформяне на пясъкозадържаща ивица по източния бряг на провлака, стабилизирана с храсти, устойчиви на екстремните екологични условия. На преден план се вижда началото на паркоустройствени действия - беседка, бордюри от жив плет, цветни лехи и др.

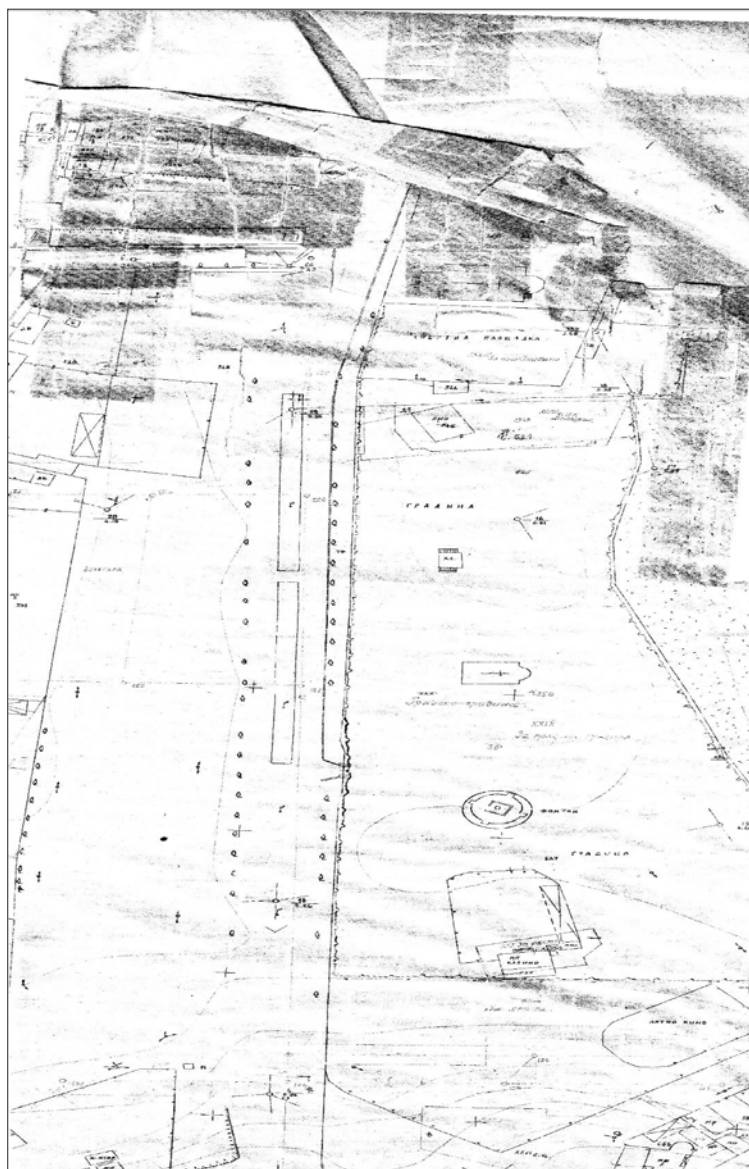
Стимул както за развитието на Созопол като черноморски курорт, така и на част от провлака като морска градина, предлагаща благоприятна микроклиматична среда за курортистите, е създаването на колония за летен туризъм през 1926г. от организацията Български морски сговор. Колонията е била разположена в съседство с Градската (приморска) градина, което е документирано със снимката по-долу.



На преден план са бунгалата на първата туристическа колония в Созопол, ситуирана в съседство на плажа и морската градина – 20-30-те години на XXв.

В средата на XX век на провлака започват да се извършват редица благоустройствени работи, от които съществено значение за неговият неповторим сегашен облик има трасирането и оформянето на уличния транспортен и пешеходен подход към Стария град, като добре озеленена алея с две платна. Тя се явява делител между плажа и Градската (приморска) градина от една страна и западната част на провлака, която има културни, делови и икономически функции. Дървесната растителност по алеята е от видовете източен платан, маклура и копривка, които в момента са достигнали оптимума на своето развитие и създават впечатляващ облик и характерна благоприятна микроклиматична атмосфера за преминаващите пешеходци.

Съвременното оформяне на градината започва след разработването на кадастрален план на града през 1955 г. На следващия кадастрален план от 1965 г., днешните граници на градската градина вече са определени и маркирани. От него може да се установи, че в градината е имало интересни паркови обекти, някои от които несъществуващи днес, предоставящи разнообразни възможности за отдих. В съседство южно от църквата „Св.св. Кирил и Методий“ е имало доста голяма по площ спортна площадка. Днешният фонтан е съществувал на същото място, а южно от него е имало сграда на казино, която в плана се предвижда да се развие в по-голям ресторант.



Кадастър на Градската (приморска) градина от 1965 г.

През 60-те години на XX век започват по-мощабни устройствени работи на провлака, с оглед все по-голямата популярност на Созопол като курортен град. Така например един План на Градския народен съвет на гр. Созопол от 1965 г. за "оформяване на центъра на града до курортния сезон", планира извършване на работи на 57 обекта на провлака и в града, включително и в приморската градина. Сред тях например се предвижда монтиране на пътеводител пред парка, полагане на бордюри по алеите в парка, боядисване на част от пейките, завършване строителството на съблекалнята на плажа, реконструкция на спортната площадка в парка, довършване на цветната ваза на входа на градината, направа на ограда на парка зад музея (църква „Св.св. Кирил и Методий“) и т.н. През 1968 г. от Главпроект е разработен проект за оформяне и озеленяване на площадното пространство пред днешният Културен дом. От обяснителната записка към проекта става ясно, че на терена- обект на проекта, са съществували стари тополи, които се препоръчва да се запазят, наред с новопроектирано внасяне на екземпляри от източен платан. В периода 1970-1972г. отново от Главпроект се извършва проектиране на декоративното осветление на площада, проекти за вертикално планиране, водоснабдяване и канализация на площада и приморската градина. През 80-те години на XX век също се разработват проекти за територията на провлака, част от които(1979 г.,1987г.,1990 г.) се отнасят за преустройство на различни елементи на Градската (приморска) градина.



План на Градската (приморска) градина на гр. Созопол от 1989 година

В крайна сметка след проектирането и преустройството на градината през последните десетилетия, нейната дължина е около 290м, най-голямата ѝ ширина е 120м, а най- малката – 50м. Последният проект, изготвен за части от Градската градина е от 2009 г. Той предвижда реновиране на морската градина с обновяване на съществуващите настилки, внасяне на нова растителност, подновяване на съществуващата детска площадка, изграждане по крайбрежната алея на изгледни площадки към морето, обновяване на фонтана в центъра на градината и внасяне на топиарни растителни форми като атракция за туристите и гостите на града.



Един от най-старите композиционни елементи в Градската градина- фонтана, чието околno пространство, а и той самият са претърпели доста промени през годините

Макар от историческа гледна точка, периодът на близо 100-годишното съществуване на Градската (приморска) градина да е несравним с възрастта на останалите археологически свидетелства в археологическия резерват Аполония, тя представлява съвременен цивилизационен етап от хилядолетното развитие на Созопол. От тази гледна точка, въпреки че е оформена едва след 20-те години на миналия век, Градската градина има културна стойност и обществена значимост за общия облик на гр. Созопол като обект за културен и морски туризъм.

Горе изложените мотиви ни дават основание да предложим в бъдеще, като важен и органично свързан елемент с археологическия резерват „Античния град Аполония”, на Градската (приморска) градина на град Созопол да се даде статут на недвижима културна ценност, съгласно Закона за културното наследство и Закона за опазване на околната среда. Това ще изисква за нея в следващите години да се разработят режими на опазване и специфични правила и нормативи за устройство.

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- Планов архив на Община Созопол

HEATING AND COOKING SYSTEM FACILITIES FROM KOKALYANSKI URVICH

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Abstract: *The “Kokalyanski Urvich” fortress is situated about 20 km far away from the city of Sofia, in the Iskar river valley, along the road to the town of Samokov.*

After the end of the Second Bulgarian Kingdom, the then authorities granted the local population a permission to build a monastery within the frames of the fortress. The archaeological research of the Late Medieval monastery (XV-XVII cent.), was carried out by team of the National Archaeological Institute with Museum at the Bulgarian Academy of Sciences. Up to now in the frame of the project between 2008 and 2018, the excavations were led by Assoc. Prof. Dr. Bonny Petrunova, Assoc. Prof. Nikolay Ovcharov and Filip Petrunov, in the different archaeological seasons. Within the confines of the monastery walls, six heating system facilities have been found and examined. They are a good example of the building traditions in the Medieval household architecture. The main goal of this article is for first time to present a full description of the sizes, the organization and the reconstruction of the remnants of the heating system facilities.

Key words: *“Kokalyanski Urvich” fortress, monastery, architecture, heating system*

1. Introduction

Kokalyanski Urvich as it is referred in the bibliography is a rocky massif between the Vitosha, Plana and Lozenska Mountains. It is formed by two hills, their long sides

are parallel to the north-south axis called Urvich. The one, which is closer to the right bank of the Iskar River, is naturally fortified to the south and west by sheer cliffs. On this location between 2008-2018 an archaeological research have been taken where on the edge of the lower north terrace a monastery have been found. The denivelation from the terrace to the upper plateau is more than 20 m. and the terrain is pretty steep and strewn with massive granite blocks. This way the Monastery was naturally protected from northwest. In addition, a low fence of two-sided stone construction, sealed with mud and covered with slab stones, was also constructed.

2. „Kokalyanski Urvich” fortress

Up to now, during the different archaeological seasons the excavations were led by Assoc. Prof. Bonny Petrunova, Assoc. Prof. Nikolay Ovcharov and by the present author. During the archaeological investigations a large part of the Monastery structures have been revealed with the exception of the east part of the fence wall, due to the high denivelation of the field, the wall is not preserved in our days. The functioning of the Monastery dates back from the beginning of the 15th to the end of the 17th century. Despite of the narration of Paisius of Hilendar who describes the existence of earlier monastery under the possession of Tsar Ivan Shishman unfortunately the analysis of the archaeological finds discovered thus far, such as - pottery and coins cannot securely confirm it. However, the examination of the large number of the wall-painting fragments, one can clearly say that there is an evidence of the long lifespan of the Church. It was probably built at the end of the 11th century, with undergoing reconstruction over the centuries, and probably rebuilt at the end of the 14th or the beginning of the 15th century. The Church construction is made by solid white and pink roughcast, at the north arm of the narthex have been discovered an renovation accomplished with slab stones and mud dated back at the last years of its existence.

The functioning of the monastery for nearly 200 years also implied a very good organization of both: the liturgical rituals and the daily life as well. This is the reason why the dining room is located middlemost in front of the entrance to the Temple, where from after the liturgy pass along via short aisle to the dry anteroom of premises number 4. In the anteroom very probably there was a bench, while immediately after the entrance have been placed a large fireplace built of stone slabs. In the common wall between the kitchen and dining room has been found a vertical rectangular niche, wich was starting from the floor. The niche was formed with stone slabs as well and it was very likely used for drying meat. Above the fireplace there was a large clay dome made by a knitted construction. Unfortunately, the two large ovens in the dining room and the kitchen (rooms 2 and 4) were significantly destroyed by a hiking pathway used from the beginning of the 20th century until 2012 when the archaeological excavations reached that section of the Monastery. In this place only parts of clay remains without traces of burning have been found, this might indicate that the burning process was too low in order to blacken with smoke the dome. However, for the shape and size of the two facilities can be judged by the well-preserved adobe which connect the two rooms and their ovens in a single implementation. Such hearths have been described in details in the

ethnographic written works as early as 1943 by E. Peteva-Filova (Proceedings of the National Ethnographic Museum in Sofia, Ognishta, 1943, 178-192). Although, that the level of the burning chambers diverges with 20 cm in height, the wall to which they are joined is massive, and from the west side are adhered by fugue to the anteroom of the food block. Most documented rooms have their own entrances and ovens, which makes possible the entire reconstruction of the Monastery. A total amount of 6 heating and cooking facilities have been discovered: two in the west wing and four in the south one. In 2018 south of the monastery next to the tower, have been discovered one more building with a oven which is not structurally linked to a wall but is 10-15 cm away from the corner of the room. The hearth functions are mixed, both animal bones and household items were found in it, as well as artefact in link with production process: melts, slags and bronze ingot. The latest is with around 1 kg weight and bears marks which clearly indicate that the ingot has been melted and part of it was taken away.

The six ovens uncovered in the Monastery are grouped in pairs attached on a common walls this way the exhaust fumes can be outlet from three points south and west of the church. Their distribution is arranged in the follow order: two in room 2 and 4, two in room 3 and 5 and two in room 5 and 6. In room 5 have been found the most elaborately built hearth moreover the room is additionally partitioned by a transversal wall and the floor is covered with slabs of stones and bricks as well.

Room № 2 is the kitchen of the Monastery with 5.14m internal dimensions by the N-S axis and with 6.09m exterior dimensions by the E-W axis. In this room have been found a fireplace, elliptically surrounded by vertically arranged bricks and filling, preserved under the slumped clay dome together with an ash buried more than 300 years ago. Knives, hooks and animal bones have been found here. The kitchen itself had a plank floor beneath which was a deep storage built by masonry walls, going all the way to the rock on 2.20m below the level of the hearth. The hearth itself has a massive construction to the south and a pavement of slab stones around the burning zone. From the west and the east sides it is partitioned with walls adhered by fugue towards the common wall between rooms 2 and 4, this way the entire oven was placed in kind of a deep niche isolating the wooden elements in the southern part of the room.

Room № 3 apparently has the follow dimensions: N-S axis -2.90 m; E-W axis - 3.50 m, it is located southeast of the apse of the Church and have been partially explored in the 1980s. It has a rectangular shape and during the excavating process at the level of the walls have been revealed three slabs which indicate the position of the entrance. From the inside it does not show a carefully shaped frontage on the wall, which suggests that it is very likely a ground floor. In its west wall have been registered remodeling with 0.90 m width in order to make a rectangular niche in the wall. Probably, these partitions were done for a dug in hearth, symmetrically situated and separated by a thin wall eastern of room 5. Thereby the common wall between rooms 3 and 5 has been narrowed in order to form two niches. The fireplace in room 3 falls lower than that in room 5 with more than 50 cm. Very probably the fire was lit up on two levels.

Room №4 is a rectangular dining room, with internal dimensions N-S axis - 8.97m and E-W axis - 3.87m about 31.5 square meters. On its eastern wall, at 2.38 m

from the southeast corner, an entrance with 1.32m width and 0.88 m height has been registered. The depth which has been reached in the room is 1.33m in the north and 0.78 in the south. At 1.00 m from the south-east corner of the room, another heating facility has been discovered built into its south wall. A threshold stone has been registered at the entrance of Room № 4, east of it a dry anteroom with a bench has been found as well. The anteroom dimensions have been tracked and outside of the entrance, structurally connected to the south wall of room №4, continues a wall extending 1.90 m from the southeast corner of the room to the east its width is 0.80m. Symmetrically to this wall, next to the frontage of the east wall of room №4, another 0.80 m length was investigated. The hearth is located below of the level of the dining table. The fire was set on slab stones arranged in approximately 8 square meters. The enclosure of the burning zone was not registered.

Room №5 is a double room with sidewalk with the following dimensions: S-N axis - 2.57m; E-W axis - 6.72m. The northwest wall is 50cm thick and has two entrances into it. The western and the eastern entrance are both with 82cm width. The transversal wall of the room is 104 cm thick in the north and in the central part where there is an arrangement of bricks and stones - 52 cm. The length of the walls is as follow: NW wall is 670 cm; SE wall is 730 cm; the transversal one is 280 cm. The room is covered with a pavement of reused bricks and slab stones. In addition to the niche of the wall of room 3 described above, to the west it has been found a raised cooking facility, 0.80 cm high from the level of the pavement. It is formed inside of the distribution wall, surrounded by elliptically arranged vertical bricks. From the north, the building is shaped in two steps with a width of 10 cm and a distance of 10 cm, used for shelves. An iron spatula was found on the top shelf. The chimney was probably made of bricks due to the large amount of bricks uncovered during the survey, on the sidewalk and on the burning zone of the masonry hearth.

The walls lengths of room № 6 is as follow : NW wall - 460 cm; SW (transversal) wall - 1.60 m; SE wall (external) - 4.70 m NW axis - 2.57m; EW axis - 3.94m - (internal dimensions). The hearth is revealed on the east wall, where again by narrowing the wall was formed a space for the oven. This facility is without preserved enclosure it looks like it was destroyed in more recent times.

3. Conclusion

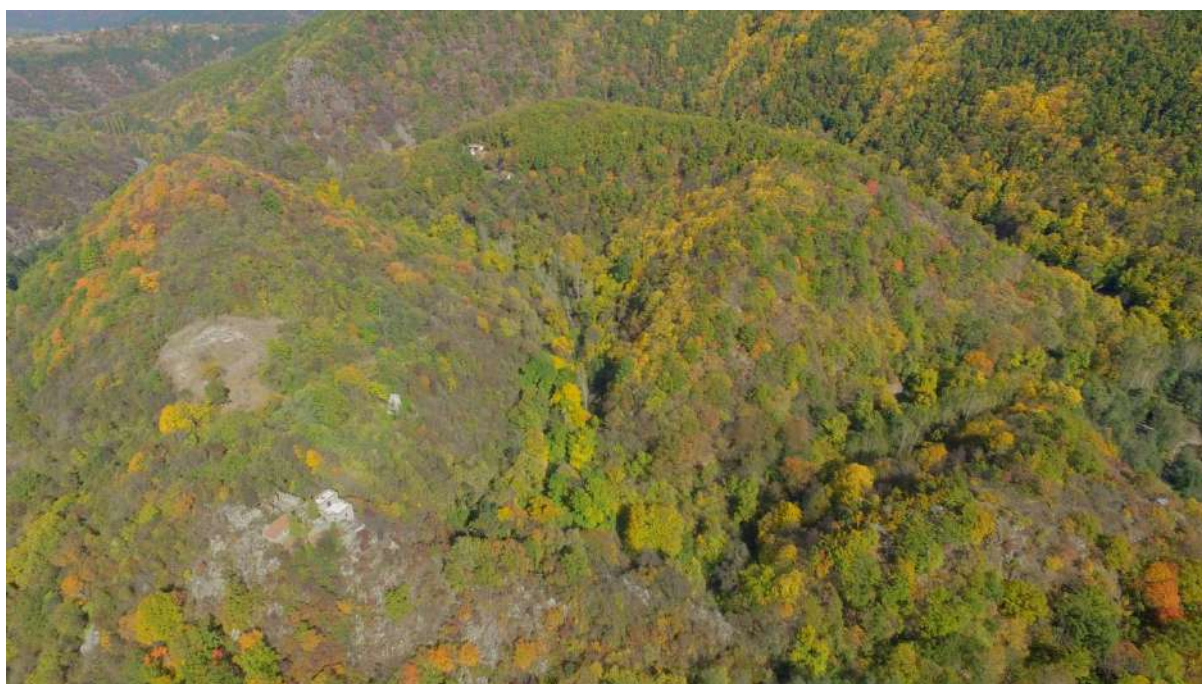
All the rooms and their facilities are made of medium and large single-shaped stones soldered by mud. In some parts the rows are level up with smaller stones of the same raw material, bricks were rarely used.

Within 1 meter the rows are leveled with an external wooden beams with dimensions 10x10 cm. The thickness of the walls varies due to the landslides and the destructions over the centuries. Mostly the thickness of the construction is 80 cm, the width of the fence wall is with the same thickness as well in some places it is narrowed because of the processes of deconstruction over the 300 years since the end of the Monastery.

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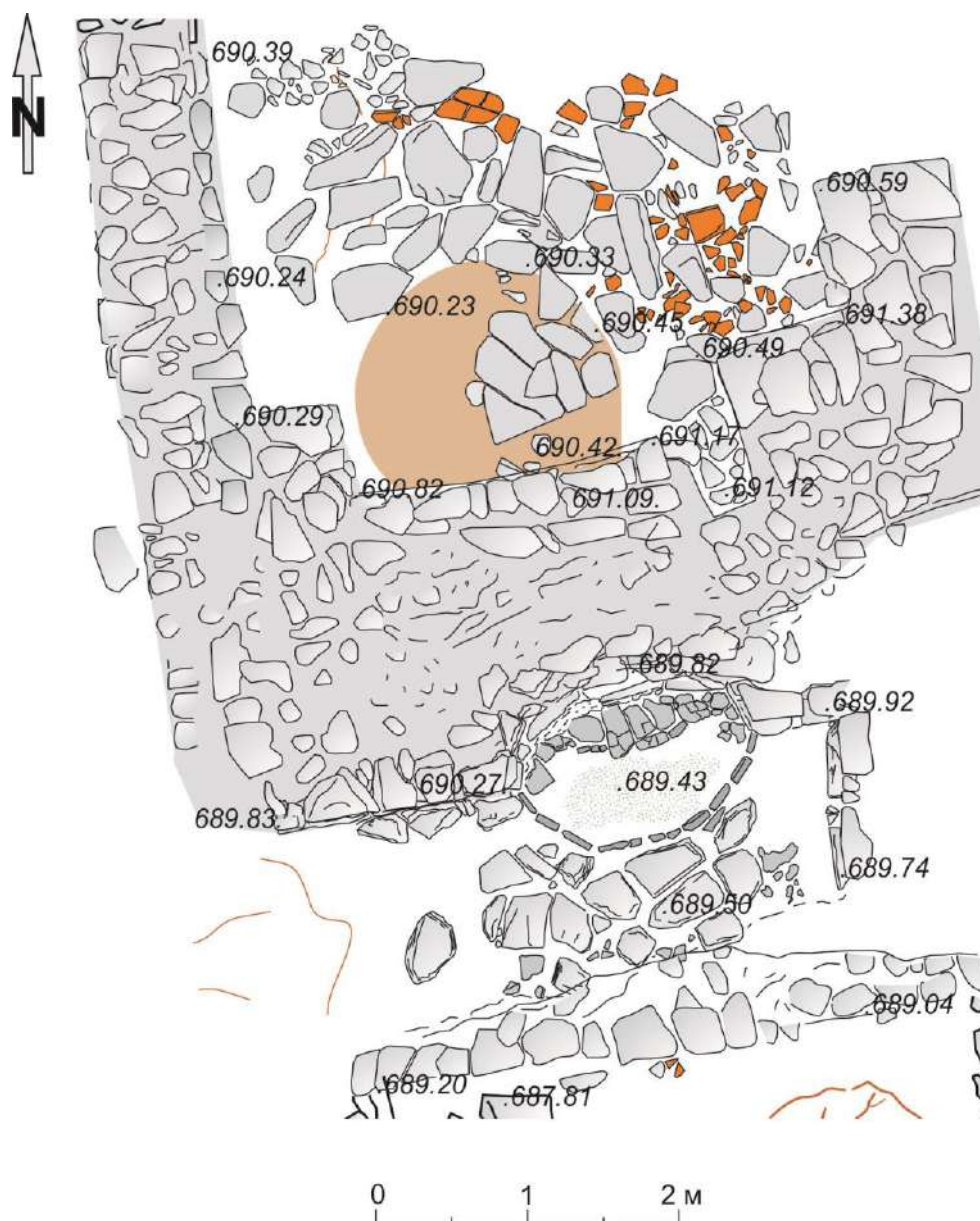
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The two hills, called Urvich.



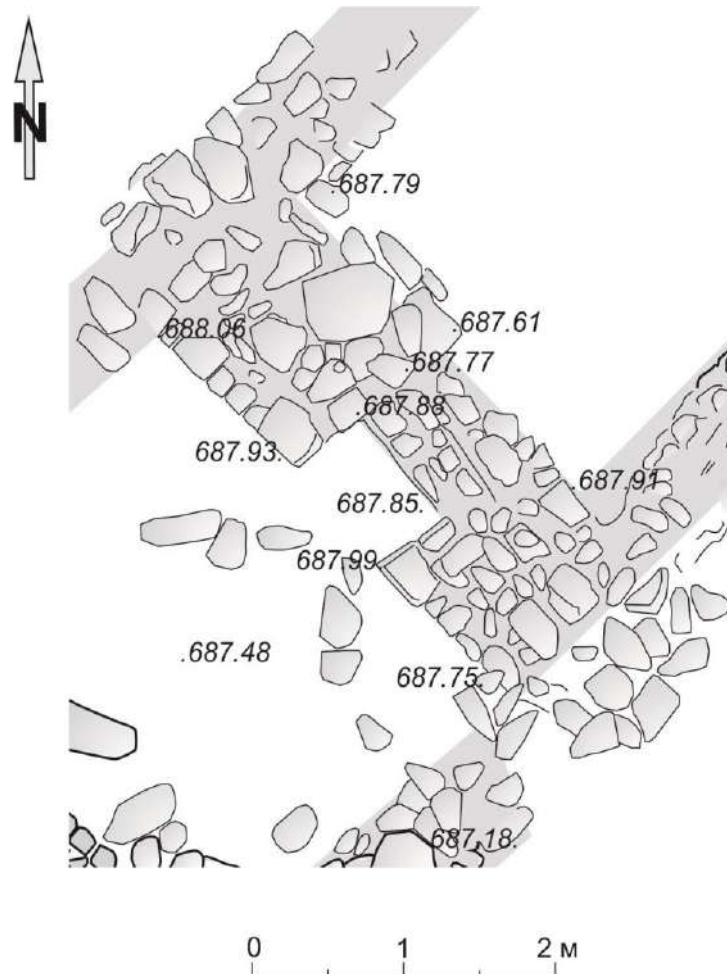
The plan of monastery.



Fireplace in room 2: 1,70x0,70m;

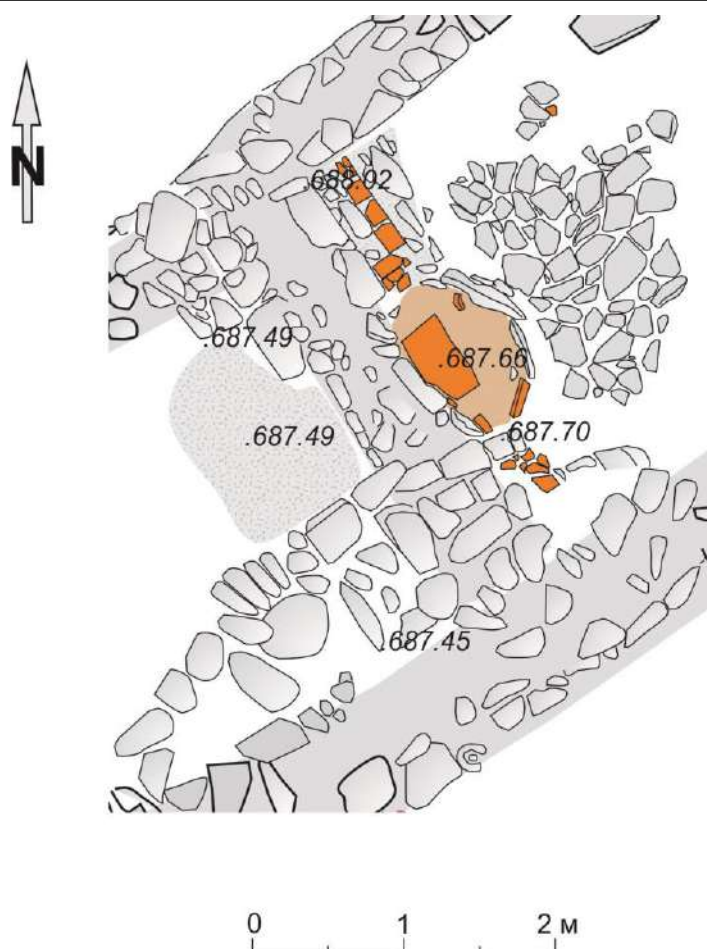
Fireplace in room 4: 1,70x1,50m;





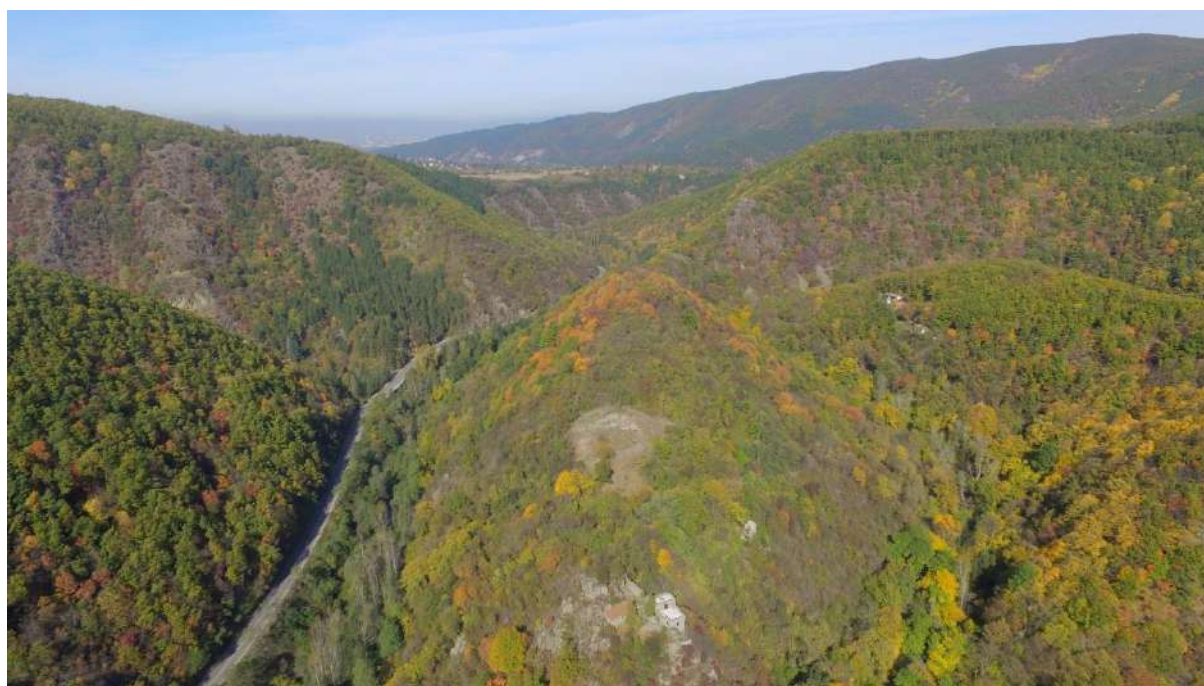
Fireplace in room 5 E: 0,90x0,50m;
Fireplace in room 3: 0,90x0,40m;





Fireplace in room 6: 1,40x1m;
Fireplace in room 5 W:1,20x0,90m;





Iskar Gorge

КРИТЕРИИ ЗА ОЦЕНКА НА НЕДВИЖИМИ КУЛТУРНИ ЦЕННОСТИ В ПАРКОВОТО ИЗКУСТВО

д-р. ландша.арх. Перчиклийски Григор

CRITERIA FOR ASSESSING THE CULTURAL HERITAGE VALUES IN THE PARK ART

PhD. Perchikliyski Grigor

***Abstract:** Cultural heritage encompasses the intangible and tangible immovable and movable cultural values that bear historical memory, national identity and scientific value. They should be in the public domain and be protected by state and municipal authorities in the interest of the citizens of the country. The main objective of the study is to explore, complement and bring out the criteria and indicators to assess the cultural values of national importance in some old gardens and parks in Bulgaria. The implementation of this objective will find modern and adequate opportunities for separation and characterization of specific objects as a significant art of the cultural and historical heritage of Bulgaria in the field of park & garden arts. Object of study are theoretical definitions that characterize these kinds of arts, laws and regulations concerning similar gardens which are designated as cultural values of real objects from Bulgaria.*

***Key words:** Heritage, Cultural Values, Gardens and Parks, Laws and Regulations, Definitions, Criteria;*

1. Въведение .

Чрез обектите на градинско-парковото изкуство в симбиоза със запазените исторически паметници от останалите видове изкуства днес може да се осъществява един непрекъснат мост между отделните епохи и да се проследява цялостното културно развитие на човечеството. Тази възможност за запознаване с промените, които са настъпвали през различните периоди от време, и новото познание, които чрез тях е достигало до обществото, са в основата на идеята за откриване, изследване, документиране, опазване и реставриране на ценни за цивилизацията исторически обекти на изкуството. Ето защо всеки обект, който е от значение за обществото и има научна или културна стойност, представлява непреходна ценност, която трябва да бъде съхранена за бъдещите поколения.

1.1. Направени са подробни проучвания на нормативните уредби в различните европейски страни по отношение избраните за изследването обекти на ГПИ, които дават ясна представа за определящите причини за обявяването на тези паркови обекти, като паметници на културата.

1.2. Направено е теоретично проучване на критериите, с които може да се характеризира всеки обект на ГПИ. Тези критерии се основават на използваните такива в различни нормативни документи на отделни страни в Европа.

1.3. Проучени са закони, действащи към настоящия момент, които онагледяват принципа и тенденциите за обявяването на отделни обекти за паметници на културата.

1.4. Изследвани са процесите на регистрация и деклариране на отделните обекти чрез установените законови актове в европейски държави, характерни със своите исторически ценности на ГПИ.



Фиг.1. Обхват на проучване на критериите за изследване.

2.Методи на изследване.

За изготвяне на настоящия дисертационен труд се използват различни методи и подходи, които обуславят и по-нататъшните изводи и решения. Постигането на главната цел се осъществява посредством направените предварителни анализи и проучвания на характерни за темата обекти. Основният метод на изследване, използван в научния труд, е метод на сравнителен анализ.

Чрез прилагане на този метод се извършва сравнение между избраните образци от българското парково изкуство и от европейското и световното културно наследство.

3.Цели и задачи на изследване.

За постигането на целта са решени различни по своята същност задачи. Основните от тях са свързани с проучването на паркови и градински единици в страната и в чужбина, които са обявени за паметници на културата и са част от българското и световното културно наследство. В резултат на направените предварителни проучвания се обособяват различни елементи за изследване в зависимост от историческите особености на обектите и от онези фактори и причини, които влияят и допринасят за тяхното определяне като недвижими културни ценности в ГПИ според проучени различни нормативни документи. В по-широк аспект изследванията са насочени към:

- Историческо Проучване.
- Проследяване прилагането и развитието на критериите за оценка на недвижимите културни ценности в ГПИ по света и у нас;

- Определяне значимостта на обектите в световното културно и историческо наследство

- Утановяване на фактори и причини за обявяването на разглежданите обекти като НКЦ.

