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Efficient solution strategies for structural-acoustic FE applications with 3D modelling of porous materials

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ABSTRACT OF PAPER

During the last decade, porous materials have been widely used in order to reduce noise for interior domain in the transports industry. During the design process, several detailed structural-acoustic analyses need to be performed. However, modelling vibroacoustic problems introducing dissipative interfaces such as porous materials can lead to prohibitive numbers of Degrees Of Freedom (dofs). It is therefore of great importance to propose efficient solution strategies to reduce the size of the model [1].

In this work, a component mode synthesis [2] is applied to the dissipative part of a 3D Finite Element structural-acoustic problem including porous material at interface [3]. The modal-based reduction of the porous media leads to an overall reduced number of dofs. A poroelastic model based on the Biot-Allard theory [4] is used to describe the porous medium, which implies frequency-dependent material parameters, as well as complex arithmetic Finite Element global matrices. Therefore, direct computation at each frequency increment is used to solve the problem, and frequency response of the mean quadratic pressure in the acoustic domain is computed as an indicator of the sound level.

In order to use real modes, and to define a transformation applied once at the initial frequency increment, the porous media finite element problem is rearranged. The suitable modal basis built is further downsized by selecting the significant contributions using an energy-based criterion. To further improve the efficiency of the resolution, reconstruction strategies are investigated in order to rebuild responses over the entire frequency range, from the solution at a few selected frequencies.

Comparing the results obtained in terms of accuracy and computational time with the complete problem shows promising performances.

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