On the vibration attenuation properties of finite periodic lattices of impact dampers

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ABSTRACT

The emergence of metamaterials as an alternative concept for the mitigation of structural vibration is increasingly attracting the interest of scientists and engineers. Recent studies [1] confirm that the development of periodic structures assembled on the basis of unit cells of favourable properties, results in a filtering effect, preventing the propagation of vibration lying within a specific frequency band. The, so called, meta-structures are thus characterized by a frequency bandgap.

For the purposes of structural vibration attenuation two main interrelated challenges are currently associated with the conceptual design of such structures: the first corresponds to the feasibility of reducing the lower threshold of the band gap within a practical setting, while the second pertains to increasing the breadth of the bandgap. One approach to addressing these challenges lies in the use of the so-called "rainbow traps", i.e., meta-structures consisting of unit cells with different properties. An alternative strategy pertains to use of nonlinear unit cells.

Both schemes are so far little unexplored in terms of applicability for structural vibration mitigation. This study attempts to contribute to this research path, by exploring the nonlinear approach, by assessing the properties of finite lattices with unit cells composed of impact dampers. These devices have already demonstrated their attenuation potential [2, Ch. 8], yet, their investigation has been mostly limited to systems of single, or two-degrees-of freedom.

To this end, a one-dimensional finite lattice is herein considered, excited on one end, with the vibration response at the unit cell lying in the opposite end studied parametrically. The analysis is conducted over critical structural parameters, including the number and the individual stiffness properties of unit cells, the nonlinear properties of the collisions, etc., while a comparison to a conventional linear lattice of mass-in-mass unit cells is additionally offered. The study demonstrates the potential of meta-structures composed of properly-designed impact dampers for vibration attenuation.

REFERENCES

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