Numerical and experimental stiffness determination of axially loaded wood screws

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In general, the connection stiffness influences the deformations in timber structures and the distribution of the internal forces in statically indeterminate structures. Examples are moment-resisting frame corners, trusses or mechanically jointed beams. Available analytical models [1, 2] for the axial stiffness $K_{ser,ax}$ of screws (fully threaded wood screws) differ strongly from each other for various screw types with the same nominal screw diameter d and the same penetration depth l_{ef} (Fig. 1a).

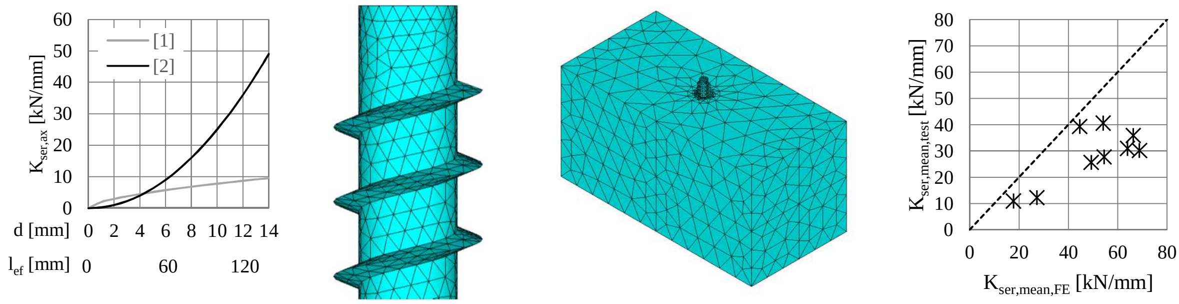

Figure 1: *Analytical models (a), modelled screw (b), FE model of the pull-out test (c), numerical and experimental results (d)*

Hence, a research project [3] was performed with the aim to develop a test method for realistic stiffness values. However, only a limited response regarding possible parameter variations can be enabled by tests. A finite element model [4] was therefore created based on the ANSYS parametric design language. The contribution mainly reports on this model, which represents the elementary test (Fig. 1c) as one of several methods. With this model, any screw geometry can be modelled (Fig. 1b) and the specimen geometry (Fig. 1c), the angle between grain direction and screw axis and the penetration depth can be arbitrarily chosen. The model was validated by tests in which the angle between grain direction and screw axis was varied from 30 to 90° and the penetration depth from 40 to 200 mm. The screws for the validation tests had a nominal diameter of 8 mm; the wood materials were solid wood (spruce and beech) and beech LVL. The comparison between numerical and experimental results (Fig. 1d) shows that the numerical approach overestimates the experimental stiffness. The mean deviation is ~50 % for spruce and ~20 % for beech. In particular, for beech wood and LVL a good agreement between model and experiment is attained. The reason is assumed in the extent of the pre-damage in the adjacent wood structure caused by the screwing process. Unlike spruce, in case of wood with high density like beech, the structure is damaged to a minor extent by this process. This may explain the higher deviation between modelled and experimental stiffness in case of spruce wood. Our future steps, therefore, concern a revision of the model to obtain a better agreement for softwoods.

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