

Architectural Modelling of Alternatives for Verification of New Interventions on the Example of the Romanesque Palace at Spiš Castle in Slovakia

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Abstract. The article presents the results of the first phase of the research project SK-VEGA 1/0951/16 on using transparent and translucent structures in historical buildings. The team of researchers from the Faculty of Architecture SUT Bratislava introduces possibilities of using lightweight roofs on the model example of a dominant medieval ruin (Romanesque Palace, Spiš Castle, UNESCO site). Architectural 3D-modelling of alternatives gains new methodical importance in conditions, when in real practice only safeguarding conservation approaches are preferred. Research based on design serves as a tool for decision-making on further restoration approaches to a specific cultural heritage object. The selected Romanesque Palace of the Spiš Castle has passed through many structural periods. The interior doesn't exist and the perimeter walls create a raised landscape landmark. Romanesque, gothic and renaissance periods were identifiable. It would be possible to reconstruct these periods partially hypothetically on the basis of saved archive materials. Inner structures and the roofing of the palace were in individual historical periods changed. Exact frame models of a new roofing were created on the principle of hypothetical reconstruction: from the indication of the medieval form, renaissance form until contemporary new forms respecting the present day horizontal palace's topping. The aim of the first stage of the research was to present a few architectural alternatives of the roof structure refilling according to the given cultural heritage determinants and structural possibilities. We introduce 12 solutions in graphic and text, which present architectural models of a new roofing, covering the interior by transparent structure based on glass panels and translucent structures based on a textile membrane. We achieve a new space for new functional use of the palace by means of various ways of physical enclosing. On the other side, we work with alternatives of the perimeter wall perforation according to the historical periods. New inserted structures are designed in contemporary technologies and materials. An analysis of particular architectural proposals is the result. The shape, material selection (steel, timber), roof support structure selection and choice of transparent or translucent covering are subordinated to the architectural concept of the historical period's presentation including contemporaneity. The solved problem was, how new interventions are able to visually coexist with historical original without diminishing its authenticity. Glazed and membrane structures used for covering authentic ruins request professional architectural modelling of alternatives based on exact historical facts. The decision making process is made easier by visualizations. Structural



shapes issued from original tectonic rules (standard, order) appear from the point of visual and also monument restoration criteria more favourable than structural shapes, which were not inspired by these rules. Plane shaped glazed roof shapes from this point of view seem to be more intrinsic than rounded. On the other side, alternatives with use of textile membranes have soft shape morphology, which is beneficial for new and also historic shapes of roofing in this researched example.

1. Introduction

The Spiš Castle is listed as Slovak National Cultural Heritage and it is also inscribed on the UNESCO World Heritage List. The Romanesque Palace of the Spiš Castle has been selected as a suitable case study to demonstrate the possibilities of design of transparent and translucent roof structures depending on the restoration method and structural limits of the perimeter walls. The main aim has been to verify the two essential determining factors of architectural design of transparent and translucent roof structures in the case of ruins. The two main determining factors for the design are: restoration method and related shape of the roof structure and load-bearing limits of the walls of the ruin structure. The Romanesque Palace is a dominating component of the castle ensemble creating a landscape landmark. The Palace is situated on the perimeter of the ensemble in an exposed position over the rocky cliff which formed a part of the external fortification from the very beginning 'figure 1'. The Romanesque Palace had passed through many construction periods. Romanesque, gothic and renaissance periods had been identified and there is the possibility of their reconstruction - partially hypothetical - according to the archive materials. Roofs of the palace had in the individual periods been subject to significant changes. In the Romanesque period, the palace had two aboveground storeys covered by a butterfly shaped roof hidden behind horizontal topping. In the gothic period, the palace was covered by a gabled roof enclosed by a gable wall towards the castle grounds on the south side. In the Renaissance period, one storey was added and the palace was covered by a high hip roof with gull wings. Internal structures and related openings had been changed. In the Romanesque period, the gallery was appended and in the Gothic period, bays were appended to the palace. In the Renaissance period, one storey was added and the palace was covered by high hip roof with gull wings. Internal structures and related openings had been changed in particular period. A gallery was appended in the Romanesque period, and bays were appended to the palace in the Gothic period. In the Renaissance period, an existence of a third storey is evident. The openings of the windows in the perimeter walls had often been subject to changes of size, position and shape related to internal arrangements of the palace.