- Анализиране на публикации, нормативни документи и сравнителни характеристики за обектите на изследване;

- Роля на историческите паркове и градини в културния живот и туризма;

4. Изложение.

4.1. теоретични критерии за оценка на обекти в ГПИ..

В резултат от проведеното проучване, базирано върху главните теоретични характеристики на обектите - образци на ГПИ, настоящата разработка извежда следните основни критерии за тяхната оценка :

- художествена стойност
- историческа стойност
- автентичност и степен на съхраненост
- взаимодействие със средата
- научна стойност
- градоустройствена стойност
- обществена значимост (взаимодействие с обществото)
- други;

4.2. Европейски действащи нормативни документи за оценка на обекти на ГПИ.

Според множеството нормативни документи изследвани в различните европейски държави, становища и предложения, въз основа на които обекти на ГПИ са обявявани за културни ценности, всеки обект на изкуството се характеризира с различни критерии за оценка, като:

- интелектуален и духовен потенциал ;
- научна стойност;
- естетико-художествена стойност;
- функционалност и стопанска значимост (икономика и развитие, туризъм);
- съотношение между модерно и историческо;
- историческа;
- достъпност, местоположение и взаимодействие с обществото;
- време (дълготрайност - веднага ли може един обект да бъде обявен за паметник на културата или трябва да отmine определен период);
- автентичност и степен на съхраненост;
- взаимодействие със средата;
- градоустройствени/урбанистични стойност;

Пример за това са паметниците на културата в Германия, които са обект на отделно отношение на провинциите, всяка от които е създала свой собствен закон за опазването им. Те се обявяват и регистрират от Министерството за историческото наследство чрез създаване на експертни съвети и органи, които да гарантират тяхната стойност.

Проучени са няколко провинции, в чиито нормативни актове се установява почти пълно сходство относно общите изисквания и критерии към отделните обекти. Определени са критерии за оценка на културни ценности, като най-значими са:

- художествена стойност

- историческа стойност
- научна стойност
- градоустройствена стойност

4.3. Обекти от национално значение, обявени за паметници на културата в ГПИ на страни в Европа, Германия.

Разгледани и проучени са паркове и градини в различни европейски държави, като „Замъкът и паркът Бенрат“, град Дюселдорф, Германия.

Регистрирането на обекта като паметник на културата е свързано преди всичко с критериите:

- историческата стойност (периода който отразява и личностите, които са участвали при изграждането му).
- художествена стойност - представител на барока в Германия.
- обществена значимост – със своите природни дадености е обект, създаващ условия за провеждане на научни изследвания.

Липсват ясни и точни документи с описани точни показатели за оценка на обекта.

4.4. Обекти от национално значение, обявени за паметници на културата в ГПИ в България.

Изготвени са и анализирани са обекти от национално значение, обявени за паметници на културата в ГПИ и в България. Един от тях е Дворцовият комплекс “Врана” (район “Искър”), състоящ се от вила 1, вила 2, кухненски бокс и топла връзка, е обявен като архитектурно-художествен и исторически паметник на културата с категория „национално значение” в ДВ бр.25 от 1998 г.

Паркът “Врана” е обявен като паметник на ГПИ с категория „национално значение” в ДВ бр.41 от 1992 г.

Основните причини за обявяване на парка като Паметник на културата и Защитена местност са:

- запазена е в автентичен вид ландшафтната композиция
- композицията на алеейната мрежа
- ценната растителност - дървесна, храстова, цъфтяща и тревиста. Тази растителност за разлика от растителността във всеки друг общоградски парк е уникална ценност, равнозначна на музеен експонат.

5. Изводи

Във връзка с установените закономерности в заключение може да се обобщи, че голяма част от изследваните обекти, които са паметници (недвижими културни ценности) на ГПИ, и в Европа, и у нас, са били обявявани за такива без конкретизирани и аргументирани предложения. Често пъти при обявяването им са използвани общи списъци с предложения, като по този начин са одобрявани групово. За останалата по-малка част от обектите, за които има запазени и открити в процеса на проучването документи, се установява, че обявяването им за недвижими културни ценности на ГПИ е вследствие съобразяване с изготвената нова нормативна база. В резултат на това изпъкват някои от най-важните критерии за оценка, които са:

- Художествена стойност
- Историческа стойност
- Научна стойност

В резултат на настоящия труд е изработена и предложена в табличен вид система с критерии и показатели за оценка на недвижими културни ценности в ГПИ. Тя може да намери успешно приложение както в българските нормативни документи, така и в тези на останалите европейски страни без да нарушава техните нормативни устройства. Наред с това тази система би могла да спомогне в синхронизирането и създаването на общи критерии при определяне на недвижими културни ценности на ГПИ както в България, така и в Европа.

Таб.1. Критериите за оценка на недвижими културни ценности в ГПИ.

	критерии	показатели
1.	художествена стойност	стил
		композиция
		единство между основните компоненти и елементи
2.	историческа стойност	принадлежащи към определен период
		връзка с исторически личности и събития
3.	автентичност	запазена автентичност (цялост и истинност)
		сравнително непокътнати
		запазени са достатъчно елементи
		уязвимост
4.	взаимодействие със средата	взаимодействие със средата, установяване на връзка и отношение към околната среда
5.	научна стойност	знанията, които ни предоставя
6.	градоустройствена стойност	местоположение
		обемно пространствено единство
		ансамблов значение
		териториален обхват - единични или групови
7.	обществена значимост - (взаимодействие със средата)	световно значение
		национално значение
		местно значение
		икономика и туризъм
8.	други	за сведение
		други

Прилагането на формулираните от изследването критерии разширява и внася допълнително съдържание в досегашните теоретични практически търсения в тази специфична сфера на ландшафтната архитектура.

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НАПРАВЛЕНИЕ 3

Исторически строителни материали и тяхното диагностициране; Нови материали за опазване на културно-историческото наследство; Исторически структури и техния мониторинг; Нови технологии за опазване на културно-историческото наследство.

TOPIC 3

Historic materials and their diagnostics; New materials for safeguarding culture heritage; Historic structures and their monitoring; New technologies for safeguarding culture heritage.

SHEAR STRENGTHENING OF UNREINFORCED MASONRY WALLS WITH VARIOUS TYPES OF COMPOSITE SYSTEMS

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Abstract: *The shear strengthening of unreinforced masonry (URM) walls needs to be carried out through appropriate and effective techniques, compatible to the particular physical characteristics of the substrates. In this paper, various types of composite strengthening systems are presented and discussed. In recent years, the composite strengthening systems, especially those made with textile reinforced mortars (TRM), have received significant attention, due to their convenient mechanical properties and sustainability characteristics. Various analytical and numerical models have been developed to quantify the strength and deformation capacity improvement provided by the composite reinforcement to the URM walls. However, there is still a lack of works that examine the overall performances of the composite strengthening systems, including their limitations which are not thoroughly known, and, in some circumstances, may lead to buckling and out-of-plane failure of the URM walls.*

Key words: *unreinforced masonry, composite strengthening systems, near surface mounted, externally bonded reinforcement, textile reinforced mortars.*

1. Introduction

The majority of existing historical masonry buildings has been constructed as unreinforced masonry (URM) structures. The design of these structures was focused mainly on the gravity loading and thus, many URM buildings are potentially vulnerable to earthquake loads. The URM walls take advantage of the adequate masonry compressive strength, and they behave satisfactorily as long as the loads are vertical. On the other hand, the shear response of URM walls is more complex and depends, mainly, on the nature of the mortar and the bricks. Furthermore, the stocky sequence of masonry units and the negligible tensile strength of the masonry material, makes these structures very brittle and with low ductility [1, 2].

The strengthening of the URM structures is an important issue and the design and the implementation of an appropriate reinforcing system represents the key aspects in order to achieve the required seismic performances in terms of energy dissipation capacity. The traditional strengthening techniques may not be very effective for historical masonry

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constructions, due to the high additional mass of the constituents and unsatisfactory mechanical attributes [3].

Strengthening URM structures with composite systems is a consolidated technique that has focused the research of several research teams in the last decades. The effectiveness of various composite products was analysed for different masonry elements (walls [4, 5], pillars [6, 7], arches, vaults and domes [8, 9]), under particular loading conditions: compression [10], static and cyclic shear [11, 12], static and cyclic bending [13, 14]. Based on various extensive experimental programs, the remarkable structural performances of the composite strengthening systems have been validated. According to these experimental programs, the bearing capacity can be improved with up to 100% in bending (thanks to the tensile contribution of composites) [15], over 20% in shear [16] and over 100 times in compression, in case of arches and domes [17].

A large share of the composite strengthening systems, designed for URM walls, are using fibre reinforced polymer (FRP) pultruded products that are manufactured under strict control procedures and visual inspection. Although these industrialised products have well controlled properties, their manual application into the strengthening system may result into structural deficiencies, usually associated with adhesive voids or inadequate curing. In order to overcome these drawbacks of the FRP strengthening systems, the textile reinforced mortar (TRM) composite, which is also referred to as textile reinforced concrete (TRC) or fabric reinforced cementitious matrix (FRCM), has emerged as an alternative strengthening technique. The application of TRM increases the shear strength of masonry walls, and it also improve the dominant failure mode. The TRM strengthened URM walls have a gradual prolonged failure, which is highly desirable, especially in the case of structures located in the earthquake prone areas [18].

2. Composite strengthening systems for URM masonry walls

2.1. Externally bonded reinforcement

The externally bonded reinforcement (EBR) technique (Figs. 1, 2) uses either pre-cured FRP composite laminates (bonded onto the masonry walls with a structural adhesive) or FRP sheets (applied by wet lay-up). The orientation of the FRP reinforcement can be horizontal, vertical, diagonal, or in a grid pattern. Furthermore, the strengthening system can be applied on one side or on both sides of the URM wall [19].

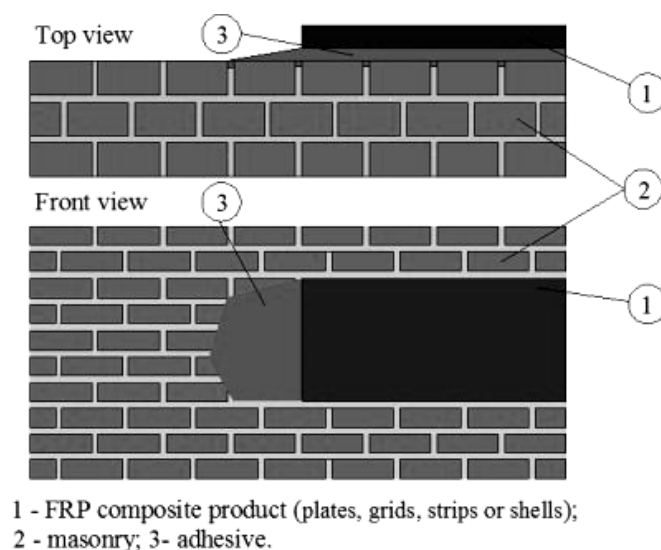


Fig. 1. FRP Externally Bonded Reinforcement (EBR) applied to URM wall [19]



Fig. 2. FRP EBR strengthening technique applied to: a) Victor Slăvescu historical building; b) Laminates bonded on an URM wall [20]

2.2. Near surface mounted

The near surface mounted (NSM) strengthening technique uses FRP composite products, such of bars or strips that are bonded with structural adhesives into cuttings, in depth of masonry walls (Fig. 3).

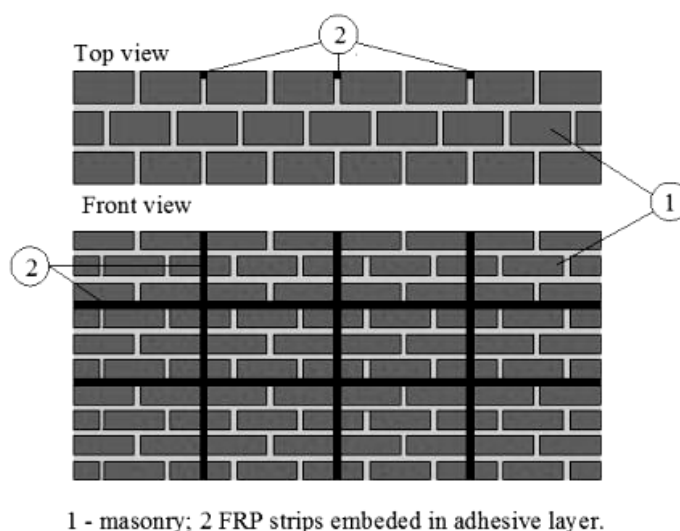


Fig. 3. Near surface mounted strengthening system applied to an URM wall [19]

2.3. Central core strengthening technique

The central core strengthened technique (Figs. 4, 5) involves drilling continuous straight vertical grooves through the head joints and the brick units and horizontally at the bed joints. After the drilling and the cleaning processes are finished, an epoxy primer is applied and the grooves are partially filled with an epoxy structural adhesive. The reinforcement used for this strengthening system consists of FRP rods installed in the grooves and encapsulated by an epoxy adhesive product. This strengthening system increases the URM wall capacity to resist in-plane and out-of-plane loading, but, at the same time, it creates regions of varying stiffness and strength properties.

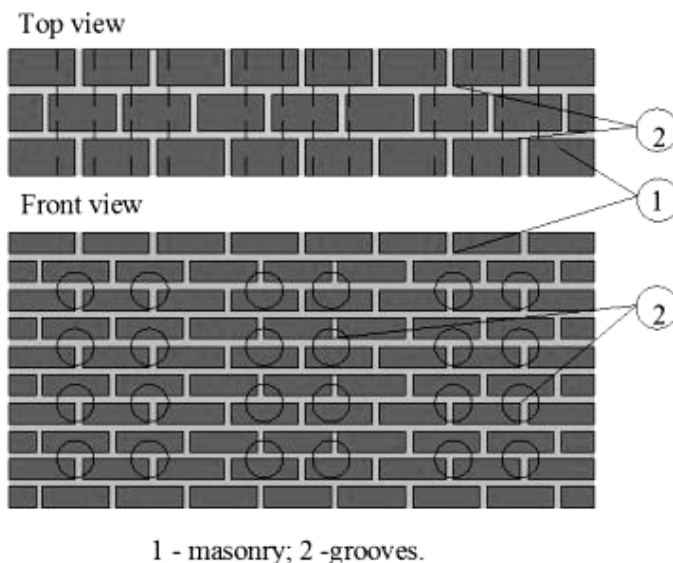


Fig. 4. Centre core strengthening technique applied to an URM wall [19]



Fig. 5. Combined EBR and Central core strengthening techniques applied to: a) Palace Hotel, Govora; b) FRP EBR and central core reinforcements applied on an URM wall [20]

2.4. Textile reinforced mortars

The textile reinforced mortars (TRM) strengthening system uses a structural layer of engineered cementitious composite (ECC) that is fully or partially (only in the case of elements with complex geometry) bonded onto the faces of the URM walls (Figs. 6, 7). The TRM are usually composed of a dry fibre mesh, embedded in a cementitious matrix. This strengthening system is particularly well-suited for the reinforcement of masonry structures due to its high compatibility with the substrate, vapour permeability and durability against environmental agents.

Moreover, a TRM system has similar advantages to the ones of an FRP system, including high strength to weight ratio and corrosion resistance, but it overcomes some major FRP drawbacks, especially those related to the unsatisfactorily behaviour under elevated temperature and un-proper application on damp surfaces [18]. The flexural capacity of an URM wall strengthened with TRM is affected by several factors. The flexural capacity of the system can be improved by increasing the number of reinforcement and mortar layers. The type of the reinforcing fibre mesh influences the overall flexural capacity of the element, due to

the dominant failure mode and bond strength associated with each type. In addition, the anchoring of the TRM system may help to increase the bearing capacity and ductility of the strengthened element, by delaying the development of the failure mode.

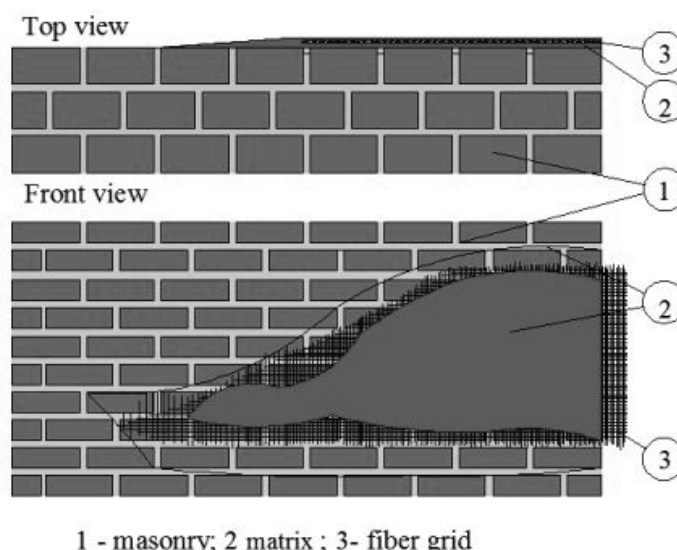


Fig. 4. Textile reinforced mortar applied to an URM wall [19]

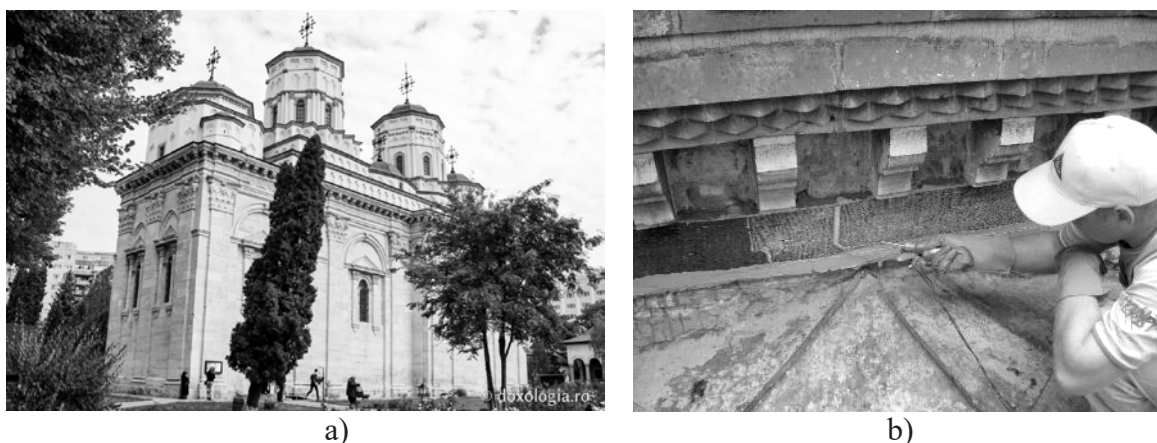


Fig. 5. Textile reinforced mortar applied to: a) Golia Monastery, Iași [21]; b) TRM applied on the monastery walls [20]

3. Conclusion

In recent years, the rehabilitation and strengthening of URM buildings has seen a remarkable development on the basis of new techniques and materials. In this study some of the shear strengthening techniques that are either suited for URM walls, or have been particularly designed for these structural elements are described. The history of past earthquakes showed that the URM buildings had performed the worst, developing un-repairing damages and also accounted for many life losses. In this frame, the already developed FRP strengthening techniques for plane / reinforced concrete, steel and timber members were also applied to masonry elements. However, the FRP composites have demonstrated unsatisfactory performance, when applied to URM structures that were located in high temperature environments, where the glass transition temperature of the resin is reached. This justifies the need to examine alternative strengthening techniques, such as the TRM systems. As it has been discussed in this paper, the TRM system has similar advantages to the ones of an FRP system, but it overcomes various FRP drawbacks, especially those related to the unsatisfactory behaviour at elevated temperature and un-proper application on damp surfaces.

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COMPOSITION, CONDITION AND LOAD-CARRYING CAPACITY OF THE EARLY AGE STEEL GHENT FLORALIA EXPOSITION HALL

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Abstract: *The Floraliahall in Ghent was built during 1912-1913 as part of a series of large infrastructure works for the world exposition of 1913. The main structure of the hall consists of 18 portal frames having 3 spans of 10.16, 40.18 and 10.16 m. The upper part of the structure is highly slender. Adversely to the customary concepts of 100 years ago, the lighter frames at 7.45 m distance, are hinged twice at the springs, whereas the more heavy frames, at 15 m distance, are completely clamped at their base. In addition, measurements show that cross-sections of compressed parts have larger area than the tensile parts. From the structural point of view, this construction sometimes has an unexpected composition. The aim was to determine whether this structure can comply with contemporary requirements and codes. From measurements and simulations follows that in limited areas high stresses appear, unacceptable even in serviceability state. This may be partly due to modifications of the roof that were made inappropriately, from the impossibility to assess certain details with the model and from ineffective analysis at the time of construction.*

Key words: *Exposition hall, two hinged frame, analysis of frames, early age steel, inadequate roof modification.*

1. Introduction - Origin

On the initiative of a high school, a botanic garden has existed in Ghent (Belgium) since 1798. The garden was intended to support education and was visited often by schools, as well as by many citizens. Plant growers, gardeners and botanists have shared their knowledge to broaden the number of plants. This garden was taken over by the university, founded in 1817. Apart from this, plant growers founded a society to promote their products. To improve publicity, in 1809 a first exposition was organised by 34 members in a room behind an inn of 48 m² [1]. In early summer of the same year already a second exposition was organized showing 139 flowering plants. As success grew, larger locations had to be found and in 1835 a casino was built in Ghent, which was used as the new venue up till 1913. The plant and flower exposition, now known as the Ghent Floralia, continues and is now organized every 4 or 5 years, attracting visitors from all continents.

After the last Floralia of 1908 and as the 1913 world exposition of Ghent was approaching and new hall was built in the citadel park. This park resulted from the demolition of army barracks, built during the Dutch period from 1815 to 1830. This military facility was erected according to requirements of the Vienna Conference and was

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intended to prevent further French invasion as during the Napoleon period. After 1830 the facility was further used by the Belgian army, till in 1870 the city acquired the premises, to transform it to a park for its citizens. The grounds were partly used during the world exposition but remained chiefly a green area. Hence, the location of the new hall at the park centre was an excellent choice.

The Floralia Hall consists of an early steel structure, the total cost at the time of its erection was around 1 million francs. The alternative of a stone structure was discussed with the city, as this would cost 50% more. The city council agreed to provide additional funding, if they would take over the ownership after the exposition. Apparently this did not happen and the horticultural society thus acquired a new permanent location for the four-year event. However, from 1990, the Floralia moved to the larger venue of Flanders' Expo outside the town, offering a total space of 54000 m² in 8 halls. The last unsuccessful event was organized in 2016, bringing the exposition back to the town centre at 4 different locations. The next edition in 2020 will come back to the Floralia hall and the surrounding park.

Today, the hall is surrounded by 3 other buildings, the urban museum of contemporary art, the ICC international congress centre and the velodrome. On the outside, only the light strips in the roof and the cemented north side with cascading recessed wall surfaces, are visible (Fig. 1).



Fig. 1. Cemented North façade of the Floralia Hall

Plans are being made to restore the hall and integrate it into the ICC in a more consistent way. The aim is to reduce some of the masonry building parts and to create a single large space. The future will tell whether successful solutions can be found.

2. The roof structure

The structure covers a space of 175*80 m and consists of 18 parallel steel frames. The frames have 3 spans of 10.16, 40.18 and 10.16 m. Hence, the central span is the most impressive and also the most slender one. The structural height of the central span reaches 19.89 m as it is equipped with an additional top ridge frame, allowing light to enter the hall. Fig. 2 shows an overview of the whole structure, the interior being cleared of any occupying event material.

As the picture shows, the portal frames are not all identical. Most frames are at a distance of 7.45 m, whereas there are 3 longer spans of 14.98 m. Hence 4 frames show an alternative composition, 2 being of a heavy type, 2 others are medium heavy, the 14 others being of the 'light' type. The main difference between these types of frames are the vertical

posts and some details in the frame nodes. In the following, we concentrate on the lighter frames.

Looking at Fig. 2, it is noticed that the horizontal members show high slenderness. For instance, the depth of the upper member at the span centre equals 0.7 m for a span of 40.18 m or $L/57.4$, which is highly slender. The lateral frames shown considerable less slenderness. In addition, there are no tension members, connecting opposite posts and increasing horizontal stability. Obviously, the designers wanted to build a light structure of maximum vertical clearance.

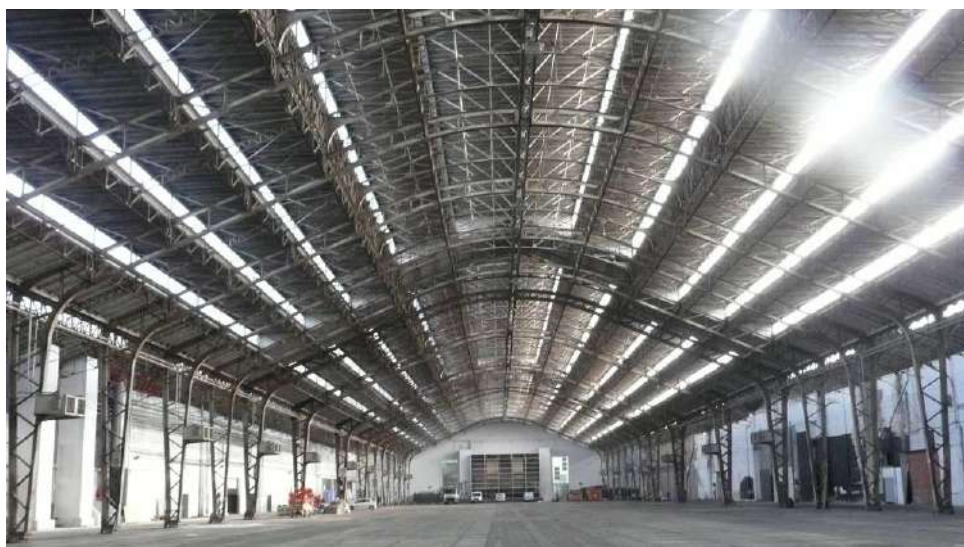


Fig. 2. Inside view of cleared hall

At the time of construction, the Polonceau frame would have been the most popular choice. This structure seems already to resist bending at the nodes and one may expect it does not behave as a simple truss.

The central part of the upper member is also curved, the outside radius being 23.23 m. The additional ridge frame, not clearly seen in Fig. 2, is located above this curved part. Because of this, there is no central hinge. The supports of the light columns or posts of the central structure are hinged as can be seen in Fig. 3a, whereas the medium and heavy frame supports are clamped, preventing angular rotation (Fig. 3b)



a)



b)

Fig. 3. Support of vertical members : a) light frame; b) medium frame

The vertical members of the side spans are not visible and consist of a latticed column, encased in concrete and part of a brickwork wall. As far as this can be discovered without invasive examination, the encasing is complete and the brickwork is filling in the space between columns.

3. Composition and material of the structure

After various searches in archives and other places, no drawings seem to be available, allowing further assessment of the structure. Hence, a thorough investigation was conducted to fully obtain an inventory of the structure. This was done by measuring with double decimeter, folding meter and slide adjuster and using an aerial platform, supplemented by photographs. There may be some flaws in the result, since some locations could not be reached, in particular in the frame corner.

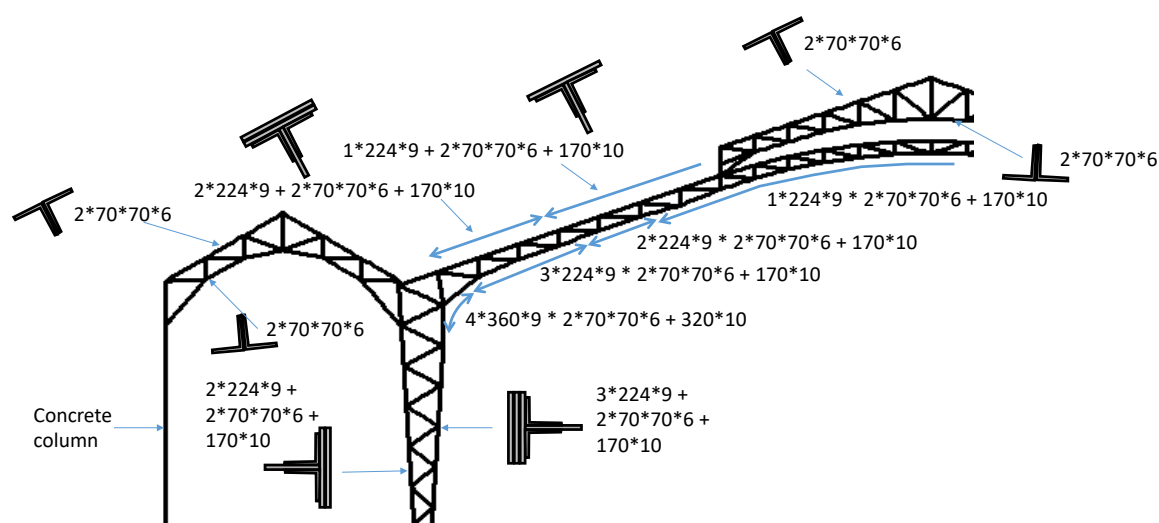


Fig. 4. Steel cross-section (half of the structure)



Fig. 5. Frame corner node (detail)

The structure consists exclusively of angle profiles and plates, which are either strips or round cut plates. Although these existed at the time of building, no I-profiles have been used. These elements are assembled by rivets of shank diameter 18 mm and head 30 mm. Fig. 4 shows the most important cross-sections of various bars of the structure. The numbers on the figure are first the flange plates, then the angle profiles and finally the web plate dimensions.

Some of these cross sections are rather puzzling. For instance, the outside member of the vertical post, where tension is expected, has a distinctly smaller cross section than the opposite inner member, which is likely to be compressed. In addition, the lower member of the upper truss has more reinforcing flanges (up to 4) than the upper member, which has a maximum of 2 flange plates. This was verified also from the photographs taken. Obviously, there are more complicated details apart from the general data in Fig. 4. For instance, the frame node and other particular locations have larger webs. This can be seen in the detailed photo of Fig. 5. The higher web plate and reinforcing flanges of the lower member, as well as the curved cut web plate of the upper member can be seen. Fig. 5 also shows part of the transverse beams that connect the parallel frames. These frames support the glazed parts of the roof covering and prevent displacement out of the frame plane.

Concerning the material, it is known from other structures, built at the same period that the Siemens-Martin and Thomas fabrication processes of steel had been developed and all data point towards the material being early age steel. For the case of 2 bridges from the same period, 3 samples were taken from the webs of crossbeams, which do not carry directly any of the traffic loads [2]. The results of the 3 samples gave values of 254, 277 and 238 for $f_{y\ 0.2\%}$ and 338, 382 and 347 for f_u . In view of the limited number, and not knowing the dispersion, application of annex D of EN 1990 [3] is virtually excluded. The material may be close to steel S 235 but the dispersion of the characteristics is rather large. This may be expected from early-age steel, since the constant character of quality was poorly monitored and large variations may have occurred. Within the 6th European Framework [4], an impressive amount of samples has been used to characterise steel produced at various periods. In addition, the Swedish Standard BVS 583.11 and the work done at Lulea university [5] are highly relevant. In these references a standard deviation of 36 MPa has been found. The average value of the 3 experimental values being equal to 256.3 MPa, the 5% fractile characteristic value of the material equals $256.3 - 1.64 \cdot 36 = 197.3$ MPa.

It should be mentioned that some literature references indicate that back at the beginning of the 20th century, an allowable tension stress of 300 MPa was considered [6]. Obviously, this value is overestimated.

4. Load-carrying capacity

4.1. Modelling of the structure

The aim of this section is to assess to which extent the structure may comply with present codes, in particular EN 1993. In view of the types of analysis at the beginning of the 20th century and of the design loads and material characteristics used, it is almost certain there will be no compliance with the present code. However, the assessment may show the weak locations or members and be of assistance in maintenance or further development.

While developing a relevant numerical model, an important matter is to decide on the type of elements to be used. These roof structures were mostly calculated by graphical methods [7] as shown in the example of a Polonceau truss of Fig. 6. Typically, all loads are applied at the truss nodes, which themselves are assumed to be hinged. The continuity of the upper- and lower members, as well as bending of the bars were not taken into account.

Merely normal forces were determined, albeit some degree of bending was introduced by increasing stresses by percentages, varying from 20 to 5%.

Today's software packages allow various types of calculations. In the case of thin-walled structures either membrane elements supplemented by bending, or the more simple beam elements are the evident choice. In the present case, with limited plates or webs, the use of beam elements seems indicated. Variation of girder webs or reinforcing flanges may be introduced by modifying the location of the member axis and using the appropriate characteristics. Obviously, the truss axis lines are adapted to the location of the gravity centre of the cross sections. This may harm the continuity of the general scheme of axes, and produce sometimes an unusual appearance. The option of beam elements is the closest to the historic analysis and is therefore the best of alternatives. Since none of the angle profiles are crossing and all are double, these members do not show eccentricity.

