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Numerical analysis of a truss system using beech LVL and axially loaded screws

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In loaded trusses, deformations occur and chords, posts and diagonals change their original angles. Secondary stresses arise in members, if connections are not perfect hinges but modelled as such in the static system. The contribution imparts new ideas for truss systems and results of its analysis. Details are stated in [1]. The new system aims at improving weak points caused by secondary stresses and by compression perpendicular to grain. Fig. 1a shows a system prototype with beech LVL double diagonals connected with inclined screws to glulam chords of spruce. Newly developed washers inserted in blind holes prevent head-pull through. The embedment of the threaded part in the softwood minimises the rotational stiffness. Beech LVL plates between posts and chords and reinforcing fully threaded screws reduce compression perpendicular to grain. The continuous chords make the prototype to a statically indeterminate structure. Therefore, stresses depend on member stiffness and translational connection stiffness to a certain extent.

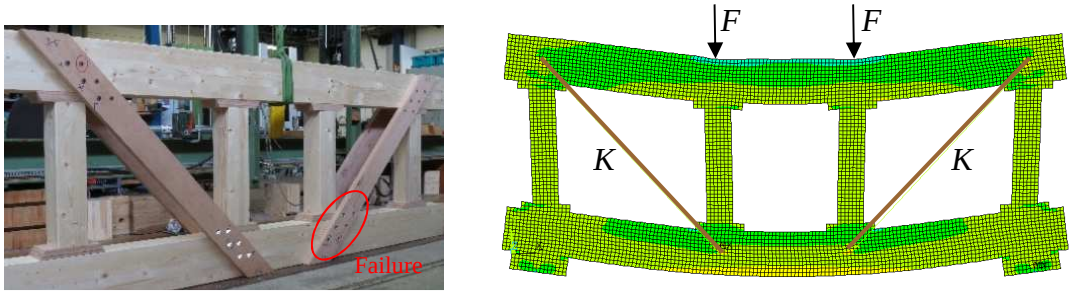

Figure 1: *Prototype of the truss system (a) and finite element (FE) model – deformed structure (b)*

The prototype, tested with two single loads *F*, failed in the connection pointed out in Fig. 1a. The load-carrying capacity was 2 x 270 kN. The load distribution between the chords and the diagonals was analysed with a FE model (Fig. 1b). Input data for the MOE was measured for the actual chords, posts and diagonals prior to assembly of the prototype. The global stiffness *K* of the double diagonals and the screw connections amounts to appr. 50 for elastic deformation and 38 kN/mm for capacity predictions. Both values are based on test results and analytical considerations [2]. Actual elastic deformations and the expected connection capacity of ~240 kN can be met with these values. However, not all mechanical parameters, influencing the connection stiffness, could be taken into account for a realistic equilibrium. *K*-values between 10-125 kN/mm were therefore considered resulting in a large stress range of 120-270 kN in the double diagonals. This range points to the need of realistic models for the translational stiffness of the innovative screw connections between softwood and engineered wood products as beech LVL. Such models are a crucial term for static analyses and deformation calculations. Open questions and lacks of knowledge raised by the study are part of a research proposal currently under review.

REFERENCES

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