STRUCTURAL RESTORATION AND STRENGTHENING OF THE RENAISSANCE PALACE IN RZĄSINY, POLAND

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Keywords: Historic Palace, Masonry Structure, Renovation, Strengthening.

Abstract. This paper is an overview of the technical interventions that should be made during the structural and functional reconstruction of the renaissance palace from 16th century. The analyzed object is a three-floor brick masonry building with multi-hipped roof. Compactness of the building is affected only in the eastern part as the result of the expansion in the 19th century. All structural and technical problems that were recognized during building examination were analyzed and to solve them proper solutions were adopted. Carried out calculations concerned checking the structural solutions, material properties and load-bearing capacity of all the structural elements and connections between them. The paper reviews some of the technical problems and presents how they were overcome with reference to this particular case.
1 HISTORICAL OVERVIEW

The first historical information about the village Rząsiny, where the renovated palace is situated, comes from the year 1305. The village is located between the cities of Lubań and Lwówek Śląski in Lower Silesia (Poland). It was probably ancillary settlement for the castle Podskale which was built at the turn of the 13th and 14th century. During Hussite wars the castle suffered the same fate as the majority of Silesian fortresses and was destroyed.

Renaissance mansion in Rząsiny was built between 1494 and 1499 from the initiative of the family Talkenberg. About 1530 the mansion was abandoned by Ramphold Talkenberg, who moved to the nearby, newly built, magnificent palace in Płakowice. One hundred years later Rząsiny estate passed into hands of Heinrich von Hochberg and then Lucretia von Hochberg. From 1630 to 1650 the property belonged to the family von Lest. In the years 1661-1668 the manor was under the patronage of royal superior over offices in Jawor, Heinrich von Poser. From 1676 to 1734 the family von Schweinitz owned the manor. The palace complex was built with redevelopment of the Renaissance court of the palace in 1740. Frequent changes of the host property took place in the 19th century. For a time, the owner of the palace was Russian Field Marshal, Prince Ivan Dybicz Zabałkański (actually Hans Karl Friedrich Anton von Diebitsch), known in Poland with suppression of the November Uprising. He rebuilt the palace and surrounding park, giving them a current classical form. In the early 20th century, palace was extended with annexes and new storeys.

2 STRUCTURAL DESCRIPTION OF THE ANALYSED BUILDING

The building of the palace in Rząsiny is a brick, three-storey structure. It is designed on a rectangular plan with a risalith on the main axis. Palace building is covered with combination of hipped and gable roofs. It is a building with relatively compact shape which was interrupted only in the eastern part facing park direction. It is a result of extending the building in the 19th century, situated on both sides of the old tower staircase. However, it can be clearly distinguished a plan from the Renaissance period with the vaulted hallway leading to a three-flights tower staircase located on the back of building. In the rooms on the ground floor original mirror vaults, Renaissance window framings and fire places have been preserved.

A three-storey and six-axis façade was formulated symmetrically. The axis of the façade is accentuated by large biaxial attic and columned portico carrying the covered balcony. Schinkel’s fluted columns shape this portico as well as architecture of the balcony. Architectural division of the façades is quite poor because it was formed by adapting the old baroque pattern. All architectural divisions are performed only in plaster, maximally simplifying them and entering pseudo-rustication and smooth plaster. Plinth zone are adorned with plaster pseudo-rustication from which grow organically pilaster strips which form pairs of window axes and support entablature with cutter and crown cornice. Pseudo-triglyphes are placed over the corner pilaster strips. Dormer window in the roof is crowned by a triangular pediment and its walls are decorated with simple pilaster strips, supporting simplified entablature, and two side stone volutes are supplementing structure (Fig. 1). The south elevation is more diversified and asymmetrical (Fig. 2). It consists of two parts: the extended three-axial and the retracted uni-axial. This irregularity is also apparent in the roof area, where the hipped roof is cut at its top part by perpendicular gable roof, which covers the staircase behind the building and lucarne on the façade. Separate gable roof covers outbuilding in the south-eastern part of the palace. This clear differentiation of the façade also emphasize architectural divisions. The tri-axial element is decorated like the façade, so there are here corner pilaster strips organically linked with pseudo-rustication of basement and simple cornices.
In contrast, outbuildings elevation is only decorated with plaster strips which perform functions of string courses. Additional diversification of the façade is cutting of outbuilding corner and change in the form of cantilever to the shape of the quadrilateral.

