Mevludin Zečević, Amir Čaušević, Nerman Rustempašić

UDK 72.04
COBISS 1.02
prejeto 23. 10. 2012

PRESERVATION OF A TRADITIONAL TIMBER ROOF: THE CASE OF THE HANDANIJA MOSQUE

OHRANITEV LESENEGA OSTREŠJA: PRIMER MOŠEJE HANDANIJA

abstract

In this article, the authors provide a brief overview of their personal involvement in the inspection of the roof timbers of the Handanija Mosque in Prusac. As well as the inspection, the authors were asked to propose a design for the roof structure. The Handanija Mosque, built in 1617, is an important example of the cultural heritage of Bosnia and Herzegovina, the mosque was designated as a National Monument of Bosnia and Herzegovina in 2005. The form, design and proportions of this traditional vernacular building render it a unique example of the classical style.

The mosque is rectangular in plan, with sides of 16.30 x 12.70 m, and belongs to the single-space type of mosque with an open porch and stone minaret. It was damaged by shelling during the 1992-1995 war, taking several direct hits to the walls, roof and minaret. The roof timbers were completely destroyed and the rest of the building was badly damaged.

The authors suggested amending the structural bearing system by eliminating the hanging trusses and introducing the traditional components of posts, beams, struts and tie beams, as typical of this type of building. A 52.5° roof pitch was suggested, in keeping with Bosnia"s traditional vernacular architecture, which also reduces the intensity of horizontal forces. Authors suggest a 52.5° roof pitch for the following reasons: it is in keeping with the indigenous architecture of Central Bosnia, it reduces the intensity of horizontal forces, and it takes account of the fact that a hand-cut roof cladding does not always ensure identical geometry and pitch.

key words

structural system, roof timbers, vernacular architecture, heritage, mosque.

izvleček

V tem članku avtorji na kratko predstavljajo svojo vpletenost v pregled lesenega ostrešja mošeje Handanija v Pruscu. Poleg pregleda so avtorje prosili tudi za predlog projekta za ostrešje. Mošeja Handanija, zgrajena leta 1617, je pomemben primer kulturne dediščine Bosne in Hercegovine. Leta 2005 je bila razglašena za nacionalni spomenik Bosne in Hercegovine. Zaradi oblike, zasnove in skladnosti je ta tradicionalna, avtohtona zgradba enkraten zgled klasičnega sloga.

Mošeja ima pravokotni tloris s stranicami 16,30 x 12,70 metra in spada med enoprostorske mošeje z odprtim preddverjem in kamnitim minaretom. Poškodovana je bila med bombardiranjem v vojni v letih 1992–1995. Zadete so bile stene, streha in minaret. Popolnoma je bilo uničeno leseno ostrešje in tudi drugi deli zgradbe so bili močno poškodovani.

Avtorji so predlagali popravilo nosilnega sistema ostrešja tako, da bi odstranili vnaprej pripravljena strešna ogredja in uporabili tradicionalne komponente, kot so steber, prečnik, opornik in poveznik, značilne za tovrstne zgradbe. Predlagali so 52,5° nagib strešine skladno s tradicionalno bosansko avtohtono arhitekturo, ki tudi zmanjšuje pritisk vodoravnih sil ter upošteva, da ročno izdelana strešna kritina ne zagotavlja vedno natančnih oblik in naklona.

ključne besede

nosilni sistem, leseno ostrešje, avtohtona arhitektura, dediščina, mošeja

The principal conditions to be met when choosing a roof structural system, besides compatibility with the architectural concept, are the expected loads, special requirements arising from unusual conditions and effects such as wind or earthquake, potential variance of laws, flexibility, impact on the height of the building and spot height, availability of materials and duration of construction, local conditions relating to construction, simplicity of manufacture (production), approved budget, and their impact on other systems, appearance, aesthetic potential and so on. Where the reconstruction of heritage buildings is concerned, care should be taken to retain original elements of the architectural composition and to employ original building methods, in keeping with accepted methods used in the renovation and preservation of the architectural heritage. The methodological approach entails an analysis of the structural damage and an attempt to identify the original form of the structure. It would be a mistake to embark on reconstruction and conservation without first identifying the causes of the damage and the original structural system. These data should then form the basis for respecting the integrity and authenticity of the historic building during the intervention and consolidation process. The analysis and assessment should be the result of cooperation from experts in different disciplines-architects, builders, designers, archaeologists, art historians and so on. In addition, it is important for everyone involved in the restoration and preservation of the building to have at least a basic knowledge of the conservation and consolidation of historic buildings.