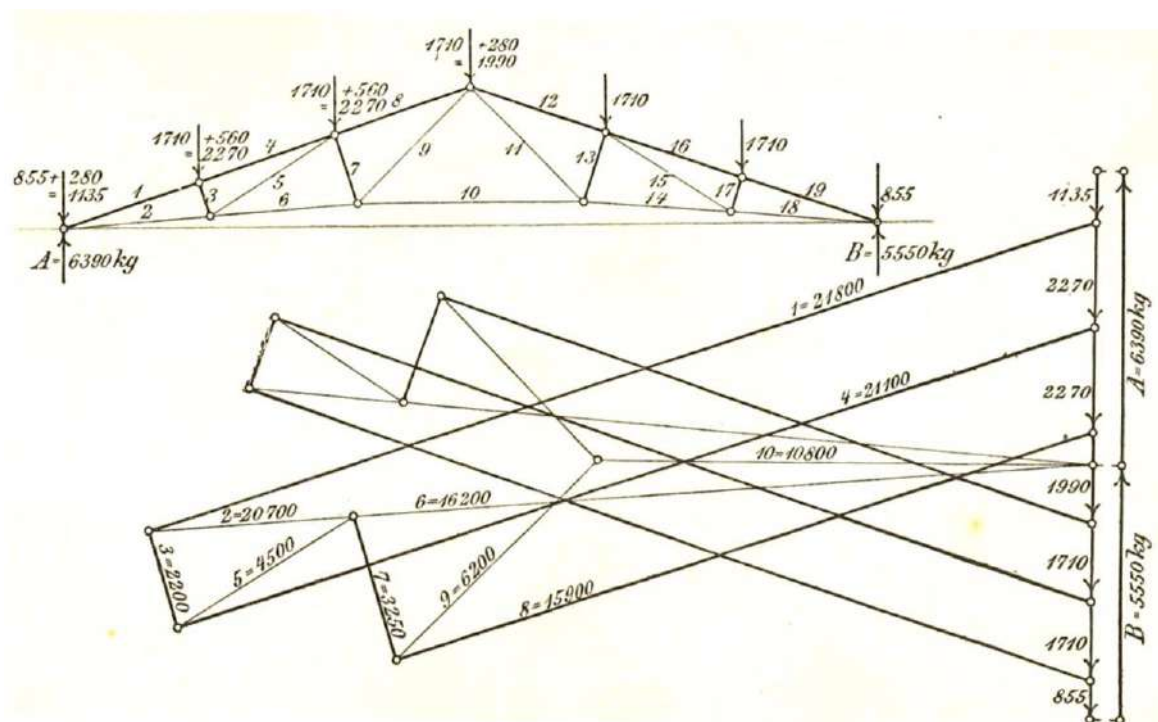


Fig. 6. Graphical calculation of member forces of Polonceau truss

However, according to EN 1993-1-8 [8] the stiffness of connecting nodes should be assessed, by calculating S_{jini} a stiffness factor found from :

$$S_{jini} = \frac{E z^2}{\mu \sum \frac{1}{k_i}} \quad (1)$$

which depends on the spring constant k of the member's web, flange, of the rivets, the distance between rivets and the edge distance. The S_{jini} must be compared to the relative stiffness of the member EI/L and may be different for each type of node. In the majority of the nodes, the stiffness does neither comply with the condition of complete stiffness, nor to a hinged mode. Hence, the connections are flexible and their stiffness was adapted to around 30% of the members.

4.2. Loads

The loads may also be different from those considered by the original designers. For the weight of the roof covering the former references indicate a maximum load of 0.3

kN/m². Today the claddings and transparent plates represent at least 0.5 kN/m². Combined with several purlins and vertical members, the present roof covering, which has been modified several times represents at least 1 kN/m², which has been adopted in the analysis.

At the time of construction, and even for a long period afterwards, the maximum wind pressure equalled 0.9 kN/m² and if all nominal loads were considered simultaneously, it was assumed this combination was the ultimate limit state of today. Considering EN 1991-1-4 [9], the wind pressure for environment class 3, the maximum height of the building and all relevant factors, the maximum wind pressure would be 1.3 kN/m² to combine with the factor of 0.6. Hence the effective wind pressure equals 0.8 kN/m².

The effect of temperature was not really considered at the time of the design. According to the present code EN 1991-1-5 a temperature change of 32°C with respect to a neutral value should be considered.

The main variable loads considered during the analysis are either wind or thermal effect. Obviously, both can take the opposite sign. Wind can be asymmetrical with pression on one side of the roof and suction on the opposite side. The thermal effect can be heating or cooling. Hence the combinations are limited to 8, the γ -factors for both being 1.5 and the ψ -factors 0.6.

All of these data confirm that design loads have increased considerably since the design was made. Therefore we would not expect the structure to comply with the requirements of the code. However, the loads that are being considered in the following certainly are realistic.

4.3. Results

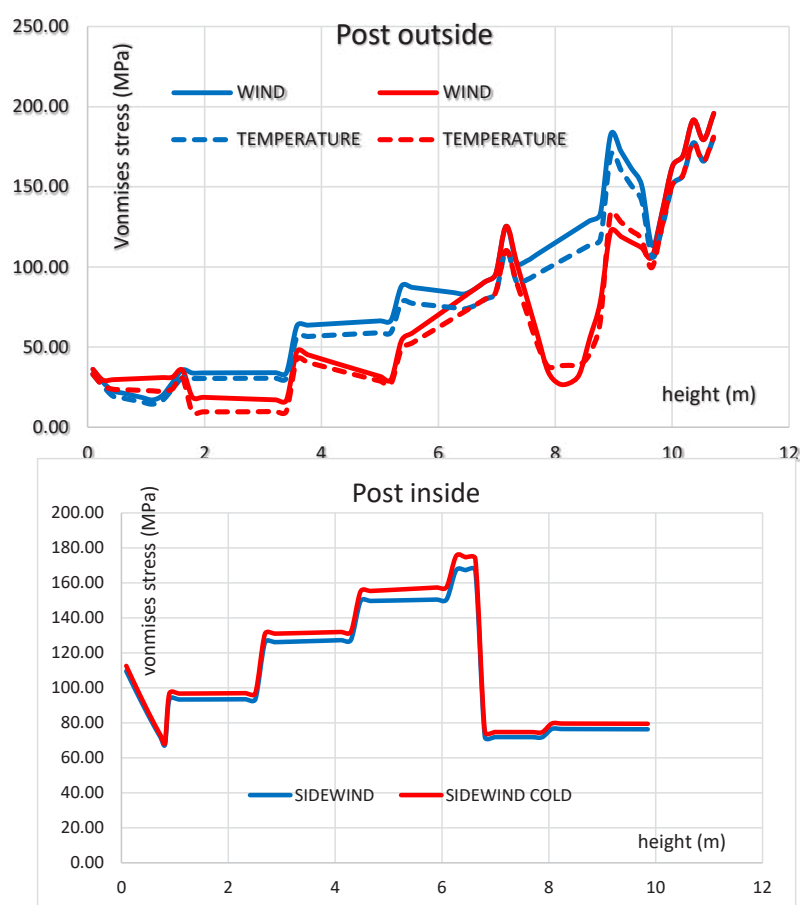


Fig. 7. Equivalent stress vertical members

In the following, the results of the analysis are presented as equivalent vonmises-stresses in various sections along the different members of the structure. Whenever possible coordinates are used, but for some members.

Firstly, the resistance of the vertical posts of the central frame is verified. This is shown in the graph of Fig. 7. Both for the inner and outside members, wind is the main variable load, temperature resulting in lower stress levels. In addition, the equivalent stress rises from the base to the frame node and reaches there 195.4 MPa on the outside member and 173.8 MPa on the inside, compressed member. In the latter, the stress drops as the flange becomes wider and the web has a larger depth. Since this type of reinforcement does not appear at the outside member, the stress continues to increase.

Surely, the asymmetrical number of flanges, shown in Fig. 4 is rather useless. Adversely, more reinforcement flange plates might have been provided at the top of the outside tension member, seen in Fig. 5. Both maximum values can be compared to $f_y = 197.3$ MPa and comply with the unity check = 0.99. Surely, this value is really close to 1.

Equivalent stresses were determined, taking into account a buckling factor, which was derived from the fundamental buckling mode shown in Fig. 8. The figure clearly shows that the buckling mode of the vertical member is out of plane, due to the presence of the diagonal members. This apparently includes a torsional deformation, due to the axial load. For the weaker outside member the buckling factor is $\chi = 0.554$ and for the inside member $\chi = 0.625$.

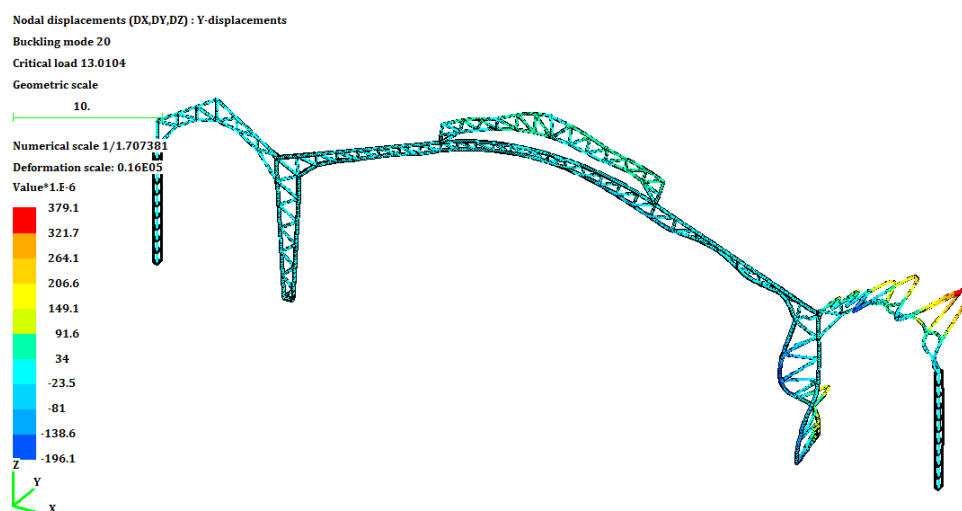


Fig. 8. Buckling mode of vertical members

The equivalent stresses in the diagonal members have been determined also and are displayed in Fig. 9. All graphs of equivalent stresses will not be shown. The result for the diagonal members shows a maximum equivalent stress of 211 MPa, in the diagonal at the centre of Fig. 5. This does not satisfy the criterion since the unity check renders 1.071. Again this occurs for asymmetrical wind.

Concerning the upper and lower members of the rafter structure, the results are shown in Fig. 9, the structural scheme being added to the picture. Clearly, a high stress concentration appears in the same section of both members. This corresponds to the first vertical bar of the rafter shown in Fig. 5 exactly at the location where the curved web is stopped and the resistance of cross sections decreases drastically. Obviously, the problem is of a local nature, since from this point the equivalent stress rapidly decreases to the end of the adjacent bars. Nevertheless, a serious lack of resistance appears in this area, both in

the upper member and the lower chord. The part of axial force in these stresses varies from 17 to 64%. Hence, bending is an important part of the stress level. Probably the designers were unaware of the existence of such high bending stresses.

Another problem subsists at the connection of the smaller rafter with the roof members. Again stresses up to 377 MPa are found in the compressed member and 219 MPa in the tension member. There is no additional reinforcement of the cross sections in this area. Again, this is a local phenomenon and the stress rapidly decreases towards the adjacent parts of the bars. Looking at this connection in Fig. 10 the top roof structure seems to be simply connected as a hinge to the rafters. Nevertheless, the vertical reaction of the whole top roof structure arrives in this location, since no further connection between both parts exists. The vertical bars of the main rafters show identical behaviour with large compression or tension, depending on the orientation of wind pressure, in the vicinity of the vertical bar supporting the top structure. The diagonal members do not show excessive stresses, except for those areas where they are directly connected to heavily loaded vertical bars. It is rather unusual that no local reinforcement was provided at the connection of the upper truss. The latter would have been expected, even in the structural assumption of purely axial force in all members.

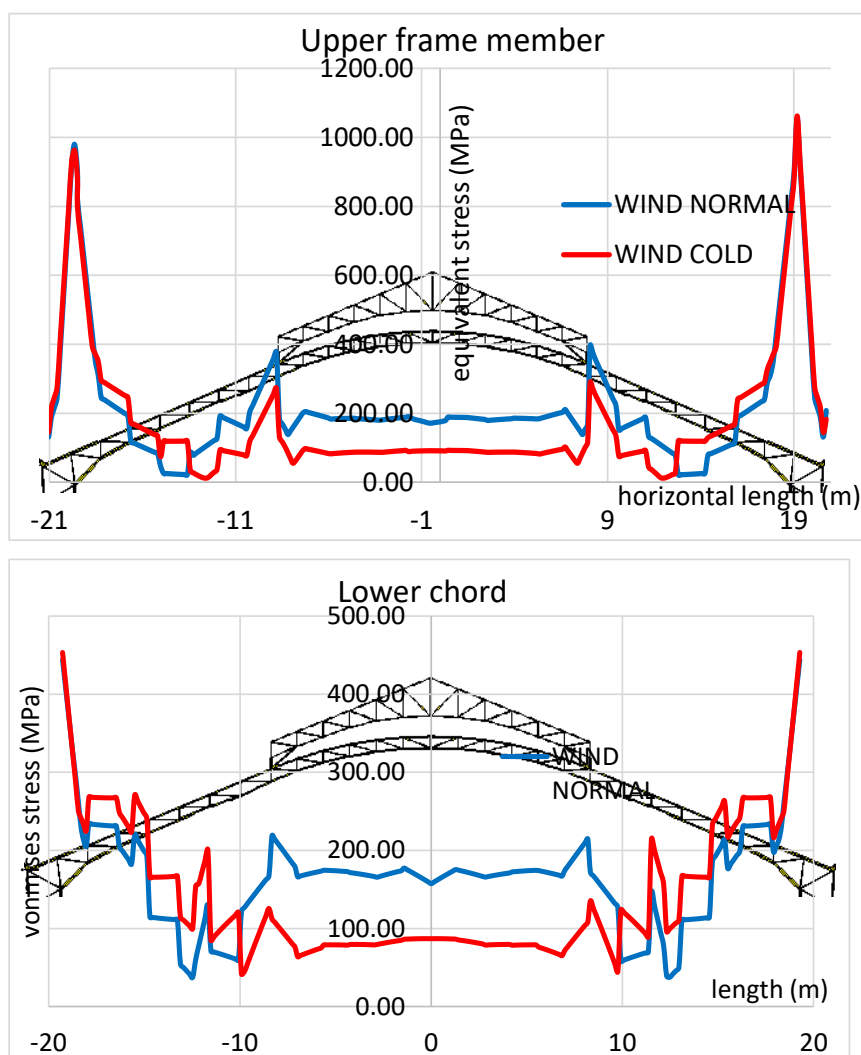


Fig. 9. Equivalent stresses in upper and lower members of main roof truss

Similar states are found in the upper- and lower member of the top truss. In a short area of the upper member equivalent stress rises up to 251 MPa, whereas in the lower member at this section the stress is limited to 205 MPa. Both results are due to asymmetrical wind pressure and suction. These load concentrations may be due to changes that were made to the roof in several phases.



Fig. 10. Connection of top truss to main roof truss

4.4. Modifications of the roof



Fig. 10. Photographs taken during construction (top) and early use

In the present state light penetrates the hall through the central light path included in the top truss. Originally, this was the only place allowing daylight to enter the hall. This is substantiated by several photographs, taken during construction and from the early years of use of the hall (during WW1), shown in Fig. 11.

When compared to Fig. 2 it becomes clear that the glazed central surface has disappeared and that many dormer strips have been added, thus concentrating loads from the roof covering and wind in a few nodes of the structure. Although it was assumed that in trusses the loads must engage in the nodes, one gets a much more favourable distribution of forces if as many nodes as possible are loaded instead of just a few where heavier concentrated loads are applied. This is an important reason why such high local stresses are found. Obviously, it becomes clear that the modifications were inadequate and with insufficient structural insight.

Today, the structure is in rather satisfactory condition. During the various visits no heavy corrosion or degradation has been found. The superficial corrosion does not progress rapidly and causes no particular reduction of steel sections. In some locations rivets have been replaced by bolts, which is an ineffective method for compressed parts as it introduces weakening of compressed sections. However, the number of these cases is limited.

5. Conclusion

The Floralia hall in the Citadel Park in Ghent is an interesting structure, dating back to the time when fabricators were just starting to use steel as a construction material. In addition, unusual compositions of sections are found. The resistance of certain critical nodes is increased by using large web plates in riveted sections and adding flange plates, not on both sides in the same panel. The structure does not comply with the relevant present codes, since high equivalent stresses appear at several limited areas. One reason for this are the structurally inadequate modifications made, to allow penetrating daylight in the hall. A second reason may well reside in the fact that the type of analysis, used at the time of construction, which was highly ineffective to this type of structure. The stresses exceed any acceptable threshold, also in serviceability state and give rise to concern for the future use of the structure. Perhaps the fact that the whole building is surrounded by 3 other buildings, substantially reduces the wind pressure.

So far, the lighter version of the frames has been examined. In future, all other frames and alternative numerical models will be considered. Other types of modelling may well result in more favourable results. However, there is sufficient reason to consider local strengthening of particular nodes and corners. Presently, an architectural competition is underway to integrate the hall with the surrounding buildings.

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DOCUMENTATION AND PRESENTATION OF THE BUILT HERITAGE

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Abstract: *Unmanned aerial vehicles (UAV) offer highly precise and efficient methods for mapping and capturing of built heritage sites and by this for their documentation and restoration preparation.*

By implementing drones, various information about the observed buildings and building complexes, regarding their dimensions, materials, age, condition etc. can be collected. Stepping on this data, three dimensional models can be easily generated, helping researchers and the society for the better understanding of the development and needs of our built heritage.

Key words: *Unmanned Aerial Vehicle, immovable cultural heritage, 3D models, aerial photography*

1. Introduction

There is a large number of objects all over the world, which need to be documented, so that they can be presented in different conditions and restored to their original appearance if needed. It should be borne in mind that many contemporary sites will be part of the tangible built heritage in the future, and images of their original condition and the changes over time will also be of interest.

The article explores the possibilities of using drones to create images and models of cultural heritage sites. The advantages and disadvantages of different techniques compared to land based equipment are indicated. Particular attention is paid to cost and time efficiency and the ability to achieve high precision by their utilization. Typical objects and techniques for drone mapping are shown, as well as images obtained from archaeological sites in Bulgaria.

2. Development of unmanned aerial vehicles and the transported payloads

Unmanned aerial vehicles (UAVs) and the payloads they use are evolving at a rapid speed, with ever increasing opportunities for their applications and their effectiveness. UAV prices and their equipment are steadily decreasing and performance is increasing.

2.1. Advantages

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A major advantage of UAVs in capturing built heritage is their ability to capture accurate 3D models of objects from different perspectives, as well as at different altitudes, in a short time.



Fig. 1. Point of Interest UAV technique [4]

The mapping/capturing can be performed by using a variety of devices and techniques: daylight cameras, thermal cameras, multispectral and hyperspectral cameras, radars, laser scanning. This allows a large amount of useful information to be obtained, including metadata for each shot.

After further information processing, the data can be used in combination with virtual and augmented reality, securely stored digitally in local and cloud structures.

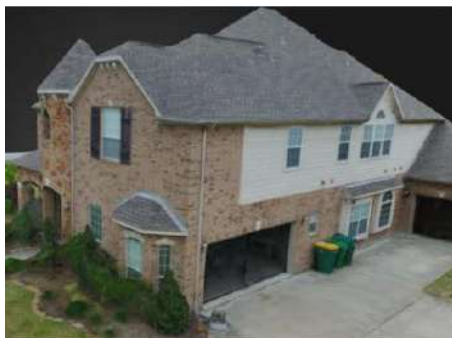


Fig. 2. Graphic reconstructions [16]

2.2. Disadvantages

Currently as disadvantages the lack of regulatory framework for the use of drones and the relatively large volume of initial investment required for hardware, software and maintenance of highly qualified personnel can be indicated. It is therefore appropriate to use the services of specialized companies, which will significantly reduce the cost of obtaining the necessary information and processing it.

3. Examples for appropriate sites for aerial capturing



Fig. 3. A master Kolyo Ficheto Bridge



Fig. 3. Start of Drone Mission



Fig. 4. The porcelain tower [5]



Fig.5. Temple dome [1]



Fig. 6 Tower [2]



Fig. 7 Heritage building for restoration [3]



Fig. 8 On-site work [5]

4. Aerial mapping of archeological sites (Archaeological Map of Bulgaria)



Fig. 9 Ortophoto map of Provadia – The salt marsh



Fig. 10. Shot of Provadia – The Salt marsh



Fig. 11. Ortophoto map of Kaliakra



Fig. 12. Ortophoto map of Chirakman

5. Conclusion

In conclusion, it can be assumed that the different techniques for documenting and presenting built heritage give different possibilities and their combined use can satisfy the requirements for price and quality.

Acknowledgement

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НАПРАВЛЕНИЕ 4

Възстановяване на сгради от културно-историческото наследство, изпълнени от зидария, дървени или метални конструкции-критерии, иновативни решения и казуси; Сеизмична рехабилитация на сгради от културно-историческото наследство; Опазване и съхраняване на недвижими културни ценности; Консолидация, възстановяване и укрепване на исторически структури; Сгради и съоръжения принадлежащи към културно-историческото наследство - след катастрофални събития: пожар, наводнения и взривни въздействия.

TOPIC 4

Restoration of historical masonry, timber and steel structures-criteria - innovative solutions and case studies; Seismic rehabilitation of historical masonry, timber and steel structures; Conservation and preservation of historical masonry, timber and steel structures; Consolidation, rebuilding and strengthening of historic structures; Culture heritage under catastrophic events: fire, flood and blast loading.

REHABILITATION AND RECONSTRUCTION OF TWO HISTORICAL TIMBER ROOF STRUCTURES AND ONE WOOD BRIDGE IN SERBIA

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Abstract: *This paper presents rehabilitation and reconstruction design of two historical structures with timber roofs, which are under the protection of The Institute for Protection of Cultural Monuments of the Republic of Serbia. An overview of reconstruction of the medieval keep tower in Bač, which was built in 1329, is given. Reconstruction was largely related to the roof structure. Bridge over the Mileševka River, near the Mileševa monastery is a very interesting project, which was developed based on historical data on similar bridges and on a single footage of the former bridge. Reconstruction of the Carmel Monastery roof structure in Sombor, which was built in 1904, was carried out by replacing the existing roof structure with a completely new modern structure made of glued laminated timber. All rehabilitation and reconstruction designs described in this paper were developed at Faculty of Civil Engineering in Belgrade.*

Key words: *Fortress; Tower; Masonry; Chimney damages; Rehabilitation; Repair; Monument; Bridge; Church; Monastery; Roof structure*

1. Reconstruction of medieval tower in Bač

Medieval fortress Bač with its suburb is located in the southwestern part of Bačka, about 14 km from the most important European river Danube. It was built near the town with the same name on the river Mostonoga. The fortress in Bač is a very important multilayer archaeological locality and a historical place, which is why it was placed under the protection of the state Srebia in 1949[1]

Archaeological research of the fortress in Bač (in 1958-59, 1980-81 and 2003) found that the location where it was built was settled from the Middle Stone Age. According to the written sources from the 11th century, the seat of the county, the bishop and the archbishop were located in Bač.

The fortress was built according to the "water town" principle. The fortress has an irregular tetragon base on which corners are protruding towers. Three corner towers have a circular base, while the northwest tower has a rectangular base (Fig. 1 and 2). Initially, the fortress was surrounded by moat filled with water. This moat is still visible today. The fortress was entered through a drawbridge.

Within the ramparts of the fortress, the most dominant and only freestanding structure is the keep tower (the watchtower). This tower is noticeable for its height, which

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is in accordance with its basic purpose, to observe the surrounding territory from it and to defend the fort.



Fig. 1. Bač fortress in 1668



Fig. 2. Bač fortress before the watchtower roof reconstruction

The tower has almost a square base (10,26 x 10,16 m) and is oriented with diagonals to the sides of the world with a spiral staircase in the northwest facade and a potable water riser on the northeast facade. The tower has a height of 34.33 m, and it has a ground floor (basement), three floors and an attic overhanged on cantilevers (Fig. 3).

The watchtower has been repaired and reconstructed on several occasions in its history, but due to lack of maintenance, its decay has occurred. The biggest damages occurred after the fire in 1993. (Fig. 4).

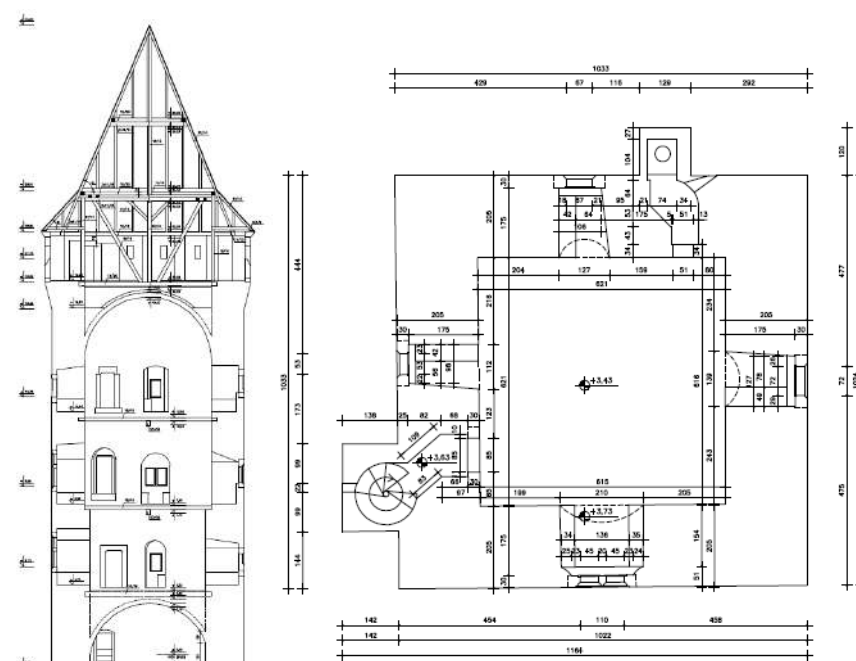


Fig. 3. Structural plan and the cross-section of the watchtower



Fig. 4. Fire damaged timber floor joists and damages the roof structure

Reconstruction of the tower, and above all the roof, was done so that the damaged roof structure was completely replaced by the new one. The old roof shape was kept, but new members to the roof structure were added to increase its stability. Furthermore, the dimensions of almost all the members were increased, and their surface treatment was carried out by sealing, as it was undoubtedly done more than six centuries ago, when the tower was built (Fig. 5). All visible connections of timber members were constructed with wrought iron, which contributed to the authentic appeal of the structure. The roof is covered with old yellow tiles, which were previously protected. With the roof reconstruction, an attractive area with visible roof is provided in the attic, suitable for exhibitions and observation of the surrounding flat Bačka landscape.



Fig. 5. Final works on roof reconstruction

2. Reconstruction of the bridge over the river Mileševka near Mileševa monastery

In the immediate surroundings of monastery complex Mileševo, beside the monastery water mill, there was once an old timber bridge. The exact time of its construction is unknown, but according to some historical data it is assumed that it was constructed in the middle of the 19th century. This bridge was destroyed after enormous floods which struck the Monastery and its surroundings at the end of 19th century[1].

The design of the bridge reconstruction had to be prepared in a way that completely corresponded to the existing written and drawn historical data and adequate preservation conditions. Since a reconstruction of an unique historical engineering structure was in question the design was based both on knowledge on bridge construction at the end of 19th century and even earlier in this region and on authentic data on stone block paving on the

part belonging to the bridge and on the right hand abutment which represented the remainder of the destroyed bridge.

Documentation for design preparation were: an old photograph of the bridge (Fig. 6), graphic layouts, plans and cross sections and the river Mileševka regulation.



Fig. 6. Old photograph of the water mill and the former bridge

Until completion of the new bridge construction, a provisory two-span structure was used (Fig. 7). The larger span (10.4 m long) was bridged by a steel structure – frame of a freight vehicle, while the shorter span (5.5 m long) was bridged by timber beams. Sheet timber beams and boards existed partially over these load-bearing elements. The river pier was a concrete block with dimensions 3x3x4 m.



Fig. 7. Provisory structure used for crossing the river before the new bridge construction

It was known that the structure of the old bridge, which was destroyed by flood flow at the end of 19th century, was a timber one, supported by massive abutments built with ashlar. Only the right-hand abutment remained until today and it gives certain data on the way that destroyed timber structure was supported. The left-hand abutment was probably destroyed together with the bridge itself. By analysing the existing data - old photographs and surveyed situation, the left-hand abutment was fixed and thus the bridge span size of 17.6 m was defined. The adopted size of the bridge span fits favourably into the transverse profile of the river Mileševka at the bridging site.

The size of the bridge span and authentic historical data point out that the bridge superstructure was an unusually shaped structure. During the late medieval times, and even earlier, a specific system of timber structures characterised by "composite beam" girders was often used in the bridge construction. These girders with several simple cross sections are placed one above other, and overhang toward the middle of the bridged profile. Since the authentic data indicated that the destroyed bridge by the mill had such "composition", same as in case of destroyed bridges in Polimlje (over the river Seljanšica and over the

river Lim), there was no doubt while selecting the "system" of the timber bridge – timber structure with main girders consisting of several simple cross sections (six beams one on top of another) with girders in which certain beams gradually overhang toward the centre of the river (Fig. 8). Taking the useful width of the bridge into consideration three main girders spaced at 1.17 m were adopted.

Since the bridge is intended exclusively for pedestrians, useful width of the bridge 2.3 m was adopted.



Fig. 8. Bridge in erection stage

Other details – pavement, bridge guard rail and the shape of the levels are identical to the existing autochthonous historical data.

The main girders were fixed to the abutment using steel anchors and concrete blocks.

Newly designed elements of the abutments were built using old ashlar from the existing – old bank protection wall downstream from the mill.

The main girders, as already stated, were designed as composite beams consisting of six cross sections in system of fixed beam with a hinge in the mid-span. Some of the beams are coupled by timber dowels (by transverse joints and screws) – Fig. 9 and 10.



Fig. 9. Completed bridge from the downstream side



Fig. 10. Completed bridge from the upstream side

Irregular, that is, ununiform arrangement of dowels along the girder resulted from the insight into the old photographs of the destroyed bridge.

The pavement surface was made from timber boards, and a special system for rain dewatering was not planned considering the relatively small length of the bridge and considerable slope of the levels. Three stone steps were made on both approaches to the bridge (Fig. 10) in order to prevent access of vehicles onto the bridge.

3. Reconstruction of the roof structure of the Carmel monastery church in Sombor

3.1. Structure and roof description before reconstruction

The Church of the Carmel Monastery in the centre of Sombor is also known as the Church with Two Towers (Fig. 11). Construction of the church began in 1860 and was completed in 1904. Its base dimensions are 58x25 m, where in structural terms the church is a masonry structure with a timber roof structure[1].



Fig. 11. Carmel monastery church

In addition to large outside walls, which are almost 2 m thick, the masonry structure of the building consists of two rows of middle columns with cross sections of approximately 160x160 cm, which are longitudinally positioned in relation to the structure at axial distances of approximately 7.6 m.

Above the described masonry structure, a timber roof structure was constructed. It is a very complex structure which is a combination of queen post roof truss and a roof with a hanger in the middle of the span (Fig. 12).

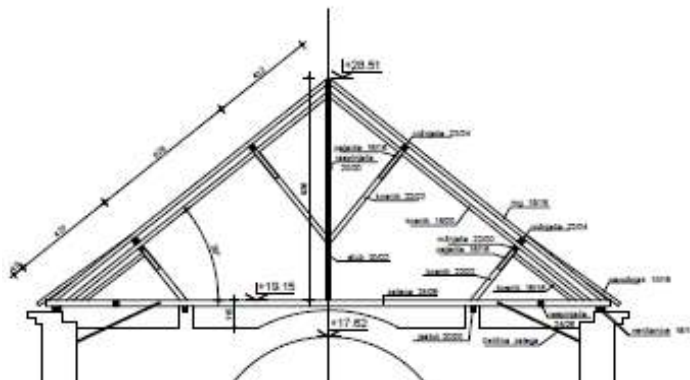


Fig. 12. Main roof structure before repair

3.2. Visually-macroscopic examination results

Visually-macroscopic examination of the roof structure revealed significant damages to the roof cladding (crown tile), as well as the battens over which it was placed (Fig. 13).



Fig. 13. Snow drifts on the roof structure as a consequence of roof cladding and battens damages

In addition to the roof cladding damages, the examination revealed following damages to the roof structure:

- rot, which is present in many places (Fig. 14a);
- a wormhole, in a very large number of timber elements (Fig. 14b);
- loosening of some connections (Fig. 15a and 15b);
- deformations (deflections) of structural elements, (Fig. 15c);
- cracks in timber (Fig. 16a);
- fractures of a certain number of timber elements (Fig. 16b).



Fig. 14. Details of rot (a) and wormholes (b) in timber elements

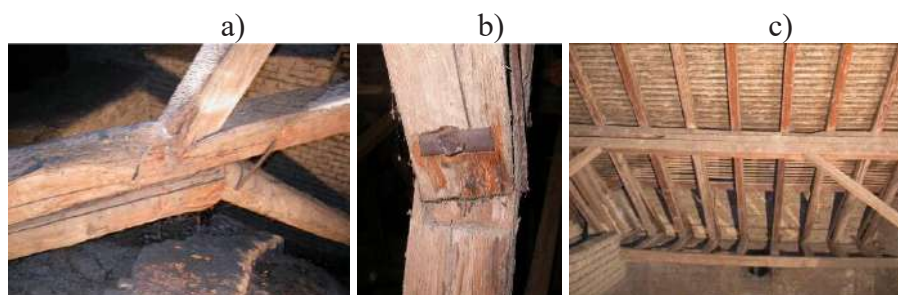


Fig. 15. Two cases of damages - loosening of connections of structural elements (Figures a) and b)) and very pronounced deflection of purlin (Fig. c))



Fig. 16. Crack in the horizontal beam (a) and element fracture between trusses (b)

3.3. Condition of the structure analysis and proposed repair interventions

Based on the findings related to condition of the roof structure in question and their analysis, it was concluded that this structure requires very radical repair interventions immediately.

Considering all the problems observed in the existing roof structure, two solutions were considered: the first meant repair of the existing structure, while the second meant that, instead of the repair, a completely new, modern glulam roof structure be made. After considering in detail all the advantages and disadvantages of both, the second solution was adopted, which, among other things, guarantees the functionality, serviceability and durability of the structure over a period of time that could be measured in hundreds of years.

3.4. Design and construction of the new roof structure

When the new glulam roof structure was designed, shape of the existing roof structure was considered, that is, the inclination of the main roof planes, its elevations and the roof design itself (Fig. 17, 18 and 19).

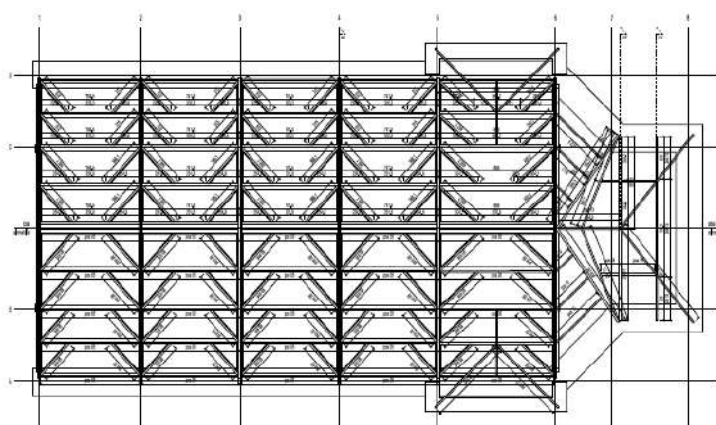


Fig. 17. The new roof structure layout

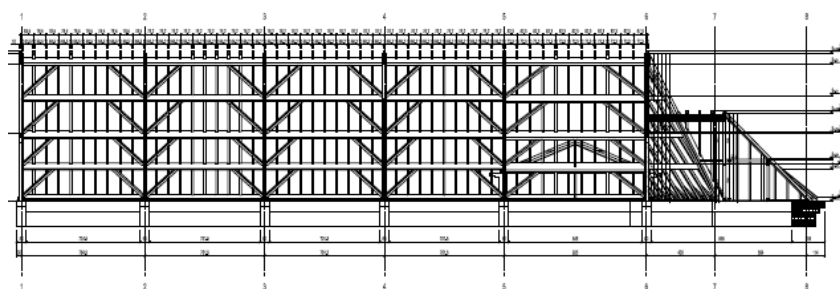


Fig. 18. Longitudinal section of the new roof structure

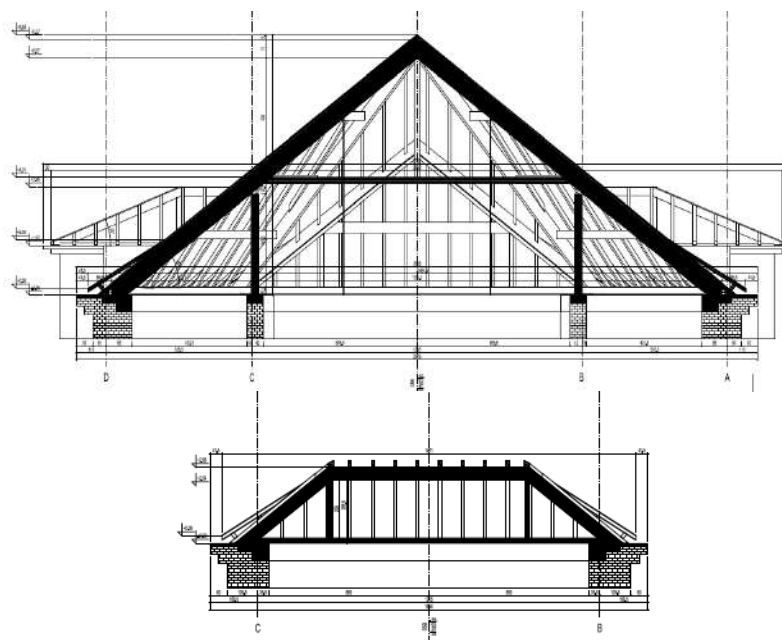


Fig. 19. Cross sections of the new roof structure

Positions of the new roof structure supports were conditioned by the existing walls, whereby it was intended that reinforced concrete ring beams be constructed over the upper surfaces of the walls - along the entire length of the walls.

The roof structure shown in Fig. 17, 18 and 19 is designed as a system of primary main trusses connected by secondary beams - purlins with corresponding diagonal braces, over which tertiary beams - rafters are placed.

All connections between timber elements within the truss were constructed using suitable steel elements.

Some characteristic details of roof construction are shown in the following photos.



Fig. 20. Main roof trusses construction

a)



b)



Fig. 21. Part of the completed roof structure from the inside



Fig. 22. Works on the roof part above the church alter



Fig. 23. View of finishing works and completed roof

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ASSESSMENT OF THE SITUATION AND REHABILITATION THE DRY MILL KIKINDA

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Abstract: Kikindska Suvaca the dry mill for grinding grain using a work horse and one of two remaining in the entire Pannonia. Declared the immovable cultural heritage of great importance for the Republic of Serbia. It was built 1899.godine, the work was stopped in 1945. It consists of three components: drive space, the space of the mill and the miller rooms. The main building has a drive space with a pyramidal roof and there is a boot device millstone. Structurally it is a multi-faceted pyramid which is located a large round, ranging around 15 m², about 45m³ volume and height is 8.50 m and secured with 12 spokes on the central cylindrical shaft mounted vertically, which is called „popa,,. The roof structure is made of wood covered with tile. The roof 14 relies on low stubby columns of baked bricks are internally and externally plastered with lime mortar of a width of 60 cm height of 1.85 m, with wedding gowns and tie rods in the top of the timber, carrying the crest and rafters over wooden columns and horizontals. The walls of the rest of the charge and of unfired adobe bricks were plastered with mortar made of clay and chaff. Review of the structure and static checking of all elements of the wooden roof construction and artisan structures, brick walls and the foundation has been established that it is in relatively good condition. All this damage does not threaten the basic safety and stability of the building, but it is necessary as soon as possible to carry out repair works on that subject would continue to deteriorate.

Key words: Dry mill, popa, craft design with gears, a short brick pillars

1. Introduction – Technical description of the existing object

The Kikinda suvača is one of the two remaining in the entire Pannonia, and in 1951 it was placed under the protection of the State and proclaimed a immovable cultural property of great importance for the Republic of Serbia. It was built in 1899, it was put into operation in 1945. It is located on the corner of Nemanjina and Moravska Street at k.8268, in the western part of the town of Kikinda(Fig.1).

It consists of three connected parts: the drive area, the mill room and the miller's room. Suvača is a dry mill that uses live labor for grinding millets. Motivating power are horses, which put into operation a grinding device.

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The main building is a drive area and it is made up of a pyramidal roof unit and there is a device for starting a millstone. In a constructive sense, it is a multipurpose pyramid where a large wheel is located, the range is about 15 m and the height is about 8.50 m. The roof structure is wooden covered with pepper tile. The roof rests on 14 low-pitched piles of baked bricks. Between the columns-walls the space is fenced with wooden fence, and on the south side there are doors for entering the horse in the souche. The drive area is a large wheel, a range of about 14m1 and a circumference of 45m1, fixed with 12 paws for the central cylindrical shaft mounted vertically, which is called "popa". At the edge of the car are wooden teeth, the gear system transfers energy to two pairs of stones for melting. From the top of the pope there are twelve paws that carry the paws and the edge of the wheel with gears. The lower part of the "pope" is chained, the shaft of the hinges lies in a metal deposit called paprika in a stable stone surface. The upper part of the pope is narrowed in the rolling neck. The seat is fixed between two horizontal beams, which are two hinges for the high the roof. On one side of this bearing is a lever-tongue, fixed only on one side for horizontal beams. The second part of the tongue can easily be lifted and the neck "pope" can be lifted by means of a rope - a "rope" that passes over the roller on the top of the roof structure and pulls out the tongue from the top of the pope. So, the pop, together with the wheel, can be turned to the free side for the introduction of the horse in the wheel. The mill space is a rectangular base with a roof of two water, lower than the roof of the courtyard, covered with pepper tile. The floor is from the crowded land. The walls are on the one side and on the other side of the brick. The devices for the grinding machine are placed on a horizontal slanted construction that is carried by six vertical wooden stubs that lift the part by 1.60 m1 from the floor. In the upper part of the room there are two pairs of stones for melting. Above are the bins for cereals, and under the boxes with sits through which the flour, bite and bran are sown. The Melinarev apartment is under the same double-deck roof as the mill space, and it makes one whole. Now it's just one large room, while he used to have a kitchen and a pantry. The floor is from a crowded land, and the walls are filled with bulk or brick. Above the mill room and over half a mills, there is a attic with planks over the bed. The south wall is a single wooden window on the mill and a wooden door, and on the mill-room there are two double-faced wooden windows. On the north wall of the miller's room there is a two-winged wooden window. The main supporting columns-the walls of the drive pyramidal part are made of full baked bricks, 60 cm wide, both sides and externally and plastered with lime plaster, 1.85 m high, with wedding dresses and tassels in the top of timber , which carry reefs and horns roof over wooden stairs and horizontals. The roof is under a slope of about 40°. The roof structure at the height of the "pop" of the main pillar has two limbs and corneas between the ridge. All ridges are connected in the top through the peak circle into one whole, and there is also a small tip that carries a wheel for pulling out the tongue so that the "popa" can be knocked down for the entrance of the horse. The roof construction over the mill and the mill is a two-seater a horn-type horn system at the top. The fall of the roof is about 40°. The dumb bellers are leaning on the outer walls and have perches, from the north side 40cm, from the south 70cm. The horns, through the small staircase system, become more comfortable on the wedding dresses and the edges of the abandoned roofs, so that the roof has a roof for the width of the slopes. Walls from cartilage and unpainted bricks are made of plaster and weeds. The depth of foundation foundation is min $D_f = 0.60\text{m1}$ in a layer of dusty clay. The facility was inspected in June 2013.



Fig. 1. Photos dry mills appearance, the roof wooden structure with pillar „popa,, i craft wooden structure

2. State and description of the object of the object

First of all, the model of the construction of the Tower in the Tower 6 program was designed to facilitate load loading and insight into the impact on the structure, to better understand the force in roof elements, attics, and woodworking of the circular mechanism, force and voltage in the walls and underlying couplings. The loaded loads are: permanent from the roof cover and the construction itself, occasional from snow and wind loads and exceptionally from seismic.

Roof and Roof Structure: The roof construction of the roof is in good condition. According to some replaced elements, it is possible to replace some of the worn out elements of the roof structure at one time. By static check all roof elements: crevices, posrg horns, posvc wedges, poszc wedges, posh horizons, posRs crusts, posrosh cornea, small horns - horns of the posRg1 mill, a small rasp-posRs1 mill satisfy a detailed static check on all loads. The paving and paving roofs are partially damaged, and damaged and broken tiles and tiles need to be replaced as soon as possible so as not to damage the wooden construction of the roof(Fig.2).

Construction of the attic: the inspection looks like it is in good condition because there are no significant cracks or gaps in the ceiling. Static inspection satisfies the wooden elements of the ceiling: damping posT1 and posT2, beam rooms posGr for permanent and occasional loadings of the attic.

The construction of the crankshaft: the inspection shows that it is in good condition except the main pillar "pope", which is with a large vertical crevice to be repaired - filled. The static check satisfies all the wooden elements of the revolving drive part: paws or horizontal shafts, posKos stems, main posPop pillar, for permanent and occasional vertical loads of the rotary mechanism. The metal mill mechanism itself was not the subject of this static check.

Walls: there are no cracks in the walls. Basically there are parts with cracked or discharged mortar, both mortar and coating, as well as broken mortar, mainly at the top of brick pillars in the part of the pyramidal drive part. In the walls of bullets and crumbs in the mill and mill mill, plaster and clay plaster was mostly cut off, mostly outside. Static walls satisfy their thicknesses for vertical and seismic loads, which is confirmed by budgetary check. It is not necessary to introduce new walls or masonry pillars.

Basic construction: the assumed depth of foundation foundation is $\min D_f = 0.60\text{m}$ in a layer of dust clay. The assumed allowed voltage is $G_{mah} = 100\text{KN} / \text{m}^2$. They are based on baked bricks and the assumption is that they are of the same width as the walls themselves. The examination shows that the walls are waterproofed to the foundations that moisture does not sink along the walls.



Fig. 2. Photos of damage pillar „popa, short walls of baked bricks and walls of adobe bricks

There is no noticeable cracks in the bottom of the walls to the foundations, which indicates that the foundations are stable and without cracks. By static check after building the model of the building in Tower 6, the effects from the load on the foundation of the object were obtained(Fig.3). A static check of the bearing capacity of the ground underneath the foundation was made, and on the basis of the bearing capacity of the ground it is a conclusion that the foundations are satisfactory because the loads for permanent and occasional and the wind load are less stressed on the ground than allowed. No intervention is required on the foundations.

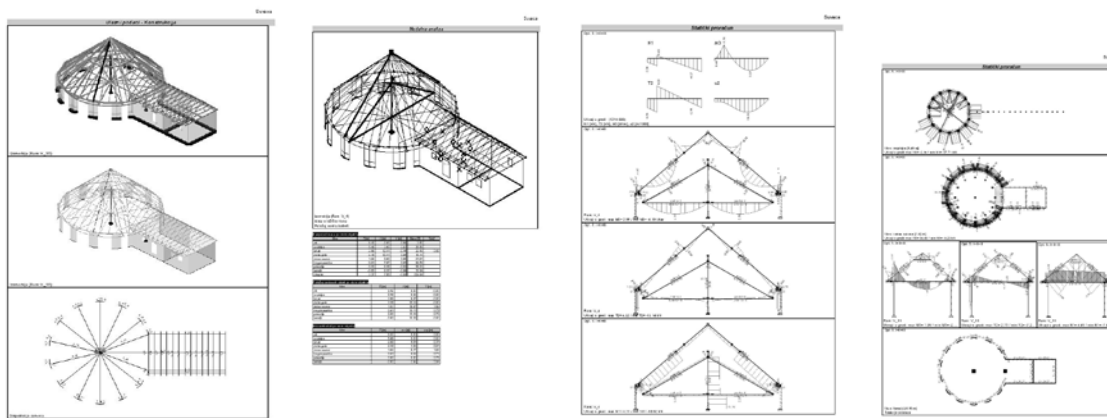


Fig. 3. Model dry mills and static impacts the roof, craft and ceiling construction and reactions based

3. Construction and reconstruction measures of static constructive

On the roof structure: No intervention is necessary on the elements of the roof structure. It is only necessary to replace the old lath and the damaged pepper tile.

On the attic construction: No intervention is required on the attic construction, except the introduction of a wooden staircase to the wall between the rooms of the mill and the room for the support of the beam that goes over the room and carries those dumbbells above the room. The inner wall is just off the shaft of the beam with a width of 50 cm wide at 12 cm wide. Therefore, a pillar of 14/14 cm should be placed beneath the beam to bear the beam that visibly crossed over that narrowed wall. On the bottom side, find the foundation of a wall that has remained wide as the previous wall and rely on the wooden column.

On a craft drive: No intervention is necessary on the elements of the construction of the plant except the main pillar "pope", which is with a large vertical crevice up to 2 cm

wide to be repaired - fill with an epoxy resin mixture (such as Sikadur 31 CF Normal) . The filler must be a repair two-component adhesive based on epoxy resins that is not leaking and convenient to work on surfaces above the head. not to leak. It is also important to cure without shrinkage, that it does not need a primer and that it has good mechanical strength, and that it may have viscosity to fill such a narrow crack. Fill the crack from the bottom of the cracks to the top and when the hardening epoxy filling "squeeze" is to be level with the pillar.

On the walls: An object model in Tower 6 was created in order to get the overall vertical load and total seismic load at the level of the foundation in the easiest way possible(Fig.4a and Fig.4b). By calculating the main tensile stress at the ground level, a much lower value than the allowed is obtained, because the walls are sufficiently massive, although the roof is quite high.

Since all cracks are up to 10mm, there is no need to do any reinforcement or reinforcement of the cracks.

The washed mortar should be cleaned and re-plastered with the same, lime or clay. It is not permitted to clear all the cracks at the same time without successively removing them, in order to avoid any subsequent damage. On the foundations: No intervention is required on the foundation structure. Conclusion: The construction of the suave is in relatively good condition. It is necessary to fill the longitudinal crevice in the main pillar "popi"; remove worn mortar on the walls and replace it with new ones; Add a new wooden pillar.

КОНТРОЛА ЗА СЕИЗМИЧКУ СТАБИЛНОСТ ОБЈЕКТА

УКУПНО ОПТЕРЕЋЕЊЕ ОБЈЕКТА НА НИВОУ ТЕМЕЉА

Добијено из Tower6 прорачуна за стално+повремено оптерећење

– Стално+повремено оптерећење према резултатима програма Tower6

$$62.00 \times 12 + 87.00 \times 2 + 50.57 + 8.80 + 204.78 + 183.50 + 94.31 + 39.46 + 178.15 + 175.99 + 175.34 = 2029.10 \text{ кН}$$

(сабрање све силе нормалне на нивоу темеља)

Укупно оптерећење:

$$P_y = 2029.10 \text{ кН}$$

УКУПНА СЕИЗМИЧКА СИЛА ОБЈЕКТА НА НИВОУ ТЕМЕЉА

Добијено из Tower6 прорачуна за сеизмичко оптерећење

– Сеизмичко оптерећење програма Tower6

врх.....	2.92 кН
распињача.....	36.58 кН
таван.....	32.43 кН
стубић гребена.....	16.11 кН
венац суваче.....	34.84 кН
круг зупчаника.....	38.78 кН
приземље.....	35.22 кН
темељ.....	13.34 кН

Укупно сеизмичко оптерећење на нивоу темеља:

$$C_s = 209.84 \text{ кН}$$

Укупна ширина зидова објекта на нивоу приземља са одбијеним отворима

$$B = 0.60 \text{ м}^3 \times ((0.7 \times 2) \times 12 + 0.7 \times 2) \text{ м}^3 + 0.50 \text{ м}^3 \times (11.55 \times 2 + 5.50 \times 2) \text{ м}^3 = 27.97 \text{ м}^2$$

(сабрање све површине зидова на нивоу темеља)

Просечни нормални напон у зидовима објекта на нивоу темеља

$$\sigma_y = P_y / B = 2029.10 \text{ кН} / 27.97 \text{ м}^2 = 72.55 \text{ кН/м}^2 = 0.07255 \text{ МПа}$$

Просечни напон смицања у зидовима објекта на нивоу темеља

$$\tau_y = C_s / B = 209.84 \text{ кН} / 27.97 \text{ м}^2 = 7.50 \text{ кН/м}^2 = 0.0075 \text{ МПа}$$

Главни напон затезања

$$\sigma_0 = (\sigma_y^2 / 4 + (1.5 \cdot \tau_y)^2)^{(1/2)} - \sigma_y / 2 = ((0.07255^2 / 4 + (1.5 \cdot 0.0075)^2)^{(1/2)} - 0.07255 / 2) = 0.03798 \text{ МПа}$$

$$-0.036275 \text{ МПа} = 0.0017 \text{ МПа} < 0.009 \text{ МПа}$$

Објект је по прорачуну стабилан за сеизмичка дејства.

Fig. 4a. Control of seismic stability of the building and control capacity of the soil under the foundation on the inside wall; replace the worn lath and the damaged tile and the dry mill function (of course, if the metal mechanism for rotating the millstone is correct).

КОНТРОЛ НА НОСИВОСТИ ТЛА ИСПОД ТЕМЕЉА

Претпоставлен допуштен напон на претпостављеној минималној дубини фундаирања
 $D_f=0.60\text{m}$ је $\Gamma_{\text{доп}}=100\text{ kN/m}^2$

а) Реакције на темелје зидова погонског дела суваче од сталног, повремених оптерећења и оптерећења ветром:

$$P = 55.00\text{ kN/m}^1$$

Претпостављена ширина тракастог темелја од печене опеке (као и зид) : $B = 0.60\text{ m}^1$

Просечни напон у темелјној спојници зида од г+п+в:

$$\Gamma_y = P/B = 55.00\text{ kN/m}^1 / 0.60\text{ m}^1 = 91.67\text{ kN/m}^2 < \Gamma_{\text{доп}}=100\text{ kN/m}^2$$

б) Реакције на зидове млинског простора и зидове млинаревог стана од сталног, повремених и оптерећења ветром:

$$P = 35.00\text{ kN/m}^1$$

Претпостављена ширина тракастих темелја од опеке (као и зидови) : $B = 0.50\text{ m}^1$

Просечни напон у темелјној спојници зида од г+п+в:

$$\Gamma_y = P/B = 35.00\text{ kN/m}^1 / 0.50\text{ m}^1 = 70.00\text{ kN/m}^2 < \Gamma_{\text{доп}}=100\text{ kN/m}^2$$

в) Реакције на Поп главни стуб погонског дела суваче од сталног и повремених оптерећења:

$$P = 50.52\text{ kN}$$

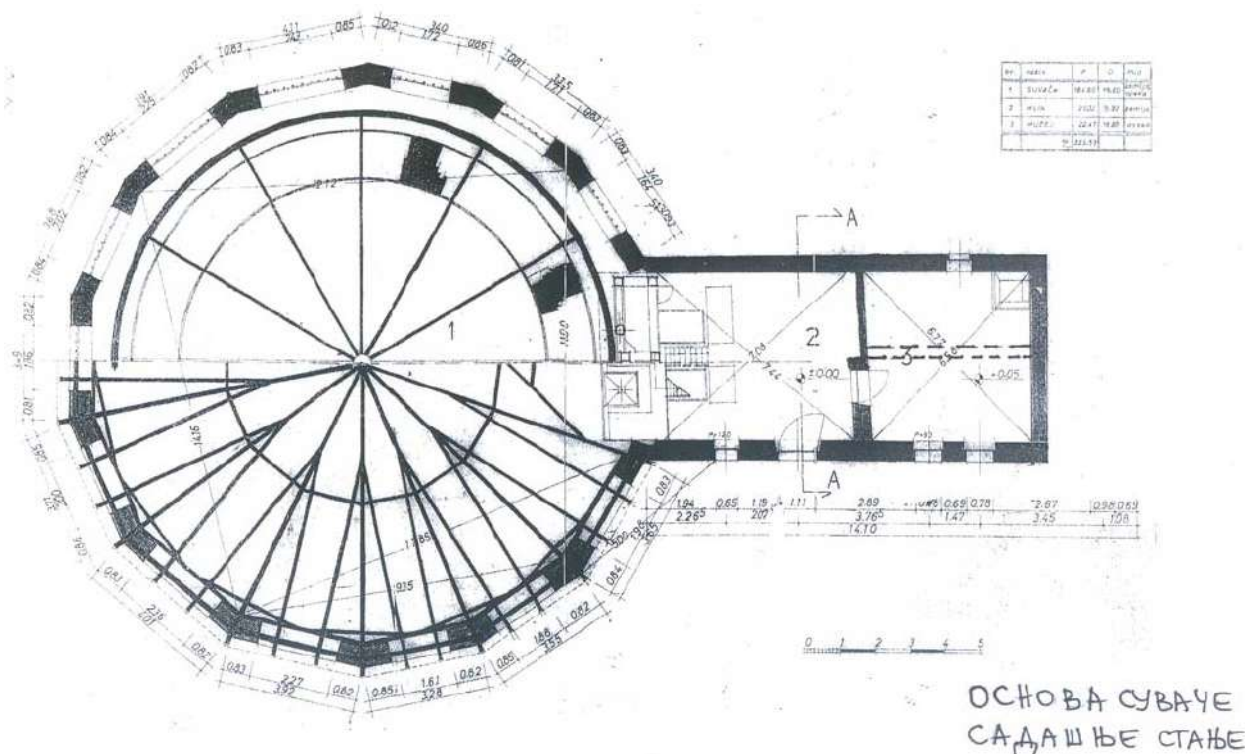
Претпостављене димензије темелја од камена: $B = 0.90\text{ m}^1$ $L = 0.90\text{ m}^1$

Просечни напон у темелјној спојници стуба од г+п:

$$\Gamma_y = P/B \times L = 50.52\text{ kN/m}^1 / 0.90\text{ m}^1 / 0.90\text{ m}^1 = 62.37\text{ kN/m}^2 < \Gamma_{\text{доп}}=100\text{ kN/m}^2$$

Све ширине темелја објекта задовољавају на дозвољену носивост терена испод њих за све комбинације оптерећења. Није потребна никаква додатна интервенција на постојећим темелјима.

Fig. 4b. All these damages do not jeopardize the basic safety and stability of the facility, but it is necessary to perform reconstruction works as soon as possible so that the facility will not be further deteriorated.



Remedial measures: Fill the crack to "pop", repair the mortar on the walls of baked and unbaked bricks and add a new wooden pillar beneath the beam(Fig.5 and Fig.6).

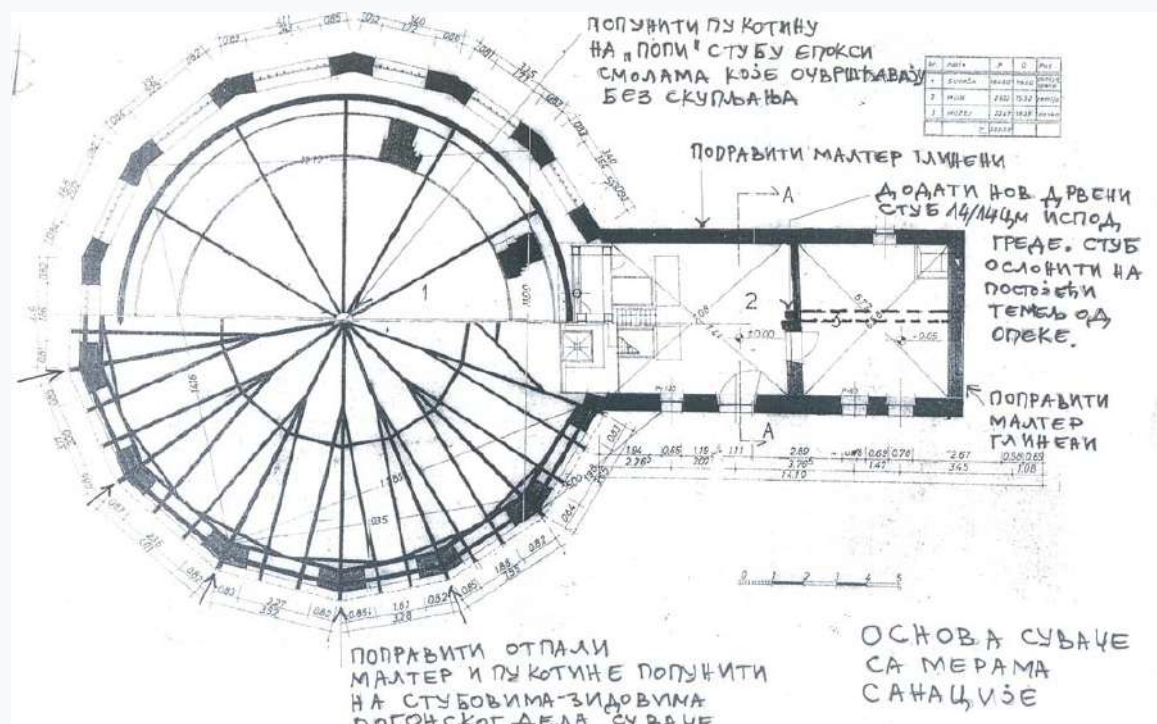


Fig. 6. Recovery procedures: the crack to „popa,,, repair the plaster on the walls of baked and unbaked brick and add new wooden pillar underneath the ceiling beam

The facility was rehabilitated according to the project at the end of 2015 and at the beginning of 2016 with the contractor PD „ Koto „, from Belgrade, with the supervision of the Institute for the Protection of Monuments(Figs. 7, Fig.8a and Fig.8b).



Fig. 7. Rehabilitation of the roof



Fig. 8a. Photos remediation short walls



Fig. 8b. Photos remediation short walls

RETROFIT OF DAMAGED BY THE EARTHQUAKE IN SOFIA 2012 BANE BASHI MOSQUE

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Abstract: *This paper represents the retrofit of the Bane Bashi mosque in Sofia which has been damaged by several earthquakes and especially by the last one on 22 May 2012. The mosque is constructed in the XV century. Its structure is a masonry one formed by stones alternated by bricks. The main objective of the paper is to discuss both emergency and seismic retrofit measures of the mosque structure. The main activities of the design project are based on the CRFP seismic retrofit of the structure. Some special attention is paid to the retrofit of the main dome and walls of the mosque. The original seismic response of the mosque is analytically compared with the one after the retrofit. Some recommendations for the further treatment of the mosque structure are made besides to the conclusions analyzing its behavior before and after the retrofit.*

Key words: *bane bashi; mosque; CRFP*

1. Introduction

The mosque Bane Bashi is situated in the central part of Sofia. It is one of the most representative Bulgarian heritage buildings. The mosque is a typical representative of ottoman architecture from 16th century. The architect of the temple was also the architect of Sultan Selim Mosque in Edirne. The building is in operation as a temple and it is the only mosque in Sofia.

This representative building which is a part of Bulgarian national heritage is a typical cubic building with a dome. The mosque is with a masonry structure which is made of cut stones and bricks. The stone layers are alternated with brick layers. The columns were cut of a single stone body. The central dome is a masonry one and it is covered by led.

The mosque has been repaired many times during the years. The last considerable repair was made around 1920. Some interior renovations have been made many times till nowadays.

The survey of the mosque was forced by the last earthquake in Sofia from 22 May 2012. Some cracks were observed in the main dome and in the entrance arches. The main objective of the survey was the seismic evaluation of the mosque structure and

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classifying the reasons for the damages. The way of the Sofia subway was executed near to the mosque and there was some doubt about the reason for the cracks in the structure.

2. Basic parameters of the Sofia earthquake from 22 May 2012

The seismic event happened on 22 May 2012 and the epicenter was located at the distance of approximately 30 km from Sofia. It was evaluated with Richter Magnitude of 5,8.

The acceleration record which had been recorded in Sofia at the distance of about 5 km from the mosque is represented in Figure 1.

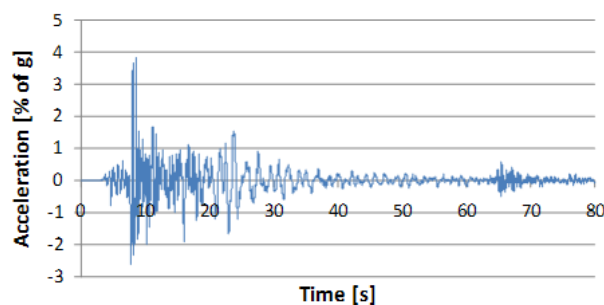


Fig. 1. Sofia earthquake acceleration record (East-West)

The registered PGA for the area of Sofia is about 0,05g and the observed intensity of the earthquake according to the modified MM scale (12 level scale) is about 5. According to the Bulgarian seismic map which is in compliance with the Eurocode 8 the referent PGA for ULS is $a_{gR}=0.23g$ and for DLL is $a_{gR}=0.11g$. The corresponding elastic response spectra are shown in Figure 2.

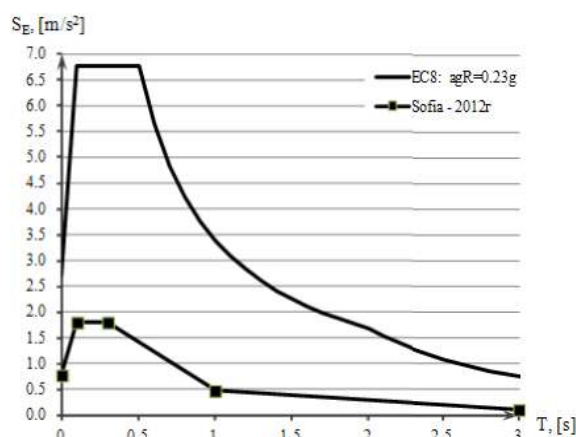


Fig. 2. Elastic response spectrum – Soil type C

The conclusions which are possible to be made on the basis of seismological data for the earthquake are as follows:

- The earthquake was with the PGA which is about 5 times less than the referent PGA for ULL (475 years return period) and about 2 times less for the referent PGA for DLL (95 years return period);
- If the damages in the mosque are caused by this relatively small for the Sofia area earthquake it is necessary to strengthen the mosque;

The survey which is presented below was focused on the task for determination the reasons for the damages.

3. Survey of the mosque condition

3.1. Geometry of the structure

The whole survey was completed according to Eurocode 8 part 3. More details about the survey could be found in (Milev, 2013).

A general view of the mosque is shown in Figure 3.



Fig. 3. A general view of the mosque

All dimensions of the church were obtained on the base of in situ measurements. The layout and the cross section of the mosque are shown in Figure 4.

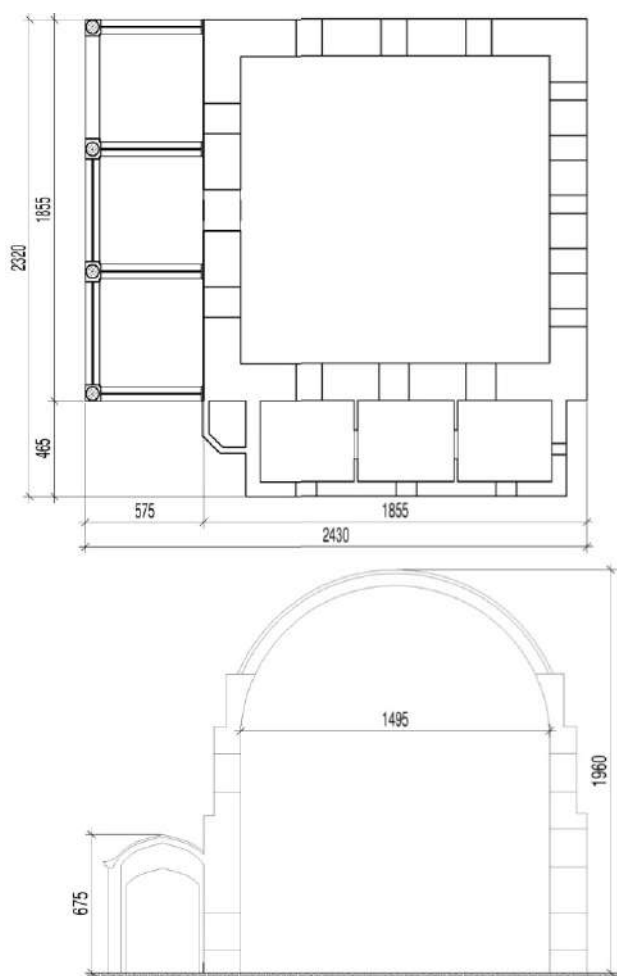


Fig. 4. Layout and cross section of the mosque

The main building of the mosque is with dimensions 20x23 meters. The thickness of the walls is 180 cm. The diameter of the dome is 15 m and the height of the mosque is about 20 m. The entrance arch structure was built later than the main building of the mosque.

3.2. Damages in the mosque

The picture of the mosque dome from around 1980 (after the last major earthquake in Sofia before 2012) is presented in Figure 5.

