Restoring Minarets as A Dominant Part of Urban Landscape Restoration of Stone and Wooden Minarets in Bosnia and Herzegovina - Materials, Structure and Urban Form

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Abstract. In a post conflict zone, restoration of monuments is not only a scientific or technical matter but also a highly symbolic and emotional act of reclaiming culture, identity and urban form. In Bosnia and Herzegovina minarets are shaped by local building traditions and materials, influenced by the ottoman classical minaret format. Most of the prominent mosques have stone minarets, especially in regions abundant with suitable stone and craftsmanship. Wooden minarets were usually built alongside local neighbourhood mosques and they defined city image due to their frequent occurrence in most parts of the urban core. Restoration of these two types of minarets is significantly different mainly due to the nature of the material itself. Interventions on stone minarets were carried out through reconstruction and re-composition of elements, based on documentation about the structure. Stone remains were actually the prime source of information for geometry and breadth of the minaret body and for the complex structural considerations – mainly how to counteract the tension forces. Restoration of wooden minarets had its own challenges, due to the fact that after a major destruction its parts could not be reused and there was less available documentation about the original state. The paper will consider different parameters and make a comparative analysis on both typologies, from materials, structure, aspects of intervention and their subsequent role in restoring the historic urban landscape.

1. Introduction

Iconic vertical landmarks such as church bell towers, clock towers and minarets are an essential element of urban landscape. The image is deeply engrained in our consciousness and it is almost impossible to find an urban agglomeration or an architectural ensemble without a vertical accent. It allows us to perceive and understand space, scale and urban form. Commonly it is located at the heart of a city or at the highest point within an urban historic landscape, conveying a message about the size, style and importance of a certain location.

Besides their prominence in physical sense a vertical landmark tries to impose as a medium between earth and heaven, man and god. Their meaning lies in both of these roles, so restoration of such elements also calls for “material” and “intangible” arguments.

Bosnia and Herzegovina is a land of minarets and church towers, fused naturally through urban historical layers – a sight that is rarely seen in the world.

In the city image there is a difference between bell towers/ churches and minarets/mosques in sense that mosques were almost always set within dense urban fabric without any spatial offsets of buildings or squares. The map of central area of Sarajevo shows the distinct street patterns of the ottoman era narrow streets and position of the main mosque, and central European style of urbanism with avenues and street accenting the main cathedral (Figure 1).

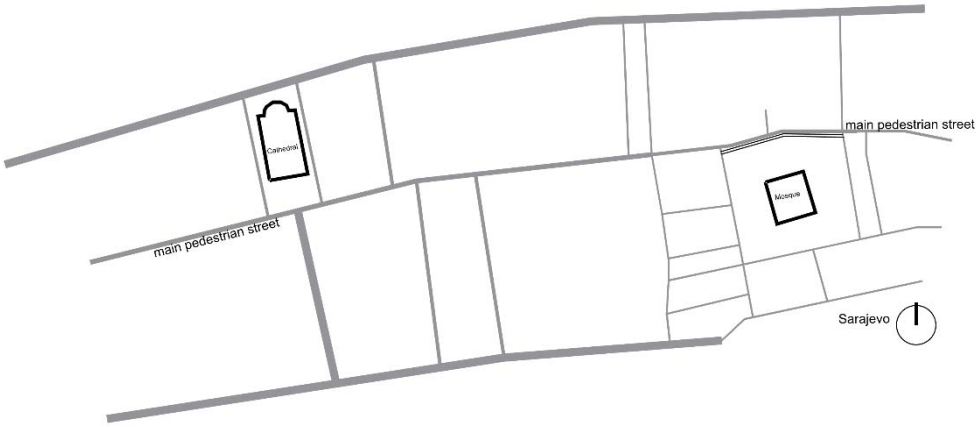

Figure 1. Sarajevo central area map. *(Source: by authors, 2018.)*

Also due to their role in daily life mosques were numerous, built as more modest structures for local neighbourhoods. There are of course prominent mosques but still not in the sense of absolute urban dominance and definition of city patterns such as gothic, renaissance or baroque churches.

This paper will focus on minarets as vertical landmarks and discuss issues of restoration through comparison of stone and wooden minaret structures. Two chosen examples for case study are typical representatives of a style and building material. Both of the structures are a part of a medieval fortification built on high ground in striking natural surroundings.

