Strength and stiffness of hardwood joints experimental and numerical investigations

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In this study, a comparison between experimental and numerical results of hardwood dowel-type joints is presented. A phenomenological approach has been used to describe the contact between wood and steel dowel. This contact usually called embedment behaviour was idealised by a beam on nonlinear foundation where nonlinear springs composed the foundation and the dowel was modelled by 1-dimensional beam elements with elastic perfectly plastic behaviours (nonlinear Moment-curvature relationship). The previous described approach was investigated for the first time for steel-to-timber dowel-type connections by [1]. This idealised scheme was repeated for each dowel and linked each other by beams with elastic behaviours thus including the connection elements deformations.

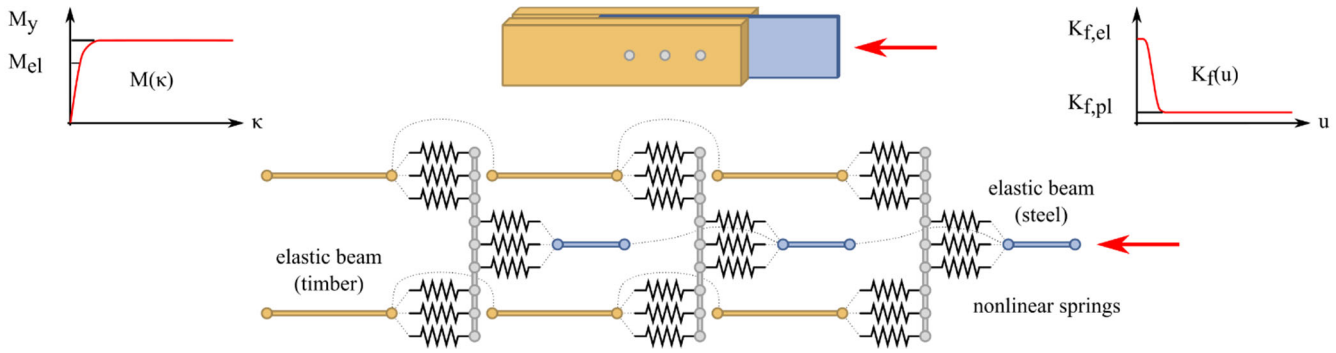

Figure 1: Description of the beam-on-foundation modelling for the numerical results of hardwood dowel-type joints (mesh example of a steel-to-timber connection with two shear planes)

In order to define the nonlinear springs behaviour of the foundation, this study was completed by embedment tests. Three different species were used: oak, beech and poplar. For each hardwood species, two dowel diameters were tested: 12 mm and 16 mm. Forty tests were carried out per subseries for the purpose to have a significant database.

The dowel steel grade being a significant parameter to describe the mechanical behaviour of timber, this study was also completed by tension tests in order to quantify the tensile yield stress of used dowels.

The comparison between experimental and numerical results was based on two types of joints with several subseries as defined in the table 1 below. The timber members thicknesses were chosen to encompass all failure modes defined by Eurocode 5.

Table 1: experimental programme of hardwood joints tests.

Type of joints	Species	n[1]	n_c[2]	d[3] [mm]	t_{out}-t_{in}[4] [mm]
Steel-to-timber	Oak	3	3	12, 16	15-12[5], 30-12[5], 85-12[5]
Timber-to-timber	Oak, beech, poplar	5	3	12, 16	15-40, 30-40, 97-75

[1] number of specimens per subseries
[2] number of dowels in a row
[3] dowel diameter
[4] respectively thickness of outer and inner timber members
[5] steel plate thickness

Beam-on-foundation model calculations and their comparison to the experimental results highlighted the validity of the numerical approach described above. In addition, effects of the dowel slenderness and diameter sensitivity were showed. These effects have already been demonstrated for timber-to-timber connections with softwoods in [2] (experimental way) and for single-fastener joints in [3] (modelling).

References

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