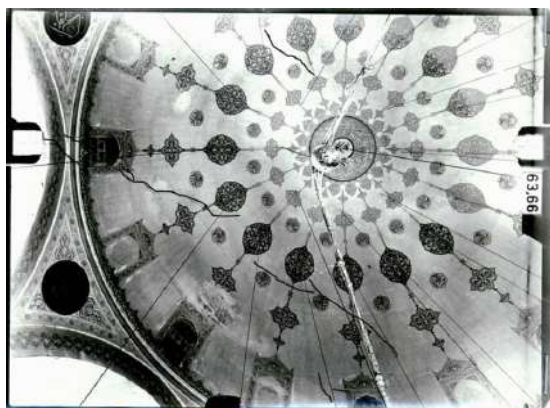


Fig. 5. Damages from the past earthquakes (1980)

It is obvious from this picture that there are some but not considerable cracks in the dome. They are probably caused by some previous earthquakes. Some pictures of the dome after the 2012 are presented in Figure 6.

The extension and enlargement of the old cracks as well as formation of some new cracks are obvious on these pictures. Some damages of the entrance arches are shown in Figure 7.

Brick masonry was studied both in situ (see Figure 4) and in the laboratory in order to obtain the strength parameters of the masonry.

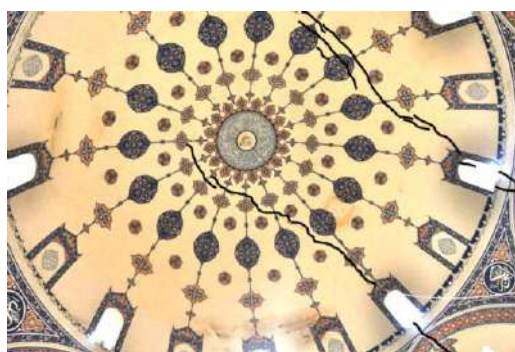


Fig. 6. Damages from the 2012 earthquake



Fig. 7. Damages of the entrance arches

3.3. Analysis of the mosque structure

The mosque was numerically studied by application of the software SAP2000. Spatial model of the mosque (see Figure 8) was developed and linear analysis only was performed. The focus of the study was based on seismic behavior of the structure as well as on the study concerning uneven settlement between main structure of the mosque and the entrance, which is much lighter than the main part. The linear response spectrum analysis is applied in order to evaluate the seismic behavior of the structure.

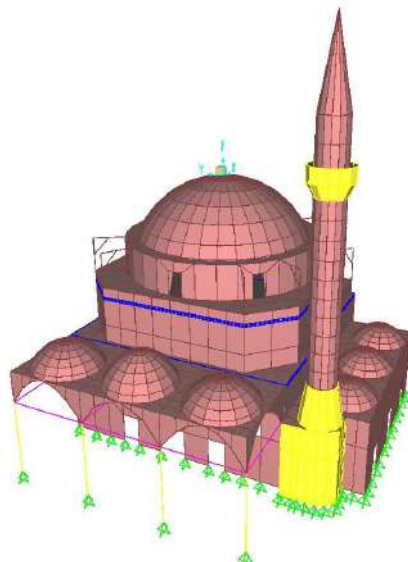


Fig. 8. Spatial model in SAP2000

The main conclusions of the performed numerical analysis could be summarized as follows:

- All stresses in the masonry structure of the mosque including the dome by gravity loading only are in compression and cracks caused by such loads are not expected.
- There are considerable tensional circumferential and meridian stresses in the dome. These tension stresses prove the appearance of cracks in the mosque dome. The distributions of both circumferential and meridian stresses together with existing cracks in the dome are shown in Figure 9 and 10.

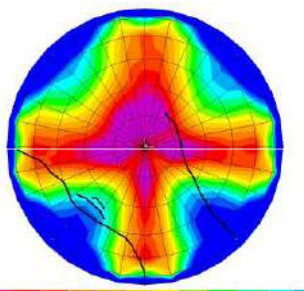


Fig. 9. Circumferential stresses and cracks in the main dome (Seismic combination)

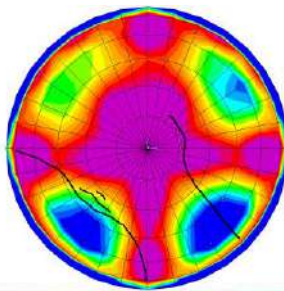


Fig. 10. Meridian stresses and cracks in the main dome (Seismic combination)

- The study of uneven settlements indicates considerable increase of axial tension forces in arch ties of the entrance together with the increase of the forces in the arches (see Figure 11 and 12). That was probably the reason for the registered damages in the arches.

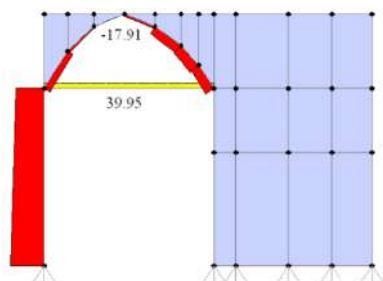


Fig. 11. Axial forces from gravity load

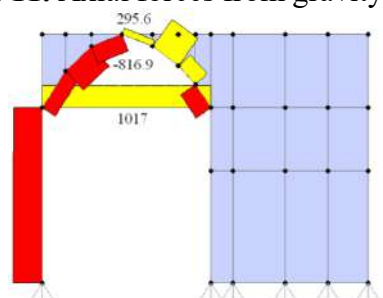


Fig. 12. Axial forces from gravity load and uneven settlements

4. Strengthening strategy

4.1. General description

The presented bellow strengthening approach is proposed in the design project for repairing and strengthening of the mosque. There are a lot of problems in the strengthening of historic masonry structures. It is very difficult to define the material parameters of masonry composites in all types of structural elements. The solutions are based mainly on the previous experience and engineering judgment. The strengthening strategy for Bane Bashi Mosque in Sofia is based on the comprehensive study presented in six volumes of FP6 PROHITECH project (see Mazzolani, 2012). Special attention is paid to the shaking table test (see Krstevska, 2009), finite element modelling (see Landolfo 2009) and the strengthening strategy (see Lazarov, 2009) of Mustafa Pasha Mosque in Skopje, which is similar by dimensions to the Bane Bashi Mosque in Sofia. The approach “design by testing” is presented in some works (see Mazzolani, 2009) and the results of these studies were applied in the design of Bane Bashi Mosque strengthening. Some other authors also applied the same research (see Gavrilovic, 2009).

The main activities of the strengthening strategy are shown in Figure 13.



Fig. 13. Strengthening strategy

They could be summarized as follows:

- Strengthening of the soil and foundation (it is not presented in this paper);
- Repair of the cracks;
- Strengthening of the brick masonry entrance arches by CFRP;
- Strengthening of the main dome as well as the dome ring by CFRP;
- Strengthening of the masonry walls by closed contours of CFRP rods on different levels.

Some of listed above measures is briefly described below.

4.2. Repair of the cracks

The cracks in the mosque structure are repaired by injection of different types of slightly expanding grout. Additionally CRFP and anchoring devices are used for cracks repair.

4.3. Strengthening of the brick masonry entrance arches

Externally bonded CFRP is used for strengthening of all the brick masonry arches (see Figure 14).



Fig 14. Strengthening of the brick masonry arches by externally bonded CFRP

All calculation are with accordance with Eurocode 8 part 3 and (NRC Guide, 2004). The intrados concept is selected for CFRP strengthening of the arches.

4.4. Strengthening of the main dome with CFRP

Externally bonded CFRP is also used for strengthening of the main dome (see Figure 15). The concept which has been applied to the Mustafa Pasha Mosque in Skopje is partially applied in the case of Bane Bashi Mosque in Sofia. The CFRP wrap is applied on the bottom part of the main dome. The effectiveness of this technique is experimentally proved in the past by the shaking table tests (see Krstevska 2009). However the verification calculations required some additional wraps on the higher part of the dome as well as some CFRP wraps in meridian direction to be applied (see Figure 15).

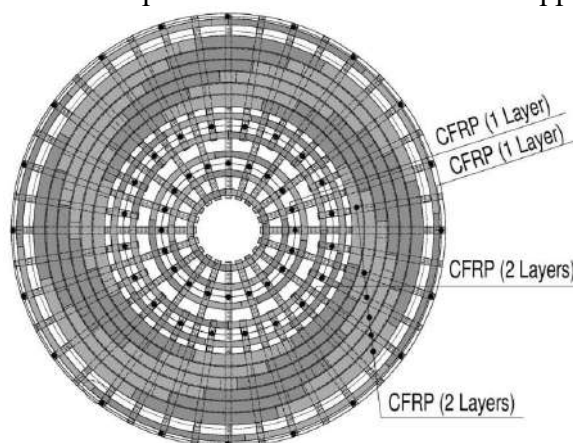


Fig 15. Strengthening of the man dome by CFRP

4.5. Strengthening of the masonry walls by CFRP rods

CFRP rods with diameter 20 mm are placed in the previously cleaned joints between bricks on outside surface of the walls. Then the bars are glued into the joints by epoxy mortar connected also to the vertical joints. Finally all the joints are filled with lime mortar in order to recover the façade (see Figure 16). This technique is applied on several levels forming closed contours (see Figure 16). The effectiveness of this strengthening system is proved by some shaking table tests which have been performed during the study of Mustafa Pasha Mosque in Skopje (see Mazzolani 2009 and Krstevska 2009).

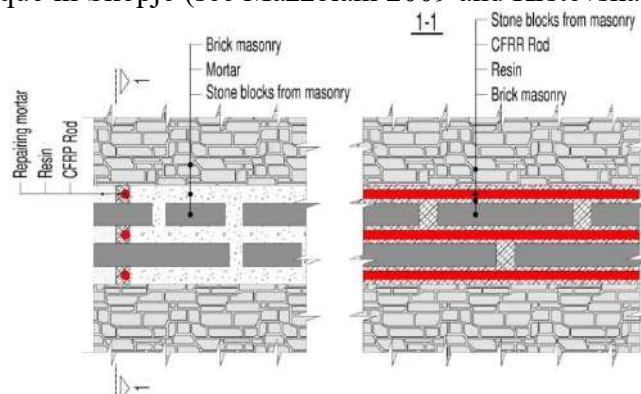


Fig 16. Detail for strengthening the masonry walls by CFRP rods

5. Verification of the strengthening strategy

The strengthening strategy is numerically studied by application of the software SAP2000. The linear of FEM analysis is performed for vertical loading and seismic excitation.

The above mentioned types of analysis were applied to both models: before application of the strengthening and after its application. The layered finite element shell elements of SAP2000 were used for modeling of the masonry which was strengthened by CFRP. Some general analysis results are presented in Figures 17 and 18.

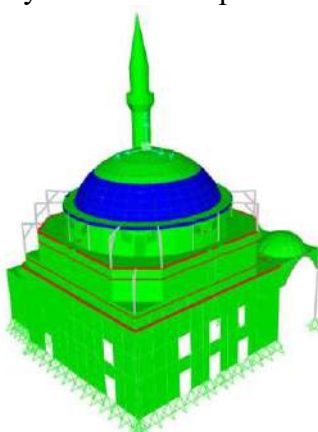


Fig. 17. Spatial model in SAP2000 with strengthening elements

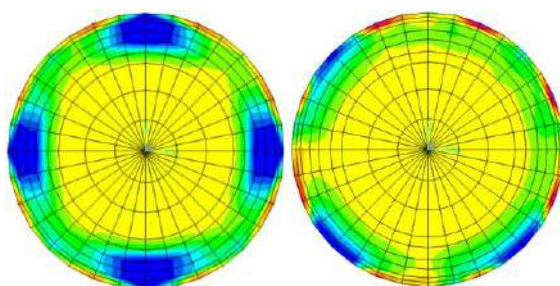


Fig. 18. Circumferential and meridian tension stresses in the brick layer (Seismic combination)

6. Conclusions

Based on the practical study presented herein the following main conclusion could be drawn:

- The damages of the Bane Bashi Mosque main dome are caused by recent earthquakes and the damages of entrance arches are caused mainly by uneven settlement of the different parts of the mosque;
- The fact that such a minor earthquake as this of May 2012 in Sofia caused such considerable enlargement of the dome cracks as well as the appearance of new cracks requires seismic strengthening of the mosque.
- The strengthening strategy was developed and executed on the basis of performed
- The numerical verification of the solution by means of FEM analysis represented considerable improvement of structural response of the building compared with the one before strengthening even in undamaged conditions;
- All studies supported the idea that the strengthening of historical buildings by CFRP is an effective technique which improves considerably the seismic behavior of building.

7. Acknowledgements

The financial support of Municipality of Sofia for performing the survey is significantly acknowledged. Moreover the authors would like to express gratitude to all structural engineers of YODA Ltd which have prepared the design project for the mosque retrofit.

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HISTORIC RC STRUCTURES STRENGTHENED BY TIES UNDER REMOVAL OF MEMBERS DUE TO ENVIRONMENTAL EFFECTS

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Abstract: *Historic structures include existing old industrial reinforced concrete (RC) buildings, which are subjected sometimes to obligatory removal of some structural element-members, e.g. columns. This happens due to various reasons, which can concern changes of serviceability and requirements, or environmental effects which cause strength degradation etc. In such cases, a modification of the structural response and a redistribution of internal actions can result to a requirement for strengthening the remaining structure after the removal of the degraded elements in order to avoid progressive collapse. The present study deals with such a case, which concerns the computational analysis of framed RC structures under the removal of some columns and the so-induced requirement of a strengthening by ties (tension only elements). The unilateral behaviour of these cable-ties, which can undertake only tension, is strictly considered, and the response of the remaining historic structure strengthened by ties is computed. Finally, in a practical case of a framed RC structure, the effectiveness of the proposed methodology is shown.*

Key words: *Historic industrial RC structures, removal of columns, strengthening by ties*

1. Introduction

Many of old existing industrial reinforced concrete (RC) structures can be considered as elements of the recent built Cultural Heritage [1,2]. Such historic (RC) structures are subjected to various environmental actions, e.g. corrosion, earthquakes etc., which can often cause significant damages. A main such defect is the strength degradation, resulting into a reduction of the loads bearing capacity of some structural elements. For some of

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such degraded elements is sometimes obligatory to be removed, and so a further reduction of the whole structure capacity is caused, which can lead to progressive collapse [2,16].

After structural assessment, a strengthening of the remaining structure is usually suggested, in order to overcome the above defects. Among the available strengthening methods [3-5], cable-like members (tension-only tie-elements) can be used as a first strengthening and repairing procedure [1, 6]. Cables can undertake tension but buckle and become slack and structurally ineffective when subjected to a sufficiently large compressive force. Thus the governing conditions take an equality as well as an inequality form and the problem becomes a high non-linear one. So, the problem of structures containing as above cable-like members belongs to the so-called Inequality Problems of Mechanics, as their governing conditions are of both, equality and inequality type [6-10]. A realistic numerical treatment of such problems can be obtained by mathematical programming methods (optimization algorithms).

This paper deals with a numerical approach for the analysis of existing old industrial framed RC buildings, which are strengthened by cable elements in order to avoid progressive collapse [16] after the obligatory removal of some degraded structural elements. The computational approach is based on an incremental problem formulation. Finally, an application is presented for a simple typical example of an industrial RC frame strengthened by bracing ties after the removal of some ground floor columns.

2. Method of analysis

A reinforced concrete (RC) framed structure containing cable-like members is considered. For the general analysis of such a structure, see details as described in [1,56]. Generally, a double discretization is applied: in space by finite elements and in time by a direct time-integration method. The RC structure is discretized to frame elements with generally non-linear behavior. For the cables, pin-jointed bar elements with unilateral behavior are used. The rigorous mathematical investigation of the problem can be obtained by using the variational or hemivariational inequality concept, see Panagiotopoulos [9]. So, the behavior of the cables and the generally non-linear behavior of RC elements, including loosening, elastoplastic or/and elastoplastic-softening-fracturing and unloading - reloading effects, can be expressed mathematically by the subdifferential relation:

$$s_i(d_i) \in \hat{\partial} S_i(d_i) \quad (1)$$

Here, for the example case of a typical i -th cable element, s_i and d_i are the (tensile) force and the deformation (elongation), respectively, $\hat{\partial}$ is the generalized gradient and S_i is the superpotential function [9,10].

For the numerical treatment of practical inequality problems, a piece-wise linearization is usually applied to relation (1), see e.g. [5-8]. So, for the case of cables, the unilateral behavior of the i -th cable-element ($i = 1, \dots, N$) is expressed by the following relations [7]:

$$e_i = F_{0i} \cdot s_i + e_{i0} - v_i, \quad (2a)$$

$$s_i \geq 0, \quad v_i \geq 0, \quad s_i v_i = 0. \quad (2b)$$

Here e_i , F_{0i} , s_i , e_{i0} and v_i denote the strain (elongation), "natural" flexibility constant, stress (tension), initial strain and slackness, respectively. Relations (2b) consist the Linear Complementarity Conditions (LCC) and express that either a non-negative stress (tension) or a non-negative slackness exists on cables at every time-moment. The above considerations lead to formulate the problem and to solve it at every time-moment as a Linear Complementarity Problem (LCP). The numerical treatment of this LCP is obtained by using optimization methods [1, 6-10].

In an alternative approach, the incremental dynamic equilibrium for the assembled structural system with cables is expressed in matrix form by the equation:

$$\underline{M}.\Delta \underline{u}(t) + \underline{C}.\Delta \dot{\underline{u}}(t) + \underline{K}_T.\Delta \underline{u}(t) = \Delta \underline{p}(t) + \underline{T}.\Delta \underline{s}(t) \quad (3)$$

Here $\underline{u}(t)$ and $\underline{p}(t)$ are the time dependent displacement and the given load vectors, respectively. $\underline{C}$ and $\underline{K}_T(\underline{u})$, are the damping and the time dependent tangent stiffness matrix, respectively. Dots over symbols denote derivatives with respect to time. $\underline{T}$ is a transformation matrix. By $\underline{s}(t)$ is denoted the time dependent cable stress vector with elements satisfying the relations (1)-(2).

The above matrix equation combined with the initial conditions consist the problem formulation, where, for given $\underline{p}(t)$, the vectors $\underline{u}(t)$ and $\underline{s}(t)$ are to be computed. For the numerical treatment of the above problem, the structural analysis software Ruaumoko [11] is herewith used, as described in [5]. When the static case of the problem is only to be investigated, a Dynamic Relaxation approach [12] is appropriately used.

3. Numerical example

The historic industrial RC plane frame structure of Fig. 1 had been initially constructed with two more internal columns in the ground floor, which are shown as dashed lines and have been removed due to degradation caused by environmental actions. Following [16], the axial loads, which were initially undertaken by these two columns, are now shown as the two applied vertical concentrated loads of 180 kN and 220 kN.

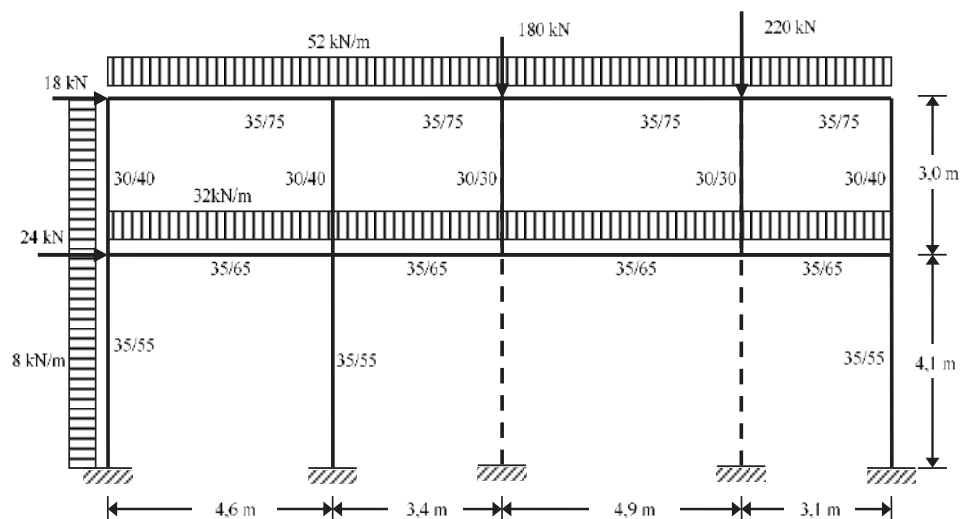


Fig. 1. The initial RC frame F0.

Due to removal of the above two columns, and after structural assessment [15] and in order to prevent a progressive collapse, the initial RC frame F0 of Fig. 1 is strengthened by ten (10) steel cables (tension-only tie-elements) as shown in Fig. 2. In the so formulated system, it is wanted to be computed which of the cables are activated and which are not, under the considered critical static loading of Fig. 1.

Using Ruaumoko software [11], the columns and the beams of the frame are modeled by prismatic frame RC elements. The concrete class is estimated to be C12/15. The effects of cracking on columns and beams are estimated by applying the guidelines of

[1-4, 13]. So, the stiffness reduction due to cracking results to effective stiffness with mean values of $0.60 I_g$ for the external columns, $0.80 I_g$ for the internal columns and $0.40 I_g$ for the beams, where I_g is the gross inertia moment of their cross-section.

Nonlinearity at the two ends of the RC frame structural elements is idealized by using one-component plastic hinge models, following the Takeda hysteresis rule [11]. Concerning the constitutive diagram of plastic hinges, a typical normalized moment-normalized rotation backbone [14] is shown in Fig. 3.

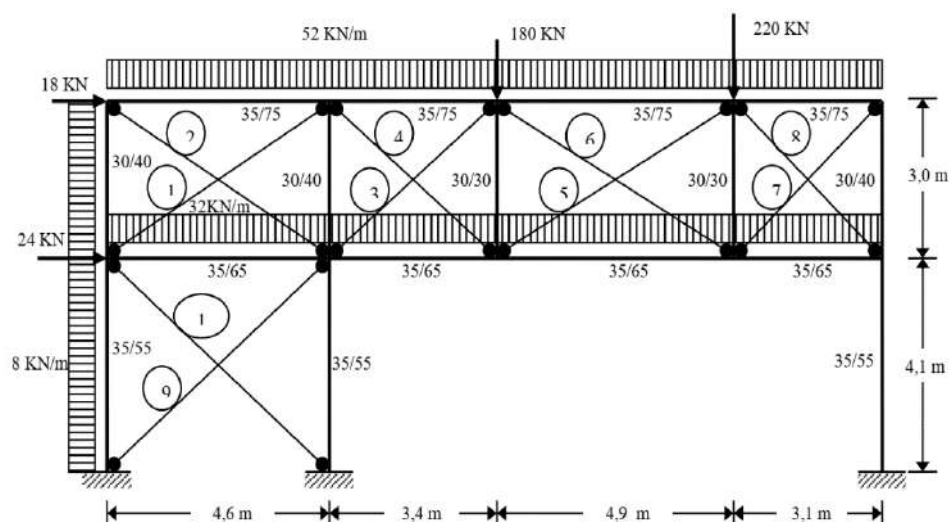


Fig. 2. The RC frame F1 (or F2) strengthened by 10 cables.

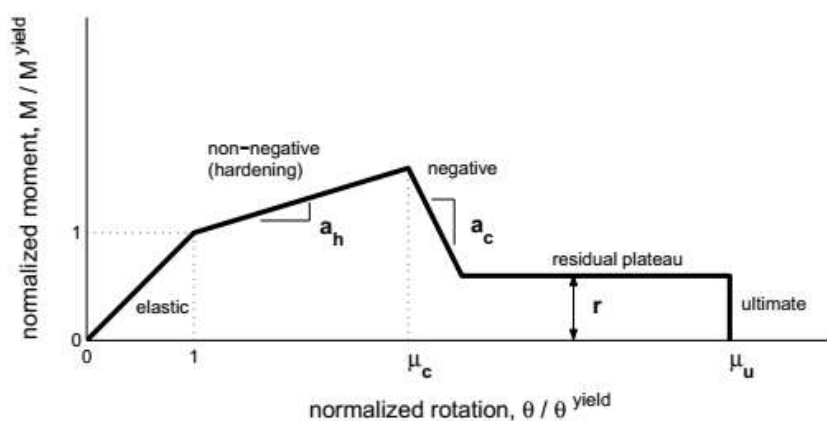


Fig. 3. Constitutive backbone diagramme for normalized moment - normalized rotation in plastic hinges [14].

The strengthening cable members have a cross-sectional area $F_r = 8 \text{ cm}^2$ and are of steel class S1400/1600 with elasticity modulus $E_s = 210 \text{ GPa}$. The cable constitutive law concerning the unilateral (slackness), hysteretic, fracturing, unloading-reloading etc. hysteretic behavior, has the diagram depicted in Fig. 4.

Table 1. Comparison of response representative values of the initial frame F0 and the strengthened frames F1 and F2.

Frame	Cables cross-section	S ₄ [kN]	S ₇ [kN]	U _{y180} [cm]	U _{y220} [cm]	M ₁ [kNm]	M ₂ [kNm]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
F0	$F_r = 0 \text{ cm}^2$	0.00	0.00	-2.46	-2.59	307.91	402.64
F1	$F_r = 5 \text{ cm}^2$	272.11	268.65	-1.67	-1.70	218.22	290.98
F2	$F_r = 10 \text{ cm}^2$	401.30	412.89	-1.26	-1.27	174.59	236.37

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КОНСТРУКТИВНИ КОНЦЕПЦИИ ПРИ РЕКОНСТРУКЦИЯ НА КУЛТУРНОТО НАСЛЕДСТВО

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Конструктивно проектиране ЕООД, София, България, БНК на ИКОМОС

Резюме: Опазването на културното наследство е деликатна област на изява на строителния инженер. Третирането на субстанцията изисква комплексни познания както на старите, така и на съвременните строителни техники и още по-задълбочени изследвания на естествените и антропогенни материали. Съчетаването на елементите на познание, както е показала практиката в изминалите хилядолетия (не бива да си мислим, че с тази дейност човечеството се занимава от вчера), е оставила на света блестящи примери. Правилният подход към субстанцията на паметника е предпоставка за постигане на основната цел – неговото съхранение. С това ние увековечаваме авторите на творението, с разбирането ни за същността - демонстрираме своята съпричастност към наследствеността и чрез нея с непреходността. Детайлните проучвания и изучаването на характеристиките на паметниците в серия инженерни области ни насочиха към избор и подход за третиране на полуразрушената конструкция на храм „Св. Тодор” в с. Бобошево. Паметникът е датиран от В. Миков към 13 - 14 в. Проучването на използваните материали ни насочи към търсене на решение с необходимата дълготрайност. Проектното решение е развито в два етапа. Първият - изграждане на стабилизираща временна система за запазване и обезопасяване, а вторият - доизграждане с техника, визуално близка до оригинала, но с допълнителни материали в скрита форма за обезпечаване на дълготрайност на зиданата конструктивна система. При проектните решения от 2016 г. е предложено всички новоизградени зидарии да се армират с геомрежи, които за разлика от стоманите предлагат по-висока дуктилност. Този концептуален подход според авторите би решил проблема на взаимодействието при съчетаване на зидарията от оригинала с новоизградената чрез по-близката им пластична работа.

Ключови думи: културно наследство, проучвания и конструктивно укрепване

1. Въведение

Проектирането на мерки за реконструкция на култови сгради и техните елементи е особено предизвикателство пред строителния инженер и независимо от мащаба на обекта, подходът към материята винаги поставя изискването за структурно съчетаване на наличната материална субстанция с новите елементи.

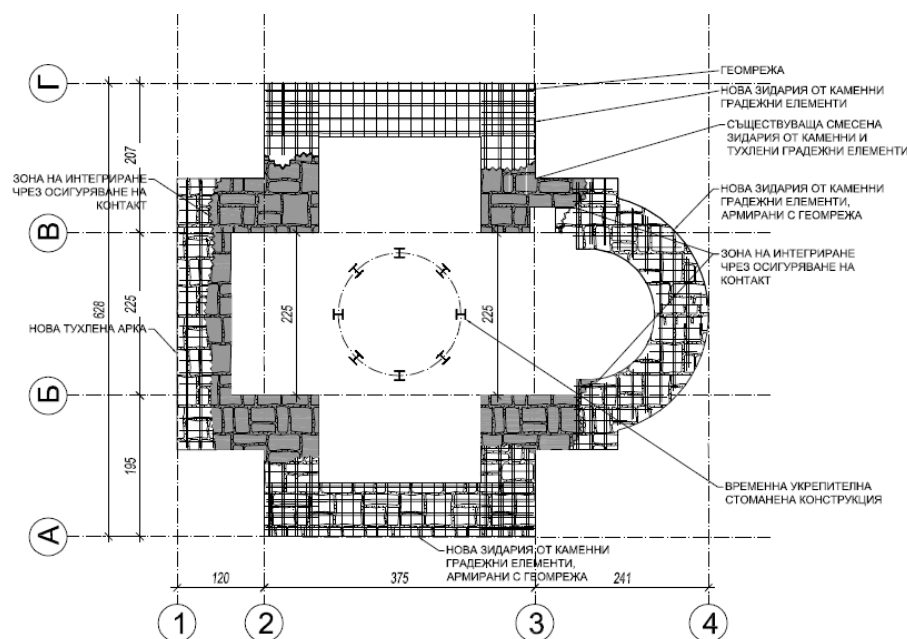
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Съвместната работа на старите и новите елементи в дълбокият си замисъл следва да обезпечи двете направления – цялостна естетика на паметника и в контекста на опазване на материалното наследство следва да гарантира дълготрайната му структурна цялост чрез подходящ подбор на строителни техники и материали. Тези основни направления изискват проучване с използване на различни техники, които имат за задача да набавят достатъчен обем от информация и технически данни, с които да се проведе качествен и количествен анализ с надеждна прогноза за бъдещото поведение на структурата. В обема на изследванията се включват измервания за дефиниране на геометричните особености, включително за определяне на вида, качествата и състоянието на вложените материали, както и положение, вид и по възможност - развитие на повредите. Съчетаването на получените данни в една интерактивна моделна конфигурация създава предпоставки за надежден прогнозен анализ. Тези моделни анализи следва да се верифицират чрез данни от регистрираното до момента състояние и поведение на конструкцията.

2. Конструктивни особености

Храмът „Св. Тодор” в гр. Бобошево се намира на 2 км северно от град Бобошево, върху възвишение на десния бряг на река Струма, в местността "Селище". Датиран е от В. Миков към 13 - 14 в., от Н. Мавродинов — 12 в., а от Д. Панайотова - към първата четвърт на 11 в. и е обявен за архитектурно-художествен паметник на културата (недвижима културна ценност), от Национално значение (д.в. бр. 38/1972 г.). В интериора са запазени два пласта стенописи. Първият слой е датиран към 12 в., а различни изследователи отнасят втория пласт към първата половина на 14 век или през 17 век.



Фигура 1. Планова схема на храма

Представлява кръстокуполен храм с издаващи се свободно рамене на кръста. Според формата и строителната техника, храмът се причислява към византийската архитектура след 9 век, която е характерна с художественото си богатство и пластична изразителност, съчетани в единно цялостно архитектурно решение. Елементът купол с пендентиви е характерен и за тази структура, като в основната част е запазил целостта си. Страничните куполи за съжаление са деградирани.

Размерите на храма са - дължина 7,40 m и ширина 6,30 m. Средният купол е разрушен, стъпвал е върху цилиндричен барабан, с четири прозореца по посока на раменете на класическата византийска кръстата планова схема. Зиданата конструкция не следва точно обичайната техника на византийската структура с регулярно използване на хоросан, тухли, камък. Градежът до основата на куполите е изцяло от камък с хоросанов пълнеж. Използвани са едроломени блокове (без обработка) от различни скали – варовик, гнайс, гранити и андезити. Обработката на камъка предопределя и широката фуга на зидария в масовата част. Единствено около отворите и някои фрагментарни части са използвани керамични тухли. Не е изявена поредицата в структурата на зидарията, характерна за класическото византийско фасадно оформление.

В структурно отношение градежът представлява изключително добре подбрана система от обеми. Дебелината на зидовете, в комбинация с дъги, цилиндрични сводове и сферични куполи, интегрирани чрез конични триъгълни елементи предопределят предимно вертикалния ход на силите в системата. Структурната кръстата схема с къси крила (в този случай) е най-важната характерна особеност на този тип конструкции, обуславяща и слабата ѝ чувствителност към движения с дълготраен и краткотраен характер. Друга характерна черта - масивната зидана структура във височината на основното ниво е предпоставка за ниски нива на напрегнатото и деформирано състояние.

В купола тухленият градеж е изпълнен с техниката „скрита“ или „потънала“ тухла, като тухлените редове са покрити от мазилка през ред.



Фигура 2. Зидария

Следвайки особеностите на конструкцията и нейната философия, проектното решение е развито в опит да се проследят важните моменти в работата на конструктивната система, чрез проучване на материалния елемент на паметника св. Тодор в с. Бобошево. Елементите на конструктивното изследване са развити в използване на аналитични техники за прогнозно описание.

3. Проучвания и мерки за намеса

Предвид техническото състояние, видно и на фотоматериалите, конструкцията е с дестабилизирана структура от дълго време. С развитието в зидарията на вредните процеси, причинявани от климатичните фактори и ерозията на материалите, сградата се определя като такава със застрашена обща устойчивост. Развитите прекъснатости

в зидарията, особено силно изразени в конхалните участъци, са довели до цялостната деградация на конструкцията в трите крила на кръста.



Фигура 3. Общ изглед

Конструктивните особености на паметника, неговият мащаб и моментното състояние ни насочиха към предприемане на проектни действия, ръководени от принципа на интегралната консервация. В детайлност е възприета концепция с използване на *in situ* примера за структурно и естетическо доизграждане, като в зидарията са имплантирани дискретно нови елементи, които подобряват интегритета ѝ.



