Topology optimization with a mixed **u**/*p* finite element formulation for acoustic-porous-structure interaction system

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ABSTRACT

This research aims to develop a new topology optimization (TO) approach for acoustic-porous-structure interaction system in the framework of a mixed **u**/*p* finite element (FE) formulation. Despite some relevant structural optimization research studies for various acoustic systems and phenomena, there is no research for TO for acoustic-porous-structure interaction system by the *empirical* material model for the modeling of porous media. It is one of the most challenging subjects of TO because the three different media with the different governing equations as well as the interaction boundary conditions for acoustic, porous and elastic structure should be alternated with respect to the spatially varying density design variables of TO. For the TO approach for this challenging multiphysics system, this research proposes to apply a mixed **u**/*p* formulation to consider the mutual coupling effects among acoustic medium, fibrous (porous) medium by the *empirical* material model and elastic structure medium. By combining the mixed FE formulation and the empirical Delany-Bazley model, we can consider the simulation of the sound propagation considering the coupling effects among the three media. For TO, the material properties of the mixed formulation, i.e., bulk modulus, shear modulus and density, are interpolated based on the polynomial SIMP (solid isotropic material with penalization) interpolation functions. To show the validity of the proposed approach, several analysis and topology design problems limited to a single frequency of interest are considered.

Key words: acoustic topology optimization, acoustic-porous-structure interaction, Delany-Bazley model, acoustic analysis, porous material, empirical material model

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