2. Contemporary situation

2.1. Contemporary state of the castle

Nowadays, the palace is a ruin, which enables the identification of particular building phases. Considering a high conservation ratio of structures from the oldest evolutionary phase, the palace is signed as Romanesque palace. Position of gothic palace topping is possible to designate on perimeter walls in contemporary state of ruin. Position of Romanesque and renaissance palace topping is possible to suppose. In the first underground storey there is conserved gothic space with arches and column's bases in the first aboveground storey. These structural elements are the guideline for further hypothesis about the types of support structures in the interior of the palace in the next building phases. All horizontal structures (roof, ceilings) are extinct. It is possible to identify the level of gothic ceilings ambiguously. The footmarks of ceilings on the perimeter walls from particular building phases are partly conserved. Vertical structures in the interior are not conserved. It is supposed, that vertical structural system is in relationship with arching structural system on the underground floor. Interior horizontal structures are supposed to be wooden beam ceilings. In the Gothic phase, it is possible that interior structural system on the first aboveground level was arching. This assumption is based on existence of conserved column polygonal stone bases on the first aboveground level. The openings in preserved walls are naked and present a separate problem. In the individual building

phases openings of previous periods had often been filled in by brick masonry according to new demands. This is the reason for the structural instability of the whole palace.



Figure 1. Romanesque Palace at Castle Spiš, UNESCO World Heritage Site since 1993.

2.2. Hypothetical reconstructions of the palace's identifiable building phases [1]

2.2.1. Romanesque phase Romanesque palace was two-storey building at the north side of the rock rim, to which fortification was connected in both sides. The main castle wall was finished by crenellation. The roof of the palace was butterfly shaped with valley gutter, hidden behind roof parapet and with gargoyles on the both sides. Perimeter walls were perforated by irregularly situated windows. In representative spaces, presumably biform windows had been used and in the other spaces slotted windows were used. An opening to the lowest storey is presumed to have been in the same place as today. The thickness of the wall tapers to the top suggests that wooden beams may have been applied in this area. In the Romanesque period, the 2nd storey gallery was discovered and another one is assumed to have been on the 1st storey. The type of interior structures wasn't detected, but there are hypotheses about wooden beam ceilings in the underground, 1st aboveground and 2nd aboveground storey.

2.2.2. Gothic phase Gothic palace had two storeys and was situated at north rock rim, with fortification on both sides of the palace. The origin Romanesque crenellation was substituted by gable roof with gable on the south frontage in direction to the courtyard. The exact inclination of the roof was restored on the gable from this period. The main castle wall was completed with crenellation. Perimeter walls had full structure perforated only by irregularly situated windows from Romanesque period. On the south frontage, an expressive bay oriel with stone consoles was added. The location of the entrance to the underground floor was the same as it is in nowadays. The new gabled roof was supported by bold stone topping cantilevers. The galleries from Romanesque period probably didn't exist in gothic phase. In the gothic phase, the underground floor was roofed by 5 arrays of ribbed vaults supported by 4 pilasters in the interior space. These pilasters continued on the 1st aboveground floor as polygon stone columns with bases and are the ground for hypothesis about the existence of another vaulting ceiling above this floor. Also, the timber beam ceiling in this position is not excluded. Second aboveground floor is supposed to be covered by timber beam ceilings. The exact positions of gothic ceilings were not detected by research, it is expected that their position was the same as in the Romanesque phase.

