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A MODERN SURVEY OF ANCIENT POČITELJ FORTRESS

Abstract. This paper provides an overview of the Master Thesis Project entitled "Instruments and Methods for Cultural Heritage Conservation and Valorization" conducted at the Faculty of Science and Technology, University of Urbino "Carlo Bo", Italy. The subject of our research was the medieval fortress of the Počitelj historic site in Bosnia and Herzegovina, built in a Mediterranean and oriental style over the period from the fifteenth to the eighteenth centuries. Different methodologies for survey and management using the modern IT techniques of architectural survey methodologies, with particular focus on survey using 3D data, will be presented. We will consider the questions of the analytical and theoretical set up of the modern instruments and techniques necessary for constructing the 3D metric model of the surveyed ruins of the medieval part of fortress.

Keywords – digitization, cultural heritage, virtual reality, virtual heritage.

1. Introduction

This paper presents a short overview of the Master Thesis Project in *Instruments and Methods for Cultural Heritage Conservation and Valorization (IMCHCV)*, conducted through international cooperation between: University of Sarajevo (Bosnia and Herzegovina), University Džemal Bijediæ (Mostar, Bosnia and Herzegovina), University „Carlo Bo" of Urbino (Italy) and University "La Sapienza" from Rome - School of Specialization for the Restoration of Cultural monuments (Italy).

The project team from Bosnia and Herzegovina was formed in 2008 including five students from three different disciplines: two architects, two construction engineers and one computer science engineer.

During a one-year research program, the project team worked on comprehensive project study „Počitelj fortress" with particular focus on its most prominent tower - "Gavran-Captain Tower", which was chosen as a representative example of an endangered heritage site in Bosnia and Herzegovina.

The project goals were to:

- Recognize and evaluate the decay level and the level of conservation of the object, using the related diagnostic methods and specific analysis;
- Suggest the most appropriate intervention for prevention, protection, maintenance, conservation or restoration, as well as propose the management style with promotion activities;
- Create IT archives which will allow management, display and analysis of the data collected during the implementation of the work.

We will present some of the results obtained during the work on the project.

The paper is structured as follows: Section 2 explains historical development of Počitelj. In Section 3, the architectural synthesis of the work on Počitelj's fortress through time will be given. Section 4 presents some of the results obtained using different survey methodologies and analysis of some construction and "decorative" elements that characterize appearance of the fortress. Section 5 will give the analysis of degradation and materials, and suggested program of interventions. Section 6 contains a SWOT analysis performed to asses the uniqueness elements of the sight and to propose the activities that will bring attention to the sight. In section 7 we propose a scenario of the future use of the fortress in a way that it can be self-sustainable. In the end, Section 8 will present results of constructing the 3D metric model of the surveyed ruins of the medieval part of the Počitelj fortress, Gavran-Captain Tower.

2. History of Počitelj

The walled town of Počitelj (Figure1) is located in Bosnia and Herzegovina, Čapljina Municipality, approximately 25 km south of Mostar, in the down course of the Neretva River. (Figure 2)

Figure 1. Počitelj, Bosnia and Herzegovina

It was built on the slopes of a hill that dominates the river and ensures its flow survey both to the north and to the south. This is why its role was always primarily strategic.

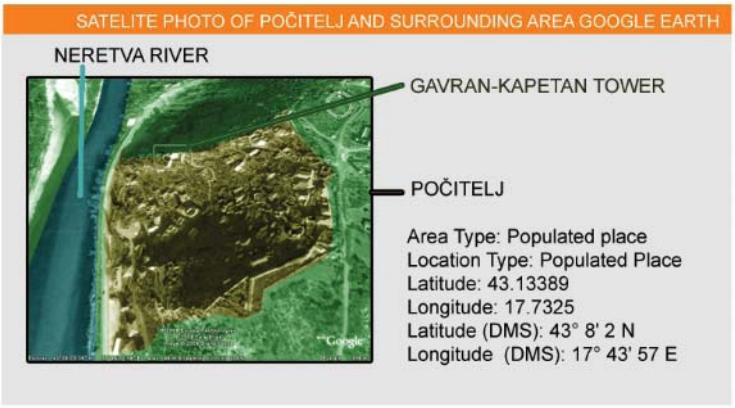

Figure 2. Satellite photo of Počitelj and surrounding area

It was first mentioned in the royal charters from 1444 and 1448, whereas in 1446 King Matija Korvin named it the "eccellentissimus castrum". [1]

Architecturally, the walled town of Počitelj evolved over the period from the 16th to the 18th centuries. [2]

Three historical periods may be observed as significant in the construction of Počitelj:

