Cut-Off Frequency Selection with Guaranteed Assembly Accuracy in Component Mode Synthesis

Lars A. L. Janssen[1*], Rob H.B. Fey[1], Bart Besselink[2], Nathan van de Wouw[1]

[1]Eindhoven University of Technology, Department of Mechanical Engineering
[2]University of Groningen, Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence
[*]e-mail l.a.l.janssen@tue.nl

Finite Element models of complex engineering systems often consist of millions of degrees of freedom which makes their usage for, e.g., design and control applications, unfeasible. In component mode synthesis techniques, the total (assembly) model is subdivided in multiple components models which are reduced in complexity and coupled to obtain a computationally feasible reduced-order assembly model.

In the structural dynamics community, it is common practice to reduce the complexity of assembly models by preserving all eigenmodes of the component models with an eigenfrequency lower than a single “cut-off frequency”. This cut-off frequency is generally selected between two or three times the maximum frequency of interest for the model’s application. However, the resulting accuracy of the reduced-order assembly model is based on the engineer's experience in selecting the cut-off frequency.

In this presentation, we introduce a mathematical approach that allows for the computation of cut-off frequencies for each component individually, given accuracy requirements on the reduced-order assembly model. We show that: 1) the required accuracy of the obtained reduced-order assembly model is guaranteed, and 2) this model contains much less degrees of freedom compared to the industrial standard approach, which results in significantly reduced computational costs associated to the usage of the model.