Composite joint of timber truss girders

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Summary

In this paper the possibility of joining elements of timber truss girder with "built-in" connection will be explored. The joint will be based on glued-in steel rod, glass and/or carbon fiber-reinforced timber element and built-in steel tube which takes the tensile force. Fibre-reinforce textile will be implemented locally between the timber layers, in adhesion layer. Glue laminated timber elements will be laminated horizontally as opposed to the usual used vertical lamination.

The study of this joint will be conducted experimentally and numerically. Experimental testing will be conducted on a somewhat smaller number of specimens with applied load at angle 0°, 45° and 90° to the grain and on the prototype of truss girder. Fields not explored by experimental laboratory testing , will be explored by examining the complex numerical models.

1. Introduction

The study is planned to extend the investigation of timber structures built-in joints with large diameter fastener. The concept of the joint will be based on the glued-in steel bars and laminated timber with glass and/or carbon fiber-reinforce.

Large number of studies were made on glued-in steel rods, and because of that this study will carry out only preliminary investigation of glued-in steel rods. Tests on the glued-in threaded steel rods will be carried out to establish the correlation between the resistance determined according to EC5 norms and the actual resistance obtained by experimental tests.

Reinforced glued laminated timber with glass fiber fabric is one of the main goals of this research. Specifically, research that was carried out for connection in reinforced glued laminated timber have shown significantly increasing of ultimate strength comparing to connection in unreinforced glued laminated timber. Experimental tests have shown that raising of ultimate strength is in correlation with reinforce factor and angle between applied load and grain [1-3].

Reinforcing of the timber elements is planned to be executed during the lamination process in a way that the fabric is placed between the layers, in the adhesive layer. Reinforcing of the timber elements in place of connection have been already explored, but the fabric in these studies was specifically knitted and the elements were studied with applied tensile force parallel to the grain. Also, previous studies were conducted with small diameter fasteners (screws, nails and studs), while in this research the plan is to use steel pipe with 50mm in diameter or more. This research should provide new insights into the behaviour of this connection. Only a few researches were carried out for a connections with a large diameter fasteners [1, 4-6].

2. Planed joint research

2.1 Experimental research

Experimental studies are planned to carry out specimens in three series, which would be divided by applied force compared to the grain. Also, within these series are planned sub-series of the reinforced and unreinforced samples; in other words one serie would consist of three reinforced and three unreinforced sample.

The angles of applied force compared to the grain which will be tested on the samples, will be 0°, 45° and 90°. Fig. 2 shows preliminary test on reinforced specimen with applied load perpendicular to the grain. Because small quantity of samples for determination of stiffness, strength and ductility, results will be used for the calibration of numerical models.

After completing the tests on small samples with dimension of the 100 × 12 × 20 [cm], and determining the resistance of the joint through the numerical models, will be cared out the tests on the four prototypes of truss girder. Prototypes of girder will be divided into two groups, those with a local reinforcement and without local reinforcement connection.

Fig. 1 Reinforcing gluelam timber specimens

Fig. 2 Testing of reinforced specimen

2.1.1 The applied materials for joint

Wood samples for testing the joints will be made from laminated timber GL24h. Bonding of laminated timber and fabric will be conducted with melamine adhesive. The fabric with

dimension of 200mm × 400mm manufactured by Kelteks will be inserted in place of the future connection. The type of fabric that will be used is WR 900HA 145 weight 900g/m^2. Glass-fibre textile will be glued between the timber layers, in the glue layer. Reinforcing of the upper and lower chord with fabric will be performed in classical lamination process as shown in Fig 1.

All steel components will be made of high strength steel. Steel pipe will be made of steel with a yield strength of 450 N/mm^2, and a thread rod and connectors will be made of steel with a yield strength of 650 N/mm^2.

The main element is a M16 screw, quality 12.9 which is mounted on the underside of the chord, passing through the steel pipe with diameter of 50mm and on the other side of the chord enters in the diagonal, in which is mounted by screwing. Mechanical property of threaded rod which is glued-in diagonal element of truss girder will be equivalent to screw 8.8., and at its end will be constructive sleeve into which the screw mounted.

2.2 Research on numerical models

Experimental researches on specimens, because of the limited number of samples, will be expanded numerical models. It will be shown the impact of numerical model complexity to the result accuracy. Numerical model, in which the wood is modelled as an orthotropic elasto-plastic material and with crack propagation for tension stress perpendicular to the grain will be compared with numerical model in which the wood is modelled as a elastic material.

Research on parametric numerical models will be explored areas that experimental research has not included. Fig. 3 and 4 are the first numerical models with applied force at angle 90 ° and 45 ° compare to the grain.

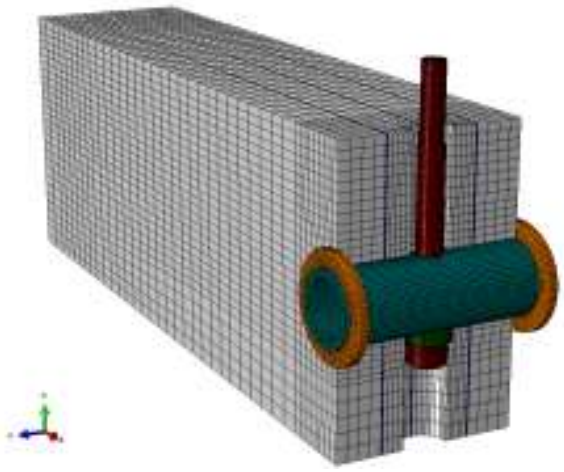

Fig. 3 Numerical model with applied load perpendicular to the grain

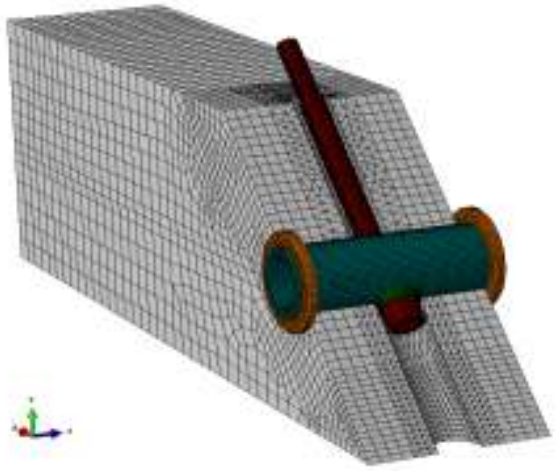

Fig. 4 Numerical model with applied load angle 45° compared to the grain

2.3 Expected research impact

It is expected that the new connection with steel pipes and glued-in rods will replace the commonly used steel plates in truss girders. Quick installation with this type of connection should give greater advantages to the truss girder against the solid timber girder.

Results of parametric analysis will give the complete picture of the behaviour of these joints. It is planned that the research will give a ultimate load of these connection depending on the coefficient of reinforcement, the size of the steel pipe and angle of applied load.

3. References

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