2.2.3. Renaissance phase Renaissance palace had three storeys and was situated at north rock rim, with fortification on both sides. One storey was built over the gothic palace and roofed by gabled roof with hips at the ends. Perimeter walls in the Renaissance phase were interrupted by regularly deployed window openings on the level of the 3rd aboveground floor and smaller window openings on the level of the 1st and 2nd storey. It is supposed, that by redesign of the storey's levels, the position of the previous ceilings was changed. That was the reason why older window openings in contact with new

ceilings were walled up. In the Renaissance period, the galleries didn't exist. The internal space of the underground floor remained Gothic, with a Gothic ribbed vault ceiling supported by 4 pilasters. There is no proof that the pilasters continue in the 1st aboveground floor as polygonal columns with bases. It is assumed, that the ceiling in this floor was the same as in Gothic period. At the 2nd and 3rd floor stone, cantilevers for the embedding of timber beams were preserved. We can presume that timber beams ceilings had been originally used in the lower storeys.

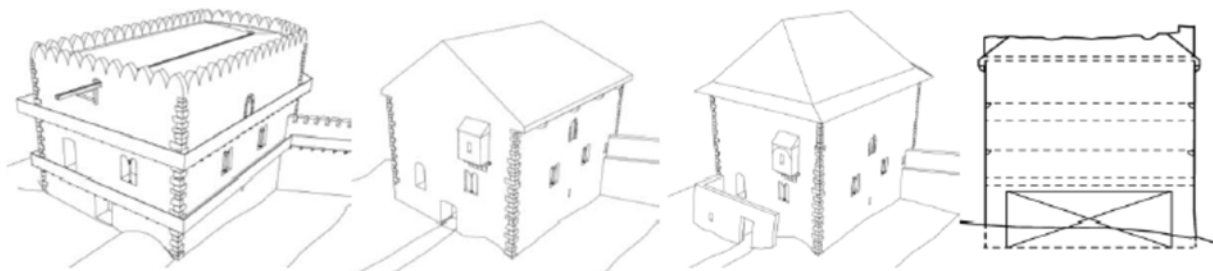


Figure 2. Hypotheses of the palace roofing - Romanesque, Gothic, Renaissance, contemporary state.

2.3. Contemporary approach to the method of the castle's restoration

Today's appearance of the whole castle gives the impression of a ruin. The dominant position of the Romanesque Palace has retained topping of walls as it was preserved appropriately, excepting structural reinforcement after accident. Today, the primary request is the conservation of originals and of the authenticity of the castle as a whole and of its parts [2]. This authenticity is differentiated as authenticity of the material and authenticity of the work. Contemporary monument restoration criteria prefer conservation of the material. In our case study, we decided to verify presentation of the palace as an authentic work. From the methodological point of view it means creating a hypothetical design according to a particular historical evolution phase including the contemporary state. The request of applying a canopy over the open interior of the Romanesque palace provides the possibility of such presentations.

3. Method of Research by Design

3.1. Aims and form of processing

The aim was to design solutions for roofing of the Romanesque palace in the standard of architectural scheme according to the determined groups responding to the protection and presentation of this important object. The design in this case study combined two meaningful determining factors: a/ Evolution phases of the roof and its position in the Romanesque, gothic, renaissance period and contemporary state, see 'figure 2'. b/ The possibility of loading the perimeter walls depends on perforation of the walls. Retained or walled up openings in perimeter walls are related to the presented historical evolutionary phase. Resulting new roof structures are supported by new inserted vertical structures independently of existing walls or new roof structures are supported by existing perimeter walls, or existing stone embedding in original positions in the walls.

The design alternatives were developed according to methodical instructions regarding the shape, material, structure, form of drainage of the roof area and interior design as corresponding to the style of the development phase. The shape of the roof was created as imitation of hypothesized shape in position of extinct style period or as a new shape in random position regarding its height. Inserted roof structures are supposed to be constructed as reversible. In presented designs, there is no supposition for filling of the openings by glazed windows. The ruin thus remains open. The proposals are presented using 3D visualizations, the floor plans of several levels, and cross sections. In these visualizations, impact of each architectural idea is seen in vertical walls, horizontal structures of the palace and in demands of fulfilments of the wall openings. 3D displaying of the interior and exterior lightened the correction of roof structure from the point of architecture and a harmony of the new

design and the preserved heritage. In the displaying, the new structure and invasions are marked by red colour, origin constructions are in black colour for better proposal's readability.

