Plate-Type Acoustic Metamaterials for Large-Scale Noise Control Applications

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Abstract

The presentation focuses on the recent works on the potential use of small-scale membrane-type acoustic metamaterials for low-frequency noise control and investigates the potential large-scale design with additional feature to complement the acoustical performance of the membrane-type metamaterials.

The proposed large-scale membrane-type acoustic metamaterial known as the meta-panel was first evaluated and verified numerically. Experimental results show that a broadband sound transmission loss (STL) improvement could be achieved by the incorporated membrane (up to 7.4 dB at 380 Hz). Numerically, parametric studies show that the broadband STL performance of the meta-panel was due to not only the resonant behaviour of the overhanging membrane but also the resonant behaviour of the sandwiched membrane along the boundaries of the unit cells. If properly designed, this resonant behaviour of the sandwiched membrane could complement membrane-type acoustic metamaterials to achieve an extended good STL performance across a broader frequency bandwidth. Thereafter, the conceptual design of a membrane-type acoustic metamaterial without the need for pretension and platelet(s) is presented. Additionally, experimental and numerical results show that the acoustical performance could be complemented by the coupling effect between two enclosed cavities via an orifice (i.e., resonator's effect). The orifice diameter could serve as a tuning parameter for broadband or narrowband transmission loss at selected frequencies. Consequently, the proposed design could address the shortcomings of membrane-type acoustic metamaterials and complement their acoustical performance with the additional feature.

Keywords: Acoustic metamaterials, noise control and applications.