A PROBABILISTIC MODEL TO ACCOUNT FOR STIFFNESS VARIATION IN GLUED LAMINATED TIMBER

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Since wood is a naturally grown material, its mechanical properties are subject to high variability. In order to exploit the full potential of structural timber, a mechanical modelling strategy should be able to take this natural property fluctuation and the stochastic nature into account. Therefore, within this work a numerical probabilistic approach for glued laminated timber (GLT) is proposed, in order to investigate the variation of its effective mechanical behaviour.

The local knot-induced grain deviation is obtained from laser scans, subsequently allowing for the computation of the stiffness distribution in longitudinal direction of wooden boards, similar to [1]. Based on the acquired data, a random process model for the stiffness profiles is employed using a numerical eigenvalue decomposition technique. The discretized random process model can be used for the generation of samples to be used within Monte

![Figure 1](image-url): Random stiffness profile of (a) one lamella and of (b) a GLT beam with 10 lamellae.
Carlo simulation (see Figure 1a) but is also capable of being combined with two different probabilistic finite-element approaches: (i) The Perturbation approach, where the system response is expanded in a Taylor-series [2] and (ii) the Spectral stochastic approach, where the system response is projected on the Polynomial-Chaos expansion [3].

Using the presented approaches, the mean and the standard deviation of the effective mechanical properties of GLT with up to ten laminations (Figure 1b) can be computed. Moreover, the well-known lamination- and size effect can be reproduced numerically, giving insight into the optimization potential of GLT. The numerical results agree very well with test results, indicating that a probabilistic approach can deepen the understanding of multi-layer structural elements as well as allowing for a more efficient and comprehensive design of timber structures.

REFERENCES