Фигура 4. Деградация на зидарията

Въвеждането на дуктилни елементи, като част от възстановката на зидовете в оригинален образец, ще подобри пластичната работа на цялата конструктивна система. Конструктивната намеса в градежа основно се определя от решенията за минимални намеси в процеса на консервация и реставрация. Конструктивните мерки се развиват с използване на оригиналната градежна техника и материали с малки ревизии. Връзката на съществуващите основи (запазвани в решението) с новото дограждане на зидовете ползва анкериране с дискретно разположени елементи. Материалите, които се използват за закотвяне на анкерите са полимерно модифицирани състави на хидравлична вар. Изграждането на новия зид се извършва с налични каменни и керамични материали с разполагане на армировка (геомрежа) за предотвратяване на разцепването на зида, което е основната причина за деструктивните процеси, наблюдавани в момента. Използва се зидарски разтвор на основата на хидравлична вар. Доизграждането на кръсторазположените сводове изцяло се довършва с идентични

керамични материали, като взела между наличния свод и новия се интегрира с влагането на анкерирания. Изграждането се извършва с основния зидарски разтвор, който се определя от технологичните решенията за консервация и реставрация. Доизграждането на основния (среден купол), който в геометрия е сегмент от сфера, стъпва на доградена по оригинален образец част от барабана. Техниката на изграждане на барабана изцяло се запазва (вдлъбнат измазан тухлен ред и изпъкнал видим), като новото изграждане се изпълнява от армирана тухлена зидария. По този начин се осигурява разпора на кулата чрез хоризонталните деформации.

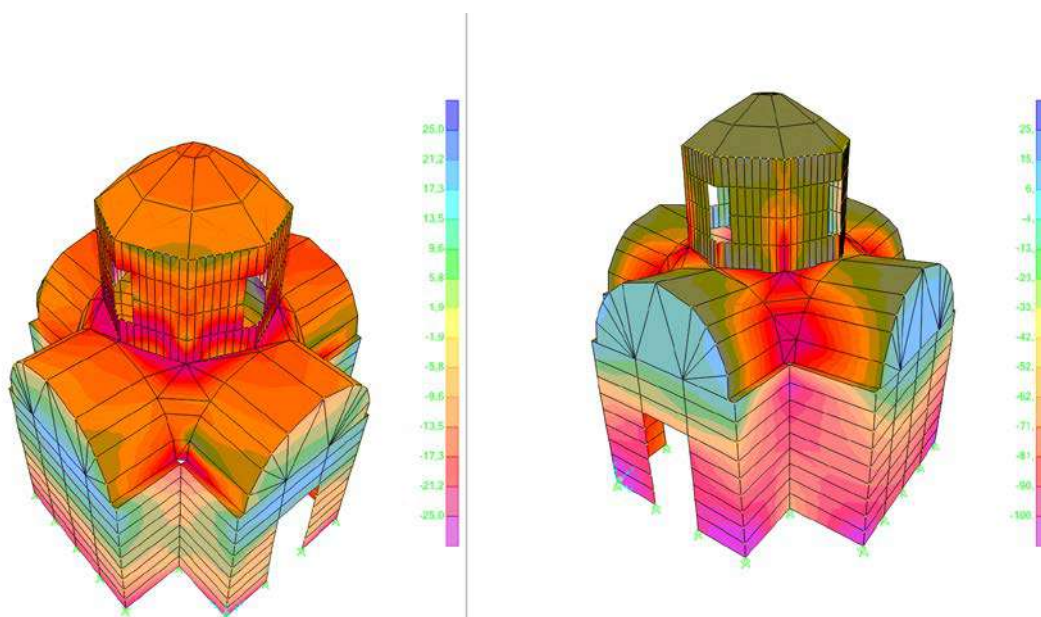
Изпълнението на тухлените зидарии по арки и куполи се извършва с керамични тела с размери 34.5/34.5/4.5 cm, които се застъпват с превръзка от половината размер на зидарийното тяло.

4. Изследване на проектната ситуация

Проектната концепция е развита чрез предложените мерки в общия контекст на възстановителните работи на храма. Тези мерки целят запазване на наличната субстанция и подобряване на естетическите и експлоатационни показатели на сградата.

В рамките на проектното решение са разработени изчислителни анализи за оценка на конструктивната цялост на строителните конструкции. Тази оценка се развива с ограниченията на използваните материали и има по-скоро качествен, отколкото количествен характер, независимо от получаването на конкретни числови стойности. В този обхват е разработен цялостен еластичен тримерен изчислителен модел в среда на SAP. Като резултат от изследването на този модел е получена картината на разпределението на напреженията, както за текущото състояние, така и след реализиране на предложените проектни мерки. В допълнение за изследване на дискретното деформационно поведение е генериран равнинен Jointed rock model в среда на Plaxis [2]. Чрез този модел са изследвани влиянията на армиранията на зидарията върху поведението на равнинните стени и този резултат е използван за дефиниция на примерния модел. Итерационното взаимодействие и работата на двете моделни постановки служат за верификация с презумпцията за началната структурна цялост.

С резултатите от серията анализи са проверени основни елементи на системата за крайни и най-вече експлоатационни гранични състояния, които показатели са белег за развиващите се работни механизми.



Фигура 5. 3D аналитичен модел

Този подход ни даде възможност да постигнем следните резултати:

- Да повторим механизма на деградация на конструкцията и чрез него да верифицираме работата на модела [1];
- Да очертаем причините за развитие на деструктивните процеси;
- Чрез първите две стъпки да определим влиянието на новите структурни решения чрез армиране на зидарията.

Тези етапи от анализа създават предпоставки за определянето на надеждни технически мерки за реконструкция и според авторите са залог за съхранение на структурната цялост на паметника.

5. Заключение

Като цяло моментното техническо състояние на конструкцията се определя като неустойчиво. Силно развити процеси на ерозия в наличните зидове, водещи до сегашното състояние и предполагащи бъдещи деструктивни процеси. Зидарските разтвори, които са налични, вероятно са изцяло карбонизирали и следователно крехки. Тази особеност прави наличната субстанция чувствителна към развиващите се във времето деформации.

Предлаганите в това проектно решение мерки целят съхранение на културната ценност, подобряване на експлоатационните показатели на конструкцията и дълготрайността на елементите. Конструктивните мерки са развити при съблюдаване на следните важни моменти [3]:

1. Премахване на несъстоятелни намеси при провеждане на досегашните мерки за опазване на храма.
2. Запазване на всички елементи, отговарящи на критериите за автентичност (оригинални образци), определени от Венецианската Харта, от националното законодателство, предвидени в разработките в части архитектура и технология на консервацията и реставрацията.
3. Заздравяване чрез новоизгражданите зидани елементи при влагане на дисперсно позиционирани геомрежи с цел подобряване на работата.

Въз основа на направения анализ може да се направи заключението, че въпреки структурната си неосигуреност като цяло, сградата ще развие разрушения с ограничено разпространение.

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ACCIDENT WITH TIMBER COLONNADE OF THE 200 YEARS OLD CHURCH AND METHODS FOR THE STRENGTHENING

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Abstract: *The article describes an accident in colonnade of the 200 years old church, "Sv. Uspenie Bogorodichno" in Kyustendil. The article has investigated several interesting approaches to amplify damaged wooden columns in historical structures in China, Azarbaijan, Iran, Spain and USA. The decision was made to temporarily reinforce the whole structure of the church during its renovation and the method of strengthening the damaged wooden columns in the church was propose.*

Key words: *wooden structures, damaged wooden columns, mechanical joints*

1. Introduction –

About the history of the erection of the church building we can say that the church was built in 1816, and is made of stone walls and a wooden roof structure. It is built according to the traditions of the Revival Age in Bulgaria and consists of walls with stone masonry, wooden floor constructions for emporium, wooden beams and columns. The outside walls are made of brick stone with a thickness of 60-70 cm. On both sides and outside, these walls are plastered with mortar. The building of the church is on one floor with height to the emporite-3.30m, height to the roof of the church with H-2.40m, with double sided roof, made with wooden constructions and roofing: boarding, waterproofing and tiles and three drum wooden dome (Fig.1a, b). The entire roof structure of the temple is wooden. Inside the church are two rows of wooden columns (6 in the main space-naos). On the columns, at the level of the floor beam designed for the emporium are located longitudinal beams embodying, respectively, the weight of the amporium and the weights of the respective parts of the roof structure. The building of the church is executed from the outside with powerful stone walls, the upper end of which reaches the level: 3,30m. In the interior of the church there are 12 main wooden columns in the longitudinal and transverse direction, which reach the level of the floor structure on the first floor of the church (the emporium).

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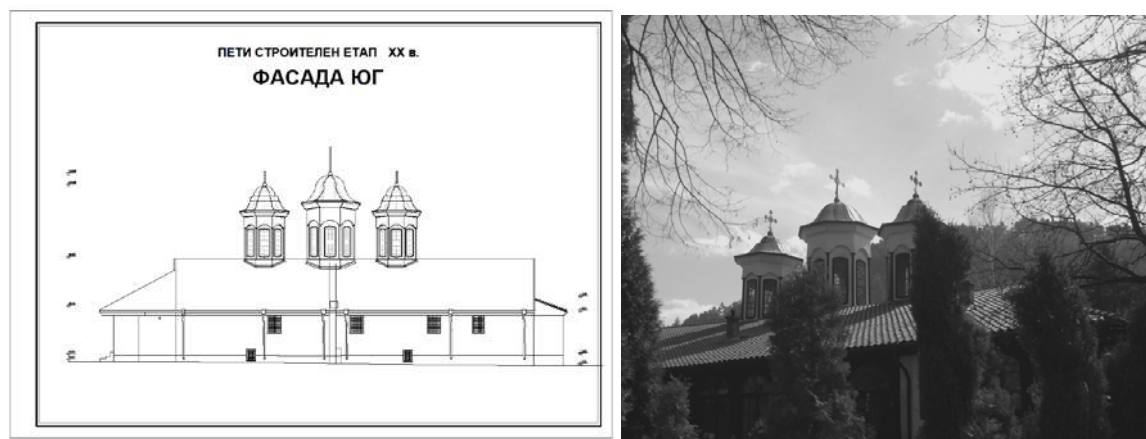


Fig.1a, b. Facade "South" and a general view on the southern façade of the building of the church

According to the plan, the church is a dyed single-pseudo-three-nave pseudo-basilica with a wooden roof structure and geometric plan dimensions: 23,60m x 14,40m (Fig.2.a.b).

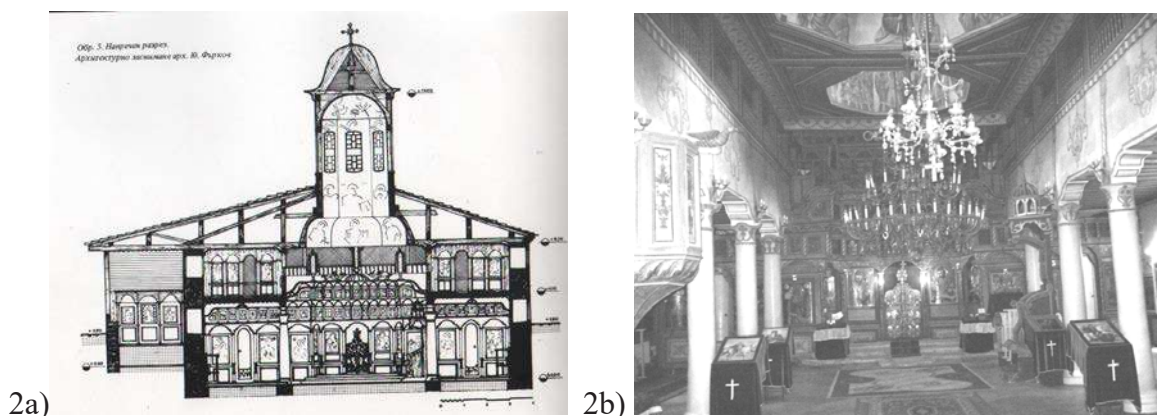


Fig. 2a, b. Crossed architectural section of the church and look at the naos of the church

In the longitudinal direction, the columns are axially spaced through: 3,70 +2,40 +290 +2,70 +2,60 + 3,03m. In the transverse direction, the columns located on the axes of the building B and B are at a distance of one another axially through 6,230m. From the longitudinal stone walls these columns are symmetrically located at 3,510 m distances. Thus the total transverse light of the church is 15,280m. In the longitudinal direction, the first row of columns is located from the stone wall, which is after the narthex at a distance of 1,800m. The last row of columns is located from the stone wall of the altar at a distance of 2,400-2,600m. Thus, the total length of the light church of the two stone walls is 24,600m(Fig.2b). The wooden pillars of the church are dressed in a special casing, covered on top with a lime - cement plaster. The columns are supported at the bottom, on stone steps whose depth of foundation at this stage of project development has not been established (Fig. 4a, b, c). At the upper end, the columns in the longitudinal direction are connected with decorated curvilinear parts, over which a longitudinal belt extending continuously along the whole length of the church is developed (Figures 3a, b, c).

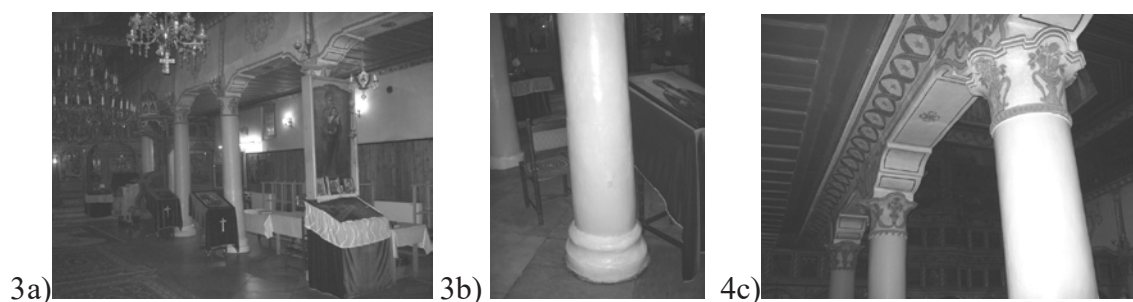


Fig. 3a, b, c. View on the inside of the church and in particular on the lower and upper end of the wooden columns

At the top, the columns before being connected to the vaults are decorated with special ornaments, which are in good condition (fig.3c). The coating of a part of the wooden columns taking the loads from the roof structure on 15.06.2015 is severely cracked during the night, which indicates a degraded load bearing capacity which imposes their emergency reinforcement with a metallic scaffold mounted between the columns (Fig. a, b). On the day of 16 June 2015, a partial temporary reinforcement of the church's support structure was carried out, covering certain areas under the longitudinal wooden beams above the wooden columns, with metal stands from the Ninebeck scaffold (Figures 4a, b, c).

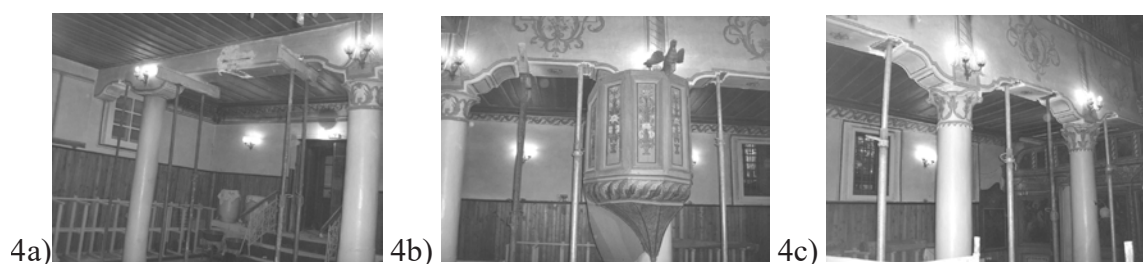


Fig. 4a, b, c. Replacing in certain places the longitudinal wooden beams located above the wooden columns with metal stands from the Huenebeck scaffolding on the A axis.

The observation carried out on the damaged and cracked cover on the columns and its detection in several places made it possible to describe the following facts. The wooden columns have a circular cross-section with a diameter of 46cm. Their support is done on stone base that protrude above the floor of marble slabs at a height of about 50cm. The revealed wooden columns show an interesting composite wooden-steel structure, made of timber, on which steel rings are attached (Fig.5a, b, c).

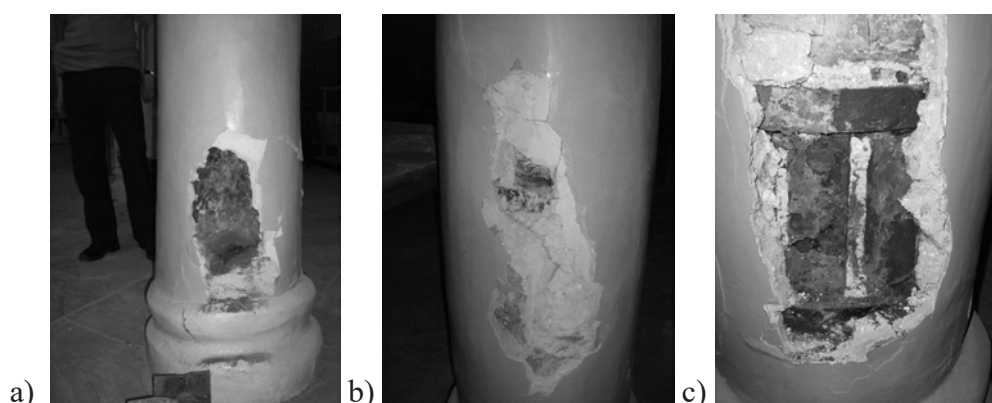


Fig. 5a, b, c. Cracked outer cover of the column in the church shot at 16.06.2015 at 18.30 hours. The ties are arranged side by side, on which about 40 cm are placed steel rings with a height of 40 mm and a thickness of 2.0 mm. The rings are attached to the wooden column with ordinary iron nails

2. Brief literature review - survey of examples concerning strengtening of the timber pillars in the historic structures

2.1 Example 1: Investigation about the decay of the timber structure of an ancient wine cellar in la rioja (spain) and sanitation proposal[1]

In 2011 the collapse of one of the timber pillars of the centuries-old warehouse of maceration that the firm "Bodegas Bilbaínas, S. A.", holds in the town of Haro (La Rioja), occurred[1]. According to the level of decay, the assessment of the damage in the different elements of the timber frame through non-destructive testing is analyzed. Based on the results obtained, it is proposed the repair process necessary to preserve the timber structure, taking into account the heritage significance and the extension of the *harm* of their components. The company is the owner of many modern pavilions for winemaking and other auxiliary buildings. Specifically, these primitives maceration and fermentation naves, which still keep the ancient *wooden vats built in 1859 (Fig. 6 and 7)*.

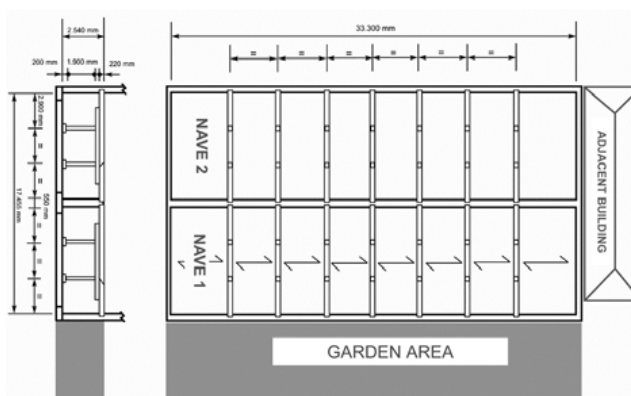
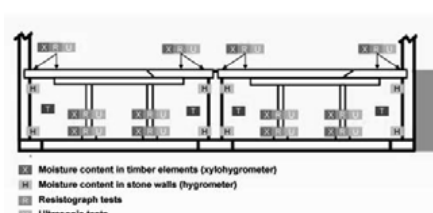


Fig. 6 Vats Fig.7. Cellar floor timber structure and cross section respectively

The structure of the nave consists of load bearing stone walls in the perimeter of the building, with thickness 60 cm. The inside masonry walls divides the cellar into two areas of nearly identical inner dimensions: 33.30 m long and 8.70 m wide. The pillars, spaced at regular distances of 2.90 m from each other and the side walls, with approximate section 220x220 mm and height 1.90 m, lead from stone bases of 200 mm on edge. On the other hand, indicate that each portico has a large girder or spreader beam of 200x200 mm section that bridges the joint, and connect the heads of the pillars, allowing a perfect load distribution. The cellar floor and its structure is shown in Fig. 7. The moisture content in all the pillars looked to be certainly high, especially in the lower part of the support, in contact with the stone bases. In fact, in some cases fungi colonies were detected during the visual inspections (Fig. 8a). *By contrast, no singularities or defects such as cracks, knots, ring shakes, or deviations of fiber, which jeopardize the stability of the parts, were observed.* Moreover, as discussed above, to a height of only 1.90 m, sections close to the 220x220 mm, the associated mechanical slenderness round the value of $\lambda = 32.90$, so it can be said that the security against buckling, for all the timber pillars in the same condition, is fully guaranteed.



However, evidences of significant moisture content in both the factories and in the timber components were detected. Furthermore, during the previous inspection, high humidity content in the indoor air was detected. According to the information gathered, the action plan and the tests to be performed on each portico and on the load bearing walls were defined as follows (Fig. 8b): The water content of the pillars should be assessed by xilohigrometers, placed in two different positions; Next to the stone bases, and 50 cm above it. In the same points, the resistograph and the ultrasonic unit should be also applied, in order to analyze the level of damage of the timber elements. From the data collected along the inspections, and the results of tests on structural timber elements some conclusion was made: The material used for the bases is too porous, and favours the rise of water from the ground to the pillars. Through the analysis of the pillar affected by termites, it could be known that it consists of *common elm* (*Ulmus minor*). The square ends of the pillars and beams that rest on the south wall are seriously affected by moisture, despite of the natural resistance to degradation of the common elm. Along the time, the water contained in the ground rose by capillarity. And later, when the moisture took contact with the wood, favoured the termite attack, causing it to collapse. Fig. 8c shows the resistograph device applied to a timber pillar. Fig. 9 shows a resistographic profile taken from the square head of a beam very close to the Southern wall As it can be seen, both graphics are completely different. The first one allows to appreciate the important decay because of the probably termite attack, while the other one keeps almost in perfect condition. The constant supply of water from the garden area, leads that the indoor surrounding air keeps a state close to saturation, with a relative humidity around 90%. In other words, that the condensation on the stone components is constant.

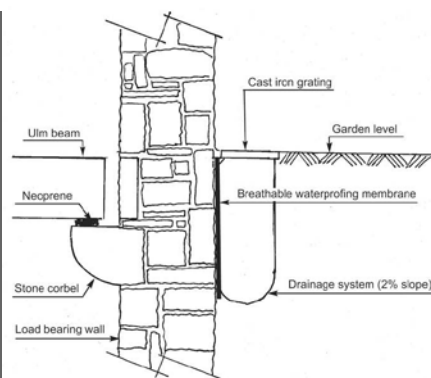
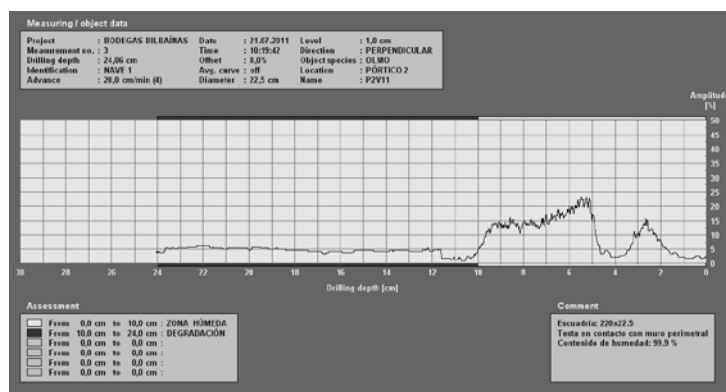


Fig. 9. Resistographic test and profile (beam on Southern wall). Fig. 10. Proposed solution

According to these problems, a group of correcting measures were suggested, in order to improve the current situation, and prolong the life of the building, preventing its demolition and subsequent reconstruction in reinforced concrete. In this sense, garden, is proposed to remove the ground to a depth of 1.0 m, and build there an open drain with minimum slope 0.5% (Fig.10). This solution should collect the rainwater, and at the same time should allow the evaporation of the humidity contained both in the wall and in the timber elements. For the pillars, since up to a height of 20-30 cm, counted from the level of the base, all of them present an excessive moisture content, there are suggested three possible actions: removal of existing supports and their bases, and supply new ones, with the treatment and moisture content suitable for the type of exposure; or remove the bases, cut the pillars at a height of 40 cm, replacing the degraded part by a wooden prosthesis glued by adhesive; and also remove the

bases, cut the pillars to a height of 40 cm, and place new non-porous stone bases, 40 cm high, waterproofed in support. Finally, the timber structure should be protected with biocides. The treatment method may be by injection, to limit the area of action and not affect the vats. Along the surrounding area, a baiting system against termites should be placed. These measures will be achieved to preserve the original timber elements of the building, ensuring its stability and security for a long time. In addition, these classic solutions have been used for centuries in strengthening structures, so that at no time will be lost the entity and the traditional style of the cellar.

2.2. Example 2: The conservation and renovation of the timber constructions in the palace museum[2]

The Palace Museum, which was constructed in the 18th year (1420) of the reign of the Yingle emperor, is the largest and the most complete ancient palace complex existent in China as well as in the world. It has manifested traditional Chinese construction technology and **revealed** a remarkable achievement in art. By illustrating the main types of the ancient timber constructions and representing the construction features, the following text provides some useful references for the conservation and renovation of the northern palace-style buildings that were constructed during the Ming and Qing Dynasties[2]. As concerning the basic structural type of timber construction: Architectural types of the Palace Museum are varied, while the main type is bond to the shape of roof. On the basis of the building's sections, the Palace Museum buildings can be divided into four types: Diantang style, Tingtang style, Column-beam style and Composite style.

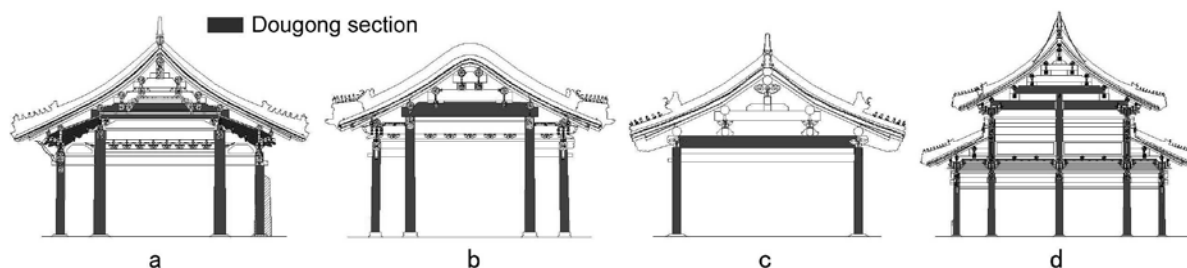


Fig. 11a,b,c,d. Sections of four kinds of structural types

In the Palace Museum, all members of the timber structures are jointed by mortise and tenon(Fig.12,13,14,15). The gaps between the mortise and tenon leave room for movement of the timber members. Under external forces, the joints connected by timber members mobilize friction on the contact surfaces of the mortise and tenon. This friction guarantees the stability of the mortise and tenon joints. Several mortise and tenon typologies can be applied to connect the timber members. Important forms used in the Palace Museum are as follows: pin tenon, dovetail tenon, corner tenon, straight tenon and half tenon. The pin tenon is used to make the column base, and it restrains the column from transversal displacements. In some large-scale constructions, the column is stable due to its thickness and the effect of the walls. The column base and column top are formed to be flat and the pin tenon is omitted, so as to make the construction less complicated.

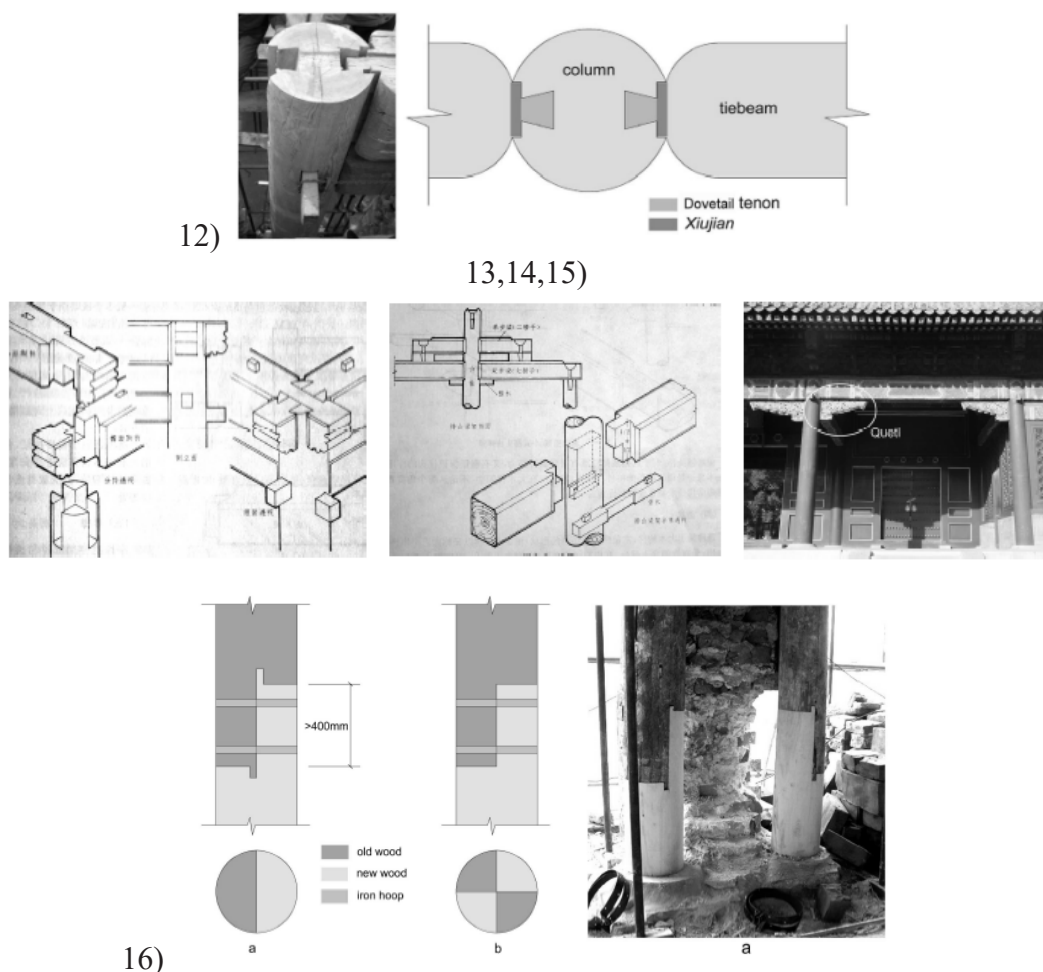


Fig.12 ,13,14,15 and 16. Dovetail tenon and Xiujian, Conner tenon, Half tenon – Queti, Two kinds of Dunjie methods

As concerning the renovation of the timber constructions for timber structural constructions, daily maintenance and renovation are necessary. The common methods including mending, matching, reinforcing, replacing, etc. These methods are applied according to each particular situation. The following specific cases of the renovation and protection of ancient buildings in the Palace Museum will be discussed in detail. According to the result of on-the-spot investigation, many of the wooden columns are rotted only on their bases; and the upper parts are intact. In such circumstance, should preserve the upper part of the column and repair the bases partially, usually by using Veneering method or by Dunjie, thus replacing the column's base, according to the extent of its decay, thus restoring the columns' bearing capacity. *Veneering method*: Generally speaking, the veneering method is used when the degradation happens only on the surface of column bases, while the core is intact and the depth of surface degradation is less than 1/5 of the diameter of the cross-section of the column. To veneer the base of the column, the Japanese chisel is used to cut off the decayed parts, and then the veneering timber is built according to the shape and size being cut off. *The veneering woods should be the same sort of old dried timber as the original column*, and the moisture content should meet the requirements ($\leq 25\%$). If the base of the column is only partially decayed, the veneering timber is used to replace just the missing parts. If the decay circles the column, the veneering timber is used to wrap the surface, with the same diameter of the column, and then reinforce the veneering wood with one to two strips of iron hoop, to ensure the balance of loading force on both original and new timbers. Both of the situations

mentioned above should guarantee the smooth and fully roundness of the column after veneering. *Dunjie method*: When the area of decay is larger than 1/2 of the cross-section, or if the centre of the column is rotten, and the decay of column-out-of-wall is less than 1/5 of the total height, and the decay of column-in wall is less than 1/4 of the total height, the Dunjie method will be used: the column's base will be replaced to recover the bearing capacity of the column. For example the Juanqin Zhai project, the column is embedded in the wall, which was dismantled to carry out the operation. Before the Dunjie operation, the weight was taken off the column, with support posts being placed beside the column, in order to bear the force from the top. Before the operation of Dunjie, supports on the second floor were set between the floor and the floor beam. Then the decay of column-in-rear-wall was examined, the decayed parts were sawn off (sawing action would be stopped rightly when any sound timber was found. The height of Dunjie parts was also controlled, because the higher the Dunjie, the weaker would be the column after the operation. The height of Dunjie should be less than 1/4 of the height of the column. The Dunjie timber requires the same sort of old dried timbers as the original columns'. Thus it is necessary to make sure the moisture content meets the requirement ($\leq 25\%$). The most common operation of Dunjie are "half tenon Dunjie" and "cross tenon Dunjie". "Half tenon Dunjie" (Fig. 16-a) is to cut off half of the diameter of the timber as the overlap parts, and the lapping length should be 1.5 times to the diameter of the column, but not less than 400 mm. Then making tenons on the top of the timbers, each 20-30 mm wide. "Cross tenon Dunjie" (Fig. 16-b) is to cut the original column and the Dunjie timber separately in 4 parts, then cut off diagonally 2 parts and to insert them. Both of the methods of Dunjie require tightness of fit in the joining points. After Dunjie, the joining parts should be bound with two to three strips of iron hoops. The hoops should be embedded into the column, making the surface of column smooth and round, thus to ensure the firmness and stability of the joining points, and to prevent movements in the joining area.

