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Uncertainty quantification in computational linear structural dynamics for viscoelastic composite structures

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Abstract

This paper deals with the analysis of a stochastic reduced-order computational model in computational linear dynamics for linear viscoelastic composite structures in the presence of uncertainties. The computational framework proposed is based on a recent theoretical work that allows for constructing the stochastic reduced-order model using the nonparametric probabilistic approach. In the frequency domain, the generalized damping matrix and the generalized stiffness matrix of the stochastic computational reduced-order model are random matrices. Due to the causality of the dynamical system, these two frequency-dependent random matrices are statistically dependent and are linked by a compatibility equation induced by the causality of the system, involving a Hilbert transform. The computational aspects related to the nonparametric stochastic modeling of the reduced stiffness matrix and the reduced damping matrix that are frequency-dependent random matrices are presented. A dedicated numerical approach is developed for obtaining an efficient computation of the Cauchy principal value integrals involved in those equations for which an integration over a broad frequency domain is required. A computational analysis of the propagation of uncertainties is conducted for a composite viscoelastic structure in the frequency range. It is shown that the uncertainties on the damping matrix have a strong influence on the observed statistical dispersion of the stiffness

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