1. The time of the Hungarian King Matthias Corvinus (1463-1471) when the King backed by Dubrovnik, Herzeg Vlatko and Vatikan, fortified the town and housed a military garrison there;
2. The period of its development under the Ottoman rule (1471-1698) when the settlement was formed under the oriental influence, with the erection of typical public buildings: mosques, Muslim primary and secondary schools, charitable kitchen, Turkish baths, an inn and a clock-tower;
3. The period of regaining of its strategic importance in 1693 after Venice occupied Gabela, until then the principal ottoman fortress against Dalmatia [2]

3. Fortification

The fort of Počitelj (Figure 3) was built between 15th and 18th centuries. Two stages of evolution of this fortified complex may be observed: mediaeval, and Ottoman.

Figure 3. Počitelj fortress, Gavran-Captain tower

The original mediaeval core of the fort is the oldest walled section, where two stages of construction can be identified: the older, inner town or fortress (a donjon tower - the Gavran Captain Tower: orthogonal plan, polygonal in cross-section, of which only the lower parts are original, with walls approx. 2 m thick, and a small ward or bailey with the entrance to the south) from the late 14th century, with later additions dating from the second half of the 15th century. [2] (Figure 4)

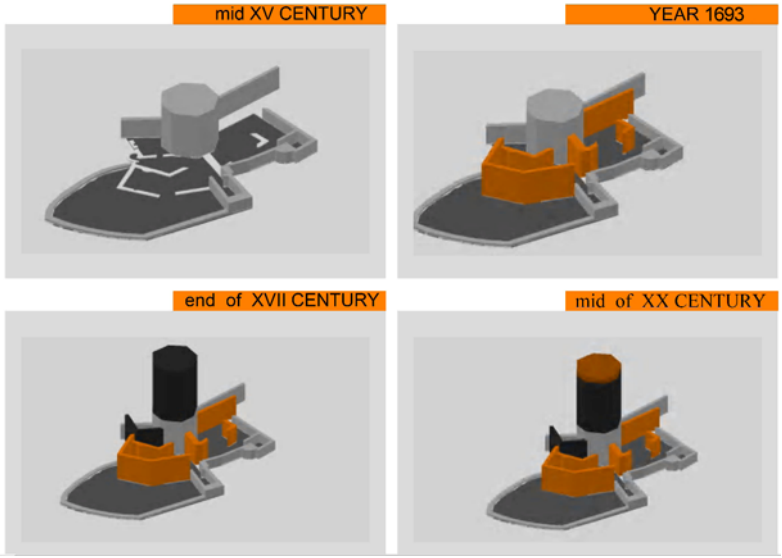

Figure 4. Reading of architectonic body: summary of the work in time

A small square tower to the left of the main entrance, and part of the west wall, south of the cistern within the fortress, belong to this second mediaeval stage of building. The central part of the complex of the fortress, where the Dizdar house stands, to judge from the details of its windows and gateways, as well as the fact that it is structurally unconnected with the older parts, dates from the Ottoman period, while the upper section of the main tower may be dated to the late 17th century, on the evidence of written sources.[3]

4. Survey

The survey presents a basis for creating documentation of cultural heritage. During the project several types of survey were used. (Figure 5) Using traditional methods such as sketching, drawing, and measuring with a meter, a "traditional model" was created. For the survey methods the main disturbances were almost unprocurable terrain, heights and imprecisions. The methods of instrumental surveys (topographical, photogrammetrical and survey using a laser scan) were used for creating the vertical projection of the fortress, and used as an input to GIS-system.

