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DEGRADATION OF ARCHEOLOGICAL SITES – CASE STUDY CARIČIN GRAD

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

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

1. INTRODUCTION

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

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

2. EXPLORED AREA

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

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

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

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

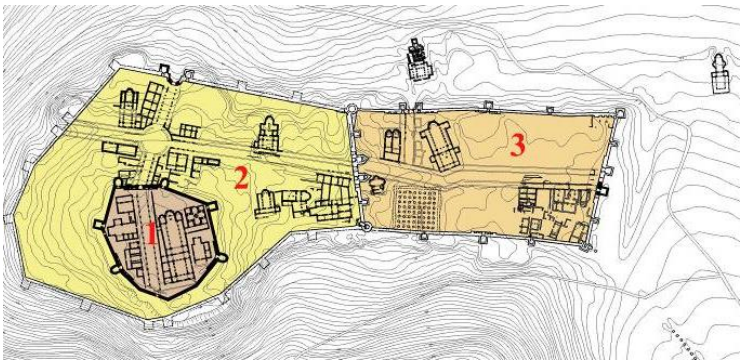

Fig. 1 Structure of the town: 1-Acropolis; 2- Middle town; 3- Lower Town
(drawing A.M.Petronijević according to the documentation Institute for Cultural Heritage Preservation Niš)

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

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

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

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

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

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

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

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

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

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

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

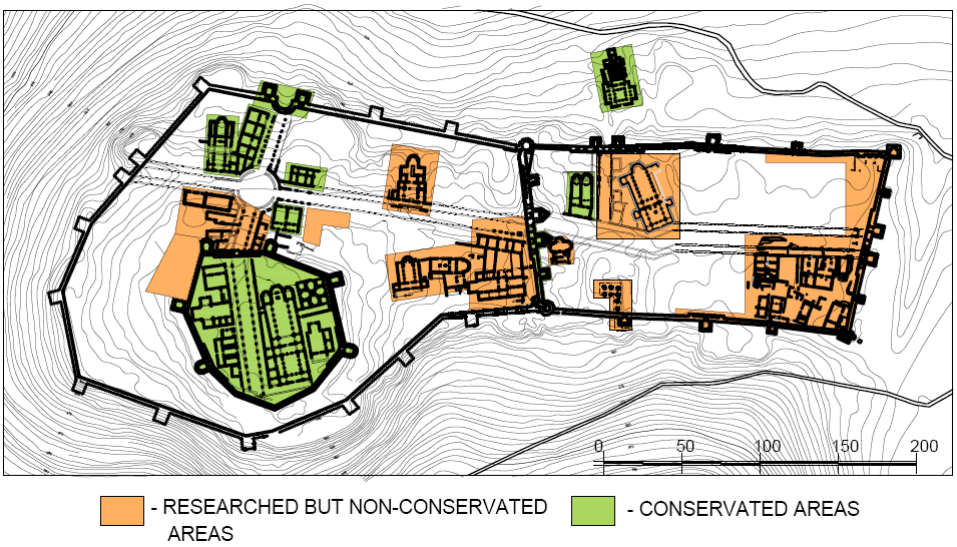

Fig. 2 Ratio of conserved and non-conserved areas on the site
(drawing A.M.Petronijević according to the documentation Institute for Cultural Heritage Preservation of Niš)

4. Deterioration Processes at Archeological Sites

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

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

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

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

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

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

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

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

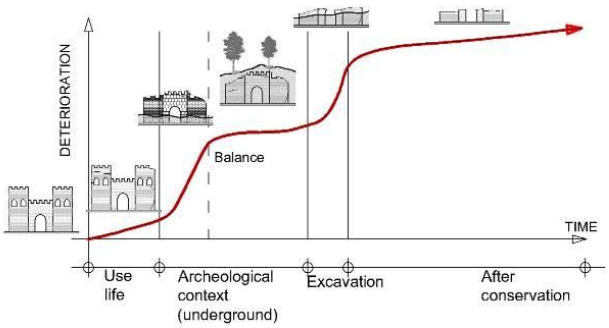

Fig. 3 Diagram of deterioration of structures, before, during and after archeological excavations. (drawing A.M. Petronijević)