2. Minaret/mosque typology

Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described. This section also may include theory, background, calculations which represent practical development from a theoretical basis. Etc.
After first paragraph, other paragraphs are indented as you can see in this paragraph. Please use the Vancouver numerical system where references are numbered sequentially throughout the text. The numbers occur within square brackets, like this [1], and one number can be used to designate several references. The reference list gives the references in numerical, not alphabetical, order. Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Unpublished results and personal communications are not recommended in the reference list.

According to a list made by an Official Gazette of Islamic Community from 1933 there were 1120 mosques in Bosnia and Herzegovina. There are 36 mosques with domes and stone minarets, out of those there are 786 mosques with wooden minarets [2].

Minarets are tall and slender structures built alongside or within the mosque. In Bosnia and Herzegovina mostly, there are two types according to the materials: wooden minarets and stone minarets. There are some made from brick, but usually do not belong to the classical era of mosque design from 16-17th century. Minarets have a delicate role in balancing and harmonizing the volumes of the mosque complex into a complete self-sufficient ensemble. Symbolic and semiotic meaning of a minaret is defined by culture and local architecture rather than a universally religious aspect as a space between heaven and earth.

Stone minarets are built with the prominent mosques and in the southern region abundant with stone. Stone minarets are built from local lime or travertine stone and are usually 30 – 40 meters high. The body of the minaret shaft is quite slender, but it is intertwined with the central post and staircase that gives additional strength to the structure.
Wooden ones are built in central and north Bosnia, with local and more modest mosques. Wooden minarets are a specialty, a regional feature that is not as common elsewhere. Most of these minarets start from the ceiling beams underneath the roof. The usual height of such minarets is 10 – 15 meters with few exceptions that go up to 20 meters. From the structural point of view minarets are essentially vertical consoles with rigid anchors at the bottom of the minaret body. Its main load bearing properties are based on the type of structure and material. Main load is vertical from its own weight and horizontal continuous load is occurring due to winds or earthquakes.
Restoration of minarets is therefore an architectural and structural task that requires a meticulous process in restoration in order to preserve the original elements and structural concepts. Besides this restoration of minarets is highly symbolic and necessary in order to reclaim the historical urban The method of preservation that is suitable for these settlements is UNESCO Historic Urban Landscape Approach that "looks at urban settlements as a layering of historical, cultural and natural values, beyond the notions of 'historic centre' and 'ensemble', to include their surroundings and their broader geographical setting…includes social and cultural practices and values, economic processes, and the intangible dimensions of heritage as related to diversity and identity [1].

The two case studies presented within this paper will briefly explain the issues with two main typologies/materials: a wooden minaret of Kušlat mosque and stone minaret of a mosque in Počitelj. Besides being extraordinary examples of vertical structures both of them are set in an exceptional natural and urban setting. Both structures have been completely devastated in the recent war in 1993.

Figure 2. Kušlat mosque, [3, 4]

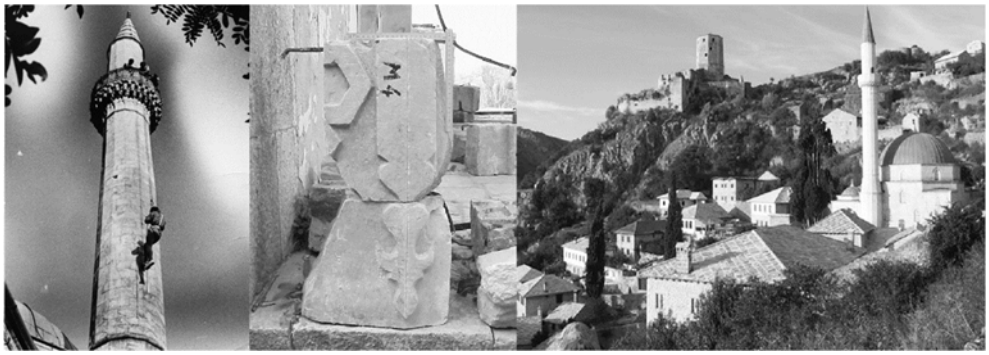

Figure 3. Počitelj mosque minaret, detail of the stone block and urban landscape. (Source: authors archive, 2002.)

Figure 4. Počitelj mosque minaret, detail of the serefet and destruction of entire minaret. (Source: authors archive, 2002.)

