Acoustics of a Sound Absorbing Wall

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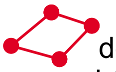
Introduction

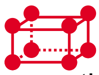
Let us consider a sound absorbing wall or panel in a noisy environment. It is difficult to predict the sound level or amount of sound absorption because an accurate description of the behaviour of the sound absorbing material is not an easy task.

Objective

The development of a new model with an accurate and efficient description of the behaviour of sound absorbing material. The model has to be compatible with standard finite element methods.

Present FEM Models

In the **surface**  description the perturbation of the pressure p and the normal velocity v_n are related through the complex normal impedance $Z_n = p / v_n$. The impedance is determined experimentally in an impedance tube (see Figure 1).

In the **volume**  description there is an interaction between the frame and the fluid inside the sound absorbing material. Among the various theories the Biot theory is the most complete. Drawbacks are the computational effort and the variety of parameters to describe the material.

A New Approach

The viscous, thermal and mass effects of the fluid in a pore or perforation are considered[1]. Important parameters are:

radius, influences the amount of viscous losses
length, determines the frequency range
surface porosity, optimizes the absorption

Samples of such perforated material are placed in an impedance tube[2] (see Figure 1). The transfer function

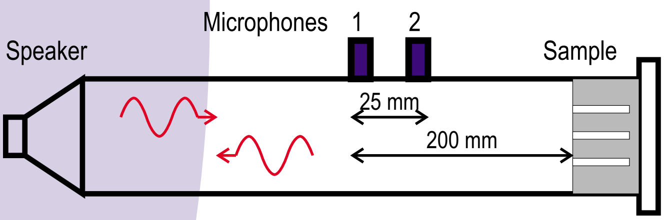


Figure 1. Outline of an impedance tube.

between the two microphones is used to calculate the impedance and absorption coefficient of the sample as a function of the frequency. Several configurations were investigated numerically and experimentally (see Figures 2, 3, 4).

Figure 2. Sound absorbing samples.

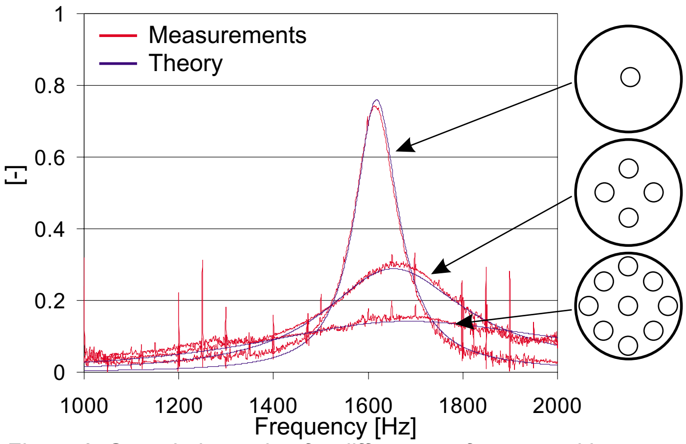


Figure 3. Sound absorption for different surface porosities.

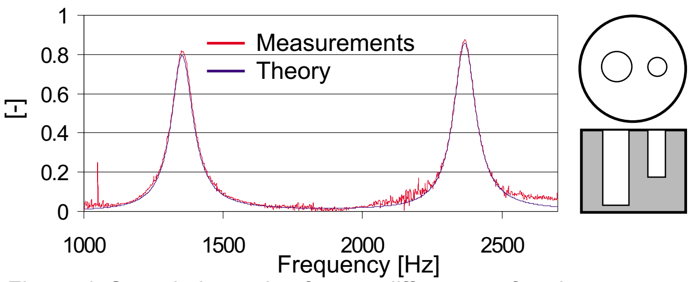


Figure 4. Sound absorption for two different perforations.

Conclusion and Further Research

For different sets of pores the sound absorption can be predicted accurately for a wide frequency range.

As a next step, oblique incident sound will be investigated as well as the acousto-elastic coupling with an elastic frame.

References

1 H. Tijdeman, 'On the propagation of sound waves in cylindrical tubes', *J. Sound & Vib.* 39, 1975
2 F.J.M. van der Eerden, H-E de Bree, H. Tijdeman, 'Experiments with a new acoustic particle velocity sensor in an impedance tube', *Sensors & Actuators A* 69/2, 1998