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A Multi-Frequency Topology Optimization Method for Vibro-Acoustic Problems

Dan Li[1], Jie Wang[1] and Haibo Chen[1,*]

[1] CAS Key Laboratory of Mechanical Behavior and Design of Materials, Department of Modern Mechanics, University of Science and Technology of China, Hefei, 230026, China

[*]Corresponding Author: Haibo Chen. Email: hbchen@ustc.edu.cn

ABSTRACT

In practical vibro-acoustic problems, the external excitation normally contains a certain frequency band structure [1]. Therefore, it is needed to perform optimization under frequency band analysis. For sound radiation problems caused by structural vibration, a topology optimization method for structural materials is proposed based on the acoustic-vibration coupling analysis [2-6] and the frequency-band matrix interpolation method [7,8]. By combining the advantages of FEM and BEM in structural and acoustic field analysis, the accurate solution of the acoustic-vibration coupling problem is achieved. The structural material interpolation model is established using the solid isotropic material with penalization (SIMP) method, and the topological sensitivity formulation is derived based on the adjoint variable method (AVM). The topological optimization design of the structural material is carried out by using the method of moving asymptotes (MMA). According to the special property of impedance matrix, the matrix interpolation method is used to obtain the objective function at any frequency point in the frequency band, which improves the computational efficiency in the frequency band topology optimization. The zero points of chebyshev polynomial are selected as the interpolation nodes to minimize the remaining terms for improving the calculation accuracy. Finally, a frequency band optimization method is established, and its effectiveness is verified by numerical tests. The optimization results show a strong frequency dependence and the multi-frequency optimization results accurately represent the material distribution in the frequency band.

KEYWORDS

Boundary element method; FEM-BEM coupling analysis; topology optimization

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