Simplified calculation model for interconnected timber elements using wood-wood connections

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Metal fasteners and adhesive bonding are the main assembly methods in modern timber constructions. However, traditional wood-wood connections can be used effectively as well, thanks to increasing automation of the construction industry (CNC, robotics, etc.). The feasibility of this type of construction technique has been proven for buildings with complex geometry such as the wooden pavilion of the Vidy theatre [1]. As a result, this research is focused on the development of a simplified calculation model for standard construction elements using wood-wood connections called Through Tenon (TT). The goal is to obtain a dimensioning tool which is easy to use in practice for roof, slab and wall elements.

The newly proposed calculation model is inspired by previous research done on interconnected timber elements using both metal fasteners and wood-wood connections [2][3]. As shown in Fig. 1a, the numerical model is composed of beam elements (lines) with eccentricities represented by rigid fictive beams (dotted lines). Associated geometrical and material properties are assigned to each beam element. For TT joints, the tenon part of the connection is also represented by beams, while the contact zone between the tenon and the mortise is defined by springs to simulate the contact stiffness of the joint (Fig. 1c).
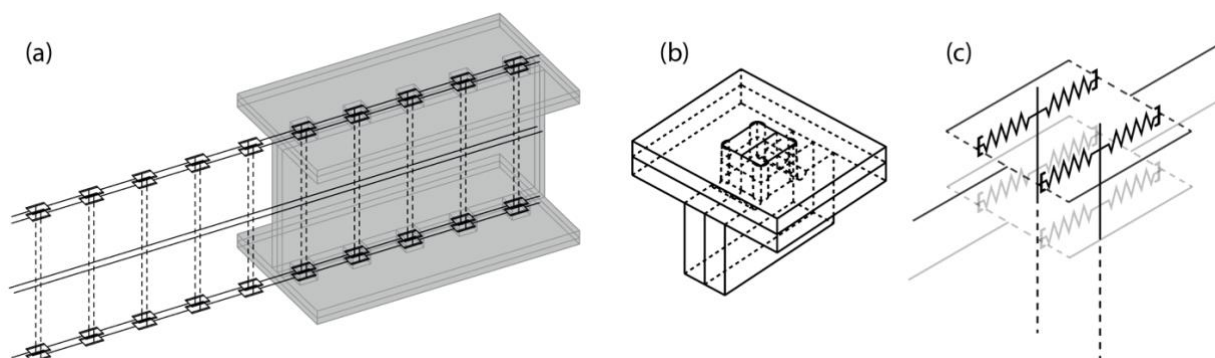

Figure 1: (a) representation of an I-Beam using wood-wood connections with the simplified calculation model (b) Axonometry of a TT joint (c) modelling of the TT joint with beam elements and springs.

The effective bending stiffness (EI_{ef}) of this type of structural element was analyzed to understand the corresponding mechanical behaviour and to assess the calculation model. Therefore, experiments were carried out on TT joints to determine the contact stiffness of the joint, and four points bending tests were performed on large specimens of eight meters made out of oriented strand board and laminated lumber veneer panels.

The EI_{ef} of the model was 12% lower compared to the test specimens, while a fully rigid model was 42% higher. The results show the importance of the semi-rigidity of TT joints. However, friction is not considered within the model which might explain the difference between model and tests. Concerning the tensile failure mode in the bottom flange, a shear lag coefficient should be applied due to the non-uniform stress distribution.

Acknowledgement

References

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