2.3. Example 3:-wood assessment and historical research on timber testing at fort Aams, Newport, Rhode island in USA[3]

Fort Adams, located in Newport, Rhode Island, USA, designed by French military engineer Simon Bernard and American military engineer Joseph G. Totten, was constructed from 1824 - 1857. Construction was overseen by Totten from 1824 through 1838. Built of stone, brick, and timber, the fort served as a testing laboratory for determining the strength of various types of stone, mortar, and timber species. An investigation was undertaken to assess the current conditions of the timber and investigate the historical significance of the testing programs developed by Totten. The following text focuses on three aspects of the project: (1) The timber testing program and its implications for construction of the fort and subsequent timber testing in the U.S. (2) using non-destructive testing to identify causes and patterns of deterioration, and recommending actions to extend the service life of the historic timbers. (3) Correlating the findings of the condition assessment with the published results of Totten's experiments. Using *Field Procedures and Findings and method of the Species identification*: Wood species were identified from various structural members by removing small samples from which the species or species group was identified using microscopic features of the wood. All of the samples removed from structural members within the fort were identified as southern yellow pine (*Pinus spp.*). As concerns moisture content measurements identify wood with favorable moisture levels for the growth of wood-decay fungi. Generally, if moisture content is less than 20 percent wood-decay fungi are unable to grow. Moisture contents from 20 to 30 percent indicate areas of concern where moisture is sufficient for fungi to grow but not sufficient to support long-term active decay. Moisture contents above 30 percent are often an indication of advanced decay with internal voids and/or surface

deterioration. Moisture content measurements were taken randomly throughout the fort with an electronic resistance-type moisture meter. Evidence of moisture damage of the wood and efflorescence of the masonry is prevalent in almost every casemate, indicating high moisture contents within the masonry and the wood (Fig.17). Moisture contents were typically greater than 30 percent, indicating that the wood has a favorable moisture environment for active wood decay. However, the fort's close proximity to the Atlantic Ocean and the presence of efflorescence on the masonry and wood, as well as the presence of "fuzzy" wood (Fig. 18), indicates the presence of salt in the wood, which can dramatically influence moisture content readings taken with an electronic meter. Archival research has also revealed that the engineers at Fort Adams were negotiating with the holders of the U.S. rights to John Kyan's process of treating timber against decay with a "corrosive sublimate" material that likely contained mercury salts, which, if used, would also have an influence on the moisture content readings. Additional testing of material samples, such as chemical analyses and oven-drying samples to attain true moisture content readings will be required to confirm whether the timbers were treated and what effect the treatment had and may continue to have on the performance of the timbers.



17)
Fig. 17. Moisture stains, efflorescence on joists within a corner casemate and arch;



18)
Fig. 18. Fuzzy (PUH,MAH,ZACAPAN,NEYASEN) wood on a timber joist along the west wall

2.3.1. Visual inspection, probing, and decay quantification

Visual inspection, used in combination with probing the wood with an awl, allows for the rapid identification of missing or broken elements as well as voids, incipient decay, and advanced decay present near the surface of the wood. For the quantification of internal deterioration, resistance drilling must be used. Resistance drilling, a quasi-nondestructive technique, is used to identify and quantify internal voids and decay by determining the relative density profile of the wood. At the fort, a combination of visual inspection, probing, and resistance drilling was used to identify and quantify deterioration in the structural timbers. Wood conditions found within the fort were divided into three classifications: good, fair, and poor. Good condition describes wood that may exhibit moisture staining and/or efflorescence but is not structurally impacted and has no evidence of insect damage or deterioration from wood decay fungi. Wood in fair condition may have minor insect damage and may also exhibit evidence of past moisture damage, including minor deterioration from wood decay fungi. Wood in poor condition may have severe visible insect damage and may also exhibit ongoing deterioration caused by wood decay fungi. In general, most of the structural members within the fort were found to be in fair to good condition along their lengths; areas of poor condition tend to be limited to the bearing areas. In a few instances, the structural members are in extremely poor condition and have failed due to deterioration caused by wood decay fungi (Fig. 19). Some of the posts are "brooming" at the base due to a combination of high moisture content and deterioration by wood decay fungi (Fig. 20).



Fig. 19. Deteriorated girder and joists within a casemate.



Fig. 20. Brooming at the base of a column.

2.4. Example 4: Mosques with wooden construction – south of East Azerbaijan province, functions and methods of conserving[4]

Wooden mosques of the south region of Azerbaijan have specific characteristics and being built in different towns such as Maraghe, Bonab, Ajab- Shir, and Qoravan village[4]. The local materials are wood, stone, brick, and adobe. Pillars and beams were made of poplar, species of willow, and aspen. Although wood was rare in the region and structure of the buildings were arch and dome, wooden construction became popular and common for the aesthetic characters and beginning of new style in Safavid period (17th Century). As is well known, wooden pillars and columns were used in Shabestan and walls. All pillars play the role of the structure and the ornaments are the parts of the construction. Pillars were constructed in 3 parts: base, wooden body, and capital in different forms. The main beams, pillars, sub beams, all, were made of wood and joints had special characteristics which add to the resistance of the building. In this study Bonab Mehrabad mosque is highlighted(Fig. 21a,b,c).

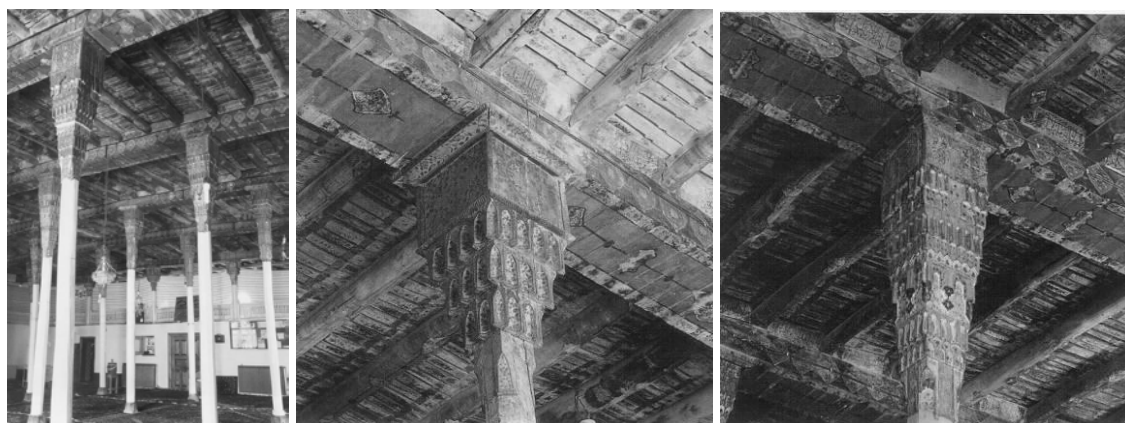


Fig.21a,b,c. Chamber(Shabestan) of Mehr- abad mosque;
Sample of capitals in Mehr- abad mosque- Bonab

The wooden structures of Azeri architecture can be observed in the West of Iran like Maragheh, Bonab, Ajabsher, Gougan. As it was mentioned this style has been used in Isfahan at the time of ruling shah-abbas and it has been imitated in many glorious Safavids palaces.(Fig.21). The foundations of wooden mosques are located in the depth of 1.5 m and by the dimension of 1.70*1.50 cm. The only decoration of the walls is perforated mud brick works with keel shaped arches. Some of them also are made of stone with the height of 90 to 150 cm and the local Sinjan stones. *The columns and the level ceiling of the mosques are all made of wood.* The height and stem of trees, poplar (Tabrizi) and aspen

trees used to cover the columns, ceiling, beams and the main beams. The main function of the wooden columns is structural and decorative. All the columns have three parts: column base, column body and capitals (Fig. 22a,b).

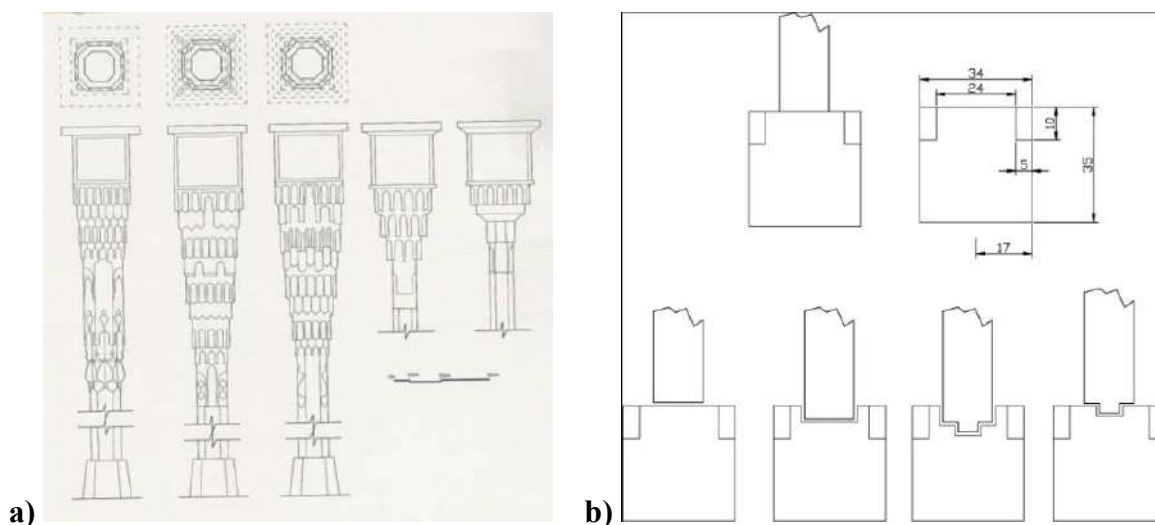


Fig. 22a,b. a) Capitals of Mehr- abad Mosque- Bonab; b) The method of arranging pillars on stone

The column bases are all made of stone and in different mosques have different forms and thickness(Fig.22b). The form and shape of the column bases are circle, square, and hexagon, but the bases are generally square on the floor and the upper part is hexagon. The material of the mentioned column bases is all black and white sedimentary stones or engraved marbles. The bases have been located on foundations that their dimension is about 1.5*1.5 m and the estimated depth is 80-90 cm. Connection of the stone bases to the foundation: flat; mortise and tenon. The column is directly located on the stone and there is no connection or mortar between the bases. The load which is transferred from the column to the base keeps the column body firm on the base. The end part of the column body is located on the mortise of the stone base which is different in the mosques. This connection is called mortise and tenon. In this connection like the flat one, there is no connection and mortar; however, in rare cases there is a space between the connections which mostly has been considered for expansion and contraction. The last part could be located inside a special pad. As the height of the column increases, its volume increases too. In high caps, this combination or increasing the volume of the caps from down to the top is influential in dividing the load. The diversity in columns and column caps in addition to showing the ability of the carpenters, could create diversity and movement in the space. Generally the caps of the columns in the mosques are divided to five groups according to their stalactite works. The column caps with rectangle section or square with decorative arches are decorated in the form of a horn of the goat. Column caps with rectangular or square section with sharp arches such as Mehrabad and Kabood mosques in Bonab. Caps which have changed from rectangle to circle. As mentioned, most of the columns are lead to the cubic wooden box where the pad) of the column cap is located on it.

2.4.1. Example 4.1-about the Mehr-Abad Mosque in Bonab[4]

One of the mosques of the region with wooden columns is Mehr-abad mosque in Bonab which has been located in the eastern side of Motahhari St. Mehrabad is one of the old allies of Bonab and the mosque is called by the same name. A stone

inscription clearly shows the date of construction and the builder of the mosque. Totally, there are four stone inscriptions in the northern walls of shabestan and eastern wall. The building date has been mentioned in two inscriptions. Considering the date, the mosque has been built in Safavid era (17 Century). The mosque has only one minaret that mostly it is built in Qajarid era. It is located in the eastern wall and the southern part of the entrance. It is decorated with small blue, azure, yellow, green tiles and geometrical designs. Mehrabad mosque is rectangular and it develops north-south that includes main parts such as shabestan with columns, terrace or women's part, porch, nave, howzkhane, and ablution place, etc. To enter the mosque, there are two porches that they are related to each other through the lane and yard of the mosque. The dimension of shabestan is 18.80 x 19.60 m. and it has 36 columns. Twenty of the columns are in the middle space and 16 of the half-columns are in women part and balconies. The columns of the middle part are located in four rows with five columns and all of them have caps with stalactite works. All the columns are wooden and hexagon with the height of 4.75 m. The bases are similar to the columns of the other mosques; made of stone and polygonal; however, the caps are different. they have different designs, colors and drawings. Generally, stalactite works include the deep and semi-deep arches and the volume of those works increases upwards(Fig.23a and Fig.23b).

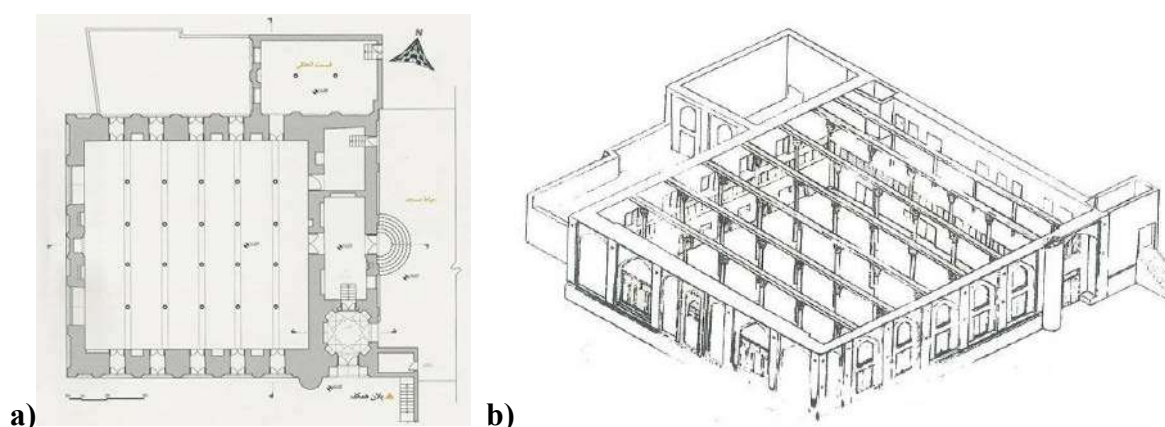


Fig. 23a,b. Ground floor plan Mehr- abad mosque;
Perspective section Mehr- abad mosque - wooden structure

As concern the pathology of wooden structures in mehrabad mosque in Bonab, we can say that the main element of damage on the body and decoration of Mehrabad mosque is decay of the materials, overloading and humidity in the inner spaces. Overloading, decay of the materials and the foundation because the columns lose their stability, bend, and the stone bases are moved. To solve the problem, piling the columns, replacing the stone bases, and enforcing the foundation was carried out(Fig.24a,24b). Then the columns and the stone bases are returned to their former position. The other problems include the breakages in wooden parts of the column caps, and the boxes because of the pressure inserted through metal joints (nails) and lack of resistant against the inserted pressures. In this stage, by using the piling and raising the main beams, the caps are separated from their original place; so, some of them are repaired and some are renewed. The loose parts are restored and the metal joints are fixed. In the parts that wooden parts were decayed, these parts are changed and the caps are restored on their original place.



Fig. 24a: Collapsing the decayed foundation and restoration of the foundation

Fig. 24b: Restored foundation and stone base

2.5. Example 5: Development of an in situ repair strategy for the timber roof of the breeding barn at shelburne farms

Shelburne Farms quickly became one of the most ambitious model farm operations in the U.S.A(Fig.25a) The Breeding Barn at Shelburne Farms, a National Historic Landmark, is dominated by its complex-sloped 8094 m² hipped roof with multiple dormers and an enormous central lantern. The timber-framed building has a main block that is approximately 32.6 m wide by 127.4 m long, with a two-story annex centered on the rear facade. The main interior feature is the riding ring, approximately 22 m wide and 114 m long, constructed for daily exercise of the horses. The roof system over the riding ring consists of a series of composite principal trusses of iron and timber, supporting a deck of timber purlins and common rafters. Trusses are supported on timber columns around the perimeter of the riding ring and bear most of the roof weigh(Fig.25b). Construction was begun in August of 1890 and by December 1891 the building was nearly complete. The barn, designed by architect Robert Henderson Robertson, was the center of Seward Webb's horse breeding operation, one of the largest in the country. **Strengthening of the wooden columns was done by cutting of the decayd part and substitute by with new wooden part(Fig.25c).** New column bases were placed on limestone plinths and white oak shims, elevating them above a concrete floor installed in the mid-20th century (left). In four cases, column splices were made at the aisle level, requiring renewal of girt joinery and replacement of the girts on either side (right))25d).

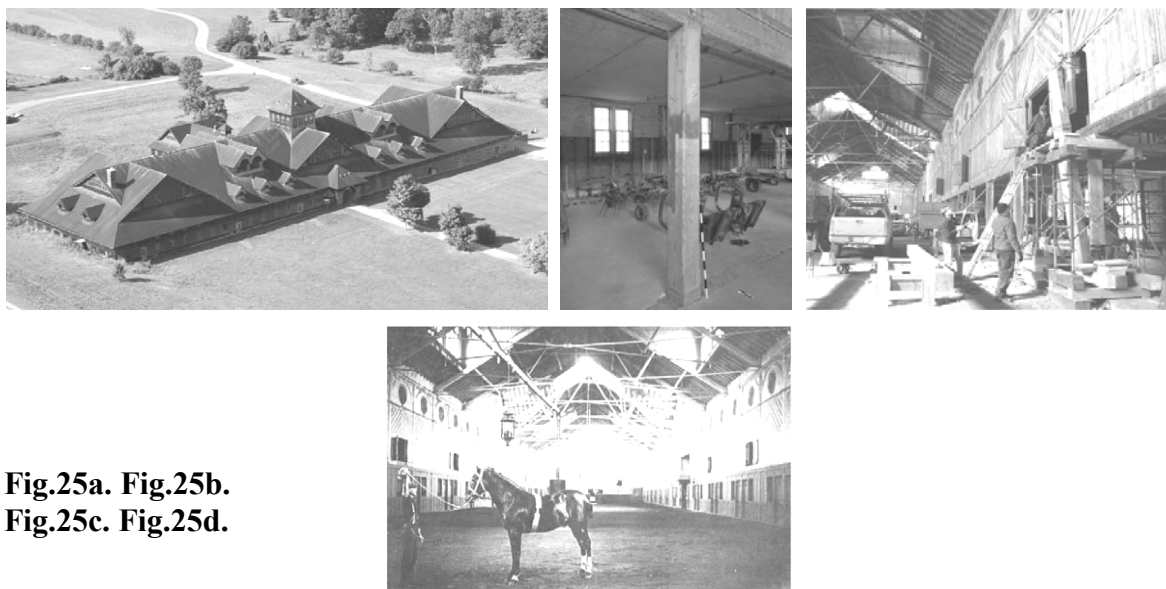


Fig.25a. Fig.25b.
Fig.25c. Fig.25d.

Conclusion

The proposal for a design-construction solution for the rehabilitation of wooden columns in the naos of the church Sv. Uspenie Bogorodicno", taking into account the high pressures in them, the disturbance of the wood structure at the lower end and the unfavorable humidity and temperature conditions for many years of work will be done in several option according the above mentioned examples. For our cases, however, the most commonly applied solutions are the dentures of columns with wooden dentures which reach 1-2 m height.

Acknowledgement

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SEISMIC RISK IMPACT AND MITIGATION PLAN OF URBAN HABITATS: A CASE STUDY

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Abstract: *This study attempts to perform seismic vulnerability assessment of a sub-urban sector of the historic centre of Sant'Antimo, a district of Naples (Italy), in order to assess the expected damage scenarios as a consequence of seismic events. The vulnerability analysis is carried out by means of an index-based methodology integrated into a GIS tool, in order to identify the Structural Units (S.U.) most susceptible at damage due to earthquakes. Furthermore, the prediction of the possible damage scenarios, by changing magnitude and epicentre distances, is adopted for the loss quantification in term of collapsed and unusable buildings and human casualties. Finally, once identified the risk, a set of retrofitting techniques are considered and examined taking into account their contribution for the reduction of the seismic vulnerability of the sample of buildings analysed.*

Keywords: *Vulnerability assessment, seismic risk mitigation, seismic attenuation law, expected damage scenario, loss estimation, retrofitting techniques.*

1. Introduction

Seismic risk can be understood as the combination of three factors, Exposure (E), Vulnerability (V) and Hazard (H). The large-scale seismic risk is a useful tool for assessing the susceptibility of clustered buildings of historical centres to exceed, in a specific period of time, a certain seismic event of an assigned intensity. As a result, a model for vulnerability assessment and for evaluation of economic and social losses would not only be able to estimate future potential losses due to the occurrence of earthquakes affecting a given region, but it should also be used to prepare and implement risk mitigation measures [1]. To this purpose, in the framework of the vulnerability assessment, the proposed study provides important indications in order to estimate the seismic impact effects in terms of spatial damage distributions on a built area of Sant'Antimo, a town in the province of Naples.

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2. Typological classification of buildings exposed at risk

Sant'Antimo is an Italian town with 33.905 inhabitants sited 16 km far from Naples, the capital city of the Campania region (Fig. 1).

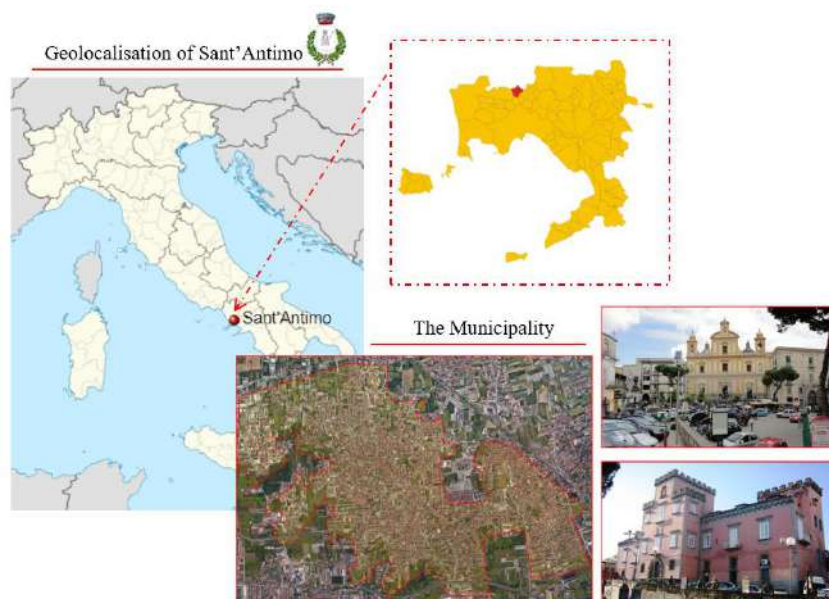


Fig. 1. The city of Sant'Antimo in the Campania region of Italy.

In the historical centre of Sant'Antimo a sub-sector composed of 42 clustered buildings with 153 inhabitants has been considered as a case study. According to the Building Typology Matrix (BTM) [2] in the examined sub-sector two different typological classes have been identified: class M3.3 for masonry structures with composite steel-hollow tile floors (in 36% of the cases) and class M3.4 for masonry structures with reinforced concrete floors and roof (in 64% of the cases) (Fig. 2).

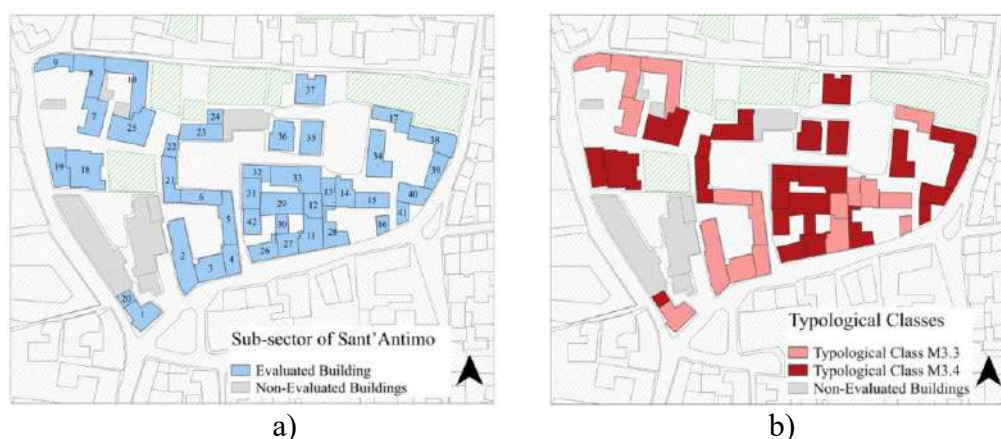


Fig. 2. Numbering (a) and typological classes of clustered buildings in the sub-sector of Sant'Antimo examined.

3. Seismic vulnerability assessment

Aiming at implementing a quick seismic evaluation procedure for masonry clustered buildings, a novel vulnerability form has been herein implemented for the study area [3], [4]. This new form is based on the Benedetti & Petrini's vulnerability index method [5], widely used in the past as a rapid technique based on the collection of some features of individual buildings to investigate their vulnerability in case of earthquake. Methodologically, the procedure is based on the calculation for each S.U. of a vulnerability

index, I_v , as the weighted sum of scores multiplied by weights related to 15 parameters. These parameters are distributed into 4 classes (A, B, C and D) having a score, S_i , with growing value from A to D. Each parameter is associated to a weight, W_i , that can range from 0.25 for the less important parameter to a maximum of 1.20 for the most important one.

The vulnerability distribution in the study area is illustrated in Fig. 3a, while the mean vulnerability curves associated to the typological classes inspected are shown in Fig. 3b.

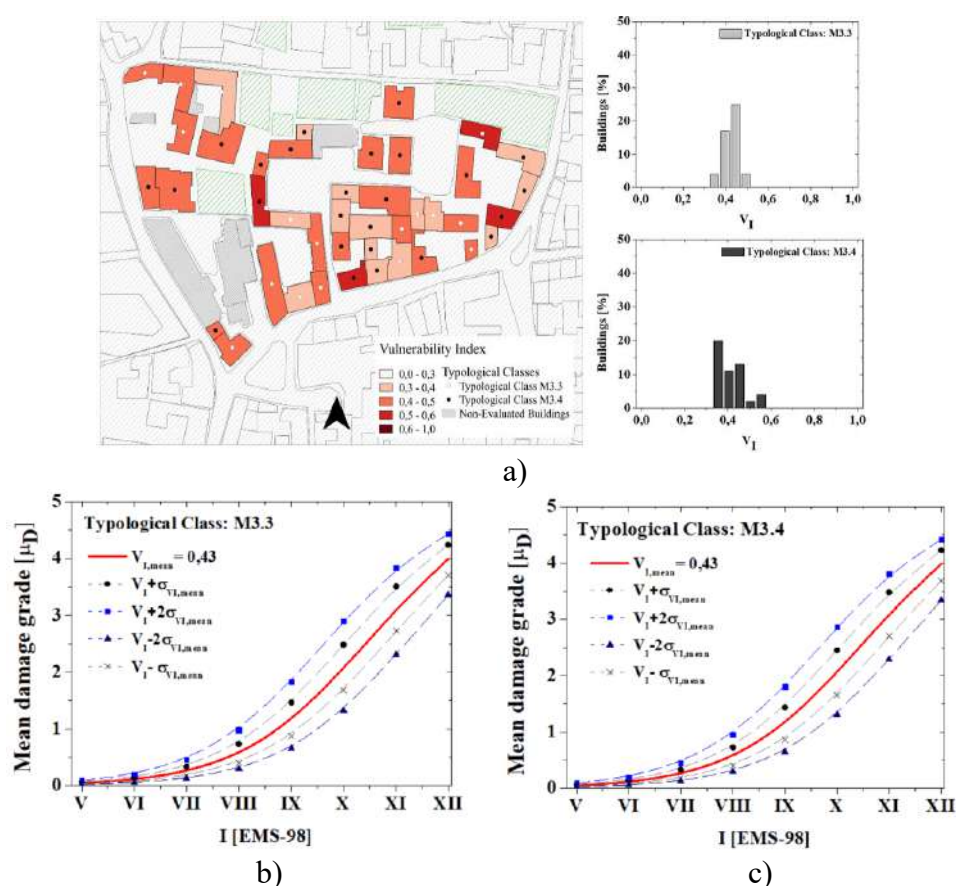


Fig. 3. Spatial vulnerability distribution in the study area (a) and typological vulnerability curves for M3.3 and M3.4 typological classes (b).

From the application of the vulnerability index methodology, it can be seen that in the study area the distribution of vulnerability indexes is quite homogeneous with an average value of 0.43 for both the typological classes analysed (see Fig. 3a). The standard deviation (σ_i) associated to the vulnerability index distributions for the analysed typological classes M3.3 and M3.4 is respectively 0.048 and 0.062. The synthetic representation of the statistical data has shown how the frequency distribution of vulnerability indexes provides for the typological class M3.3, 25% of buildings with a vulnerability index of 0.45 and 8% of them with an index of 0.35. On the other hand, for the class M3.4, 20% of buildings have a vulnerability index of 0.35, while 4% of them have an index of 0.55.

4. Parametric damage scenarios

The proposed study is based on empirical forecast analysis, which allows to estimate the probable damage scenarios by means of the disaggregation of the seismic hazard for the N-sources combined. Such a procedure is usually obtained by correlating each moment magnitude, M_w , to the site-source distance, R , for evaluating the global hazard. According

to the seismic hazard map proposed by National Institute of Geophysics and Volcanology (INGV) [6], the city of Sant'Antimo is characterized by a maximum expected PGA of 0.25 g (medium-high seismicity) with a probability to be exceeded of estimated 10% in 50 years. Furthermore, based on the disaggregation of the PGA's, the maximum moment magnitude, M_w , is 5.15.

Thus, the seismic damage severity is addressed in this work on the basis of appropriate analyses performed according to the seismic attenuation law proposed in [7], which estimates the seismic damages suffered by the built-up under different epicentre distance. The correlations obtained between moment magnitude, M_w , and macroseismic intensity, I_{EMS-98} , for different epicentre distances, R , are provided in Table 1.

Table 1 Correlation between moment magnitude and macroseismic intensities for different site-source distances.

Magnitude M_w	R= 7 [km]	R= 21 [km]	R= 35 [km]
	Macroseismic Intensity I_{EMS-98}		
4	IX	VI	V
5	XI	VIII	VII
6	XII	IX	VIII

Therefore, nine damage scenarios to evaluate the damage parameter, μ_D , of buildings investigated in the study area have been obtained. For the sake of example, the most severe analysis cases are shown in Fig. 4 for a moment magnitude equal to 6 and different epicentre distances.

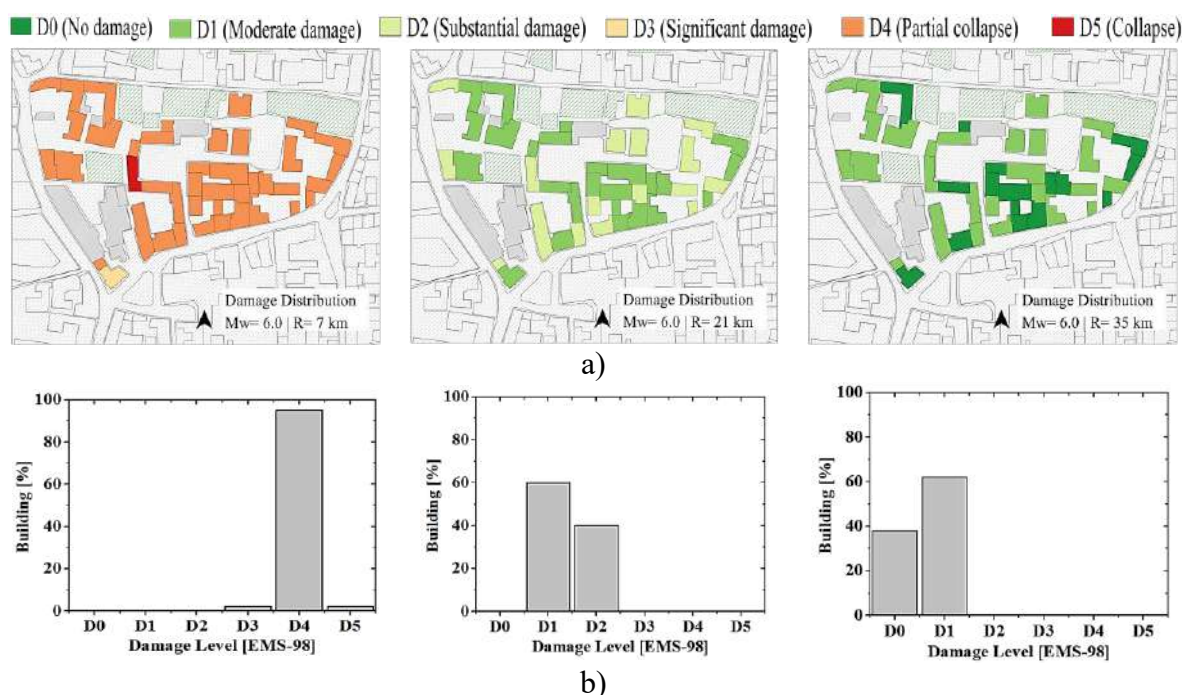


Fig. 4. Damage scenarios in the study area (a) and spatial distribution of detected damages (b).

From the previous figure it is apparent that the damage level mainly depends on the site distance from the seismogenic source. In particular, it is possible to note that, when increasing the magnitude, the expected damage tends to increase progressively.

5. Retrofitting techniques for risk mitigation

Although historical masonry buildings work satisfactorily under service loads, they can be severely damaged in the presence of high lateral loads, such as earthquake inertia forces. The demolition and replacement of these old structures is generally not feasible due to the enormous effort and cost of the new constructions.

Consequently, for risk mitigation, especially in areas with high population density, retrofit strategies are a solution to reduce the seismic emergency problem. In the specific case, in order to improve the buildings behaviour also in a cost-effective perspective, two distinct solutions are taken into consideration: steel tie rods (TR) [8] and floor shear connectors (FSC) (Fig. 5).

