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Original Research Article

TECHNICAL ASPECTS OF RENOVATION OF THE 16TH-CENTURY ROOF TRUSS

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Abstract

The main causes of damage to wooden structures in historic buildings are the effects of weather conditions and related aging processes. In the case of the roof truss of a 16th-century church in Lubów, the technical condition is additionally affected by leaking roof covering, damaged gutters, downpipes and flashings. Some elements of the wooden structure underwent biological corrosion, which lost its strength values. The roof truss of a 16th-century church in Lubów comes from the period of construction of the building. Due to the historic values of the structure of the truss, the renovation works do not intervene when the works would change its form, shape and type. The truss renovation is based on the assumption of maintaining original construction solutions, location of elements and cross-sections.

Keywords: roof truss, technical condition, renovation

1. INTRODUCTION

In historic buildings, the selection of appropriate methods of renovation works should always take into account the historic character and historical values of not only the objects as a whole, but also its individual elements [3, 4, 6]. Renovation works in these facilities should be based on minimal changes in material, construction and technological solutions [1, 4].

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2. 16TH-CENTURY CHURCH IN LUBÓW

The church in Lubów was built in 1520. The building has one nave, made in traditional technology. The facility is founded on the plan of an elongated rectangle with a three-sided closure from the east and an extension - a porch on the north side. From the west, the church had a wooden tower - bell tower, removed in the 1940s. of the twentieth century.
The walls are made of stone and brick, thickness: 60 cm plastered on both sides. The covering of the nave is a network vault with girts, the roofing of the porch is a barrel vault. Elongated window openings closed with full arch, door opening closed with full arch with a flat portal.

Photo 1. South view. Visible deflection of the ridge, roof slope deformation

Photo 2. Truss structure with two supporting walls reinforced with dead bolts.

The church is covered with a gable roof, in the presbytery part - a complicated wooden structure. Covering of carp tiles covered with lace on a lime mortar. The roof pitch is about 62º. The roof truss comes from the period of church construction.

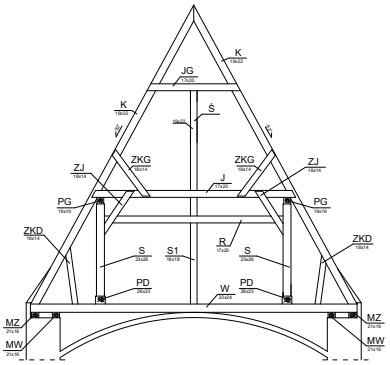

Fig. 1. Truss cross-section - full truss W1

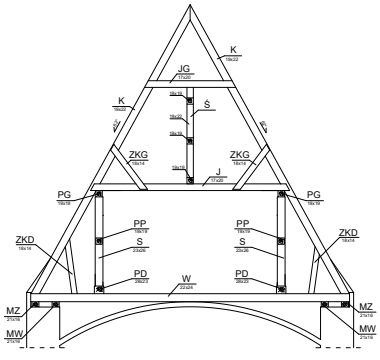

Fig. 2. Truss cross-section - empty truss W1a

Truss structure is of collar beans with two supporting walls reinforced with transoms. Full trusses are additionally reinforced with a spreader beam. Between the full trusses in the longitudinal direction braces stiffening the structure. The cannula is additionally supported with braces.