History, architectural and structural characteristics of the Handanija mosque

The Handanija Mosque was built in 1617, as recorded on the chronograms over the entrance doorway and the gateway to the harem surrounding the mosque. It is known as the Handanaga, Handanbey or Handanija Mosque after its founder, Handan-aga, a wealthy Ottoman official, whose tombstone can still be seen inside the mosque harem. Throughout its history, the mosque has been the centre of the cultural and religious life of Prusac, occupying the position once held by the mediaeval fort. It contained ceramic levhas1, the only known example of the use of ceramics for this purpose in Bosnia and Herzegovina; they were the gift to the Islamic community from a Muslim traveller who visited the mosque. For almost three hundred years, these three decorated ceramic plaques - two representing the Harems2 in Mecca and Medina, the third a verse from the Qur"an in calligraphy - were on the mihrab3 wall. The Handanija Mosque is an important part of Bosnia and Herzegovina"s heritage, with much remaining of the original 17th century mosque, evidence

of its long cultural and religious history. It is rectangular in plan, with sides of 16.30 x 12.70 m; the minaret is partly set into the south-east wall. The interior is a single space roofed by a timber interior dome. Four kinds of limestone were used to build the mosque, which is entirely plastered and whitewashed apart from the window lintels. This is the only mosque in Prusac with a stone minaret.

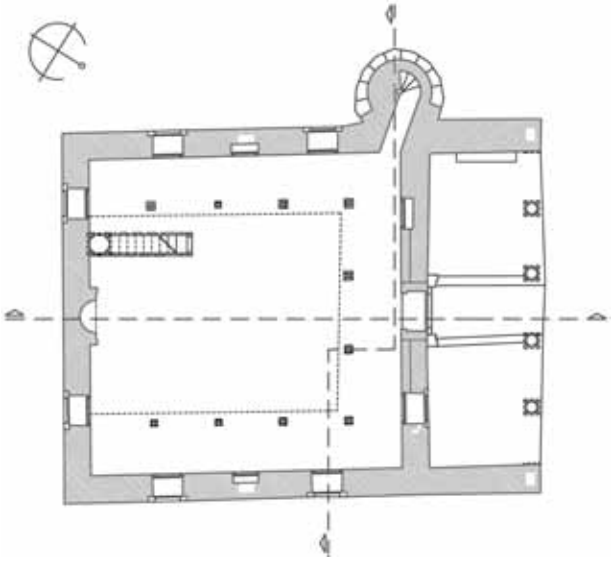

Figure 1: Plan of the Handanija mosque immediately prior to restoration [http://www.chwb.org/regional/documents/The_Handanija_Mosque_Restoration.pdf].
Slika 1: Tloris mošeje Handanija.

The Handanija mosque has two features that make it unique - its remarkable arcaded porch, and the octagonal segmented timber dome over the prayer hall. The sections of the domical vault below the hipped roof have four breaks between the base and the flat central ceiling called "sofraluk" from which hangs a wrought iron lamp. The ceiling boards are fixed to the frame, adding strength to the frame of the dome. The ceiling is decorated with edging boards with a fleur-de-lis design, and semicircular mouldings were nailed to the ceiling boards to form an orthogonal pattern. In 1993 the Handanija Mosque took several direct hits from shells, which caused extensive damage to the walls, roof and minaret. The roof timbers were destroyed by fire and the rest of the structure was badly damaged. The entire building was destabilized, and no traces of the ceiling and dome structure remained, with the exception of the corners of the roof beams. The interior suffered further damage when the fallen timbers were removed by local residents, who used them as firewood. Earlier photographs reveal that the original roof cladding of shingles was replaced by tiles during the 1940s or 1950s. It is not known whether the roof timbers were also replaced at that time.

Analysis of reconstructive interventions on the Handanija mosque

In 2002, on the initiative of the Islamic Community of Bosnia and Herzegovina in cooperation with CHwB and the Faculty of Architecture in Sarajevo, a survey of the mosque was conducted and project documentation was produced, on the basis of which the Handanija Mosque was restored to full use in 2003. The architectural design produced by CHwB was used as the basis for the structural design, with additional input from the findings of the survey. The basic principle specified for the project was the use of traditional materials and techniques.