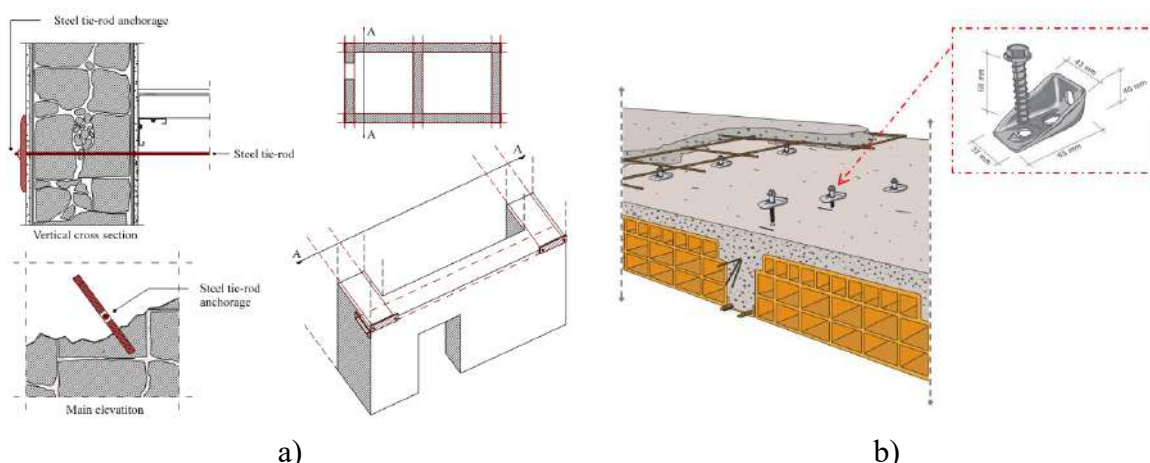


Fig. 5. Mitigation interventions: steel tie-rod (a) [12] and floor shear connectors (b).

The peculiarity of these methods is to guarantee a good structural performance under seismic conditions. Specifically, the TR system guarantees an important constraint between perimeter walls, a prerequisite for the survival of the building to seismic actions. Generally, this intervention technique consists in using a steel tie rod with a diameter between 16 mm and 20 mm, to connect horizontally the walls, which are anchored by means of metal plates in order to guarantee a box behaviour of the structure (see Fig. 5a). On the other hand, the use of shear connectors together with a new RC slab armed with a steel mesh allows to increase the height of the floor height, avoiding therefore the formation of cracks induced by the flexural regime (see Fig. 5b).

The proposed intervention techniques (PI=TR+FSC) have been indistinctly applied to all buildings in the study area.

In methodological terms, this can be done by reassessing the vulnerability classes, S_i , of the parameters that are related to those features, namely Parameter 1, which evaluates the organization of the vertical structures, Parameter 7, which assesses the horizontal diaphragms, and Parameter 8, which deals with the roofing system. Thus, the buildings have been virtually retrofitted and the effects of proposed interventions have been considered reducing the original vulnerability indexes and, consequently, their mean damage grade values, μ_D (Fig. 6).

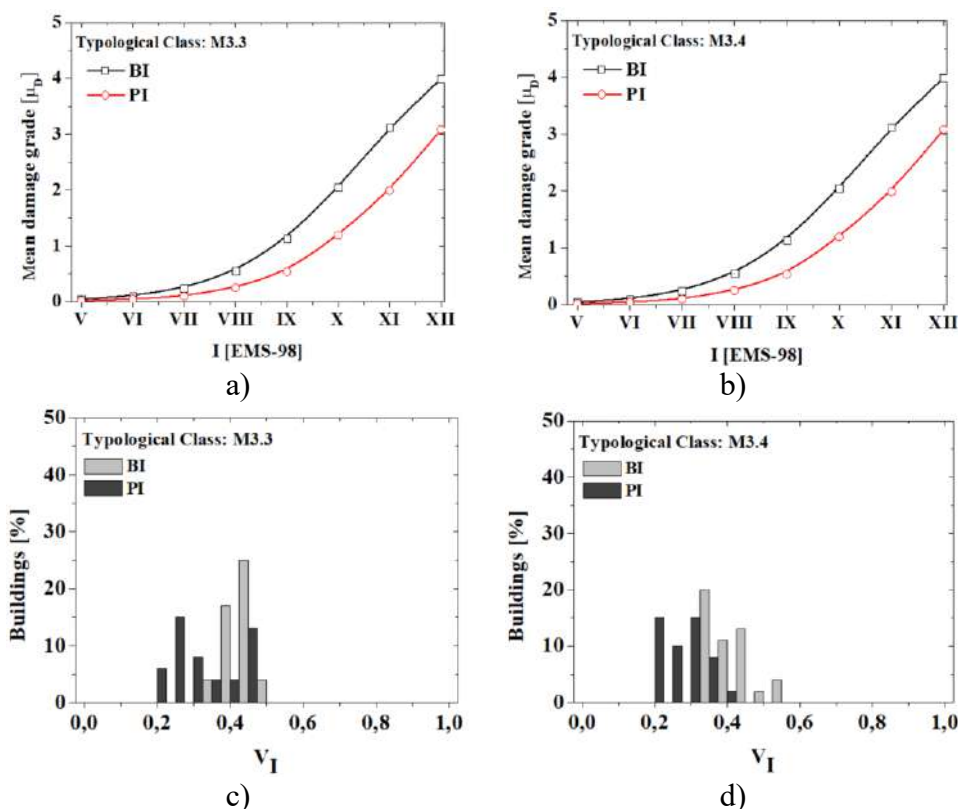


Fig. 6. Comparison between mean typological vulnerability curves before (BI) and post (PI) interventions (a, b) and vulnerability distributions for the building classes examined (c, d).

From the results achieved, it is possible to see how the retrofitting strategies taken into account are able to improve the global behaviour of the building samples. In particular, there is a vulnerability reduction of about 39% for both typological classes. Statistically, the standard deviation provides a measure of the magnitude of the sample variation examined, with a reduction of 4.16% and 11.29% for typological classes M3.3 and M3.4, respectively.

Furthermore, adopting the same criterion followed in Section 4, the worst-cases damage scenarios have been presented aims in the PI condition (Fig. 7).

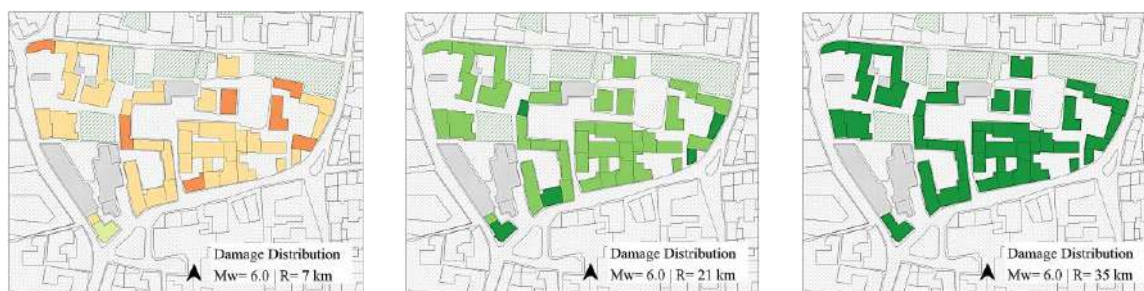


Fig. 7. Worst-cases damage scenarios considering the proposed retrofitting strategies.

Subsequently, the consequences of seismic events in terms of collapsed and unusable buildings have been evaluated following the empirical correlations proposed for the Italian territory in [9] on the basis of the observed damages. Thus, the probabilities of collapsed and unusable buildings have been estimated for the damage scenarios analysed (Fig. 8).

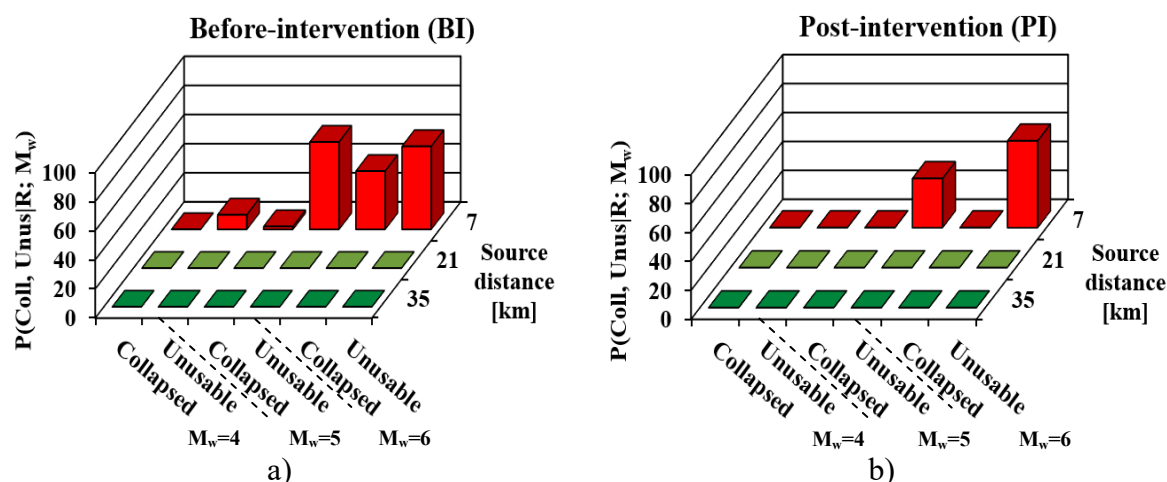


Fig. 8. Estimation of collapsed and unusable building before (BI) (a) and after (PI) (b) interventions.

From the results obtained, it has been seen how the two retrofitting solutions provide a significant reduction of expected losses. In fact, focusing on the worst-case scenario ($R=7$ km, $M_w=6.0$), we moved from a situation where about 40% of buildings are expected to collapse to a situation without any collapse.

Moreover, identified the number of collapsed and unusable buildings, it has been possible to estimate casualty rates, that is number of deaths and severely injured people, and homelessness. The number of deaths and homelessness have been computed for buildings expected to suffer partial (D4) or total collapse (D5) and in the cases of substantial (D2) and significant (D3) damages or partial collapse (D4), respectively [10]. According to the model proposed, the simulation of the casualty rates has been achieved (Table 2).

Table 2 Estimation of casualty rates before (BI) and post (PI) interventions

Source distance R [km]	Number of casualties and homelessness (BI)					
	$M_w=4$		$M_w=5$		$M_w=6$	
	Deaths	Homelessness	Deaths	Homelessness	Deaths	Homelessness
7	-	-	3 (2%)	92 (60%)	64 (42%)	87 (57%)
21	-	-	-	-	-	-
35	-	-	-	-	-	-
Source distance R [km]	Number of casualties and homelessness (PI)					
	$M_w=4$		$M_w=5$		$M_w=6$	
	Deaths	Homelessness	Deaths	Homelessness	Deaths	Homelessness
7	-	-	-	52 (34%)	10 (7%)	92 (60%)
21	-	-	-	-	-	-
35	-	-	-	-	-	-

As it can be seen from the gotten results, referring to the worst-case scenario, there is a strong reduction (about 85%) of casualties after retrofitting interventions.

6. Concluding remarks

In the paper a seismic damage forecast model has been proposed for a built-up area of Sant'Antimo, a town in the district of Naples. Based on the seismic hazard map of the study area, a deterministic approach based on the selection of a set of magnitudes (M_w) and

epicentre distances (R) has been applied aiming at evaluating the influence of these factors on the seismic damages suffered by clustered buildings in the inspected urban habitat.

The results obtained have shown that, as expected, for distances very close to the site of interest, the damage increases with increasing seismic intensity. In fact, for $R=7$ km and $M_w=6$, the most severe scenario (57% of unusable buildings, 40% of collapsed building) has been achieved, it being characterised by 64 casualties and 87 homelessness.

Subsequently, two risk mitigation techniques, namely tie rods and shear connectors for floors, have been used to reduce the seismic vulnerability of buildings in the investigated urban sub-sector. From a critical comparison of results in terms of losses before and after these interventions, it has been noted that the proposed retrofitting systems reduce the number of casualties of about 85%. In the cases of site-source seismogenic distances of 21 and 35 km, the earthquake effects before and after interventions have not caused any losses and homelessness. In conclusion, the presented work has shown the high seismic vulnerability of the study area and it can be used as effective tool to implement emergency management plans.

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**CHURCH OF SAINT THEODORE,
BOBOSHEVO, PROVINCE OF KYUSTENDIL**

A survey and project for conservation and restoration

Architecture: Arch. Hristo Ganchev¹, Arch. Yuliy Farkov², Arch. Vladislav Kolarov³

Structure: Anton Maleev, engineer

Frescoes: Iliya Nikolov, Nina Nikolova

Abstract: *The proposal for a complex approach was described in the report in 2016 regarding the surveying and development of a project for reinforcement, conservation, and restoration of the architectural and artistic values of the mediaeval church of St. Theodore – a typical representative of the archetype dating from the period of the second flowering of Byzantine architecture (867-1204 CE). The characteristics are described, and it is noted from the ruins that have remained up to this day that the church is a cross-in-square domed building of the square dome type with freely extending cross arms. The frescoed decoration has been preserved in fragments in two painted layers dating from the twelfth and fourteenth centuries. The technical condition is marked, and it is noted that the stability of the constructional and artistic structures is compromised, despite the partial reinforcement works carried out over the last sixty years. On the basis of these findings, a multidisciplinary set of problems has been set out relating to the preservation of this value. The methodological grounds and arguments for the proposed solution are summarised and comprise several major areas. In relation to the architectural appearance, it is noted that a significant part of the superstructure has been preserved, which gives sufficient grounds for the analysis, and motivates the restoration of the tectonic and decorative structure according to authentic information. This permits the structural reinforcement of the building to be integrated into a restored architectural appearance whilst preserving the authentic architectural impact. Regarding the preservation of the artistic values, an integrated programme of conservation and restoration interventions is proposed. The aspects relating to the elements of the environment and the cultural landscape have been clarified, and the authors consider that the restoration of the church will also restore the structural and spiritual significance of the church as part of a series of religious sites in the area of the Struma River. The proposal for a complex approach was described in the report in 2016 regarding the surveying and development of a project for reinforcement, conservation, and restoration of the architectural and artistic values of the mediaeval church of St. Theodore – a typical representative of the archetype dating from the period of the second flowering of Byzantine architecture (867-1204 CE). The characteristics are described, and it is noted from the ruins that have remained up to this day that the church is a cross-in-square domed building of the square dome type with freely extending cross arms. The frescoed decoration has been preserved in fragments in two painted layers dating from the twelfth and fourteenth centuries. The technical condition is marked, and it is noted that the stability of the constructional and artistic structures is compromised, despite the partial reinforcement works carried out over the last sixty years. On the basis*

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of these findings, a multidisciplinary set of problems has been set out relating to the preservation of this value. The methodological grounds and arguments for the proposed solution are summarised and comprise several major areas. In relation to the architectural appearance, it is noted that a significant part of the superstructure has been preserved, which gives sufficient grounds for the analysis, and motivates the restoration of the tectonic and decorative structure according to authentic information. This permits the structural reinforcement of the building to be integrated into a restored architectural appearance whilst preserving the authentic architectural impact. Regarding the preservation of the artistic values, an integrated programme of conservation and restoration interventions is proposed. The aspects relating to the elements of the environment and the cultural landscape have been clarified, and the authors consider that the restoration of the church will also restore the structural and spiritual significance of the church as part of a series of religious sites in the area of the Struma River.

1. Architectural survey – archetype

The Church of Saint Theodore is located 2 km north of the town of Boboshevo. The archetype and some particularities in the construction technology (which will be described later) provide the grounds for the authors to presume that the church was built during the period of the second flowering of Byzantine architecture (867-1204 CE) – more precisely, during the eleventh century. A particular characteristic of Byzantine architecture is the decorative richness and sculptural expressiveness in a unified architectural design that combines and is subservient to an organic link between arches, vaults, and domes. The so-called tectonics (the harmonious unification of structural form, function and systematics with artistic and aesthetic symbolism and significance) of the buildings is additionally accented by the decorative impact of the materials used in the different elements, so that in this way an integrated whole is achieved in the artistic impact (fig. 1).

St. Theodore's Church is a typical representative of the archetype of this period and comprises a cross-domed building in its cross-in-square form with freely extending arms of the cross (fig. 2). This type dates from the ninth century and was widely used in the construction of small churches, as in the case of the site being researched here. The length is 7.40 m, and the width is 6.30 m. The dome has collapsed, but it rested on a cylindrical drum with four windows along the directions of the arms of the cross. The church is built of stone, while the dome and vaults are made of brick. In the dome, the brick construction was carried out using the technique of "concealed" or "sunken" brick, where the bricks are plastered in alternating rows. This creates a decorative system with a ratio of brick to grout of 1:2. The stone construction is mixed with brick fragments with an even grout (the surface of the façade is flush with the plasterwork that covers the concave parts of the stone, while the convex parts are left visible) (fig. 3). The clearly defined openings along the facades and the drum are particularly characteristic, being formed with brick or stone framework and with facing bricks in their depths. The generally accepted intended use of these openings is to support the construction scaffolding where, in their standard formation, they are closed off with bricks or stones as part of the general decorative scheme, remaining concealed and difficult to discover. In the case of St. Theodore's, they have been left open and are clearly formed with stones or bricks. And so, in their tectonic sense, they have acquired an independent significance and have become a part of the overall architecture. In the opinion of the authors, apart from their intended use related to the construction process, these openings were also intended for airing out the masonry structures during use of the church. The characteristic of the construction work using not well-shaped stones supplemented by brick fragments, non-homogenous sealing and a dense grout provides the prerequisites for penetration and retention of highly capillary

damp in the walls. That is why these openings could have helped to ventilate the building and quickly remove the damp (fig. 4).

2. Condition and authenticity

The church has reached the present day in ruins.

No systematic care has been taken of it. In 1962, a wooden protective cover was built over it, which was renovated in 2012-2013 with a metal framework and plank sheath. Over the nearly ten centuries of its existence, the church has undergone a series of repairs and attempts to shore it up, including using earthworks, additional sealing of the tops of the walls, patching, reinforcement of the frescoes, laying of cement foundations for coverings, etc. All these constructional interventions have wiped out the original substance of the church and the immediate surrounding area.

We garnered information regarding the preserved original structures of this cultural monument from preserved archival photographs from the end of the nineteenth century and the beginning of the twentieth century (fig. 5). As regards the interventions carried out and the preserved parts of the building, as well as the availability of authentic data, we made our judgements from the survey carried out on-site regarding:

- Materials and substances that have been preserved: the main structure (load-bearing side walls of the vaults, part of the vaults, pendentives, drum of the dome) and fragments (arches above the windows of the drum, the bays of the vault of the bema (sanctuary), the original floor level, partial remains of the walls and figuring of the facades, the openings for scaffolding and ventilation;
- Traditional techniques: the general principles of the tectonics in Byzantine architecture and the synthesis of the sculptural and decorative systems, and the connection between the dome and the vaulting via a drum set on pendentives have been established; the appearance of the vault structure in the facades; the characteristics of the “sunken” or “concealed” brickwork, plastered and forming a wide grout; mixed walling made of stone and bricks;
- Symbolic/metaphorical sources of information: a conformity with the characteristics of Byzantine churches of the same type and historical period was discovered together with the proportional relationships (2:3 ratio of width to height of the interior space, and 1:1 ration of width to height in the exterior measurements of the church); analogous details (cornices, shaping of the windows); the type of roofing elements and other details (fig. 6 and fig. 7);

Technical condition: the stability of the building is generally ruined as a result of serious destruction and compromised or weakened connections between the load-bearing elements; the stability of the structures themselves is in a critical state due to ruin and weakening of the strength of the mortar; the grouting of the facades has lost its structure everywhere; poorly implemented patching and reinforcement with unsuitable sealings; erratic earthworks (fig. 8).

3. Theoretical grounds for the methodological approach

- In relation to the church:

The accepted methodological approach is regulated in the Cultural Heritage Act as “reconstruction in an authentic way” (§ 4, p. 15 Supplemental provisions of the CHA), namely: “partial rebuilding on the basis of graphic, textual, photographic documentation and other sources that provide information about the form and design, the materials and the substance, the use and function, tradition and techniques, location and situation, spirit and mood/feel and other internal and external factors”. The proposal is in accordance with the directives of the Venice Charter (1964-1965), more precisely: “[the] aim [of restoration] is to preserve and reveal the aesthetic and historic value of the monument and is based on respect for original material and authentic documents”, and is in complete synchronicity with the philosophy and definitions of the Nara Document on Authenticity (1994), namely: “Depending on the nature of the cultural heritage, its cultural context, and its evolution through time, authenticity judgements may be linked to the worth of a great variety of sources of information. Aspects of the sources may include form and design, materials and substance, use and function, traditions and techniques, location and setting, and spirit and feeling, and other internal and external factors. The use of these sources permits elaboration of the specific artistic, historic, social, and scientific dimensions of the cultural heritage being examined”. This document defines sources of information as “all material, written, oral and figurative sources which make it possible to know the nature, specifications, meaning and history of the cultural heritage.”

- In relation to the surrounding space:

The principle of “integrated conservation” is accepted, which “includes various measures aimed at enshrining cultural heritage as part of a corresponding environment created by Man and Nature, where the usage and adaptation of the heritage sites are for the needs of society (§ 4, p. 10 Supplemental provisions of the CHA). This regulation is in the context of the doctrine of sustainable development within the spirit of the following documents: European Charter of the Architectural Heritage; The Declaration of Amsterdam; Congress on the European Architectural Heritage; Resolution 76 (28) of the Committee of Ministers; the Grenada Convention; Guiding principles for development of legislation and management systems for cultural heritage; Leading principles for sustainable territorial development of the European continent, 2000, Recommendation (2000) 1 of the Committee of Ministers.

4. Proposal for interventions to the cultural monument

- In relation to the church (fig. 9 and fig. 10)

Based on the cited theoretical, methodological and legal regulations, the proposed project plans for partial reconstruction and restoration according to authentic information. The proposal is predicated on respect for the preserved original substance and type of material (Venice Charter). It envisages preserving all the elements corresponding to the criteria for authenticity as set forth in national legislation and international documents. It is proposed that the obviously inconsistent interventions be removed. Restoration of the architectural look of the façade design and the impact of the interior is based on the preserved original elements and symbolic/metaphorical sources of information (pursuant to the Nara Document on Authenticity). The planned actions are directed towards:

- Restoring the lost tectonic link between the architecture of the exterior and the interior, and the general tectonic structure of the church (vaults and load-bearing walls) by correcting them in relation to the organic

connectivity of the elements in the Byzantine tectonic system and its decorative impact;

- Restoring the unity and connectivity of the structure of the building by building up the wells with mixed masonry (stone and bricks) and vaults with bricks, and so returning the original scale of the walling with bricks corresponding to authentic Byzantine sizes: 34.5x34.5x4.5 cm;
- Restoring the authentic chromatic-decorative impact of the facades on the basis of research into the composition of the original mortar and the formation of the facades of the lower register typical of the church (mixed masonry) with the flush grout and the profile and structure of the grouting at the enveloped brickwork of the drum;
- Restoring the authentic structure of the windows;
- Restoring the authentic look of the roof covering with single-curve roof tiles;
- Restoring the entrance opening on the west façade with the original stone architrave demolished in front of the entrance to the church;
- Restoring the stone courtyard surrounding the church.

- In relation to socialisation:

The project envisages optimal socio-cultural realisation through revival of the pilgrimage functions, the liturgical functions of the church for major Christian holidays, exposition of the artistic, architectural, and archaeological treasures, and providing opportunities for including the church within the system of cultural tourism.

- Within the surrounding space:

The solution for civil works in the surrounding space is directed towards reviving the significance of the church for the region and the country. The church is a part of a series of religious sites in the Struma River valley. In this context, the project envisages reestablishment of its structural and spiritual meaning. Using a new, compositional solution, the aim is to maximise its appearance and functionality within the context of the natural surroundings – the hillside and the river. It is planned that the property be landscaped and a new vertical plan offering the opportunity to exhibit any archaeological structures found in the future. In this regard, all the civil works must be carried out under the supervision of an archaeologist.

- Structural policy and integrated conservation

The project includes various measures aimed at showing off the qualities of the cultural monument, the archaeological remains, and the importance of the surrounding space. The functionality of the church and the area around it provide an opportunity for organically connecting the cultural monuments with their religious purpose, which is aimed at opening up the social and cultural potential of the tangible and intangible elements of cultural heritage as sustainable elements for regional development.

The Red Ruins of a Church: Upcoming conservational interventions at the Church of Saint Theodore near Boboshevo

Iliya Nikolov

The church is located in the centre of the Bishopric of Velbazhd. It belongs to the so-called cross-in-square type of cubic buildings organised around a central space. Two layers of frescoes have been documented (in places there are traces of a third). The frescoes are dated within a wide time range in several publications from the eleventh to the fourteenth century. V. Minkov dates them to the 13th-14th century; N. Mavrodinov – 12th century; D. Panayotova – first quarter of the eleventh century. The second layer of frescoes dates to the first half of the fourteenth century.

The first conservation works on the polychromatic decoration and paintings of the church were carried out in the 1970s. The preserved fragments from this stage amount to about 57 square metres. Despite a series of interventions carried out over the years and administrative correspondence in the period 1993-2010, the “temporary wooden sheathing” collapsed onto the church. The frescoes and plaster support subsequently experienced exceptionally aggressive stress. (fig. 8 and fig. 11)

Up to now, the silhouette of the church is as it was described by Konstantin Ireček – as “red ruins of a church”. The temporary roof and the emergency work and interventions carried out to date have not solved the structural problems. Serious architectural, conservation and restoration work are planned which must be synchronised with preservation of the interior of the church space up to complete conservation and exposition of the church. The present project deals with the mediaeval Church of St. Theodore in Boboshevo, together with its frescoed decorations. The proposals for conservation work at the church relate to the interior of the church – conservation in situ. The conservational intervention would permit the application of the so-called holistic approach to the original, i.e. use of materials in conservation practice that are close to the authentic technology.

The earliest layer of frescoes is preserved partially but is distinguished by its high artistic and historical value. It includes genre scenes from Bulgarian mediaeval painting such as “The Last Supper”, “Pedalavium”, “The Agony in the Garden of Gethsemane”, “The Betrayal of Christ by Judas” etc. The frescoes comprising the second layer are, according to S. Angelov, the work of the Master of the Kastoria school of painting who frescoed the Church of St. Nicholas Magaliouin Kastoria (1504/5), and also those at the Church of the Archangel Michael above the village of Saparevo, District of Dupnitsa.

The upcoming conservation works shall be carried out within those months when the weather conditions are beneficial for such interventions. The conservation-restoration techniques developed are based on a detailed survey of the particularities of the construction and frescoing of the church.

Identification of the microflora will assist in carrying out an appropriate biocide procedure. At the same time as removal of dirt, the frescoed layer needs to be supported – the areas with disintegration and flaking. We propose that the emergency stabilisation of the disintegrating paintings and the eroded plaster support be carried out with acrylic compositions. The deep reinforcement of the sections with peeling and gaps, and also those with a poor binding between the plaster and the painted layer, shall be adhered with lime casein tempera. Before being injected with the tempera mixtures, the frescoes will be protected with a protective layer of Japanese paper and tarpaulin.

Buffers comprising sandwiches of textile, Fibran and polyurethane foam will be fitted at the site. They will form a negative surface with the shape and volume of the original structure. Thus protected, the frescoes will be resilient during the restoration of the

architecture, and afterwards, the buffers and the temporary structural supports will be removed.

At the same time as removal of dirt is taking place, reinforcement work will be carried out on the painted layer, the places where disintegration and flaking is evident, and also in those microsections where the bonding with the plaster support is poor. The final exposition of the decorative plaster and the chromatic reintegration shall complete the integrity of the church.

ILLUSTRATIONS:



Fig.1.

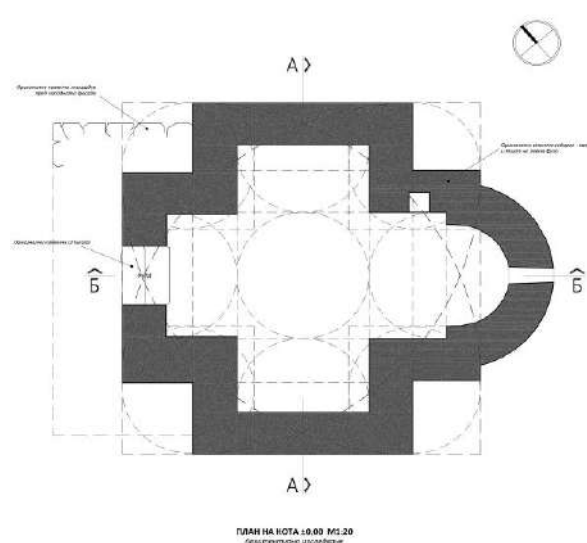


Fig.2: Floor plan at height ± 0.00 scale 1:20



Fig.3.



Fig.4



Fig.5

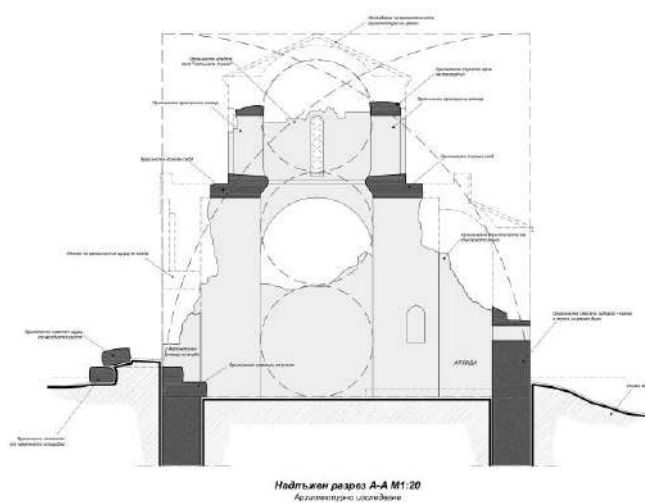


Fig.6: Lengthwise section A-A

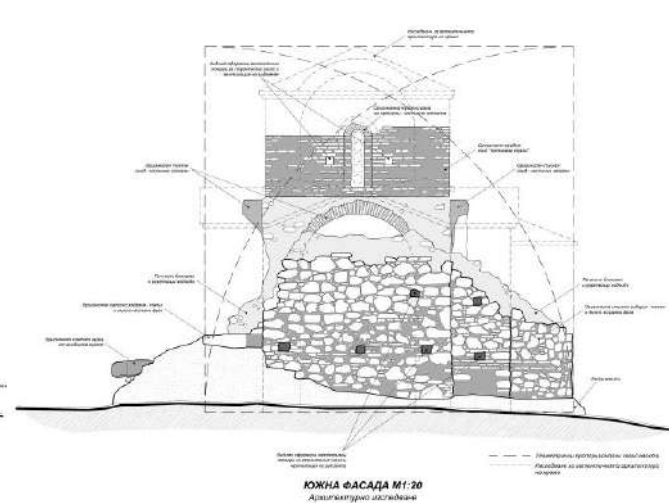


Fig.7: South façade – architectural investigation

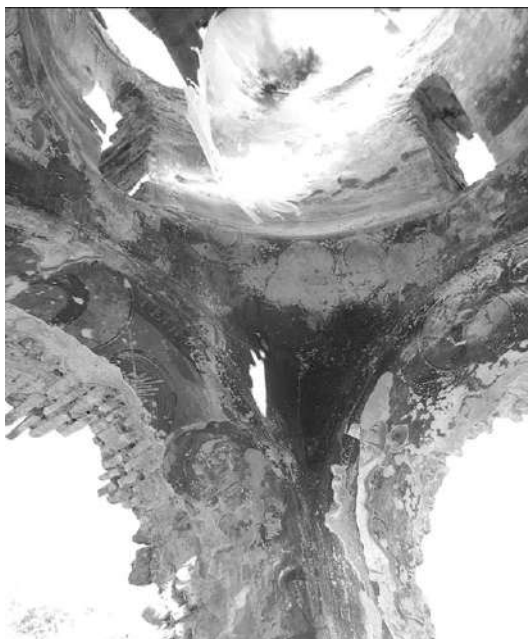


Fig.8.

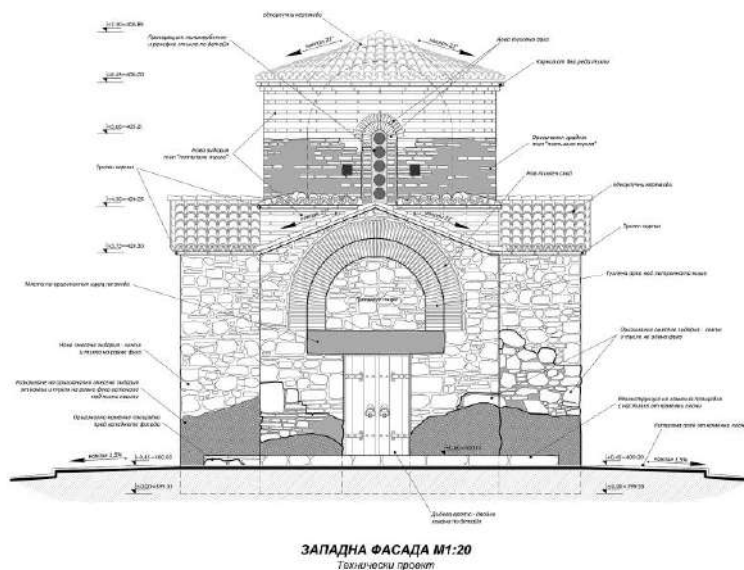


Fig.9: West façade– technical project

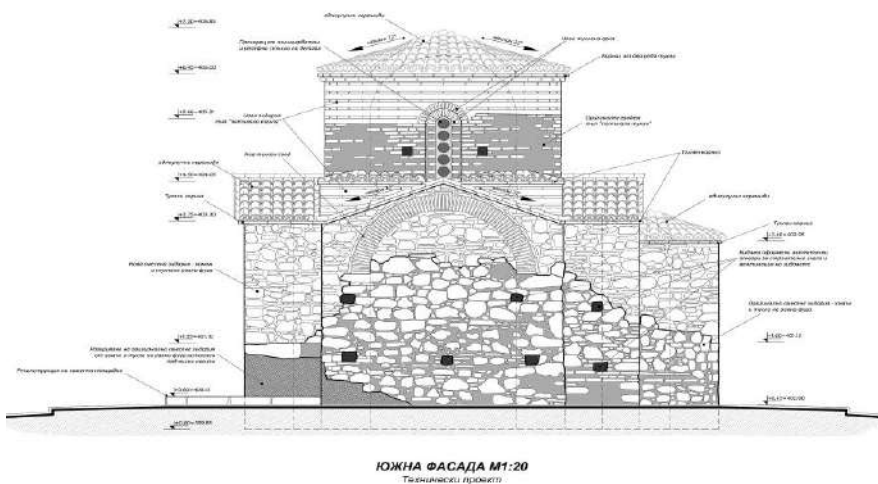


Fig.10: South façade – technical project.



Fig.11

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