Strengthening of timber structures on the example of roof truss girders in public building

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Abstract Method of repairing and strengthening of damaged laminated timber roof truss girders in the newly built library building is presented in the paper. The supplier of the laminated timber structures did not keep to the appropriate executive regimes while preparing trusses in the production plant. Moreover, after installing trusses on the roof, roof covering was not appropriately made that resulted in pouring rain water over the timber trusses. As a result of these errors occurred stratification and destruction of many structural timber elements and a necessity of repairing. All the trusses were checked and survey of damages and calculation of their carrying capacity was realized, considering damage and imperfections. Decision about the range and method of strengthening of these timber elements was also taken. After the realization of the repairs and reinforcements construction was allowed for further exploitation.

Keywords strengthening, roof truss girders, resistographical investigation

1. INTRODUCTION

1.1. General information

Timber roof truss girders in the newly built building of the high school library are the object of the analysis presented in this paper. In the connection with negligent and overdue realization of the building structure the investor took the decision on breaking a builder contract, and construction was stopped for the period of almost 3 years. Many structural elements of the building, also roof construction, were not properly protected. It cased existence of essential damage and failure of the structural elements of laminated timber roof trusses. Moreover, numerous irregularities were stated in the existing timber structure of the roof and they were caused by imperfect erection and execution of trusses. All these elements caused that after renew realization of the structure, evaluation of the technical state of timber and research analysis based on roof trusses should be realised. For this purpose the authors realized static analysis, examination of timber structures “in situ”, surveying of available technical literature and obligatory standards (PN-EN1194:2000 and others). The main purpose of the study is structure verification by means of the static analysis and description of the current state of behaviour of existing timber roof elements, as well as elaboration of directives in the scope of improvement the existing technical state.

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2. EXAMINATION OF ROOF TRUSSES

2.1. Construction and technical state of roof trusses

The lattice trusses which have different span and construction consist of: arched upper chord and bottom chord in the shape of upside down arch, central pillar and two braces. Longer trusses have two additional support pillars. One bay trusses are independently abut on supports and are not connected one to the other.

There were places of extensive efflorescence on supports in the significant number of trusses, however wood was not humid. In upper and bottom chords appeared longitudinal fractures with little opening. Timber keys situated on supports under bottom chord were partially separated from this chord. Outermost pillars localised on supports and between upper and bottom chord, in many trusses were not glued to chords of trusses and were not connected by steel dowels to the vertical metal sheet of support elements. There was also detected timber decay with slight losses in the final parts of the bottom chord.

All these defects caused that trusses in existing technical state could not be admitted to exploitation.

3. NUMERICAL ANALYSIS

3.1. Static analysis

The main aim of the static calculations was assessment of the bearing capacity and stiffness of roof trusses executed from laminated timber. After making the analysis of the geometry of trusses truss KR01 was accepted for calculation. It has a span equal to 7410 mm and spacing of 3500 mm. On the basis of the material analysis and the resistographical investigations class GL24c of laminated timber for dimensioning truss was assumed. In further static analysis class wood GL28c and class GL32c were also calculated (producer declared class GL30c). The calculations were realized using ROBOT Structural Analysis Professional 2009 program according to Polish standard PN-B-03150:2000. Static analysis for assumed wood classes was introduced because of actualization of design code and took into account results of material examination. That analysis allowed a safe determination of the state of construction strain and its usefulness to the exploitation. However, connections in zones of the support were excluded.

4. RECOMMENDATIONS AND STRENGTHENING OF THE TRUSSES

During examination of roof trusses the control of every anchorage of supporting elements of expansion anchors was realized. Absent anchors were added. Considerable deviations of the base of dowels from the plain of the structure occurred in sections in which steel dowel T-bars were used. It was suggested to execute injection of the epoxy resin in these places. The epoxy resin was filled with quartz dust to the consistency enabling the injection. There was also assumed possibility of realization of new anchorages of trusses to reinforced concrete elements.

5. CONCLUSIONS

Investigations of construction of laminated timber roof truss girders and carried out static and-strength analyses allowed to make the accurate estimation of their technical state. Level of safety of the structure was determined in this way. Technical information received in this analysis allowed making a decision about the way of structure protection and for its strengthening in damaged places.

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