Dispersive wave propagation in magneto-electro-elastic waveguides with periodic microstructure

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Abstract

Magneto-electro-elastic waveguide devices boast a large variety of applications in many sectors of engineering [1].
Field equations of a magneto-electro-elastic (MEE) waveguide characterized by a periodic microstructure are given and complex variables are introduced to simplify their expression. In this framework, a MEE layered periodic material is considered and the propagation of electro-magneto-mechanics waves travelling along the direction perpendicular to the material layering is investigated. Afterwards, field equations for the MEE layered material are rewritten in terms of the Bloch amplitudes and the frequency band structure is retrieved according to the transfer matrix procedure [2] and by imposing the Floquet-Bloch boundary conditions. Finally, the eigenproblem governing the free progation of bulk waves in the microstructured periodic material is sort out by exploiting the symplecticity properties of the transfer matrix
and the associated fourth-order palindromic characteristic polynomial. The proposed approach is tested on illustrative examples where total band gaps in the Floquet-Bloch spectrum can be observed and the stability, depending on the coefficients of the characteristic polynomial, is discussed. Finally, the exact dispersion functions are compared with the approximate ones stemming from asymptotic perturbation methods [3].

References

Piliposyan, D.G and Ghazaryan, K.B. and Piliposian, G.T. (2014). Internal resonances in a periodic magneto-electro-elastic structure. Journal of Applied Physics, 116:044107.

Fantoni, F. and Morini, L. and Bacigalupo, A. and Paggi, M. (2021). The generalized Floquet-Bloch spectrum for periodic thermodiffusive layered materials. International Journal of Mechanical Sciences, 194:106178 97:575–92.

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Bacigalupo, A. and Lepidi, M. (2016). High-frequency parametric approximation of the Floquet-Bloch spectrum for anti-tetrachiral materials. International Journal of Solids and Structures, 97:575–92.