3. Case Studies

3.1. Pocitelj Mosque

Počitelj is an urban settlement placed at Neretva river valley, on a slope that forms an amphitheatre with fortification facilities on the top and partly embracing the city, built from XV to VXIII century. Počitelj had more public facilities, built in the ottoman times, domed mosque, medresa, han, clock tower and large residential area that spreads from top to bottom of the hill interlaced with paths and greenery. Visually it is spectacle, but currently very scarcely populated.

Pocitelj mosque was a type of single-space domed mosque – a perfect cube of 10 x 10 meters an architectural heaven a construction of pure geometrical bodies of the cube, the sphere, the cylinder, and the cone (the latter two making up the minaret). Počitelj Mosque is distinguished by complete clarity and strict regularity of the architecture and careful proportions of horizontal and vertical elements. In composition of the space a harmonious relationship is visible between cubic main geometry and the semicircle of the dome, while on the outside there is a dynamic relationship between the cubic form and vertical minaret (Fig.3).

The minaret was destroyed by dynamite placed in the transition part and the lower part of the shaft (since the blocks are of these two segments are completely lost). The stones were scattered in the area and laid unprotected. When the project for restoration of Pocitelj begun in 2001 the stones were moved many times and were never recorded. In April 2002 when the design for the mosque was carried out the existing situation was recorded on the site and lower part of the base was still in place but severely damaged. During the actual reconstruction of the mosque some of the blocks of the base were removed with partial identification. On the site in December 2002 about 320 stones of the minaret were recorded as well as the decorative elements. Approximately one quarter of the original stone blocks could have been reused [5].

Destruction of the minaret was so severe that only first five rows and several blocks from the base were preserved in situ, and the rest of the minaret body was cut out of new stones (Fig.4). There were only a few decorative and one cornice piece from the top of the base so the decoration had to be reproduced based on photographs and documents, and the remaining segments. The transition and the shaft were most damaged since it was the focus of the explosion, only few blocks were reused in the shaft.

Sherefet (the "balcony") on the other hand had a lot of pieces surviving that helped to figure out the complex richly decorated element that was not documented in great detail previously. (Fig.4). Most of the surviving segments were from the upper shaft, and them were reused during reconstruction.
One of the biggest challenges were that there was no detailed technical documentation, even the height of the minaret and its components were determined through a combination of sources. The specific stone material that was used is a local lime stone – tenelija.

It is a stone medium softness, wrought iron clamps fixed with molten lead, lime mortar with brick dust are essential components of both of these structures. Tenelija is an exceptional stone, ivory white color, easy to cut and shape, and performs better over time because of its porosity and ability to absorb the connection material. Its performance under pressure is in the range of 25 i 45 Mpa, depending on the moisture of the stone. This limestone, called is a rare and regional speciality from the region around Mostar. Fresh from quarry tenelija is yellowish and after a while it turns white-grey (by drying out and atmospheric influence).

