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Effects of discontinuous impedance boundaries on sound absorption coefficient measurements in a standing wave tube

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Abstract

The standing wave tube (SWT) method is widely used for measuring sound absorption coefficients of acoustic materials. The effects of circumferential edge constraint[1,2] or air gaps[3,4] between the sample and the SWT on sound absorption coefficient measurements were studied previously. While sample sizes are significantly smaller than that of the SWT cross section, the measured sound absorption coefficient of this discontinuous impedance boundary (DIB) may be smaller than its actual value. Based on the benchmark theory of porous material impedance proposed by K. Attenborough[5], in this paper, we investigate the influence from DIB on absorption coefficient measurements in the SWT based on the finite element method. Two types of DIB are investigated in Fig. 1. In Fig. 1(a), the sample width and length are both smaller than those of the SWT cross section ($0.5W < a < W$, $0.5W < b < W$). While in Fig. 1(b), there is one side of the sample equal to that of the SWT ($a=W$, $0.5W < b < W$). Results in Fig. 2(e) show that measured sound absorption coefficients are sensitive to positions of the sample at medium and high frequencies, and absorption attenuation at high frequencies decreases when the sample is placed at the center of the SWT. It is also shown that different sample shapes with a same area (see (a) and (d) in Fig. 2) also affect the measured sound absorption coefficients at high frequencies. This paper can be the basis of the measurements of actual sound absorption coefficient on the condition of sample sizes significantly smaller than that of the SWT cross section.

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Key words: Discontinuity impedance boundaries; Sound absorption; Standing wave tube

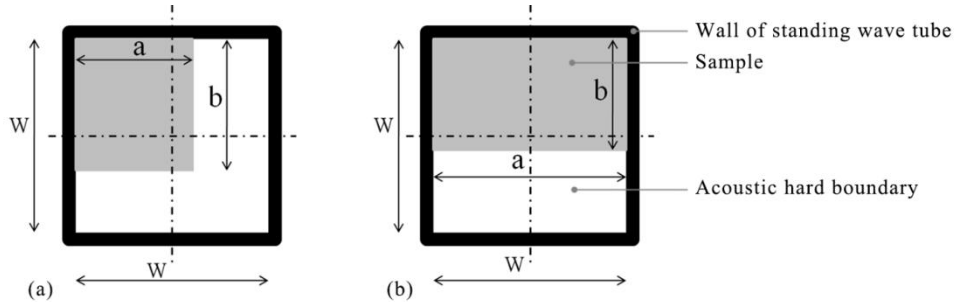

Figure 1: Schematic diagrams of the relation of cross section size between porous material sample and the square SWT

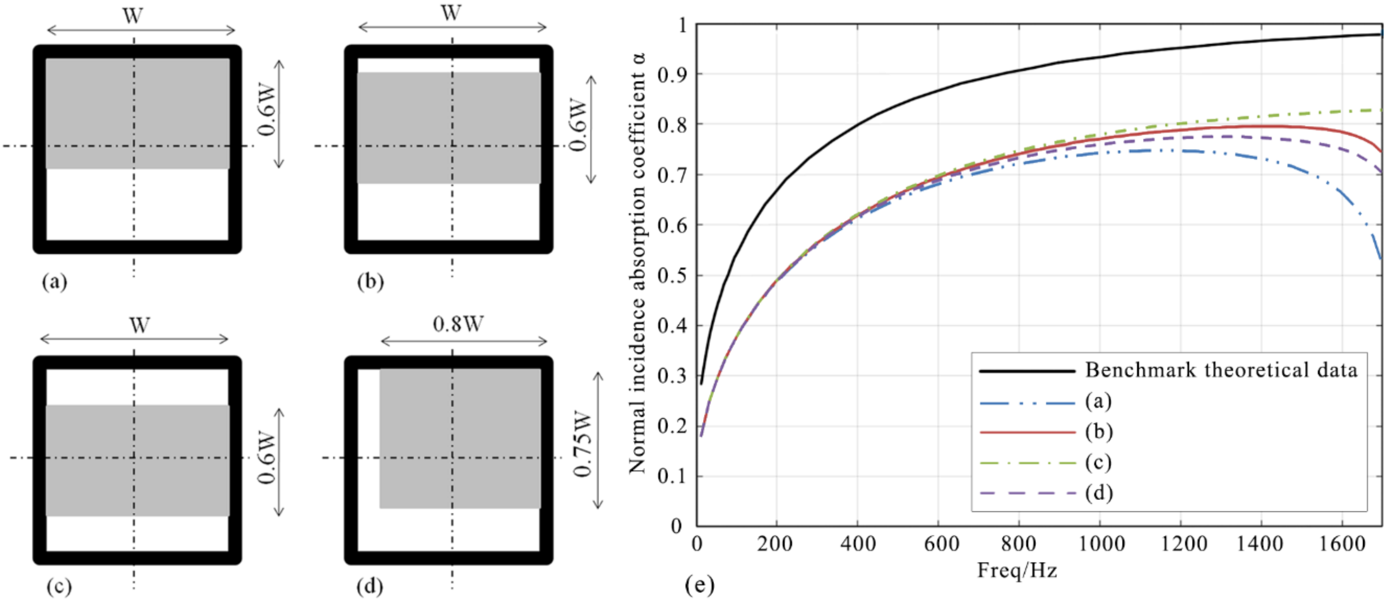

Figure 2: Effects of sample positions ((a), (b), (c)) in the SWT and shape (d) on sound absorption coefficient (e) of DIB. (Note: the areas of (a), (b), (c), and (d) are equal)

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