Experimental investigation of an acoustic metamamaterial barrier design composedof a square prism within a hexagon recess

ABSTRACT

This paper presents an experimental investigation of an acoustic barrier composed out of an acoustic metamaterial unit cell. The design of the unit cell consists of a square prism, acting as a resonator, within a hexagonal recess manufactured out of a single material. Two materials were used to manufacture the unit cell: PolyMide Polycarbonate and Polylite Polylactic Acid. The acoustic performance of the unit cell was quantified for both materials using the acoustic absorption coefficient and acoustic transmission loss values for frequencies between 100 Hz and 5,000Hz. The experimental results indicate that the design reduced the peak absorption coefficient for both materials while also introducing two additional peaks at around 1,500 Hz and at 4,000 Hz. Changes to the absorption coefficient values were observed for frequencies above 1,000 Hz while minimal changes were observed for frequencies below 1,000 Hz. These results indicate that the proposed design, is able to widen the effective frequency band, or stop band for acoustic absorption for frequencies above 1,000 Hz compared to the absorption coefficient of the material. The experimental results also indicate that the design increases the peak transmission loss by about 7 dB at 4,000 Hz. For sounds below 3,000 Hz, the design will only change the transmission loss by about 3 dB for frequencies between 100 Hz to 3,000 Hz. These results indicate that the acoustic metamaterial design, consisting of resonator in a recess manufactured out of a single material, is able to broaden the effective frequency range for sound absorption for frequencies between 1,000 Hz and 4,000 Hz and at increasing the transmission loss values for frequencies between 3,000 Hz and 5,000 Hz. It can be concluded that the resonator in recess metamaterial design, manufactured out of a single material, can be used to increase the stop band for acoustic absorption for frequencies above 1,000 Hz and to increase the transmission loss for frequencies above 3,000 Hz.

Keyword: Acoustic barrier design; Acoustic metamaterial; Noise control