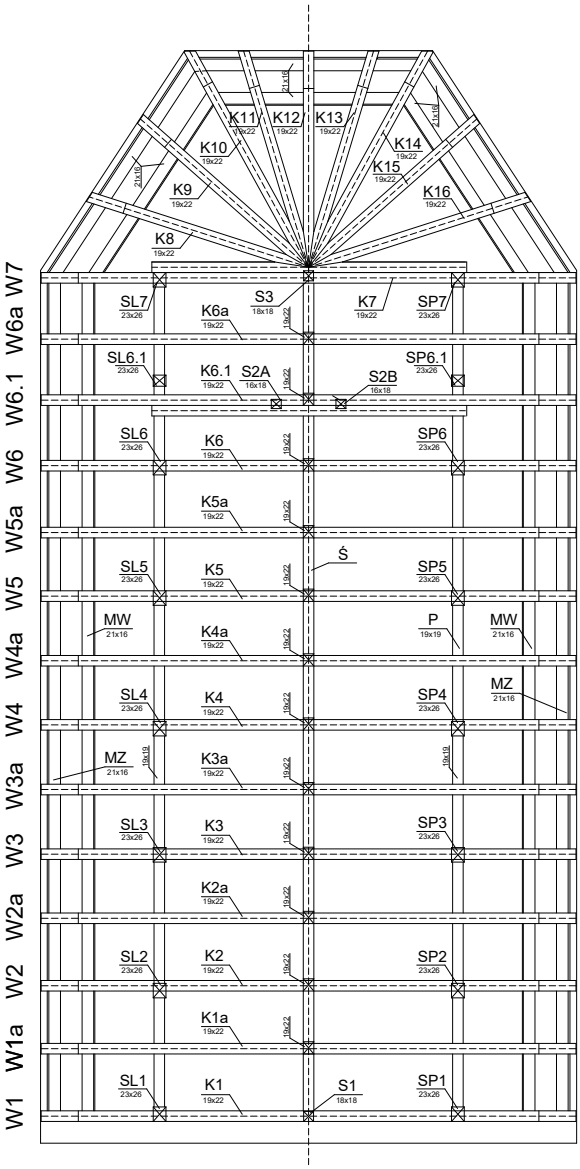

Fig. 3. Roof truss projection

In the upper part of the roof, a wooden mullion-transom frame is supported on the yards, additionally stiffened with braces running in one direction. The frame supports the tabs on the upper level. The truss is based on truss beams laid on two platforms.
Above the presbytery, rafters stiffened in the upper part with cross-braces. Truss beams are located above the temple's ceramic vault. From the west, the roof is covered with a stone gable wall.

3. TECHNICAL CONDITION OF THE ROOF TRUSS

An assessment of the technical condition of the church roof truss was carried out. As a result of the research, it was found that the degree of wear of many elements is within 70% - 80%, and the supporting-dead bolt wall supporting the upper tab is worn 100%. It was found that some of the carpentry joints were split and displaced, numerous traces of secondary reinforcements and repairs are visible.


Photo 3, 4. Corroded supporting-dead bolt wall elements

Photo 5. Bent collar beams and dead bolts

Photo 6. Split connections of support and transom wall elements

Photo 7. Places after removed struts.

Photo 8. Corroded rafter secondary reinforced with counter batterns

Measurements of deviations and displacements of the church roof truss structure were made. Deviations from the vertical columns of SL1 - SL7, SP1-SP7, S1, S2A, S3 were measured. Deviations from the vertical of the columns are in the range of 2.0 - 20cm. In addition, the rafter deflections are 20 cm in places, the deflections of the collar beams and dead bolts reach 25 cm.
In the W2 and W3 trusses there are no braces, in the W4 and W5 trusses there are no single braces. In the W2a, W3, W3a, W4, W4a (L) trusses, the corroded ends of the truss beams are reinforced with wooden prints, the washers used between the lower purlin PD and the truss beam are used.

Photo 9. Corroded truss beam ends are reinforced with counter battens from boards

Photo 10. Wedges between the lower purlin and truss beams

Photo 11. Place after the removed pole, biological corrosion of the collar beam

Photo 12. Split connections of truss beams above the presbytery

4. MAIN REPAIR POSTULATES

The roof truss has historic values both due to the original material and the type of construction, therefore no interference that would change the form, shape, type. During renovation works original construction solutions, location of elements and their cross-sections should be kept [1-4, 6-7]. Connections of roof structure elements should also be made using the same carpentry joints as the original ones, only modern elements should be used in elements reinforced with overlays.

