FINAL PROJECT

ACOUSTIC CHARACTERISTIC ANALYSIS OF AN EGG CRATE TYPE SOUND ABSORBER USING FINITE ELEMENT ANALYSIS METHOD

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ABSTRACT

Noise pollution can adversely affect human health and the environment, particularly in industrial facilities and occupied buildings. Micro-perforated panels (MPPs) are commonly used as absorbers to address such noise problems because of their effectiveness in absorbing sound within specific frequency ranges. However, the flat MPP absorber has a limitation in its narrow absorption bandwidth. The egg-crate-type MPP absorber is a potential alternative for addressing this limitation because its profiled surface creates a distribution of local cavity depths and modifies the arrangement and orientation of the microperforations, which may broaden the sound absorption response. This final project aims to analyze the effect of profile angle, in combination with microperforation diameter and pitch, on the acoustic characteristics of the egg crate-type MPP absorber.

The simulation was carried out using the Finite Element Analysis Method with Harmonic Acoustics. The simulation model is represented as a tube with a source of noise at the inlet and a sound absorber at the outlet. To understand the acoustic characteristics of an egg crate-type sound absorber, the model is varied over the egg crate profile angle, microperforation diameter, and pitch. Structural material properties and structural deformation were not considered because the MPP absorber was assumed to be structurally rigid.

The baseline FEA models satisfied the predefined validation criterion, with relative errors below 10% for both the peak sound absorption coefficient and resonance frequency. The average errors were 1.50% and 4.49%, respectively. An increase in profile angle leads to an increase in peak sound absorption for the 0.3 mm microperforation diameter group, but leads to a decrease in peak sound absorption for the 0.6 mm and 0.9 mm groups. Regarding resonance frequency, increasing the profile angle generally shifts it toward higher values, nearly all the models. Increasing the profile angle generally widens the relative half-peak absorption bandwidth. For the 0.3 mm diameter group, the wider bandwidth is accompanied by a higher absorption peak, whereas for the 0.6 mm and 0.9 mm groups, it is accompanied by a lower absorption peak.

Keywords: Noise, Micro Perforated Panel, Egg Crate Structure, Sound Absorption, Bandwidth, Finite Element Analysis