Vibration and wave propagation in pre-deformed periodic lattice frame structures

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Abstract

The optimization of materials and structures regarding their vibration and wave propagation properties is an attractive and important area of research. Phononic crystals, which are artificially made materials consisting of periodically arranged structures, can manipulate the characteristics of the elastic wave propagation [1]. Thus, it is feasible to create band-gaps, which prohibit the propagation of elastic or acoustic waves at certain frequencies [2]. This basic concept can also be applied to periodic lattice frame structures. Besides altering the stiffness and the mass, it is also possible to manipulate the vibration and wave propagation properties by pre-deforming the structural members.

In this study, the influences of the pre-deformations on the vibration and wave propagation characteristics in periodic lattice frame structures is analyzed by using the finite element method (FEM). For this purpose, the pre-deformations under external compression are calculated for each element using a harmonic or a polynomial function. The dynamic analysis is carried out for harmonic and transient excitations. The calculation is conducted in the time domain by utilizing the modal transformation to uncouple the equations of motion. By means of the Fourier-transform, the influences of the pre-deformations are also investigated in the frequency domain. Numerical examples are presented and discussed to explore the effects of the pre-deformations on the vibration and elastic wave propagation properties of periodic lattice frame structures.

Keywords: Wave propagation, band gap, periodic structures

References

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