3.2. Visual presentation of the proposals



Figure 3a. Steel support structure with frames in cross-sectional direction with point fixed glazed tables allows to create open space.

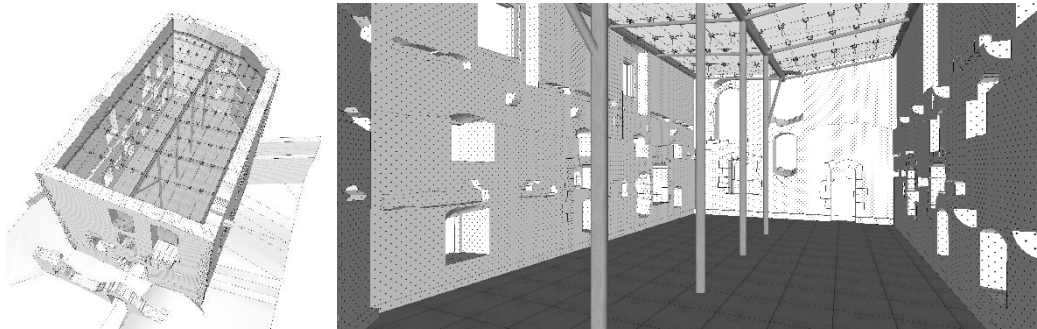


Figure 3b. Steel support structure with frames in longitudinal direction with stressed cable trusses with struts as secondary structure. New steel columns are situated in the positions of origin pilasters.

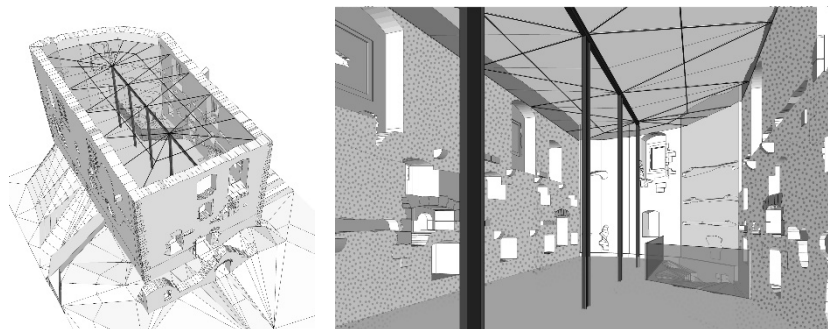


Figure 3c. Frame structure with steel columns situated in the positions of the origin pilasters and using existing stone embedding in perimeter walls. Roof covering is presumed as textile membrane.



Figure 3d. Steel roof structure is laid on existing stone embedding in perimeter walls, the interior is free, roof covering is presumed as translucent textile membrane.

Figures 3a – 3d. Designs inspired by the Romanesque roof maintaining the present day silhouette of the walls. New structures /a,b,c/ are not anchored in the perimeter walls, d/ the roof is supported by the original stone cantilevers.

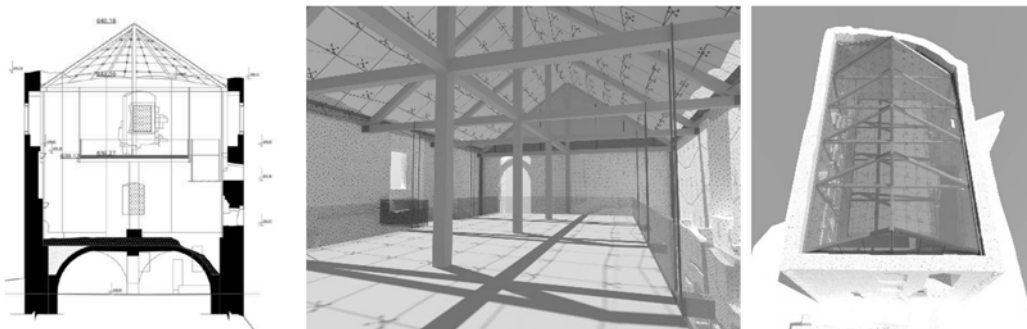


Figure 4. The design is inspired by the Gothic phase roof shape. In the origin site of gothic ceiling is inserted new timber ceiling and gable roof supported by timber columns. The covering of the roof is presumed by stressed cable trusses with struts as secondary structure.

