Damping structural vibrations by vortex shedding

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Introduction

Structural vibrations can be reduced via squeeze film damping by placing a narrow air layer parallel to the vibrating surface. This damping type is based on viscous shear in the air layer. The damping can be improved by placing barriers in the layer. The vortices formed behind the barriers increase the dissipation of vibrational energy.

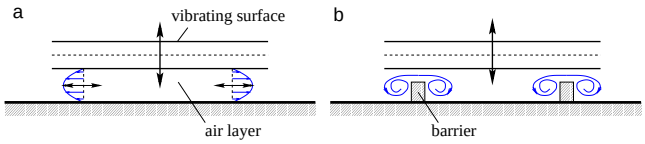

Figure 1 : Two damping mechanisms. a: Viscous shear, b: Vortex shedding.

With a simple model it can be shown that the vortex damping behaves non-linear. This in contrast with the squeeze film or viscothermal damping which is a linear type of damping.

Experiments

Experiments to validate the damping effects are performed with a setup which is very suitable for measuring the influence of an air layer on the dynamical behaviour of a vibrating structure. Barriers are placed in a narrow air layer (12.0 mm) under a stiff, light weight panel of 1m^2 suspended by springs.

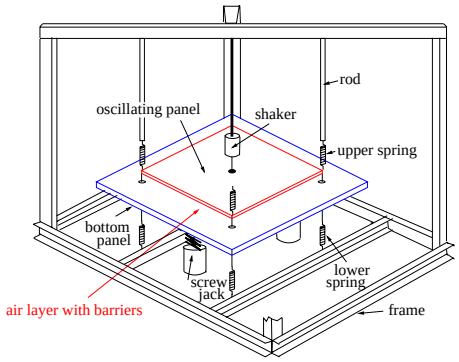

Figure 2 : Experimental setup.

Results

The vortices are visualised with smoke during one period for a vibration of 1.0 Hz, see Figure 3.

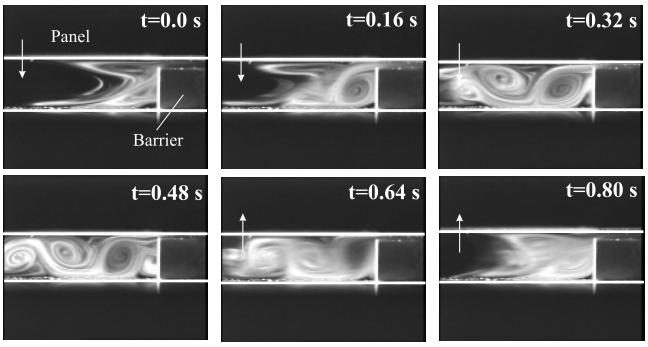

Figure 3 : Vortex visualisation.

Damping levels at resonance ($\approx$ 5.5 Hz) for various amplitudes and barrier heights are shown in Figure 4.

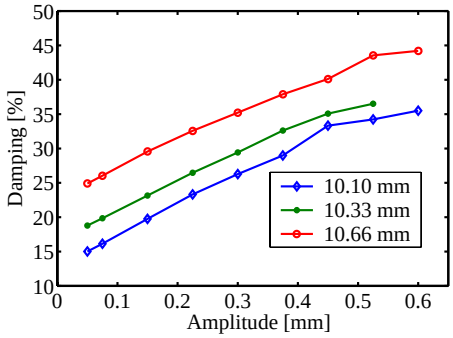

Figure 4 : Damping versus amplitude for different barrier heights.

The damping can be considered as a superposition of viscothermal and vortex damping. The latter mechanism behaves non-linear as shown in the figure.

Conclusions

Vortex damping is an interesting type of damping and should be used combined with viscothermal damping to reduce structural vibrations. Applications are for instance folded solar arrays or double wall panels. Moreover, a novel method to determine the energy dissipation in vortices is applied.

References

1. Basten, T.G.H., Tijdeman H. (2000) Damping of structural vibrations by vortex shedding, ISMA 25 Leuven, Belgium.