Numerical modelling the acoustic behaviour of a large periodic set of resonators by an efficient 3D BEM model

Paulo Amado-Mendes[+]*, Luís Godinho[+], Adriana Baio Dias[+], Matheus Pereira[+]

[+] ISISE, Dep. Civil Eng., University of Coimbra
Rua Luis Reis Santos, 3030-788 Coimbra, Portugal
e-mail: pamendes@dec.uc.pt, web page: http://www.dec.uc.pt

ABSTRACT

Noise abatement provided by acoustic metamaterials, is one of the peculiar features presented by these very interesting materials that has been investigated in detail by many researchers in recent years [1]. The use of local resonant elements and their periodic distribution in sonic crystal arrangements, has demonstrated to be a valid approach to enhance the properties of already proposed acoustic metamaterials.

In this work, having the development of absorptive/insulation acoustic panels in mind, the authors present a numerical analysis of a 3D system composed by periodic arrangements of resonators. Since the detailed and complex geometry of these system leads to very large discretized spatial domains, the computational models to be solved become of impractical use, taking too much time to achieve accurate solutions at medium to high frequencies. In the present case, the adopted 3D numerical model is based on the Boundary Element Method (BEM), and only the rigid interfaces of the resonators have to be discretized. In fact, an efficient strategy has been devised that adequately takes into account the periodicity of the resonators and enables the definition of a matrix in repeated blocks (therefore calculated only once), resulting in significant savings of computational memory, considerable CPU times reduction, and allowing the simple parallelization of the involved calculations. Additionally, the Adaptive Cross Approximation (ACA) technique is also used [2,3], further reducing the computational requirements. Therefore, after the verification of the model, the acoustical behaviour of a large periodic set of resonators is analysed in the frequency domain, highlighting the main acoustical features (acoustic absorption and noise attenuation) provided by different configurations of these type of periodic structures.

REFERENCES

[1] Craster, R.V., Guenneau, S. (eds.), *Acoustic Metamaterials. Negative Refraction, Imaging, Lensing and Cloaking*, Springer, 2013.

[2] Godinho, L., Amado-Mendes, P., Santos, P. G., Cordeiro, M. An efficient and accurate numerical model for the 3D analysis of sonic crystals, in *Proceedings of 22nd International Congress on Sound and Vibration*, Florence, 2015.

[3] Godinho, L., Soares Jr., D., Santos, P.G. Efficient analysis of sound propagation in sonic crystals using an ACA-MFS approach. *Engineering Analysis with Boundary Elements*, 69, pp. 72-85, 2016.