

Resonant Auxetic Metamaterial for Automotive Applications in Vibration Isolation

Authors : Adrien Pyskir, Manuel Collet, Zoran Dimitrijevic, Claude-Henri Lamarque

Abstract : During the last decades, great efforts have been made to reduce acoustic and vibrational disturbances in transportations, as it has become a key feature for comfort. Today, isolation and design have neutralized most of the troublesome vibrations, so that cars are quieter and more comfortable than ever. However, some problems remain unsolved, in particular concerning low-frequency isolation and the frequency-dependent stiffening of materials like rubber. To sum it up, a balance has to be found between a high static stiffness to sustain the vibration source's mass, and low dynamic stiffness, as wideband as possible. Systems meeting these criteria are yet to be designed. We thus investigated solutions inspired by metamaterials to control efficiently low-frequency wave propagation. Structures exhibiting a negative Poisson ratio, also called auxetic structures, are known to influence the propagation of waves through beaming or damping. However, their stiffness can be quite peculiar as well, as they can present regions of zero stiffness on the stress-strain curve for compression. In addition, auxetic materials can be easily adapted in many ways, inducing great tuning potential. Using finite element software COMSOL Multiphysics, a resonant design has been tested through statics and dynamics simulations. These results are compared to experimental results. In particular, the bandgaps featured by these structures are analyzed as a function of design parameters. Great stiffness properties can be observed, including low-frequency dynamic stiffness loss and broadband transmission loss. Such features are very promising for practical isolation purpose, and we hope to adopt this kind of metamaterial into an effective industrial damper.

Keywords : auxetics, metamaterials, structural dynamics, vibration isolation

Conference Title : ICAV 2019 : International Conference on Acoustics and Vibrations

Conference Location : Tokyo, Japan

Conference Dates : October 07-08, 2019