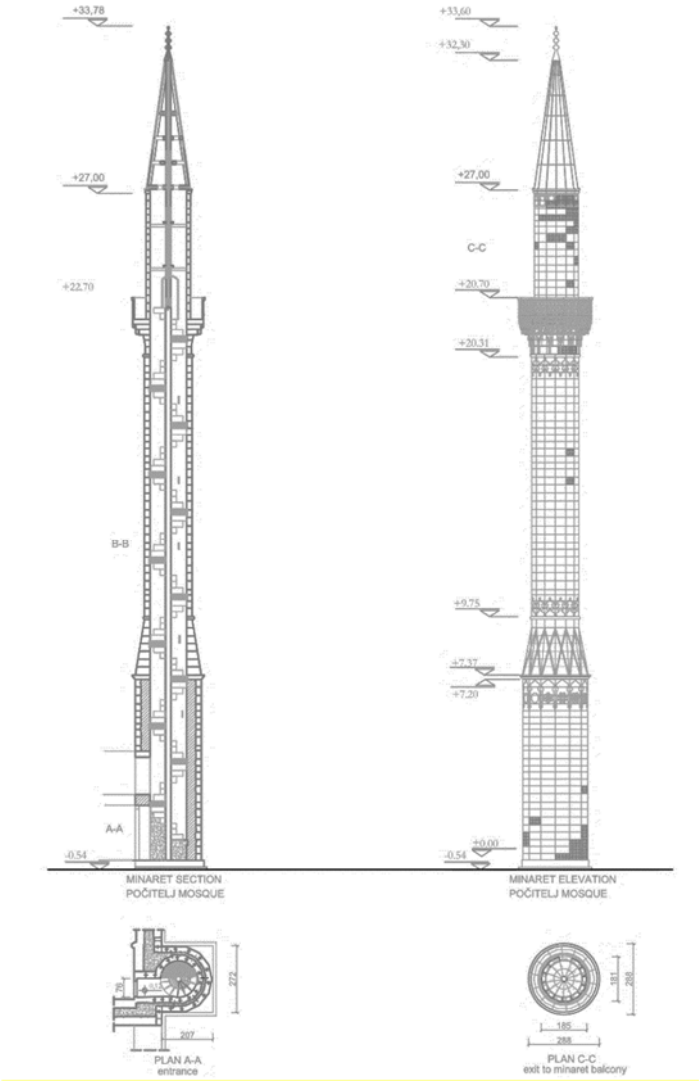

Figure 5. Počitelj mosque minaret horizontal and vertical sections. Shaded areas in elevation mark the original stone segments *(Source: by authors, 2018.)*

3.2. Kušlat Mosque

Kušlat mosque is a part of medieval military fortification. The fortification dates from 14th century. The fortification was conquered by the ottomans, and a mosque was probably built in the 15th century. The fort and mosque are on a Cliffside, providing one of the best panoramic sights in the country. This Mosque was completely destroyed during the recent war (Fig.2). The typology of this mosque is very specific, it is a compact wooden structure, square shaped with four-sided pitched roof. The roof construction is simple but specific with two columns supporting two V shaped roof supports. Minaret starts at ceiling level beams, with additional support beams at the lowest level. Its basic structure is formed around a central post, anchoring the staircase. The outer shell is made out of edge posts shaping the 10 angles of the minaret. Wooden planks form the exterior shell and at the top there is a widening of the shaft – the balcony or serefet. Since the minaret was a wooden one it is reasonable to assume that there were repairs made during its life cycle. The authenticity of such minaret is grounded in its shape, function, historical importance and as a landmark.

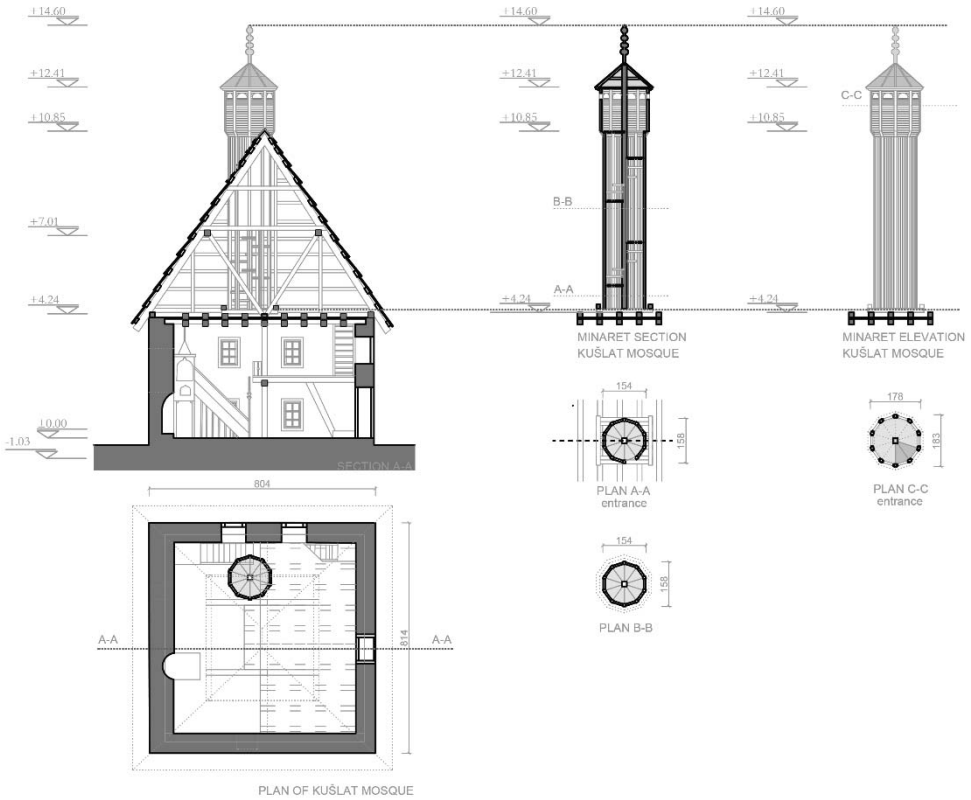

Figure 6. Kušlat mosque section, plan and minaret details. (Source: by authors, 2018)

