engineering mechanics

First Engineering Mechanics Symposium

23 - 24 November 1998
Rolduc, Kerkrade

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Acoustics of a Sound Absorbing Wall

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Let us consider a sound absorbing wall or panel in a noisy environment. Then it is difficult to predict the sound level or the amount of sound absorption. The main reason for this is that an accurate description of the behaviour of sound absorbing material is not an easy task. Therefore the subject of this study is the modeling and experimental validation of the behaviour of sound absorbing material.

Roughly there are two ways to describe a sound absorbing material: via a boundary condition at the surface or as a volume. Both methods are well suited for implementation in a Finite Element Formulation. The surface method is usually applied in the form of a normal impedance condition. It provides a fast numerical method. However, measurements are needed to determine the normal impedance values as a function of the frequency. In the volume method there is an interaction between the frame and the fluid inside the sound absorbing material. A distinction can be made in increasing order of complexity: the ‘Rigid’ theory treats the frame as infinitely stiff, the ‘Limp’ theory treats the frame without stiffness and the ‘Biot’ theory includes the stiffness of the frame and the acousto-elastic coupling. Although the Biot theory is the most complete the computational effort and the variety of parameters to describe the material are drawbacks.

Another way of describing sound absorbing material, slightly similar to Biot, is a description of the behaviour of the fluid in the cylindrical pores. In such a pore viscous, thermal and mass effects are present. The model is validated with experiments in an impedance tube and the results show a good agreement for the complete frequency range. Variations of the radius, the length and the surface porosity are investigated. Also a combination of pores is examined. As a next step, oblique incident sound will be investigated as well as an elastic frame to account for the acousto-elastic coupling.