Low frequent sound reduction by thin air layers

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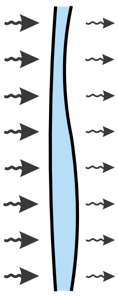
Introduction

The vibrational behaviour of light weight structures, like a thin plate, is strongly influenced by nearby thin air layers. A lot of vibrational and acoustic energy can be dissipated by using the viscous and thermal behaviour of the air.

Reducing low frequent sound



Low frequent sound is usually reduced by introducing large amounts of mass in a structure. The objective of this research is to investigate if the viscothermal effects in thin air layers can be used for reducing this low frequent sound. Applications are for instance motor shielding or silent walls.

Figure 1 : Sound reduction by a thin air layer

Methods

Tools with which the viscothermal wave propagation in relation with fluid-structure interaction can be studied are being developed.

Finite element modelling Acoustic elements which take into account viscous and thermal effects and which enable full fluid-structure interaction are implemented in the B2000 Finite Element Program.

Experimental investigation With a special experimental setup the influence of the airgap on the dynamical behaviour of a flexible plate has been investigated

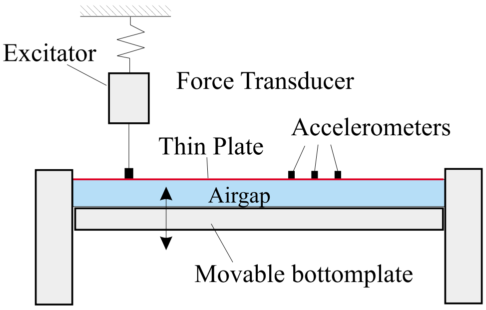


Figure 2 : Experimental setup

Results

The airlayer has a strong effect on the vibrational behaviour of the plate. For example the asymmetric modes of the plate induce a strong pumping effect in the airlayer.

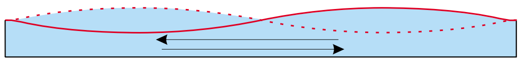


Figure 3 : Pumpeffect of the 2-1 mode

As a result the eigenfrequencies decrease. The viscous and thermal properties of the air cause strong damping of this mode for small layer thicknesses.

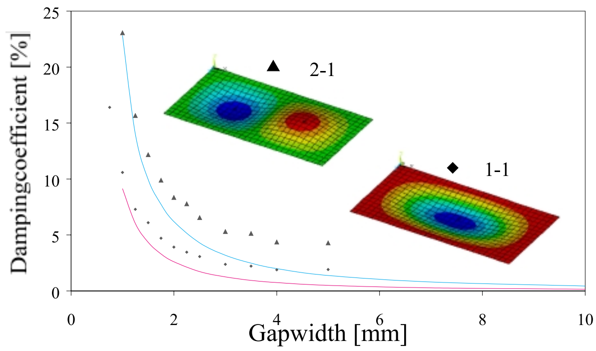


Figure 4 : Damping as a function of gapwidth

Conclusions and further research

By tuning the acoustics of the airlayer(s) and the vibrational behaviour of the plate(s), low frequent sound in bandwidths around typical frequencies of the source can be reduced efficiently. Additional experimental and numerical tools are being developed to investigate the practical possibilities and optimal configurations.

References

1. Beltman, W.M. (1998) Viscothermal wave propagation including acousto-elastic interaction, Enschede, PhD-thesis.