ABSTRACT OF THE DOCTORAL THESIS

Analysis and modeling of wave phenomena associated to the design of noise barriers based on sets of insulated scatterers. Device Homologation

by

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One of the most common solutions for the control of environmental noise during its transmission is given by the use of acoustic barriers. In recent years, the ability to manipulate sound by means of periodic structures of scatterers led to the idea of using these media as an alternative to classical noise barriers. These systems present an interesting property that allows their use as noise barriers: the existence of frequency ranges in which the sound is not transmitted through the structure due to Bragg's diffraction, that is, due to a multiple scattering process associated with the periodicity of the structure. However, due to its own characteristics, the interference phenomenon is not enough, by itself, to ensure the existence of a high sound attenuation at broad frequency ranges. Two research lines have been followed in classical literature to increase the attenuation capability of these systems: (i) adding new acoustic mechanisms in the scatterers to control the transmission of sound and (ii) searching for new arrangements of scatterers to maximize Bragg`s diffraction. Here we show the construction and characterization processes of two prototypes of acoustic barriers based on arrays of scatterers following the two research lines named before: (i) adding resonances and absorption materials in the scatterers and (ii) presenting a new arrangement of scatterers based on fractal geometries. The goal of both prototypes is their use as real traffic noise reduction devices and, accordingly, both barriers have been tested, patented and standardized.

Secondly, a theoretical overlapping design model for this kind of acoustic barrier is presented. The model, based on tunability, analyzes each one of the acoustic mechanisms involved in the acoustic propagation throughout the barriers. The tunability principle considers that each acoustic phenomenon acts independently without affecting the others, and therefore can be analyzed separately. Thus, the comprehensive model proposed, developed using the finite elements method, is a simplified model that allows the transformation of a real situation (3-dimensional case) into the sum of several two-dimensional cases, thereby reducing the computational cost. Finally, the developed model allows the choice of the acoustic phenomena involved in the design of this kind of barrier, providing interesting technological and design procedures in the field of acoustic barriers.