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Procedia Engineering 153 (2016) 400 – 406

Procedia Engineering

www.elsevier.com/locate/procedia

XXV Polish – Russian – Slovak Seminar "Theoretical Foundation of Civil Engineering"

Modern moment resisting timber connections – theory and numerical modelling

Arkadiusz Leśko[a]*

[a]*Warsaw University of Technology, Faculty of Civil Engineering, Al. Armii Ludowej 16, Warsaw 00-637, Poland*

Abstract

The paper relates to innovative solutions of the moment resisting timber connections. Solutions based on traditional connectors (screws, rivets), and modern connectors (glued in rods, rigid inset) are presented on the basis of literature. Summary of a number of conclusions ensuing from the experimental studies is enclosed

Spatial models called a "beam to beam" connection, based on the glued in bars were created. A comparative analysis of the models based on two types of the material: isotropic and orthotropic wood was done. Finite element model based on Abaqus is studied.

Peer-review under responsibility of the organizing committee of the XXV Polish – Russian – Slovak Seminar "Theoretical Foundation of Civil Engineering".

Keywords: connection; fabric; timber; modeling, finite element method

1. Introduction

Connection in timber structure is a junction of elements with usage of connectors and/or carpentry work in order to ensure mutual cooperation of the connected elements. It is the most susceptible place in the structure of the object, which has, apart natural notches, a weakness inducted during montage. In addition, joints are the most loaded places in the constructions, where, in addition to static / dynamic loads, other influences such as deformation of

* Corresponding author. Tel.: +22 502 900 745.
E-mail address: a.lesko@il.pw.edu.pl

Peer-review under responsibility of the organizing committee of the XXV Polish – Russian – Slovak Seminar "Theoretical Foundation of Civil Engineering".
doi:10.1016/j.proeng.2016.08.140

fasteners or drying of the wood is considered. All these factors make that knots in the timber structures are in need of the special care and attention at every stage of the design process.

Modern buildings where wood is the main structural material pose new challenges for the designers. One of them are connections carrying a bending moment which are required in "beam to beam" or a "beam to column" joints. Numerous experimental studies are conducted to introduce of systematic solutions of the "moment" joints.

The aim of this paper is to collect and summarize the latest developments and research conducted on connections of elements of wooden structures which transmit the moment. Additionally a spatial model which shows the possibilities of implementation of experimental research for calculation purposes was prepared and analyzed. Selected results are presented in the paper.

2. Selected modern moment resisting timber connections

Classic solutions

Classic solution of the connection transmitting bending moment consists of shaping the geometry of the node, to provide the transfer of the unusual load by conventional fasteners. That methodology of the connection the elements made from glulam was used in the studies [2]. The research concerned connections based on screws and rivets with cover plates. Joints with screws only were also considered (Fig. 1.).

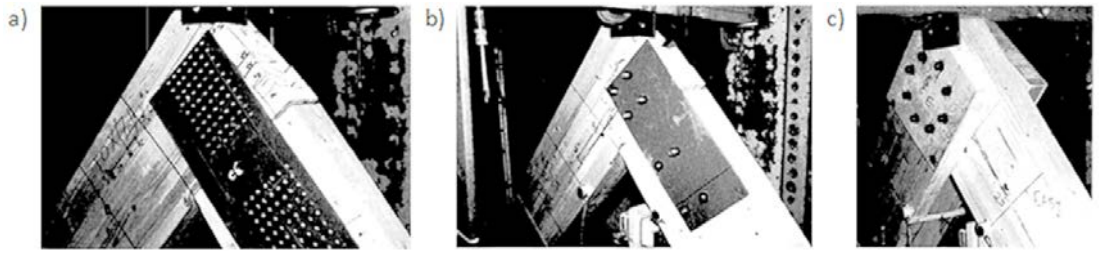

Fig. 1. (a) Rivets connection with cover plates [2]; (b) Screws connection with cover plates; (c) Screws connection without plates.

Research [2] and the other papers lead to a number of conclusions:

- Rivet based connection with cover plates is more durable and stiff than screw based joint with cover plates also. The immediate cause are clearances due to the tolerance of the bolts mounting and the way of the dispersion of the load transfer. Bolts transmit loads between elements in a concentrated (spot-centered) way, while rivets are characterized by spot-distracted loads transfer.
- Usage of the overlay plates or / and corner shims strengthen and stiffens the node. Much more effective are overlay plates from the pad in the form of angle bar (the same principle as the connection with supporting stool in steel structures). The share of the overlay plates and pads in total load on bending is respectively 60% and 40% (in comparison with the connections without additives).
- Destruction of connected elements, as the rule is caused by exceeding the durability of wood due to stretch across the grain. It is recommended to do not use connectors directly in stress concentration areas, and increase their amount in sensitive areas (while reducing their diameter). It allows to redistribute loads properly and frees the load-carrying ability of the whole connection form bearing capacity of the single coupler.

Moment resisting connections – rigid reinforcement

Connections of the reinforced Glulam elements with the use of rigid insets, find their beginnings in 1980 in Denmark. However the first experiments with Glulam braced by glued in rods dates back to 1965. (Sweden). Thenceforth many academic institutions are looking for seamless solutions, research and computational methods