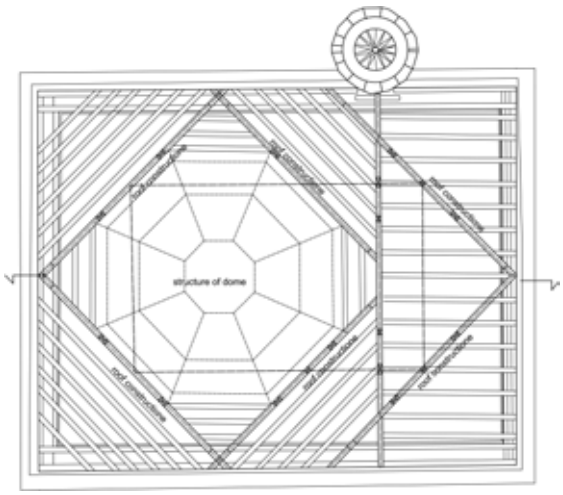

Figure 2: Plan of the primary structure of the newly-designed roof by CHwB [http://www.chwb.org/regional/documents/The_Handanija_Mosque_Restoration.pdf].
Slika 2: Tloris osnovne strešne konstrukcije - nova streha.

The structure decided upon for the timbers of the hipped roof, with a pitch of 45°, consisted of ridge beams, wall plates, purlins and hanging trusses, forming the primary structure, with rafters as the secondary structure. Tower 5 software was used to compute the spatial model, on the basis of which the roof elements were analyzed and their dimensions determined. The 14 x 14 cm rafters are of category II softwood, varying in length from 3.20 to 4.20 or 6.80, set 85 cm apart. The ridge beam, measuring 16 x 20 cm in section, was also of category II softwood; based on the survey findings, the same section of 16 x 20 cm was also adopted for the roof arris. The purlins, also 16 x 20 cm in section, are also of category II softwood.

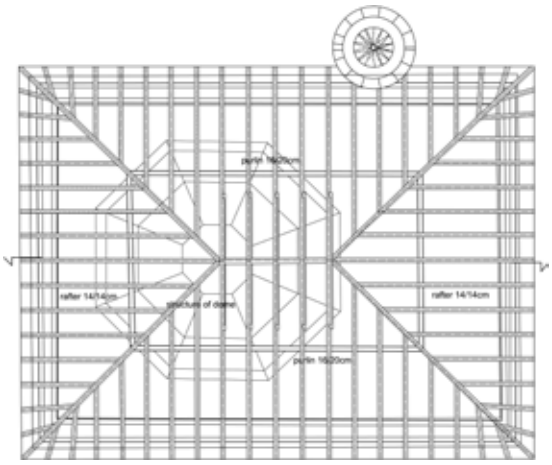

Figure 3: Plan of the secondary structure of the newly-designed roof by CHwB [http://www.chwb.org/regional/documents/The_Handanija_Mosque_Restoration.pdf].
Slika 3: Tloris strešne konstrukcije - nova streha.

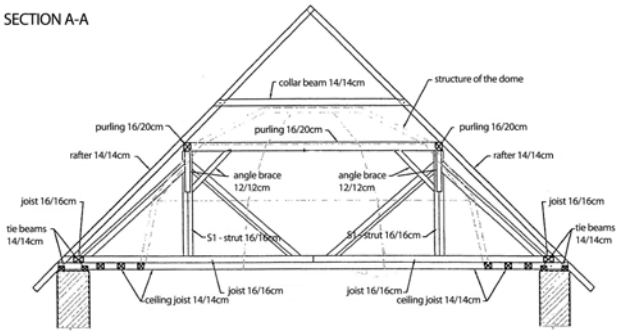

Figure 4: Section A-A of the newly-designed roof structure by CHwB [http://www.chwb.org/regional/documents/The_Handanija_Mosque_Restoration.pdf].
Slika 4: Prerez A-A, nova streha.

Following a statics computation, the following hanging trusses V1 and V2 were adopted: 20 x 24 cm tie beam of category II softwood, and 16 x 16 cm posts and struts, also of category II softwood.

