Investigations about the modelling of acoustic properties of periodic porous materials with the shift cell approach

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ABSTRACT

The main advantage of designing sound packages with periodic arrangements is that they can provide a combination of absorption effects, resonance effects and wave interferences effects. This offers different applications in transportation (aeronautics, space, automotive, railway), energy and civil engineering sectors, where both weight and space, as well as vibroacoustic quality of performance and comfort, still remain as critical issues.

The application of shift cell technique is presented and discussed for periodic porous media described with equivalent fluid models: it consists in a reformulation of classical Floquet-Bloch (F-B) conditions, whose major advantage stands in allowing the introduction of any frequency dependence of porous material behavior, through the resolution a quadratic eigenvalue problem, providing an efficient way to compute the dispersion curves of a porous material modelled as an equivalent fluid.

The central part of this work shows the results, in terms of absorption coefficient and transmission loss curves, obtained through a numerical test campaign involving different melamine and polyurethane foams. The 48 test cases involve a cubic unit cell of porous material with a cylindrical inclusion.

Furthermore, some absorption coefficient and transmission loss comparisons are shown, between a homogeneous unit cell and a unit cell with a perfectly rigid inclusion; the comparisons are carried out at fixed dimensions, then at fixed mass and then at fixed performance in the periodicity peak range. The results clearly point out the advantage of designing foam layer with periodic inclusion patterns in order to improve the performances in a specific range of frequencies, allowing a save both in terms of thickness and, most of all, mass, respect to a classical homogeneous foam layer.