Engineering Risk Analysis Group
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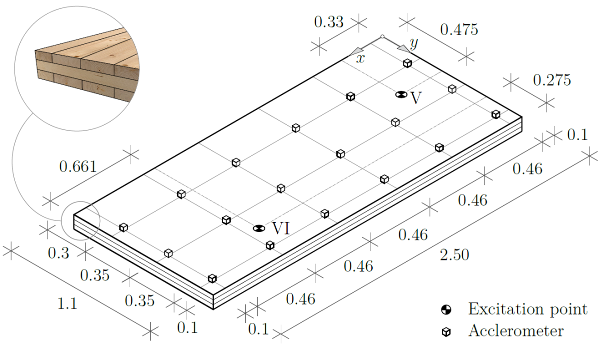
MSc thesis

Bayesian identification of cross laminated timber plates using surrogate models

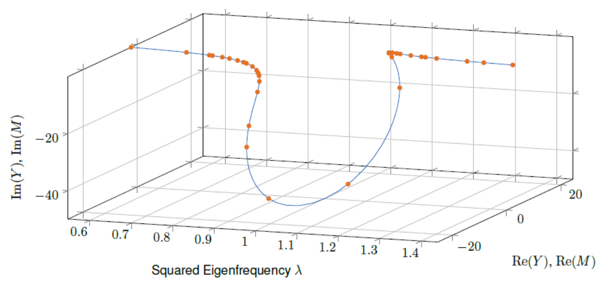
Felix Schneider, December 2017

Background

The work aims at identifying dynamical material properties of cross laminated timber (CLT) to be able to make qualified predictions in the planning process of timber structures. For this purpose, Bayesian model updating is applied. Using frequency response data obtained from measurements, stiffness and damping parameters of a linear-elastic Finite Element model are updated. To increase computational efficiency, surrogate models are investigated. The developed surrogate model uses a rational approach, consisting of the ratio of two polynomial chaos expansions, where the coefficients in the expansion are complex-valued. This novelty approach allows for very accurate surrogate models of the highly nonlinear frequency response functions.



CLT plate with accelerometer setup



Rational surrogate model for SDOF frequency response

Methodology

Impact excitation measurements of the structure from University of Applied Sciences in Rosenheim are used. From acceleration and force time data, frequency spectra are found. For Bayesian updating, the likelihood-function is defined, using a complex multiplicative error. Samples of the posterior distribution of the material properties are obtained via Bayesian Updating using Structural Reliability Methods. The Adaptive BUS with Subset Simulation implementation by Engineering Risk Analysis Group is applied.

Conclusion

Overall good accurate surrogate models can be obtained with the proposed method in the context of frequency response functions. In general, large model errors occur under the proposed error model. This can be linked to the used hysteretic damping model. It shows, that the CLT plate shows different damping, depending on whether the corresponding mode shape is governed by bending or shear. Furthermore it is suspected that impact excitation adds further error sources. Youngs and shear moduli are identified reliably in the frequency range up to 180 Hz.

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