On the structural characterization through k-space methods: assessments and validations

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ABSTRACT

Periodic structures are very common and widely used in any engineering field. Many methods were developed based on the spatial repetition of a unit cell; the unit cell modelling approach allows to reduce the computational effort working on a small geometrical part of the structure and applying periodic boundary conditions at the edges, and it is widely used to simulate infinite media. Elastic periodic structures can be designed and employed to attenuate the wave propagation in certain frequency bands, originating the so-called band gaps. This physical behaviour can be obtained in two different ways, which are: resonant metamaterials (usually spatially distributed resonators) and phononic crystals. The band gaps generated by phononic crystal are related to the Bragg's effect; band gaps occur when the incoming waves are scattered by a periodic structure, giving rise a destructive interference. This physical effect occurs when the distance between the two scatters is of the same order of magnitude of the wavelength of the propagating waves. *K-space* methods are widely employed to determine the dispersion characteristics, to identify the direction of propagation and to estimate the equivalent material properties of complex structures through an inverse approach, when the analytical models are not available or too complex to be developed. In addiction to the classical Fourier-transform based methods, other methods were developed, such as the *Inhomogeneous Wave Correlation* (IWC) method [1,2]. In this paper, the physical characteristics of periodic structures are employed to analyse the vibroacoustic response of several complex structures in the wavenumber domain. The idea is to investigate a mechanical system with a certain degree of periodicity to control and attenuate the vibration of a structure subjected to a harmonic excitation. The proposed technique shows an accurate description of the band gaps and of the wave attenuation, giving some interesting information about the physics of the problem and the structural damping of the system. The optimal wavenumber, at each frequency, is obtained by a maximization function, making a comparison between the vibrational field (usually calculated in a *finite element* framework) and the one generated by an inhomogeneous travelling wave or by a set of Hankel's functions [3].

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