

Sound Absorption Performance of a Perforated Plate with a Backing Cavity

Daisuke SHIRAGA^{1, a}, Shinji AKAMATSU^{2, b}, Yuki MITSUI^{3, c},

Tonau NAKAI^{1, d}, Masaharu NISHIMURA^{1, e}, Tomonobu GOTO^{1, f}

¹Tottori University, 4-101 Koyama-minami, Tottori, Tottori, 680-8552 Japan

²Mitsubishi Hitachi Power Systems, 2-1-1 Shinhamanai, Takasago, Hyogo, 676-8686 Japan

³Mitsubishi Heavy Industries, 2-1-1 Shinhamanai, Takasago, Hyogo 676-8686 Japan

^aM16T8006M@edu.tottori-u.ac.jp, ^bshinji_akamatsu@mhps.com, ^cyuki_mitsui@mhi.co.jp,

^dnakai@damp.tottori-u.ac.jp, ^emnishimura@mech.tottori-u.ac.jp, ^fgoto@damp.tottori-u.ac.jp

Perforated plates are effective for sound absorption and often used for noise reduction. In the present study, we measured the sound absorption coefficients and the acoustic impedances of a perforated plate with a backing cavity of different depths when the sound pressure level was around 100-150dB. The measured impedances were compared with the predicted values provided by Guess [1].

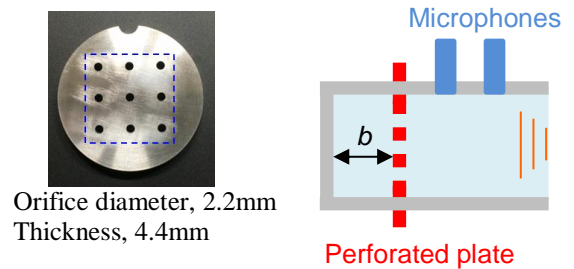
To measure the sound absorption coefficient of a perforated plate, we adopted the two-microphone method. A perforated plate was located at one end of an impedance tube (Fig. 1). A white noise was generated by a speaker at the other end of the impedance tube, and the sound wave was incident perpendicularly on the surface of the plate. The sound absorption coefficient and the acoustic impedance were calculated from the transfer function of the sound pressures measured by the two microphones mounted on the sides of the impedance tube.

The solid lines in Fig. 2 show the measured sound absorption coefficients α of the perforated plate with different backing cavity depths, $b = 0.74, 2.2, 11\text{mm}$ at 100dB sound pressure level on the surface of the perforated plate. The dashed lines are corresponding values predicted according to Guess [1]. When $b \geq 2.2\text{mm}$, the resonance frequency, at which α at 150dB is maximum, agrees well between the measured and predicted values. On the other hand, in the case of $b = 0.74\text{mm}$, the measured resonance frequency is quite different from the predicted value. Guess's prediction is based on the one-dimensional plane wave propagation. When the backing cavity is very thin, the space in the cavity is insufficient for the sound wave entering through the orifice to form a plane wave.

We also measured α at 150dB sound pressure level (data not shown). When the backing cavity depth b is 11mm, the non-linear effect due to the intense alternating flow passing through the orifices appears. As it is expected from the prediction, α at 150dB is higher than the value at 100dB. The oscillatory flow speed, which is estimated as the overall particle velocity over the frequency range 1-7kHz, is 11m/s. In contrast, when $b = 0.74\text{mm}$, the non-linear effect is not apparent, and the measured α at 150dB is as much as the value at 100dB. The estimated oscillatory flow speed is only 1.1m/s. When the backing cavity depth is small, the oscillatory flow speed does not increase even if the sound pressure level on the plate's surface is at 150dB.

Reference

[1] A. W. Guess, "Calculation of perforated plate liner parameters from specified acoustic resistance and reactance", *Journal of Sound and Vibration*, Vol. 40 (1975), pp. 119-137.



Orifice diameter, 2.2mm
Thickness, 4.4mm

Fig. 1 The perforated plate and a schematic of the impedance tube.

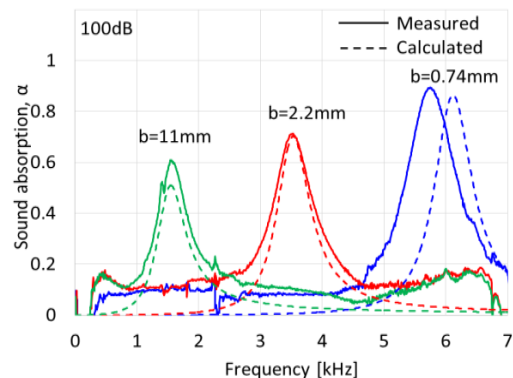


Fig. 2 Sound absorption coefficients.