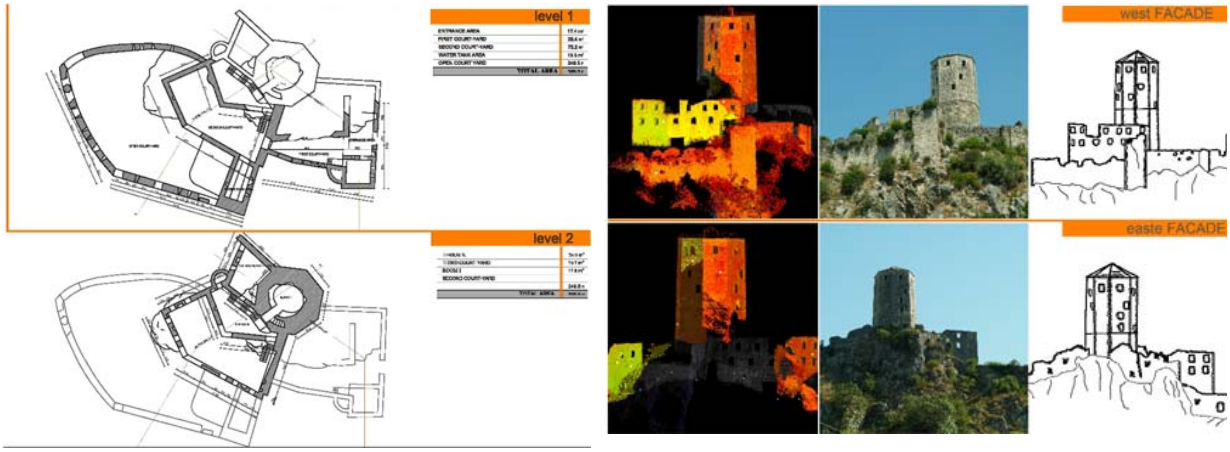

Figure 5. Examples of different surveys used during the work

Fortification part dating from the Ottoman period does not show achievement in decoration and monumentality. What characterized Ottoman structures was perfection in construction, solving the problems of the force, making a perfect balance, using simple elements, and creating a balance between open and closed elements. The decorations in this object were made of wood, as were the doors, and the element on the window. (Figure6)

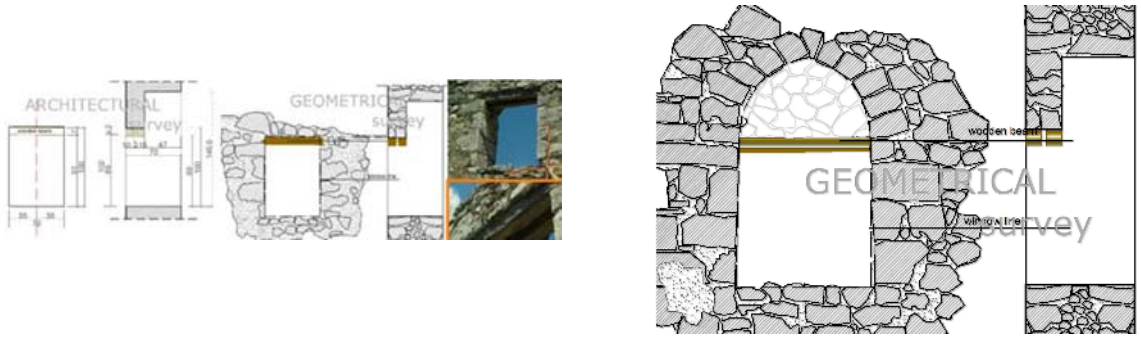

Figure 6. Analysis of the stylistic and constructive features

By observing window elements, the use of Golden Section for proportion in Ottoman constructions was found (Figure 7). As it is known, the Golden Section represents the perfect Section in nature.