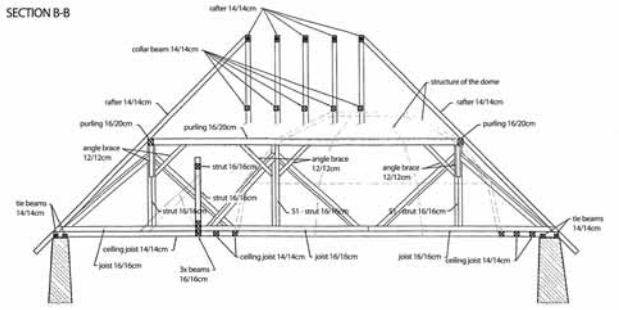

Figure 5: Section B-B of the newly-designed roof structure by CHwB [http://www.chwb.org/regional/documents/The_Handanija_Mosque_Restoration.pdf].
Slika 5: Prerez B-B, nova streha.

The interior dome consists of 5 x 16 cm centring fixed with E 42/110 nails. The ceiling joists are 14 x 14 cm in section.

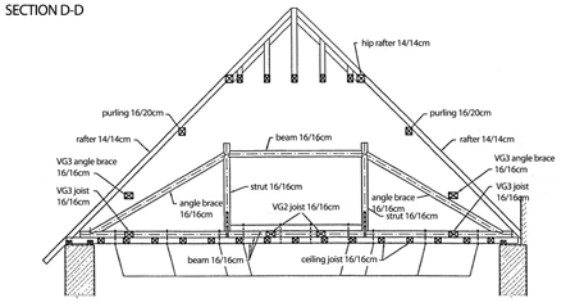

Figure 6: Section D-D of the newly-designed roof structure by CHwB [http://www.chwb.org/regional/documents/The_Handanija_Mosque_Restoration.pdf].
Slika 6: Prerez D-D, nova streha.

The structural bond between the newly-designed roof and the current supports - the walls - and the level and definition of the bearings are not clear. The bearing structure consist of the vertical masonry structure, which should be examined, repaired and consolidated, after which the components for fixing and bearing the roof structure should be prepared. The design that was the subject of review was a modification of the roof structure in line with the wall, eliminating two posts in line with the wall and transferring the load from the hanging trusses and part of the roof to the main truss, thereby creating a potential structural weak spot, given the nature and susceptibility of a hanging truss bearing structure. The span structure also takes the load of the other span structures without assurance that the chosen geometry will remain unaltered...

The basic principles of established methods of reconstruction and preservation of cultural monuments are to some extent neglected as regards the consistent application of the building"s authentic proportions and its historical and geographical context. Despite the absence of proper project documentation based on the proportions typical of the architecture of the region, it was possible to achieve an authentic architectural expression. In fact, though the roof pitch of 45° all round makes the construction of the roof simpler and more practical, and the proportions of the resulting structure are approximately equal to the ratio between the deep overhang and the height of the building to the eaves typical of Central Bosnian architecture, to be authentic the pitch of the hip ends of the roof should be less steep than that of the longer sides. In addition, though the roof was originally clad with wooden shingles, which again is typical of Central Bosnia, dictated by the climate and geographical features of the region, the new roof was clad with tiles. An analysis of the architecture and the characteristics of the structural system of buildings of the same type and architectural style in Bosnia and Herzegovina, the single-space mosque with open porch and stone minaret, dating from the classical period of Ottoman architecture, makes it possible to propose a new design that would to a great extent provide authenticity of form and concept. It is clear from representative examples from the same period that the load of the roof is transferred uniformly along the outer bearing walls. This type of structure can be seen in both public and residential buildings in Bosnia and Herzegovina, such as the Gazanferija Mosque in Banja Luka, which is of the same date and style as the Handanija Mosque in Prusac. An "attic dome" is also to be seen in the Čaršijska Mosque in Bosanski Novi, the Azizija Mosque in Bosanska Kostajnica, the Ferhadija Mosque in Tešanj, the Magribija Mosque in Sarajevo, the Tabačica and Šarića Mosques in Mostar, the Turalibey Mosque in Tuzla and the Jahja Pasha Mosque in Skoplje near Glamoč. The wooden domes in these mosques could be either an indigenous architectural concept or the result of repairs following the failure of a masonry dome, in an attempt to conjure up the former beauty of the mosque.

