hardwood_joint

Project objectives
Foster high-performance hardwood structures by developing economic, reliable and innovative joint technologies for hardwood members and the design thereof.

Tasks
(1) Joints with staples and nails
(2) Joints with axially loaded screws
(3) Joints with laterally loaded fasteners
(4) Joints with shallow grooves
(5) Modelling of joints

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Screw deformation in connections at a relative displacement of 10 mm:

Softwood

Hardwood

Title:
hardwood_joint – innovative joints in hardwoods

Start date: 01.02.2019

End date: 31.10.2022

Partners:

Innovative joints in hardwoods

(3) Joints with laterally loaded fasteners

Connections with dowels

An important load transfer mechanism of joints with laterally loaded fasteners is the rope effect. According to current design rules, the rope effect is only considered for fasteners with axial resistance, i.e. with resistance to pull-through of the head or withdrawal of the thread. In order to determine a similar phenomenon in joints with smooth-shank fasteners, joints with dowels were investigated. For this purpose, a tailor-made dowel with a glued-in strain gauge was used. Strains were recorded in the dowel during lateral loading and allowed measuring of the normal force in the dowel. With these experiments, the rope effect as friction between the dowel and the timber could be recorded and verified. In addition, the fastener failure was investigated. The tests on dowelled joints were used to validate BoF-models, see (5) Modelling of joints [1].

Connections with screws

The load-deformation behaviour of joints with screws in softwood and hardwood is quite different, so that the screw deformation is not comparable at a relative displacement of 10 mm. This displacement limit is generally required in connections to avoid sudden and brittle failure and to define minimum edge distances and spacings. In beech LVL, clearly distinct plastic hinges occur, while in softwood, the prevailing failure is embedment failure with minor bending of the screw. To ensure the calculated load-bearing capacity, a relative displacement of 10 mm should always be achieved. This criterion ensures sufficient formation of plastic hinges in hardwoods, which can be considered as ductile failure mechanisms. If the deformation limit is not fulfilled, an increase of the fastener distance a_1 is recommended.
A non-predrilled screw insertion is a challenge when installing on site. Due to high insertion moments, a screw bit slipping or difficulties with a firm attachment of the screw head are possible. Therefore, predrilling of screws in hardwood is recommended [2].

[1] Schweigler, M.; Vedovelli, M.; Lemaître, R.; Bocquet, J.-F.; Sandhaas, C.; Bader, T. K.: Beam-on-Foundation Modeling as an Alternative Design Method for Timber Joints with Dowel-Type Fasteners – Part 3: Second Order Theory Effects for Considering the Rope Effect. INTER 2021

[2] Kuck, E.; Sandhaas, C. (2022): Load-bearing behaviour of partially threaded screws in hardwood, Wood Material Science & Engineering, DOI: 10.1080/17480272.2022.2084453