The east elevation is relatively irregular by varying the dimensions of the various parties (Fig. 3). Essential element of this elevation is axially located risalith of staircase, which is elevated and crowned with triangular fronton. Uniaxial outbuilding adjoins to this risalith in the south side. It is pentagonal on the ground level and four-sided above. However, from the north side there is a distinct dislocation which is filled by terrace at the height of the first floor.

Elements that create a whole elevation are the simplified architectural divisions in the form of plaster strips which serve as string courses. Furthermore, plinth zone is decorated with plaster pseudo-rustication from which grow corner pilaster strips of main body of the building.
The north elevation is formed similarly as the south one. It currently consists of two parts: the extended three-axial and retracted one which form a windowless north wall of the staircase, preceded by a terrace. Architectural divisions take similar forms like for the south elevation. Under the main body of the building there are extensive cellars available from the staircase. All these areas were roofed with barrel vault which has low arches coming down (Fig. 4).

In the middle part of the ground floor is a representative hall with Renaissance portals (Fig. 5). This hall is covered with barrel vault with lunettes. Similarly vaulted also two rectangular rooms in back tract. Slightly different were covered two large chambers in front tract. One is covered with a barrel vault, which lunettes aren't connecting oneself and the other is adorned with rich cloister vault with lunettes along three walls. Newer rooms built in 19th century are covered with ceilings.
Figure 5: Representative hall on the ground floor of the palace with Renaissance portals covered with barrel vaults.

Most areas on the second floor are covered with ceilings with bevels. One room in the south-east corner has the mirror vault (Fig. 6). This room and the adjacent room are decorated with rich stucco decoration.
An adjacent room, localized in the south-east corner of the palace, has also a richly decorated vault, which is formed on the base of mirror vault. Its central part is adorned with a large plafond (Fig. 7). Vaults crossing is marked by scaly ornament and axes of narrow webs are filled with fruit and floral overhangs. On the longitudinal axis of the ceiling are placed oval plafonds with painted coats of arms, covered in cartouche decoration (Fig. 8). On the short axis there are smaller plafonds with monograms. Stuccowork adorn also the edge of a large semi-circular closed windows. Stylish form of vault decoration indicates that they come from the beginning of 18th century.

On the third floor there are areas that cover not decorated ceilings with bevels. Only the hallway ceiling is adorned with symmetrically composed stucco decoration in the form of two large late Baroque plafonds (Fig. 9).

Figure 6: Representative room on the second floor covered with mirror vault.

Figure 7: Decorative plafonds in the room on the second floor.
3 DESCRIPTION OF THE BUILDING TECHNICAL STATE AND STRENGTHENING OF DAMAGED STRUCTURAL ELEMENTS

Load-bearing walls of the palace are made of different technologies, mainly conglomerate of stone, limestone slate and in part of ceramic brick on lime mortar. Construction of palace building was repeatedly subjected alterations during many years of exploiting. As a result of inspection of masonry bearing wall it was found fragments of construction rebuildings of wall and supporting pillars. Alterations and walling were not always carried out in accordance with the requirements of building standard. Therefore structural damage in the form of failure and cracks occur mostly in bricking up a window or door openings without keeping toothings. Cracks also occur in parts of the walls, which is caused by excessive horizontal forces from outward thrust of cross vault. During the inspection of the building construction it was found that these cracks are danger for safety of palace building. Due to the stabilization of supporting systems and overall rigidity of palace construction, it was necessary strengthening load-
bearing walls to prevent damage of interior walls elements and palace vaults. Due to the fact that construction of walls has varied material, the authors predicted different ways of its integration. For example in brick parts it was proposed a wall bricking with toothings or alternatively stitching the wall by bars Ø6 mm which are glued in wall joints on a depth equal approximately 5 cm in each row of joints. The walls of the conglomerates structure are more difficult to strengthening, therefore in these fragments decided to local demolition of masonry walls, after stamped ceiling and performed wall restoration by using historic demolition material for cement and lime mortar.