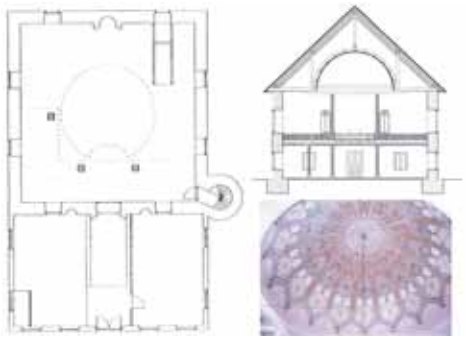

Figure 7: Drawings of the Gazanferija Mosque in Banja Luka [Husedžinović, S., (2005): Documents of Survival, MGZ, Zenica, page 434].
Slika 7: Načrti mošeje Gazanferija, Banja Luka.

The Magribija Mosque in Sarajevo has a barrel roof rather than a dome. Nonetheless, drawings of the mosque reveal a typical example of traditional roof timbers in Bosnia and Herzegovina, without the use of hanging trusses as in the design for the reconstruction of the Handanija roof.

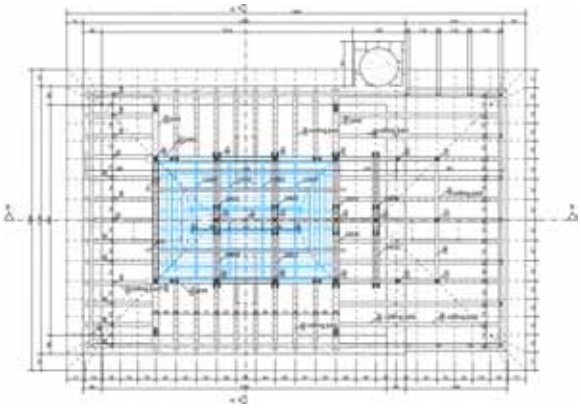

Figure 8: Plan of the roof of the Magribija Mosque in Sarajevo [Bećirbegović, M., (1990): Mosques with Wooden Minaret in Bosnia and Herzegovina, Veselin Masleša, Sarajevo, page 46, 178].
Slika 8: Tloris ostrešja, Magribija, Sarajevo.

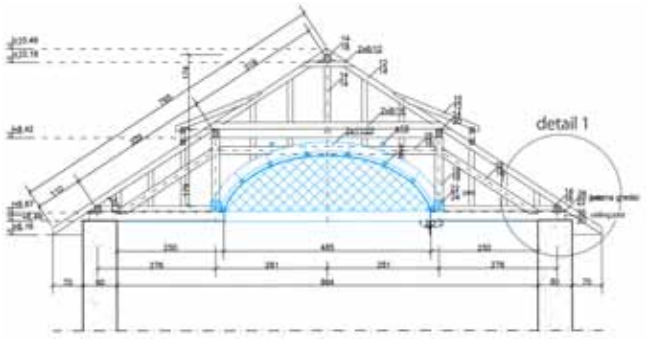

Figure 9: Section of the roof of the Magribija Mosque in Sarajevo [Bećirbegović, M., (1990): Mosques with Wooden Minaret in Bosnia and Herzegovina, Veselin Masleša, Sarajevo,. page 46, 178].
Slika 9: Prerez, Magribija, Sarajevo.

The drawing below is of part of the angle of the roof structure of the Koski Mehmed Pasha Mosque in Mostar, which transfers the load to the outer walls.

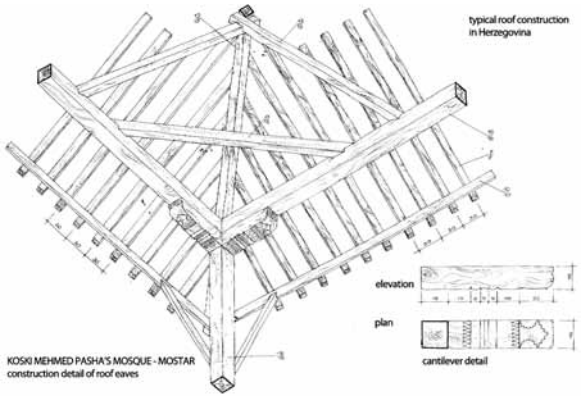

Figure 10: Example of roof structure: part of the Koski Mehmed Pasha mosque in Mostar (2004 : Journal of the Commission to Preserve National Monuments, Baština/Heritage, Sarajevo].
Slika 10: Prostorski prikaz ostrešja, Koski Mehmed Paša, Mostar.