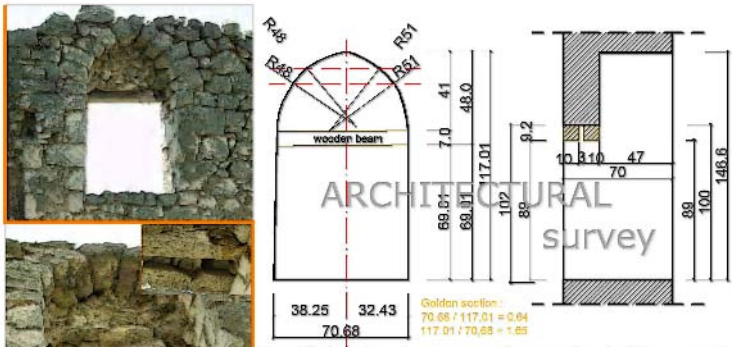

Figure 7. Analysis of the stylistic and constructive features

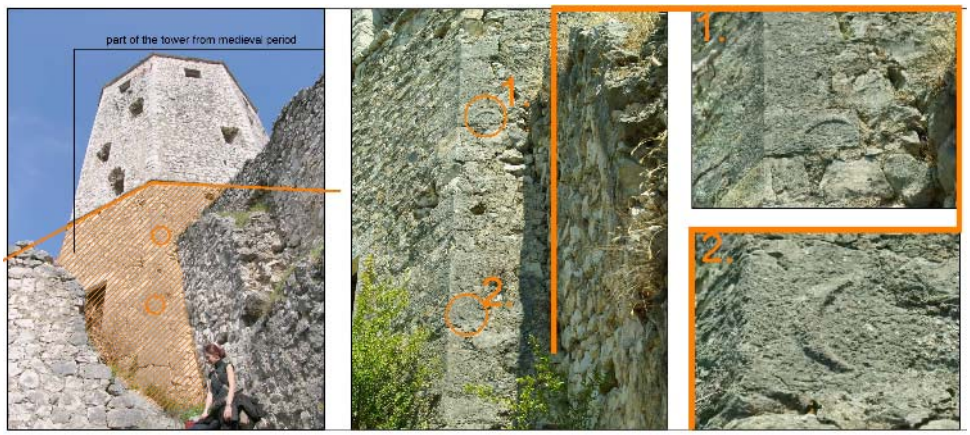

Figure 8. Symbol of the "moon" found on the west side of the tower

The stylistic elements in Ottoman architecture were found: a fortress' gate, doors, windows, recess, and frontline of towers. The main decoration element is a horseshoe arch and segmental arch on windows and the main door.

During the observations of the walls on a west side of the tower, very interesting elements - epigraphs "the moons" were found. (Figure 8). The moon symbol is not unknown in the history of BiH. It may be also found on gravestones (Steæci) dating from the medieval period. Considering the fact that this symbol was found in the base of the tower, which, according to written documents dates back to medieval time, it may be presumed that cut-offs of Steæci were sometimes used as construction elements for the tower.

5. Analysis of degradations and program of interventions

During a degradation analysis of the Počitelj fortress, it was found that the main cause of degradations was negligence of the site and lack of maintenance.

Beside this, vegetation growth, soil pressure, loss of material, weight of tower, cracks on the construction wall of fortification, rainfall and ground waters continuously irrigate a ground. General erosion of the fabric has placed several areas in unnecessary danger. [3]

Containing some of the oldest intact material in Počitelj, the solid rubble masonry construction of the fortress presents the need for future planned strategy with lack of maintenance of the main tower and surrounding ruinous building, resulting in fresh loss of material and threatening the integrity of this monument.

The following figure shows the full list of decay pathologies found on the south wall caused by different materials, together with recommended programs of interventions. (Figure 9)

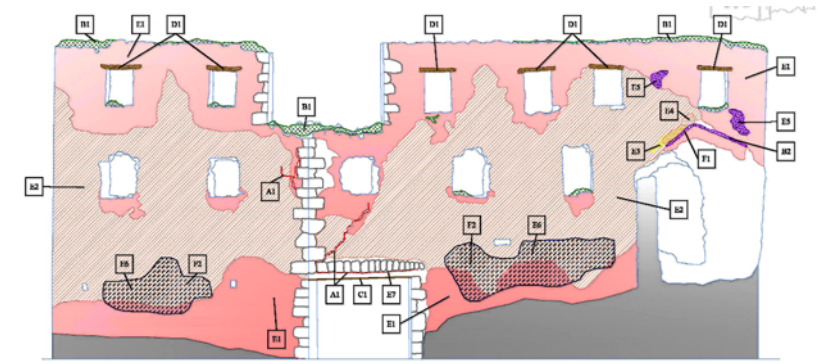

Figure 9. Table of degradations, causes and interventions

6. Socio-economic valorization

When talking about the heritage value and the significance of Počitelj it is impossible to distinguish the Fortress from the rest of the historical town, because the old town and the Fortress form the historical and urban core.

Old town of Počitelj is on the list of National Monuments of Bosnia and Herzegovina as the highest category on state level and at the same time it is on UNESCO World Heritage Tentative List at the international level.

At this moment, the old town of Počitelj hosts only few families. One of the biggest strengths of the old town in order to increase its significance and attract more tourists would be to bring life into Počitelj and make it a naturally isolated town. This is very possible because of its position in a natural valley, and it would mean better protection of Počitelj.

Applying general and area questionnaires among people from the region showed that they were very well aware of the significance of Počitelj, but also well aware of the changes and developments that are needed.

As was the case in the past, today's Počitelj is situated at a very good geographic and traffic location. There are several places near Počitelj that attract millions of tourists over the year. We believe that with good promotion and an interesting offer, a significant percentage of that number can be attracted to Počitelj. From the economic point of view this can be important income that will help better conservation, protection and further development of the old town of Počitelj. (Figure 10)

