A NOVEL DESIGN OF PHONONIC CRYSTALS WITH TUNABLE BAND GAPS VIA LARGE DEFORMATION

Yilan Huang[1], Ronghao Bao[1,2,3,*] and Weiqiu Chen[1,2,3]

[1] Department of Engineering Mechanics, Zhejiang University, Hangzhou, Zhejiang, 310027, China
[2] Key Laboratory of Soft Machines and Smart Devices of Zhejiang Province, Zhejiang University, Hangzhou 310027, P. R. China
[3] Soft Matter Research Center (SMRC), Zhejiang University, Hangzhou 310027, China

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ABSTRACT

In the past two decades, plenty of researches have shown the great potential in designing acoustic devices with phononic crystals (PCs) due to their excellent band gap structures, such as wave filter, acoustic waveguide, vibration isolator, etc. To broaden the applications of PCs with more flexibility, tunability of band gaps (BGs) with external stimuli including electric fields, magnetic fields, temperature and mechanical loadings, has become one of concerns in the recent years.

The research group in Harvard University led by Bertoldi has conducted a series of works on the post-buckling behaviour of periodic porous with various holes and the consequent effects on the BGs, providing the opportunity to tune the BGs of soft PCs in an effective and reversible manner. Both the geometric and material nonlinearities induced by the large deformation under external loading are included and analysed in their models.

In the present work, we will introduce a novel design of PCs, comprising of undulated beams made from soft material and concentrated mass blocks made from metallic material, and assembled like a chiral structure. The band structures of our design are analysed using finite element method (FEM), and the effects of the amplitudes of undulated beams and the size of concentrated hard inclusions are both discussed in details. Furthermore, bi-axial load is applied on the sides of soft PCs to control the geometry of undulated beams. With the increasing of tensional force, the beams are found to be straightened gradually, and the BGs could be significantly altered under large deformation. In comparison with the way through post-buckling deformation, our design is more feasible to be realized, and it is not sensitive to the geometric imperfections, which should be always considered in the way through post-buckling deformation.

* Corresponding author: Ronghao Bao
E-mail address: brh@zju.edu.cn