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Integrated multi-scale vibro-acoustic topology optimization of structure and material

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Abstract

Vibration and noise attenuation is one of the most concerned problems in vibro-acoustic field, where structural topology optimization can act as a strong tool. Most of the present work concerning vibro-acoustic design generally focuses on topological optimization of the macrostructure including the distribution of the materials and damping. A few works concern the topology optimization of the microstructure of the materials to achieve the optimum vibro-acoustic properties [1-2], which normally just involves single scale design. In order to exert the potential of the structure and material to the largest extent, it is necessary it is necessary to establish a multi-material and multi-scale model and further develop an effective and efficient method to combine the vibro-acoustic topology design of the macro and micro structure simultaneously.

The paper deals with the problem of the integrated layout design of macro and micro structure taking into consideration vibro-acoustic criteria. A multi-scale topology optimization model is presented for minimization of the sound power radiation from the vibrating composite structure with different designable periodic microstructures in different domains of the macrostructure. An extended multi-material interpolation model based on SIMP [3] and PAMP [4] is developed to implement the concurrent multi-scale topological design of the structure, and to achieve optimum distribution of the prescribed number of materials at both the micro and macro scale. The equivalent material properties of the macrostructure are calculated using homogenization method. The method of MMA [5] is utilized to solve the multi-scale optimization model. Numerical examples are given to validate the model and the method developed.

References

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