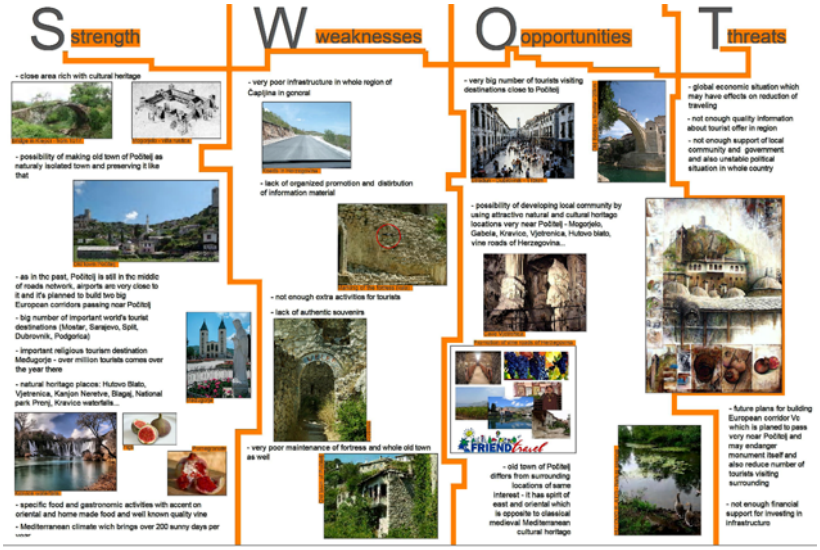

Figure 10. SWOT analysis

7. Suggestions for future use

The badly needed recreation of the economic and social environment of the Počitelj's Tower and surrounding area requires a new strategy for interventions, which will contribute to its popularity. We believe that any kind of reconstruction or constructing a new element in the area of fortress would jeopardize the beauty of the monument and would degrade the whole complex. It is necessary to adapt it for the new purpose under conditions that ancient and new structures can be integrated.

Our scenario suggests adapting the ancient Tower for the purpose of modern-day use - multimedia museum. A solution would be the so-called "augmented reality" technique which provides great opportunities for on-site virtual reconstructions. In this scenario, a visitor is equipped with special see-through glasses in order to see, in real time, a 3D reconstruction of the site he/she is looking at. The visitor can see real images through these glasses which can display information from a computer over the real images.

The scenario for adapting the Tower for the purpose of multimedia museum would be as follows:

1st level: *open stage*

2nd level: *info center*, where a visitor can obtain glasses and a handset to listen to a presentation and watch the virtual reconstruction of the tower and whole Pocitelj

3rd level: *interactive video-kiosk* with a touch-screen where visitor can receive information on the history of Počitelj

4th level: a presentation and workshop room

The courtyard would be used for presentations and as an open stage for different cultural events. (Figure 11)

Figure 11. Proposal of Tower's future use – multimedia museum

8. 3D model of the tower

High accuracy and photorealistic 3D modeling is of great importance for the preservation, restoration and documentation of Cultural Heritage. Laser scanners provide a method of capturing accurate 3D information about complex object surfaces.

In our work, we used Leica Geosystems laser scanner. [4] This is TOF (time of flight) scanner, which is the kind of laser scanners that calculate the 3D coordinates of each point from the measurement of the expired time between the emission of the laser beam and the detection of the returning beam after it hits the object. TOF scanners are used for surveying large objects at a distance ranging between 10 and 800 meters. Laser scanners produce point clouds, the sets of 3D coordinates [5] (Figure 12)

Point clouds produced by laser scanners are generally not directly usable in most 3D applications and therefore are usually converted to triangle mesh models, NURBS surface models, or CAD models so that they can be used for various purposes. [6] But data sets acquired with emerging 3D scanning technology easily reach the size of several gigabytes and produce extremely complex 3D models that can hardly fit in the address space of common PCs. [7] In our case, the process of visualization of the scanned tower was unsuccessful. After converting point cloud to 3D mesh, we ended up with an enormously large mesh which was unmanageable with common 32-bit desktop PCs. After remeshing, simplification and reconstruction of 3D mesh of the tower using MeshLab software [8], the size of 3D mesh was significantly reduced but it was then of very bad quality.

Figure 12. Point cloud of the tower produced by laser scanning (Leica Geosystems HDS software)

3D model of the tower was then built from scratch using Autodesk Maya software [9] according the real dimensions of laser scanned model. (Figure 13). Different modeling techniques were used, such as polygonal, Non Uniform rational B-Splines (NURBS) and subdivision modeling.

Figure 13. 3D model of the tower created in Autodesk Maya

High quality digital photographs of the tower were used for creating materials and textures for mapping the 3D model of the object. Different mapping techniques were used, such as planar, cylindrical, spherical and unwrap mapping. 3D model of the Tower was then exported from Maya to e-on Vue v7.5 xStream [10], software for the creation, animation,

rendering and integration of natural 3D environments, where a highly realistic atmosphere with the sky, clouds and plants was created. Final rendering was done using Vue v7.5 xStream render engine, and postproduction was done in Adobe "After effects CS4" [11] (Figure 14)

Figure 14. Final renders of 3D model of tower

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