Dynamic behavior of acousto-elastic phononic crystals incorporating fluid sloshing and communicating channels between unit cells

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Résumé

Phononic crystals (PCs) and elastic metamaterials have been employed as innovative solutions for various applications, such as mitigating vibration levels, controlling wave propagation behavior, and enhancing material properties. However, acousto-elastic PCs, i.e., those periodic structures that combine solid and fluid (water) media, still lack investigation. Therefore, this work explores the dynamic behavior of box-type acousto-elastic PCs considering two scenarios: (a) internal cavities partially filled with fluid, exhibiting the sloshing phenomenon under external disturbances; and (b) fully filled internal cavities incorporating communicating channels of varying geometries between adjacent cells. Modeling is performed using the Wave-based Finite Element Method and a novel model-order reduction scheme. Numerical simulations illustrate that partially filled PCs allow for the opening of more bandgaps at lower frequencies compared to fully filled or empty PCs, while also being more suitable for lightweight applications. Simulations also reveal that the propagation of elastic and acoustic waves can be blocked by incorporating communicating channels between adjacent cells in a periodic lattice. The findings of this study highlight the potential of acousto-elastic PCs in enhancing wave control and vibration mitigation, thereby paving the way for their application in advanced engineering solutions.

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