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Modeling approach to estimate the bending strength and height effect of glued laminated timber beams

Christoffer Vida[1,*], Markus Lukacevic[1] and Josef Füssl[1]

[1] Faculty of Civil Engineering, Institute for Mechanics of Materials and Structures,
TU Wien, Karlsplatz 13/202, A-1040 Vienna, Austria
christoffer.vida@tuwien.ac.at
www.imws.tuwien.ac.at

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Numerical simulations provide a highly efficient way to estimate the bending strength of glued laminated timber (GLT) beams. A reliable estimation of the strength requires the consideration of adequate material behavior and relevant failure mechanisms.

Therefore, the approach uses section-wise constant material properties, i.e., longitudinal stiffness and tensile strength, which were derived along entire timber boards based on the procedure proposed by Kandler et al. [1]. Tapia et al. [2] proposed the use of discrete cracks without predefined positions within the framework of the extended finite element method (XFEM). Additionally, the formation of progressive crack networks is enabled by implementing cohesive surfaces between adjacent lamellas. For the validation, four-point bending tests of GLT beams were simulated to estimate the bending strength of specific beams from an experimental study with well-known knot morphology, which was presented by Kandler et al. [3].

Finally, the height effect on the bending strength was studied by simulating GLT beam sections loaded with a constant bending moment. The beams' height ranged from 135 mm to 3000 mm. The boards are randomly arranged within a beams' structure. As a result, we obtained fitted probability distributions of the bending strength for different global failure criteria and beam heights.

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