Due to their material and geometry - stone and wood structures behave differently. The wooden minarets, with their lower weight and overall more connected and compact nature withstand vertical and horizontal stresses without much deformation. Historical masonry structures of towers have several structural characteristics – its form undermines their low capacity to redistribute load through thickness of walls and concentration of loads and forces in the lower. Stone minarets have much higher height and own weight and tension forces can be substantial leading to leaning or fractures. Tenelija stone and iron clamps have stood the test of time and proven to be materials of enough flexibility to counteract these movements/forces.

Two striking features characterize masonry minarets. On the one hand, their height and slenderness necessarily result in a shortfall in the corresponding absorption of the distribution of stresses (tensions), a shortfall in the dissipation of energy along the structure with a concentration of stresses in plan and weakness resulting from the predominant vertical actions, and weakness of the damaged masonry. On the other hand, about the dynamic behaviour of masonry minarets, their longish fundamental vibration period is a positive feature.
For this reason, the dynamic behaviour of the tower is limited by the falling curve of the response spectrum. Whether this will be favourable depends above all on the seismic risk of the area under investigation, as well as on the actual condition of the structure and the materials from which it was built. Combining these two contrasting properties generates the corresponding (accurate) prescribed seismic assessment of a masonry tower.
Generally, the important results of the structural analysis are similar for all of the minaret examples. Relatively high values of tensile stresses lead to the conclusions that some sort of strengthening methods are inevitable, if one wants to fulfil the design criteria imposed by the regulations reused [6].
Reconstructions of structures is always a controversial issue, but questions of authenticity are resolved through the process of reconstruction and its final outcome – coherent and truthful expression of cultural and historical conditions - the consideration of authenticity in conservation practice is to clarify and illuminate the collective memory of humanity [7].

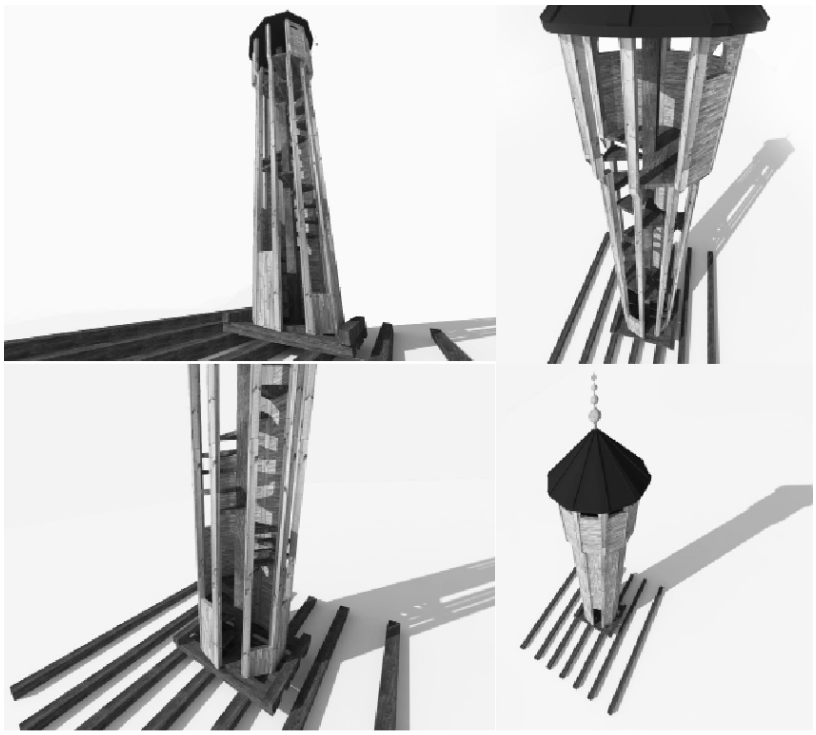

Figure 7. Kušlat mosque 3D model, (Source: by authors, 2018.)

