The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

Elastic wave control via octet-based architected lattices

Giulia Aguzzi*, Andrea Colombi and Eleni N. Chatzi

ETH Zürich, Zürich 8093, Switzerland aguzzi@ibk.baug.ethz.ch, colombi@ibk.baug.ethz.ch, chatzi@ibk.baug.ethz.ch, https://chatzi.ibk.ethz.ch

Key Words: *Octet lattice, wave control, finite element method.*

The recent breakthroughs in additive manufacturing, accompanied by the progress in computational performance, have paved the way for a multitude of architected structures to be investigated in dynamics. Among these are frame-based lattices, known for their exotic ability to manipulate waves stemming from so-called bandgaps, frequency components in which the wave propagation is hindered [1].
In this work, we explore the potential of octet-like lattices in controlling the trajectory of elastic waves. We, therefore, design a reticulated plate by periodically tessellating the octet topology [2] in two spatial directions. Firstly, we focus on the constitutive cell and by computing its band structure, after combining the finite element method with Bloch theorem in numerical simulations, we unravel the dynamics of this lattice. We prove the octet cell has a broad and easy-to-tune bandgap, in which local-resonance and Bragg scattering naturally coalesce. We ultimately leverage the underlying physics of this stop band to identify geometrical parameters capable of tuning the band structure and to numerically build two metadevices, for attenuation and guiding of waves within the lattice plate; a metabarrier and a metalens, respectively.
Our numerical findings reveal the potency of octet-based lattice plates in effectively inhibiting wave propagation or, alternatively, focusing their energy [3], thus laying the ground for development of novel wave control devices in vibration isolation and energy harvesting.

REFERENCES

[1] A.S. Phani, J. Woodhouse, and N. A. Fleck. Wave propagation in two-dimensional periodic lattices. *The Journal of the Acoustical Society of America*. Vol. **119**, 4: 1995-2005, 2006.

[2] V. S. Deshpande, N. A Fleck. And M. F Ashby. Effective properties of the octet-truss lattice material. *Journal of the Mechanics and Physics of Solids.* Vol. **49**, 8 :1747-1769, 2001.

[3] G. Aguzzi, K. Kanellopoulos, R. Wiltshaw, R. V. Craster, E. N. Chatzi and A. Colombi, Octet lattice-based plate for elastic wave control. *ArXiv preprint*, *arXiv:2110.13590* (2021).