A numerical study of the vibration filtering effect of periodic structures

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ABSTRACT

The effect of phononic structures in attenuating the propagation of sound waves is well known, and has been thoroughly investigated in the literature. It has been clearly identified that these structures possess the property of almost eliminating the propagation of sound energy at specific frequency bands, usually designated as forbidden frequency bands or band gaps. Information regarding the behaviour of periodic structures embedded in a solid is, however, scarce, and only a few works can be found related to this topic [1, 2]. Applications of such concept can be, nevertheless, quite interesting, and may allow new vibration control devices to be developed, tailored at specific applications. For example, buried periodic structures may be used to control elastic wave propagation in soils, and thus to help reducing the vibrations in sensible structures.

In the present work, the authors present the result of a numerical study concerning the behaviour of a sequence of embedded inclusions within an elastic material, when subject to the incidence of waves with different frequencies. A numerical model is proposed for this analysis, based on a hybrid FEM-MFS formulation. In this approach, the FEM is used to model the heterogeneous part of the propagation medium (containing the multiple periodic inclusions), while the MFS is used to account for the infinite surrounding domain; this model is verified against a well-established finite element model. An initial study concerning the incidence of plane waves in the presence of circular inclusions with different properties is presented, in order to better understand the physical behaviour of the system. Then, the influence of the shape of the inclusions is addressed, and a final numerical application is presented.

REFERENCES

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