hardwood_joint

Innovative joints in hardwoods

(2) Joints with axially loaded screws; long-term investigations

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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Due to a remarkable increase of the growing stock of hardwoods with a simultaneously decrease of softwoods in the European forests, the application of hardwood species as construction material, with remarkable short-term mechanical properties, is growing rapidly. However, to make these high mechanical capacities widely usable, high performing fasteners (e.g. self-tapping screws) and therewith composed joints (e.g. end-grain joints) are essential. Due to a significant gap in knowledge in regard to the long-term behaviour of those dowel-type fasteners, several short-term as well as long-term test series have been initiated. The duration-of-load (DoL) effect of self-tapping screws, i.e. the decrease of resistance with increasing time under constant load, has been investigated especially for end-grain joints with screws featuring a screw axis-to-grain angle $\alpha = 0°$, under quasi-static climatic conditions (service class 2) according to the European Standard for timber constructions (EC 5). Within this test program different wood species {Norway spruce | Beech | Birch} and structural timber products {structural timber (ST) | glulam (GLT) | laminated veneer lumber (LVL)}, three different screw types, various execution conditions and three load levels *LL* = {60 | 70 | 80 %}, as percentage of the average maximum short-term resistance against withdrawal failure, (Figure 1, left) have been varied. Preliminary results of modification factors k_{mod}, which accounts for this DoL effect, calculated from the short- and long-term outcomes for single screws (i.e. Screw Type 1, ST 1) inserted in beech {BE_{ST} | BE_{LVL}} are shown in Figure 1, right.

Load Duration Class		EC 5	ST 1	
			BE_{ST}	BE_{LVL}
permanent	(10a – 50a[1)])	0.60	0.70	0.58
long-term	(6m – 10a)	0.70	0.72	0.61
medium-term	(1w – 6m)	0.80	0.77	0.67
short-term	(1/10s[1)] – 1w)	0.90	0.82	0.74
instantaneous	(<1/10s[1)])	1.10	1.07	1.07

[1)] assumption; values not specified in EC 5

Figure 1: *left: Test setup "single screw"; right: Summary of k_{mod}-factors*

So far, the following conclusions can be drawn: (i) there is no significant influence from the applied execution conditions and (ii) a good over-all match of the k_{mod}-factors of BE_{LVL} and BE_{ST} compared to EC 5 can be observed. Based on these outcomes revising current regulations for the long-term withdrawal capacity (especially for $\alpha < 45°$), i.e. allowing better performing and more economic joint solutions, is recommended.

Title:
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Partners: