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Reliability-Based Microstructural Topology Design with Respect to Vibro-Acoustic Criteria

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Abstract

A reliability-based vibro-acoustic microstructural topology optimization model taking into consideration the uncertainty of several selected design-independent parameters, such as the direction of the load, the frequency of the excitation, or their combinations is presented. The design objective is minimization of the sound power radiation from the macro vibrating composite structure that is assumed to be constructed by periodic micro unit cell filled up with two prescribed isotropic materials. A design process consisting of the serial execution of the uncertainty analysis and vibro-acoustic microstructural topology optimization is proposed. Numerical examples show that the uncertainty of the excitation frequency plays more important role in the vibro-acoustic microstructural design in comparison with the uncertainty of the loading direction. It is also shown that the optimum microstructural topology is not so sensitive to perturbation of the loading direction when the normalized variable corresponding to the excitation frequency takes the higher value, i.e. the optimum design is robust for perturbation of both the excitation frequency and the loading direction.

Keywords: Microstructural topology optimization; vibro-acoustic criteria; reliability index; uncertainty analysis; bi-material interpolation.