Vibration Measurements using Sound

J.W. Wind, Y.H. Wijnant and A. de Boer

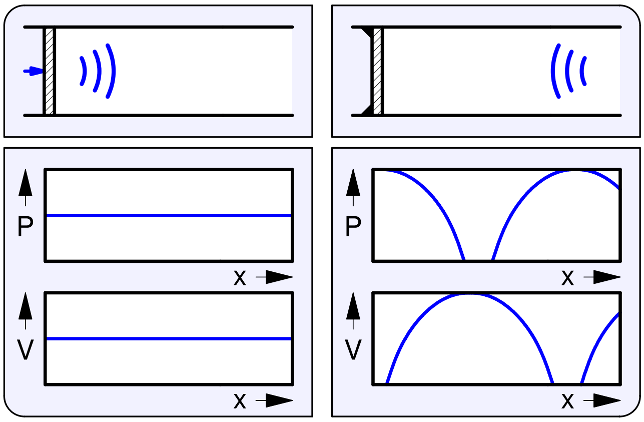
Institute of Mechanics, Processes and Control
Chair of Structural Dynamics and Acoustics
University of Twente
P.O. Box 217, 7500 AE Enschede, The Netherlands
phone +31-(0)53-4893605, email j.w.wind@ctw.utwente.nl

University of Twente
The Netherlands
Impact
Institute of Mechanics, Processes and Control - Twente

Introduction

An attractive way to perform vibration measurements is to measure the sound near the structure surface. However, the acoustical pressure is often overshadowed by background noise. Theory suggests that the fluid velocity does not have this drawback. We present new measurement results to confirm this claim.

Theory



(a) (b)

Figure 1: Acoustical response to (a) structural vibration and (b) incoming noise

In a 1D model, the pressure and velocity respond equally to structural vibration (see figure 1(a)). An interference pattern occurs for incoming noise because the sound reflects from the structure (see figure 1(b)). Near the structure surface, the pressure is at a maximum but the velocity tends to zero. By superimposing signal and ambient noise, it becomes clear that ambient noise hardly contributes to the velocity measurements near the structure surface: only structural vibration is measured.

Experiments

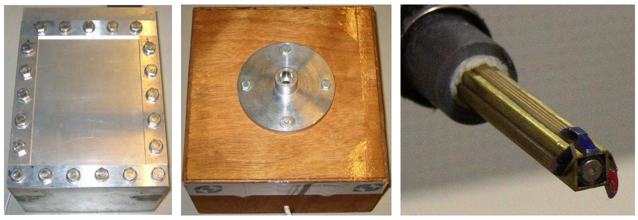


Figure 2: aluminium box, incoming noise source and sensor

Experiments are performed in an anechoic chamber. Structural vibration is created by a loudspeaker in a stiff aluminium box covered with a 1mm plate (see figure 2) and the incoming noise is represented by a loudspeaker in the far field of the structure. Pressure and fluid velocity are measured at several distances from the structure. Results are depicted in figure 3.

Conclusion

Both the structural behavior and the distance to the structure surface have significant impact on the sensitivity to background noise but off-resonance, velocity measurements tend to be10dB less sensitive to noise than pressure measurements near the structure surface.

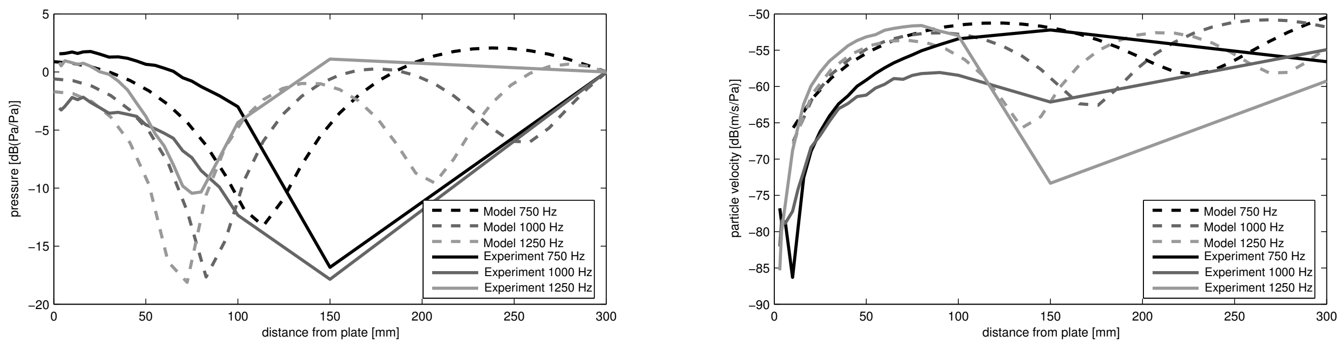


Figure 3: Experimental results. Left: Pressure, Right: fluid velocity