4. Wooden minarets

It is encountered with the mosques with wooden minarets in almost every region of Bosnia and Herzegovina having access to wood. In almost all these minarets, the pole fixed as the main core, carries body/shaft, balcony, spire and stairs. The pole usually connected to load bearing parts of ceilings and roof structure provides minarets rising from the roof of the mosque. End of timber minaret is connected to the joist beams at the ceiling level, with additional support to the roof structures elements at the upper

level. The structure of rounded wooden minaret is formed around a central post, anchoring the staircase. The steps arranged around the pole are again usually covered with timber cover boards. As in masonry minarets, it is reached to the minaret balcony by a door opened from the upper part of the minaret, at the end of the stairs. The statics model of such a structure is the cantilever, abutting with its fixature at the lowest point, bearing the vertical central load of its own weight and the horizontal stresses (continuous) over the entire height of the building (usually of earthquakes and wind). About earthquake stress, it is typical of this structure that the critical points at which greatest damage and possible collapse occur are in the top parts of the structure, where higher amplitude oscillations are usually crucial.
A column interaction diagram is a visual representation of the combined loads (bending and axial) that will cause the column to fail. See the diagram below. On the diagram, the arrows show the procedure for determining the boundary longitudinal force Su and the bending moment according to the theory of second order. The interaction diagrams consist of acceptable combinations for the moment resistance and the axial resistance of a structural element.

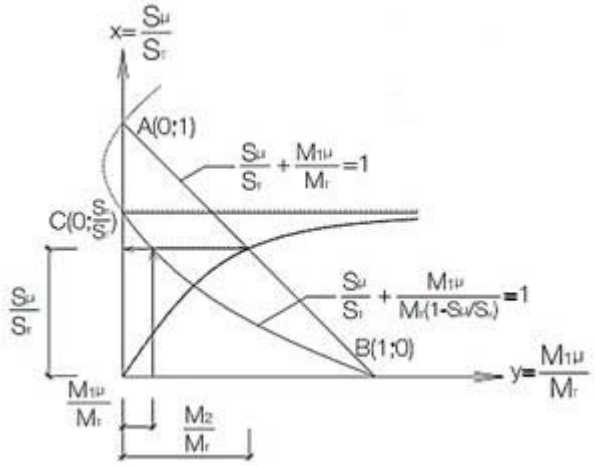

Figure 8. Column interaction diagram in the field of non-elastic deformation of the material

Column interaction diagram basically comprises two variables namely Normal force which is commonly called axial force and Bending. Naturally pols are a vertical structure. As a result, they are subjected for Normal force which has a direction parallel to the axis of the column and additional reaction moment due to a connection column and beam at a certain point along the column height.
This circumstance Unlike beam structures (which are basically flexure members and are always subjected for bending moment only) needs a certain balancing consideration of these two forces while designing the capacity of a column section. The process of producing an interaction diagram is lengthy, and the explanation of such a process even longer. The diagram is used to help visualize what magnitude of loads and eccentricity of loads concrete columns can safely handle. The interaction diagrams consist of acceptable combinations for the moment resistance and the axial resistance of a structural element. [8].

5. Conclusion

Materials and urban circumstances played a crucial role in shaping of the vertical landmarks – minarets. Both are highly adapted to local conditions and overall scale of space, as well as reflecting the abundance of material - stone or wood.

Restorations of stone minarets, due to its material endurance carried with it more original substance, by reusing some of the original stones. If it was not possible to reuse the stones, it was a valuable and reliable source of information and helped establish a scientific base for the reconstruction process.

In case of wooden minarets, most of the physical tissue was lost, but also there was not enough technical information on details, joints sizes of elements so part of the reconstruction was a typological. Wooden minarets are still in greater risk of inappropriate replacement of elements and in general use of low quality grade wood. The most common in wooden minaret structure is the need for repair or strengthening of the existing structure elements. Since wood is rather light and easy to incorporate and manipulate with, it seems that the most convenient procedure would be the replacement of the structures as they are relatively easy to unload.

The composition of the architectural ensemble, the relation between individual elements reflects the relation between the mosque and its natural and built surroundings. Aldo Rossi considered that 'The city itself is the collective memory of its people, and like memory it is associated with objects and places [9]. The white and precisely cut stone is an antidote to roughness and randomness of the morphology of natural rock and stunning Neretva riverside. The powerful architecture of the mosque in Počitelj and Kuslat is enhanced underlined with the extraordinary urban setting in which it resides.

The destruction of the structure evoked the dereliction of the entire landscape in its visual, symbolic and physical aspect. By restoring these objects and landmarks, a visual accent and integral part of the cityscape was essential for preservation of entire settlement.

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