NONLINEAR PERIODIC CHAINS WITH FRACTIONAL DAMPING

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ABSTRACT

In recent years, there is a growing interest to investigate mechanical metamaterials owing to their unique wave attenuation properties. Periodicity in geometric or material properties is the main mechanism for formation of band gaps in such materials. Alongside with the investigation of linear metamaterials the nonlinear wave propagation problems were studied with the help of perturbation methods for studying this problem. Recently, some researchers investigated low-amplitude travelling waves in a periodic chain having both quadratic and cubic nonlinear terms. Interaction of waves in monoatomic chains having cubic nonlinearity was also studied in the literature [1]. On the other hand, dissipation in phononic crystals and metamaterials can cause significant change in band structure, where consideration of damping is unavoidable from the viewpoint of future practical applications [2]. In this communication, we show the model of nonlinear chains with fractional-order damping included. The model includes point masses connected through cubic nonlinear and linear springs and fractional spring-pot elements, where solution is found by using the multiple scales perturbation and fractional derivative expansion method [3]. Parametric study is conducted to examine the effects of model parameters on dispersion curves. Here, we demonstrate that consideration of nonlinearity and damping can play important role in predicting the wave dispersion behavior of the nonlinear periodic chains and help in future analysis and pre-design procedures of metamaterial based wave filtering and waveguiding.

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