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

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

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

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

5. Types of Material Used at Caričin Grad

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

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

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

6. Deterioration Processes at Caričin Grad

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

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

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

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

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

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

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

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

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

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

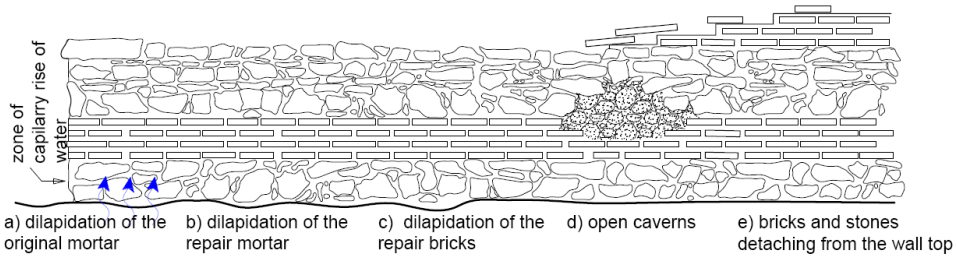

Fig. 8 The most frequent forms of wall degradation due to frost action
(drawing P.Petronijević)

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

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

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

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

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

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

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

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

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

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

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

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

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

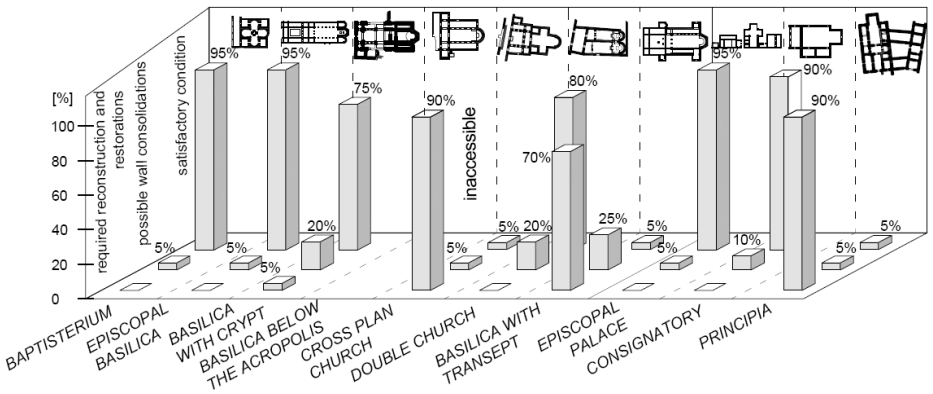

Fig. 15 Assessment of the condition of wall masses on the individual structures in Caričin Grad (drawing P.Petronijević)

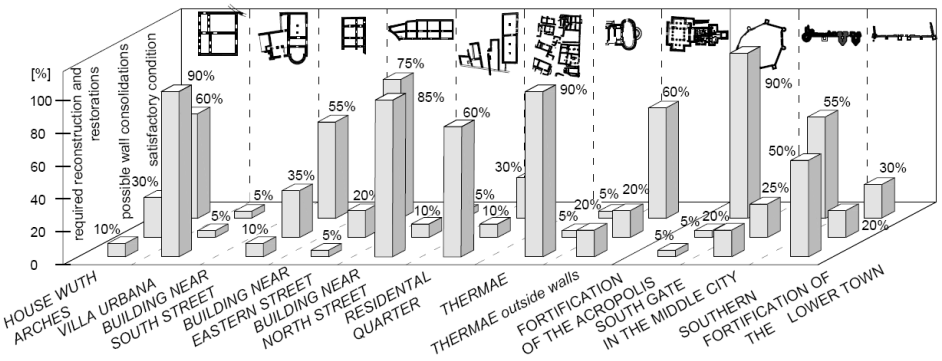

Fig. 16 Assessment of the condition of wall masses on the individual structures in Caričin Grad (drawing P.Petronijević)

7. CONCLUSION

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

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

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

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

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

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

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DEGRADACIJA ARHEOLOŠKIH NALAZIŠTA – STUDIJA SLUČAJA CARIČIN GRAD

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

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