Proposed reconstruction following survey and analysis

The proposed load bearing system eliminates the hanging trusses and introduces the traditional elements of posts, beams, struts and ties typical of this kind of building. The roof pitch should be 52.5° on the long sides and 48° at the hip ends, in keeping with the indigenous architecture of Central Bosnia. This also reduces the horizontal forces.

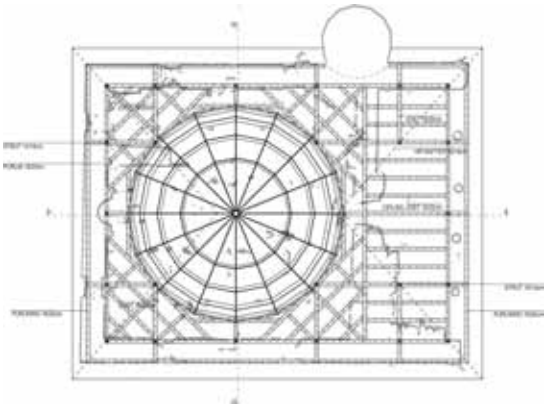

Figure 11: Plan of ceiling structure - proposed new design.
Slika 11: Tloris stropa, predlog obnove.

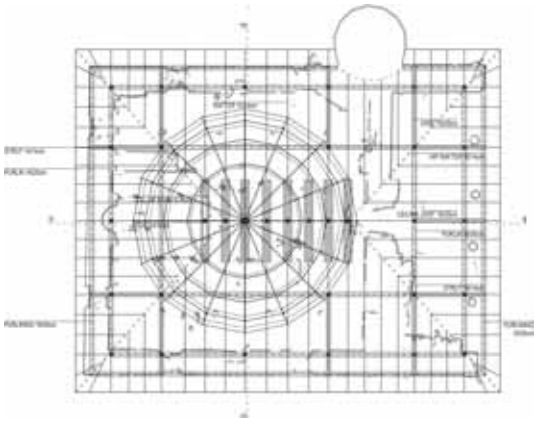

Figure 12: Plan of primary roof structure - proposed new design.
Slika 12: Tloris osnovne strešne konstrukcije, predlog obnove.

The uniformity, spacing and layout of the posts create a system of triangles around the perimeter of the building, which increases the building"s resistance to the winds that are a feature of the region at certain times of the year.

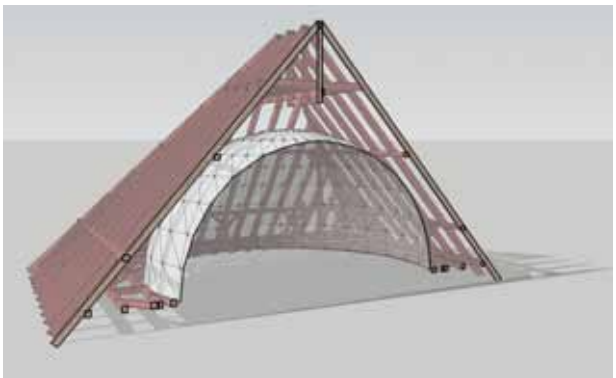

Figure 13. Spatial layout of the roof structure - proposed new design.
Slika 13: Prostorski prikaz zasnove ostrešja in kupole, predlog.

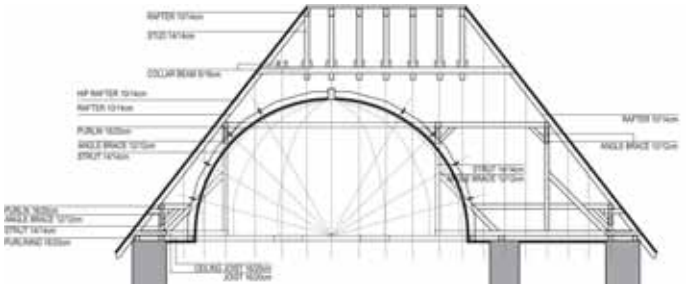

Figure 14: Longitudinal section of the roof - proposed new design.
Slika 14: Vzdolžni prerez ostrešja, predlog.

