The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

PARAMETER IDENTIFICATION FOR A CROSS-LAMINATED TIMBER SLAB BY BAYESIAN INFERENCE

M. Kawrza*[1], T. Furtmüller[2] and C. Adam[3]

[1] University of Innsbruck, Unit of Applied Mechanics, Technikerstr. 13, 6020 Innsbruck, Austria, michael.kawrza@uibk.ac.at

[2] University of Innsbruck, Unit of Applied Mechanics, Technikerstr. 13, 6020 Innsbruck, Austria, thomas.furtmueller@uibk.ac.at

[3] University of Innsbruck, Unit of Applied Mechanics, Technikerstr. 13, 6020 Innsbruck, Austria, christoph.adam@uibk.ac.at

Keywords: *Cross-laminated timber, Bayesian model inference, Transitional Markov Chain Monte Carlo algorithm*

In recent decades, cross-laminated timber (CLT) has become a serious alternative to traditional building elements such as reinforced concrete and masonry. Compared to buildings made of these traditional materials, structures made of timber elements have a large stiffness-to-weight ratio, which facilitates the realization of lightweight structures. However, this makes timber structures more prone to vibrations and therefore the design of these structures is often driven by serviceability criteria to limit vibrations. The dynamic behavior of a structure made of novel elements such as CLT is predicted using computational models, which are ideally based on experimentally determined material parameters of a specimen under laboratory or in-situ conditions. By employing experimental data in a model updating process, the predictions of the model can be improved and a point estimate of suitable input parameters can be identified. However, this process generally does not account for uncertainties in the model, material properties, or experimental data. Therefore, a probabilistic approach is adopted in this contribution to identify the most likely set of input parameters (material properties and parameters related to boundary conditions) for a finite element model of a CLT slab to realistically predict the measured dynamic behavior of the specimen in the low frequency range. The Transitional Markov Chain Monte Carlo (TMCMC) algorithm [1] is applied to evaluate the posterior distributions of the input parameters. The study has shown that the formulation of the likelihood function based on modal data (natural frequencies and mode shapes) leads to an ambiguous correlation between the parameters when both the stiffness properties and the density of the structural element are uncertain. As a remedy, a novel formulation of the likelihood function is proposed that uses the frequency response functions obtained from an experimental modal analysis to obtain unambiguous posterior distributions.

REFERENCES

[1] J. Ching and Y.C. Chen, Transitional Markov Chain Monte Carlo Method for Bayesian Model Updating, Model Class Selection, and Model Averaging. *Journal of Engineering Mechanics*, Vol. **133**, pp. 816–832, 2007.