

Public Abstract

First Name:Shuyi

Middle Name:

Last Name:Jiang

Adviser's First Name:Perngjin. "Frank"

Adviser's Last Name:Pai

Co-Adviser's First Name:

Co-Adviser's Last Name:

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Title:FINITE-ELEMENT DESIGN OF METAMATERIAL BEAMS FOR BROADBAND WAVE ABSORPTION

Metamaterials were first introduced for dealing with electromagnetic waves. By creating a material with negative magnetic permeability and electric permittivity, it is possible to manufacture perfect optical lenses, electromagnetic absorbers, technologies for rendering objects invisible and so on. Later researchers began to look into metamaterials for dealing with acoustic waves.

This thesis presents the modeling and analysis techniques for design of metamaterial beams as elastic wave absorbers.

The work shows that the metamaterial beam is based on the concept of a conventional vibration absorber, which uses the local resonance of subsystems to generate inertia forces to work against the external load and prevent elastic waves from propagating forward. This concept is also extended to design a multi-stopband metamaterial beam that can absorb broadband elastic waves. It shows that, for a multi-stopband metamaterial beam, a high damping ratio for the secondary absorber combines two stopbands into a broad one while a low damping ratio for the primary absorber guarantees quick response to the coming excitation elastic wave.

Amazing progress has been made for acoustic metamaterials over the past few years. This new concept provides great opportunity in the design and development of exotic functional devices. Beyond metamaterial beams, more complicated mechanical configurations can be designed in the future, such as metamaterial plates, shells or 3D structures.