Numerical Simulation of Wooden Structures with Polymorphic Uncertainty in Material Properties

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Abstract

Due to nature, uncertainties are inherently present in structural parameters such as loadings, boundary conditions or resistance of structural materials. Especially material properties and parameters of wood are strongly varying in consequence of growth and environmental conditions. The considered uncertainties can be classified into aleatoric and epistemic uncertainty. To include this variation in structural analysis, available data need to be modelled appropriately, e.q. by means of probability and furthermore fuzzy probability based random variables or fuzzy sets. Therefore, a limited empirical data basis for Norway spruce, obtained by experiments according to DIN EN 408, is stochastically analysed including correlation-, sensitivity analyses and statistical tests. In order to comprehend uncertainties induced by estimating the distribution parameters, the stochastic approach has been extended with fuzzy distribution parameters to fuzzy probability based random variables according to Möller and Beer (2004) and Möller et al. (2000). To cope with epistemic uncertainties for e.g. geometric parameters of knotholes, fuzzy sets are used. The consequence for wooden structures is determined by fuzzy stochastic analysis, see Götz et al. (2015), in combination with a FEM-simulation using an model suitable for characteristics of a timber structure by Jenkel and Kaliske (2014). The uncertain results (e.g. failure load, displacements) constituted by the proposed holistic approach – defining the material properties based on an empirical data basis and the attempt of representing the uncertainties in material properties and methods itself – will be discussed in terms of further processing in engineering tasks.

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