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PROCEEDINGS

On Broadband Continuum Modeling of Lattice Metamaterials

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ABSTRACT

Unlike classical condensed matters with the characteristic microstructural size far smaller than the undergoing wavelength, lattice metamaterials call for a kind of subwavelength continuum modeling, which should be able to provide successful predictions throughout the first Brillouin zone. We classify lattices into two groups. The first category stands for the mass-spring systems composed of dump masses and massless springs, for which three attempts have been made: the strain gradient continuum based on wavelength-dependent Taylor's expansion [1, 2], Pade approximation [3] and Symbiotic Optimal Search (SOS) [4], respectively. The results of these newly developed models agree well with those by discrete models, suggesting their satisfactory performances. The second category includes lattices composed of trusses with continuous distributing mass [5]. Now we employ the so-called dynamic stiffness formulation which is in principle workable for any arbitrary exciting frequency, to develop the dynamical effective constitutive model based on the nominal equivalence of strain energy in the chosen unit cell. Then the intrinsic frequencies and modes are determined with the help of the William-Witrick method. The proposed model is verified by comparing with finite element simulations. In brief, this study has provided a series of continuum-type models for lattice metamaterials, which are believed to be helpful in metamaterial designs.

KEYWORDS

Broadband continuum theory; lattice metamaterial; dynamical stiffness; William-Wittrack method

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