The construction of the basement and the ground floor is designed as cross vaults, cloister and the barrel vault with lunettes. In addition, there are single-span and two-span masonry floors on steel beams which are based on the walls and stiffener arch. The vaults are made of ceramic bricks on lime mortar (Fig. 10). Some vaults have ribs which reinforcing them. In parts of the vaults there are cracks and failure which have different width and deformation of vaults curvature. During static analysis, which takes into account geometric imperfections because of cracks and deformations which are the result of exceeding stresses in the vaults. In analysis assumes reduced values for the material parameters of brick and mortar.

In order to improve the static vaults, it was decided to relieve them by removing heavy rubble-sand backfill and filling the space over the vault using “leca” stabilized with lime. Adopted in this way static system ensured in the levels of ceilings rigid body of the building and fulfillment of the conditions of ultimate and serviceability limit states (Fig. 11, 12).

In parts of the upper storeys and attics were executed wooden floor. The main supporting elements are wooden beams arranged in different spacing (80÷95 cm). Between the beams were laid boards of false ceiling with backfill consists sand mixed with lime. From the bottom side the floor was closed with boards of the soffit to which was nailed cane mat. Finishing of the ceiling was carried out with cement plaster. From top the floor was covered with boards which were nailed on floor beams.

Technical state of bearing beams was determined on the basis of uncovering. Inventory of damage beams, and their deflections and structural defects allowed performing a detailed static analysis, taking into account physical and geometrical imperfections, which led to make decision about strengthening method of ceilings construction.
Damaged parts of beams near the supports were strengthening by exchange of ends and combine them with well part by using jointery connections. These connections were additionally reinforced with bolts so as to transfer shear forces in the joint. The beams that did not fulfill bending condition in the middle of the span were strengthening with bilateral constructional elements combined with the main beams by draught-board nailing. In addition the ends of beams were equipped with anchors mounted in the walls to stiffen the ceiling system and bearing walls.

Top of the walls of the building was heavily cracked, which was caused by excessive expansion forces of the roof trusses and the loss of the right connections between ground beams and plate beams (Fig. 13).
Furthermore, in order to stiffen the coping and reducing outward thrust from the roof structure were made ring beams. In these ring beams are attached with anchors wall plates which support the roof rafters. This action allowed for a significant reduction in bending of wall which was caused by outward thrust from roof structure.

Palace building is covered with combination of roofs: main hip and gable roofs. The roof of the palace building is made in a diverse wooden structure depending on the covered spaces. Covering was made with double lapped tiles. In roof covering distinguished two types of plain tiles. The original tile is simple fluted old type plain with dimensions: 41 cm length and 22 cm width. Span of the girders of the main roof is about 17.0 m, whereas corresponding height of the roof amounts 8.20 m. Supporting of rafters is realized by wooden stretcher which is based on two wall plates. Support system and cornice node are visible in the section figure (Fig. 14). Joining roof construction are different and depend on components which are connected by bolts and carpentry nodes. Purlins and angle braces are connected mainly by joinery connections.
Numerical calculations of wooden roof structure which verifying its carrying capacity showed that stress are not exceeded and there is no risk of failure of construction. However, roof structure should be supplementary renovated and locally strengthened. Sample pictures of the roof truss structure shown in Fig. 15.

During long-term exploitation the roof structure was subjected to periodic renovation. This is evidenced by preserved on roof spaces two types of plain tiles (Fig. 16).

Generally technical condition of the whole roof structure is assessed as satisfactory. However there are few constructional components which technical condition is evaluated as bad because of biotic damage and these elements require reinforcements.

4 FINAL REMARKS

Issues related to renovation of historic buildings are inherently complex and difficult [1, 2, 3, 4, 5, 6]. Determining causes of the structural destruction of old buildings is complicated and requires extensive analysis of historical background and static-strength calculations, backed up by the experience and knowledge associated with the ancient techniques of building. Applied methods of strengthening of load-bearing walls, cross-ribbed vaults as well as fungicidal and insectidal impregnations of timber roof constructions were assumed as generally well known from technical literature. Therefore details of those solutions were omitted in this paper. At present, there is being prepared a final design of repair, protection and strengthening of the palace building.

REFERENCES