4.1. Strengthening damaged roof truss components

Strengthening of damaged upper and lower purlins, collar beams, and dead bolts has been designed by using double-sided C30 wood seasonings with cross-sections supplementing the amount of hewn wood 6cm x 19cm (or 20cm). The beams will be joined together using M16 threaded rods, class 5.8. Between the purlin (beam, transom) on the non-corrosive section and the reinforcements, in the place of the bolted connection, double-sided stud plates should be used [5]. Corroded truss nodes in the support zone should be replaced. Before starting the work, it will be necessary to apply the concentration transferring the load from the reinforced truss to the outer wall of the church. The bracing will be in the form of struts located in the plane of the roof slope.

After completing the preparatory work, wall plates sections must be replaced. Asphalt roofing felt should be placed under the wooden elements. Individual sections of the wall plates will be connected to the overlay using a double-sided stud plate. Wall plates will be anchored to the wall with a threaded rod and nut mounted on epoxy resin.

Then proceed to strengthen the corroded truss beams. Truss beams will be reinforced with additional beams located on the sides of the damaged element. The beams will be interconnected with M16 threaded rods, class 5.8, and between the girder beam on the non-corrosive section and the reinforcements in the place of the bolted connection, double-sided stud plates will be used [5].

4.2. Completing the roof truss components

Fill in the missing swords with 17 x 20cm wooden elements, and the missing S2B pole in the truss W6.1. A combination of elements for the overlay with narrowing was designed, adapting it to the existing cut-outs in the support and purlins [5]. Seasoned C30 grade wood, protected against biological corrosion and fire, by means of vacuum-pressure deep impregnation or hot-cold baths will be used for all newly introduced wooden elements.

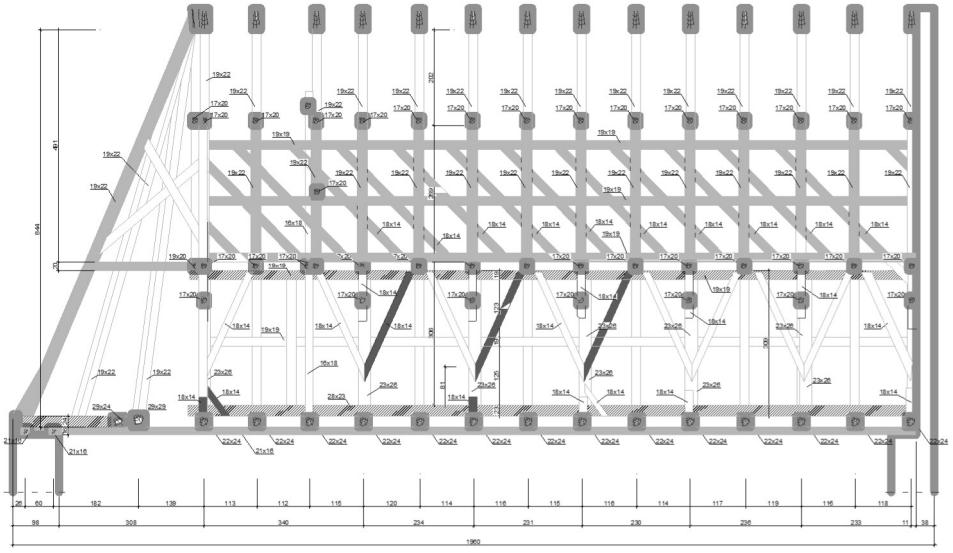

Fig. 4. Longitudinal section of the truss

4.3. Replacement of structural components of roof truss

It is planned to reconstruct the upper part of the roof truss structure, virtually 100% corroded, maintaining the same type of structure and shape. Replacement of elements includes a mullion-transom frame, which is located in the upper part of the roof, along with stiffening struts and rods on the upper level.

Seasoned C30 grade wood, protected against biological corrosion and fire, by means of vacuum-pressure deep impregnation or hot-cold baths will be used for all newly introduced wooden elements.
The reconstructed elements will be mounted on traditional carpentry joints according to original solutions.