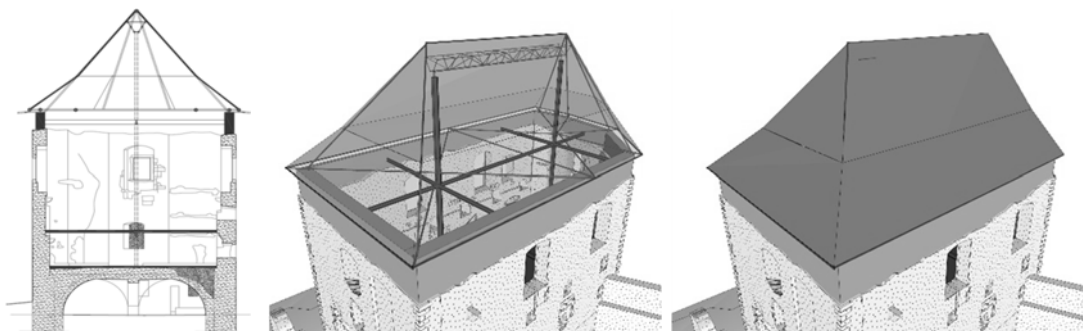


Figure 5a. Gable roof with hips is covered by translucent textile membrane. Steel structure with steel head truss is supported by steel interior columns in new sites.

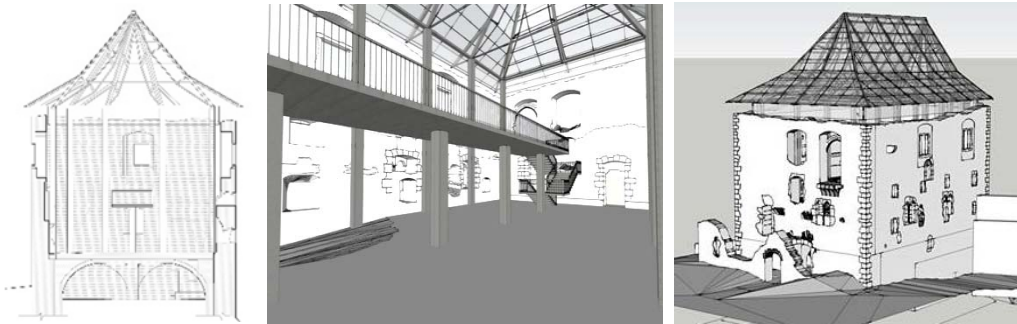


Figure 5b. Gable glazed roof, an imitation of original pilasters is seen in the interior.

Figures 5a- 5b. Designs are inspired by the Renaissance phase roof shape.

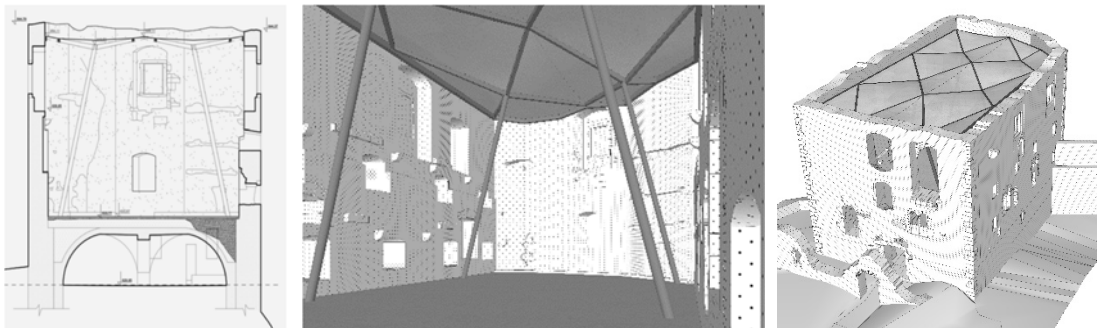


Figure 6a. Steel structure with inclined columns combined with a translucent textile membrane.

