The Summer Undergraduate Research Fellowship (SURF) Symposium
20 August 2017
Purdue University, West Lafayette, Indiana, USA

Dynamic Characterization of Periodic Lattice of Elastically-connected Bi-stable Elements under Seismic Excitation

Lingwei Meng, Myungwon Hwang, Andres F. Arrrieta,
School of Mechanical Engineering, University of Purdue University

ABSTRACT

Metamaterials are engineered materials, typically in periodic arrangements, which exhibit unconventional or extreme properties not found in nature. Understanding the dynamics of metamaterials enables the design of structures with specific functionalities. The dynamics of metamaterials in linear regime has been relatively well studied in recent years, however the unique phenomena arising from nonlinearities in metamaterials are yet to be explored. In this paper, we focus on an array of bi-stable elements connected by elastic springs under various forms of external excitations acting on the entire system. The general equations of motion are derived to handle any degree-of-freedom (DoF) systems of interest. The MATLAB-based code is developed using finite difference method to solve numerically the system of equations and is validated through the correlation studies with the analytical solutions in previously known linear systems. Numerical investigations are performed on 2-DoF and infinitely-long systems under various excitation levels with focuses on nonlinear responses. The predicted behaviors are experimentally verified from the dynamic testing, using 3D-printed lattice samples.

KEYWORDS

Metamaterials, Periodic structures, Nonlinear dynamics