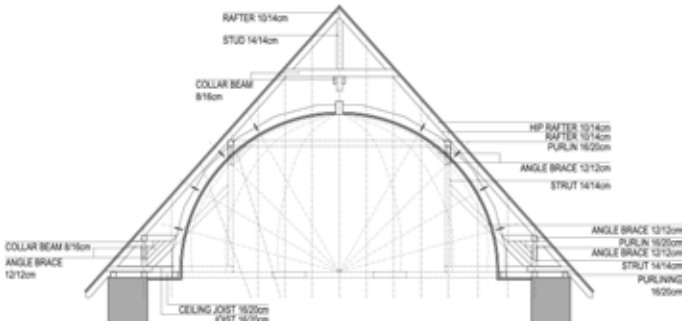

Figure 15: Cross section of roof - proposed new design.
Slika 15: Prečni prerez ostrešja, predlog.

The proposed roof pitch is 52.5° on the longer sides and 48° at the hip ends, for the following reasons:

- it is in keeping with the indigenous architecture of Central Bosnia,
- it reduces the magnitude of the horizontal forces,
- it takes into account the fact that hand-cut roof shingles do not always guarantee the same geometry and imbrication.

Conclusion

The fundamental principle applicable to work on architectural monuments is the use of traditional techniques, structural systems and materials, with an awareness of the problems arising from the lack of traditional materials and craftsmen. The roof timbers consist of the traditional elements of posts, beams, struts and ties typical of this type of building. The large trigonous volume of the roof, with its deep overhangs, remains an important element of Bosnian architecture where the roof is a dominant feature of the composition. In a climate such as that of Central Bosnia, deep eaves provide shelter from the elements, an "open-closed" space giving traditional houses a sense of continuity with nature, while the subtle profiles of such roofs reflect the Bosnian aesthetic sensibility. In addition, these buildings were major architectural features at the time they were built, and remain important determinants of our cultural heritage and witnesses of our past, deserving our attention and efforts to preserve them for future generations. If the traditional features of our heritage continue to be disregarded, the glories of our past will be consigned to oblivion. Timber construction in Bosnia as a whole should be inventoried and documented to ensure that we are aware of the value and current state of these buildings. Programmes for their preservation and consolidation could be drawn up on the basis of this documentation, and conservation strategies developed accordingly.

Another important point to take into consideration is that thoughtless interventions destroy the structural continuity of historic buildings. Before embarking on any intervention, the social, cultural, economic and political context of the building should be analyzed. Historic buildings and monuments form an important link between our times and the past, reflecting past social, cultural and economic circumstances. The intervention and consolidation should respect the integrity and authenticity of the historic building. It would seem that the aesthetic virtues of traditional Bosnian buildings praised by foreign architects are the very features that undermine their structural integrity and render them vulnerable to earthquakes, leading these architects to propose a fake design. The work of analysis and evaluation should be a cooperative effort by specialists from different disciplines - seismologists, architects, engineers and art historians - who should also have a shared knowledge of the conservation and consolidation of historic buildings.

New interventions, outward changes or appropriate new structures should not destroy the historical materials and features of the buildings and their typical proportions so that, if such alterations are reversed in future, the basic form and integrity of the historical features would remain intact. Though it is impossible to give a general rule for the choice of intervention, certain guidelines can be proposed: respect for the original concept, a careful balance between safety and durability, the principle of minimal intervention, and a detailed assessment of the opportunities provided by old and new technologies and techniques.

Asst. Prof. Mevludin Zečević, BSc.Arch. MSc.
mevludinz@af.unsa.ba
FA Univerza v Sarajevu

Asst. Prof. Amir Čaušević, BSc.Civ.Eng, Dr.Sc.
causevicamir@hotmail.com
FA Univerza v Sarajevu

Asst. Prof. Nerman Rustempašić, BSc.Arch. Dr.Sc.
nermanr@af.unsa.ba
FA Univerza v Sarajevu

Viri in literatura

Cultural Heritage Without Borders http://www.chwb.org/regional/documents/The_Handanija_ Mosque_ Restoration.pdf, <september 2012>.

Husedžinović, S., (2005): Documents of Survival, MGZ, Zenica. (2004) : Journal of the Commission to Preserve National Monuments, Baština/Heritage, Sarajevo.

Čaušević, A., Zečević, M., Rustempašić, N. (2011): "Preserving the original system of a timber roof structure: the example of the Handanija mosque in Prusac", SHATIS"11 International Conference on Structural Health Assessment of Timber Structures - Lisbon, Portugal.

Bećirbegović, M., (1990): Mosques with Wooden Minaret in Bosnia and Herzegovina, Veselin Masleša, Sarajevo.