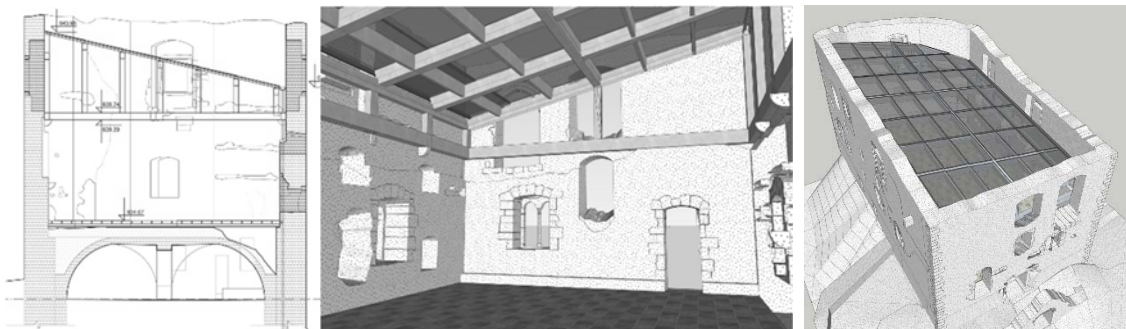


Figure 6b. Glazed roof structure is supported by original stone cantilevers, the interior is free.

Figures 6a – 6b. Designs of new roof shapes suitable for the present state, which is understood as an evolution phase.

4. Results and discussions

At this stage of the research project, 12 verifications of architectural alternatives were processed. The proposals were designed according to given determinants. The resulting scope of proposals presents other informative value in comparison with architectural competition. Designed solutions have demonstrated two effects on the original mass of the palace. The first effect is minimal, in this scope of proposals the contemporary silhouette of the palace ruin is retained. Second effect is more expressive with the addition of masonry, walling relevant windows openings and the completion of silhouettes by new roof construction. Material of new roofs was selected as transparent glass or translucent textile membrane. The support structure was designed from timber and steel. Steel as a material evokes stronger modern architecture. The timber in support structure represents traditional historical material. Glass was excluded from some complicated shapes of the designed roofs in favour

of textile membranes. The structural aspects are an important conditioning factor, when working with ruins. Selected architectural proposals will be verified also statically.

The further search for eligible new interventions by this research method may require the application of other determining factors simultaneously. In case of ruins work with structural aspects is indispensable. In the subsequent stage these shall be further examined in more depth. Selected architectural proposals will be structurally and mathematically verified. A separate problem is represented by the load-bearing capacity of the original window openings in the perimeter walls, as the whole palace is significantly destabilized.

5. Conclusions

Research carried out using architectural design proposals is important in that it clearly shows the impacts on the determining aspects. The results can then be used to define the detailed conditions for the architectural competition or a real proposal [3].

Preservation of the castle ruins in the given environment represents the established way of protection [4]. The method of "research through the design" verifies through alternatives other recovery options such as conservation. By creating "passports" with analyses the process of decision-making on the approach can be helped. Currently the demand has been to create a free interior space in the area of the castle ruin. Overlay by new transparent or translucent design allows the observation of the principle of reversibility of the intervention, as well as preserving the originals, which corresponds to the international legislation.

All students participating at the research were familiar with the system approach to design. They gained an expert insight into qualified approach to the restoration of cultural heritage with complex historical development in consultations and final presentation. At the same time, they gained knowledge and skills in the application of contemporary structures in atypical building structures.

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