Transition of buckling patterns and its effects on elastic wave propagation in lattice structures

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Abstract

Cellular solids or lattice structures are now widely applied in engineering areas due to their superior structural properties, such as energy absorber, heat management, vibration isolator, wave filter, acoustic cloaking device, phononic crystals and so on. A plenty of work have been done to reveal the static and dynamic properties of lattice structures with different materials and topologies, while little attention has been focused on the post-buckling behavior of lattice structures, which is usually considered as the failure of structures. However, recent researches have proved that the post-buckling of soft periodic structures trigged by mechanical loadings can be effectively harnessed to tune the elastic wave propagation properties, which can be manipulated reversibly and repeatedly as long as keeping the deformation fully in elastic range.

A novel algorithm based on the commercial FEM software - ABAQUS is developed to systematically analyze the post-buckling of two-dimensional periodic lattice structures under mechanical loadings, and the consequent elastic wave propagation as well. Both the effects of lattice topologies and the mechanical loading conditions on the post-buckling patterns and wave band gaps are explored and discussed. Moreover, transition of post-buckling patterns in deliberately designed lattice structures can be triggered by controlling the loading conditions, which might bring a potential way to tune the elastic wave propagation. Furthermore, it is demonstrated that this new algorithm can handle higher order and closely-spaced post-buckling patterns without the assumption of geometric imperfections, which were introduced by the most of available numerical methods.

Keywords: lattice structure, post-buckling, pattern transition, elastic wave tunability;