Accepted Manuscript

Experimental demonstration of a dissipative multi-resonator metmaterial for broadband elastic wave attenuation

Miles V. Barnhart, Xianchen Xu, Yangyang Chen, Shun Zhang, Jizhou Song, Guoliang Huang

PII: S0022-460X(18)30542-X

DOI: 10.1016/j.jsv.2018.08.035

Reference: YJSVI 14327

To appear in: *Journal of Sound and Vibration*

Received Date: 17 April 2018

Revised Date: 28 July 2018

Accepted Date: 16 August 2018

EXPERIMENTAL DEMONSTRATION OF A DISSIPATIVE MULTI-RESONATOR METMATERIAL FOR BROADBAND ELASTIC WAVE ATTENUATION

Miles V. Barnhart[1], Xianchen Xu[1], Yangyang Chen[1,*], Shun Zhang[2], Jizhou Song[2] and Guoliang Huang[1,*]

[1]*Department of Mechanical and Aerospace Engineering, University of Missouri, Columbia, Missouri 65211, USA*
[2]*Department of Engineering Mechanics and Soft Matter Research Center, Zhejiang University, Hangzhou, 310027, China*

ABSTRACT

Elastic metamaterials (EMMs) encompass a relatively new class of composite materials that exhibit unique dynamic effective material properties and possess the ability to mitigate or even completely inhibit the propagation of acoustic/elastic waves over specific frequency spectrums (band gaps). However, it is extremely difficult to achieve broadband energy absorption with single resonance based EMMs. Dissipative EMMs with multiple resonators have recently been suggested for the attenuation of elastic wave energy spanning broad frequency spectrums. In this study, we fabricate a dissipative EMM with multiple resonators comprised from layered spherical inclusions embedded in an epoxy matrix and experimentally demonstrate broadband elastic wave mitigation. An analytical solution combined with numerical simulations is used to validate the accuracy of the fabrication based on a single unit cell test. We also numerically investigate the dynamic wave dispersion behavior of the fabricated dissipative EMM and find that the two strong attenuation regions induced by the two internal resonators can be effectively combined into a broadband wave attenuation region by the intrinsic damping properties of the constitutive materials used in the design. This broadband wave attenuation is finally demonstrated through an impact test performed on finite EMM samples where the frequency spectrum of the transmitted amplitude is in very good agreement with the numerical results. This design can be easily scaled and implemented into different length scales, which will benefit a range of applications requiring broadband vibration elastic wave, and/or seismic wave mitigation.

Keywords: Dissipative elastic metamaterials, broadband energy attenuation, microstructural design