World Academy of Science, Engineering and Technology
International Journal of Mechanical and Industrial Engineering
Vol:14, No:04, 2020

Effect of Geometric Imperfections on the Vibration Response of Hexagonal Lattices

Authors : P. Caimmi, E. Bele, A. Abolfathi

Abstract : Lattice materials are cellular structures composed of a periodic network of beams. They offer high weight-specific mechanical properties and lend themselves to numerous weight-sensitive applications. The periodic internal structure responds to external vibrations through characteristic frequency bandgaps, making these materials suitable for the reduction of noise and vibration. However, the deviation from architectural homogeneity, due to, e.g., manufacturing imperfections, has a strong influence on the mechanical properties and vibration response of these materials. In this work, we present results on the influence of geometric imperfections on the vibration response of hexagonal lattices. Three classes of geometrical variables are used: the characteristics of the architecture (relative density, ligament length/cell size ratio), imperfection type (degree of non-periodicity, cracks, hard inclusions) and defect morphology (size, distribution). Test specimens with controlled size and distribution of imperfections are manufactured through selective laser sintering. The Frequency Response Functions (FRFs) in the form of accelerance are measured, and the modal shapes are captured through a high-speed camera. The finite element method is used to provide insights on the extension of these results to semi-infinite lattices. An updating procedure is conducted to increase the reliability of numerical simulation results compared to experimental measurements. This is achieved by updating the boundary conditions and material stiffness. Variations in FRFs of periodic structures due to changes in the relative density of the constituent unit cell are analysed. The effects of geometric imperfections on the dynamic response of periodic structures are investigated. The findings can be used to open up the opportunity for tailoring these lattice materials to achieve optimal amplitude attenuations at specific frequency ranges.

Keywords : lattice architectures, geometric imperfections, vibration attenuation, experimental modal analysis
Conference Title : ICSV 2020 : International Conference on Sound and Vibration
Conference Location : Boston, United States
Conference Dates : April 23-24, 2020