4.4. Conservation of roof truss structural elements

All wooden elements attacked by insects, which are intended for repair, after cleaning to healthy wood will be impregnated with an insect control agent.
All new wooden elements that will be introduced into the structure will be impregnated by the pressureless bath method.
After performing all repairs and additions, all elements of the roof truss and the attic should be protected against fire.
For the control of fungi a biocide having appropriate authorization has been proposed.

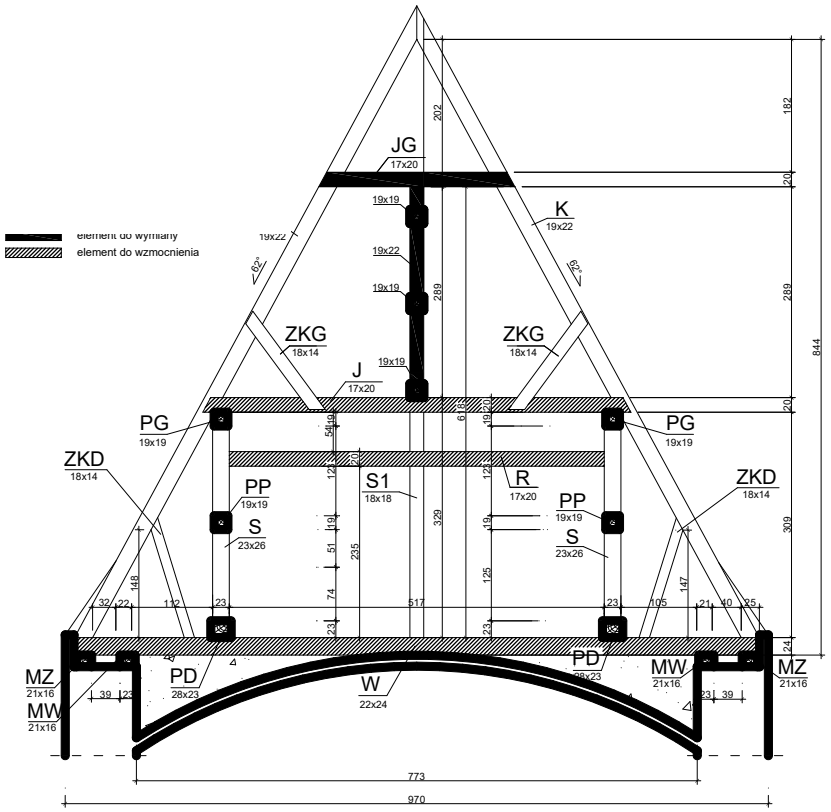

Fig. 6. Cross section of one of the full elms

4.4. Change of roofing material

The complete replacement of the church's roof covering is planned. It is planned to use a flat tile laid in lace. Use a tile that is selected from different palettes to achieve different shades.
In the scope of renovation works, a new payment with 6 x 4 cm patches is planned. The maximum patch spacing is 30 cm. It is also necessary to replace the chokes in all truss trusses. One row of ventilation roof tiles should be made in the eaves zone, while two rows of ventilation roof tiles in the ridge zone.
The ridge is designed in the form of conical ridges laid dry. The ridge batten is made of ridge batten attached parallel to the eaves with ridge batten brackets. The ridge should be laid on a patch with the necessary ventilation. The roof capping will be overlapped for approx. 40 mm, and then the clamp will be fastened with anti-corrosive nails or screws to the ridge batten [5]. Aluminum ridge gaskets will be used as the seal.

4.4. Drainage

New gutters ø192 and downpipes ø 120 are being designed, as well as flashings made of zinc-titanium sheets with a thickness of 0.7mm. Rainwater drainage from the roof should be made outside the immediate vicinity of the plinth.

5. SUMMARY

The technical condition of churches in small towns in the Lubuskie Voivodeship in most buildings indicates the need for a wide range of renovation works. Due to the lack of funds, most often these works are not carried out, but in a few years the progressive degradation will require much larger outlays [6-8]. The inhabitants of the village of Lubów are trying to stop the process of destroying their temple. The first stage of repair work is the renovation of the truss with the roof covering. These works will eliminate the destructive effects of weather conditions on this object.

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