

Project Title: Development of a metamaterial-based resonating lattice system for efficient vibration isolation

Duration: 2 Years (1st April 2024 to 31st March 2026)

Objectives:

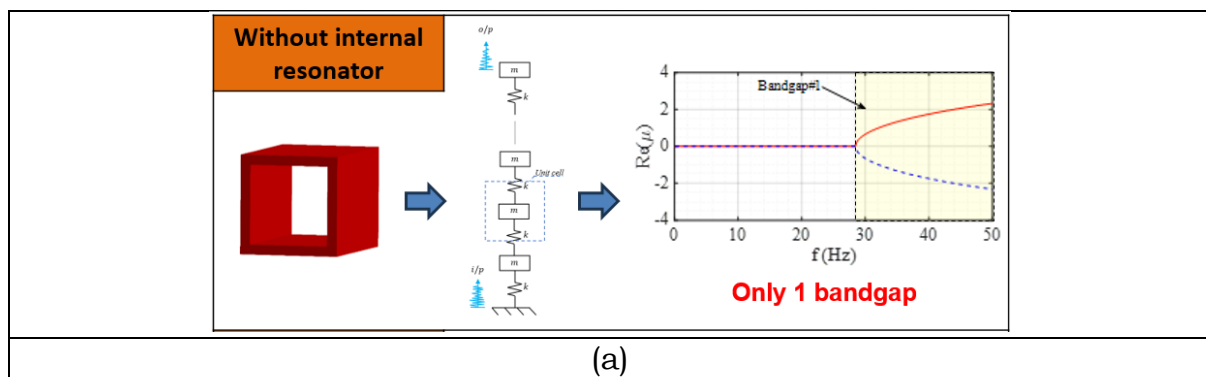
- Develop metamaterial-based periodic systems for vibration isolation and their numerical investigation
- Formulate a comprehensive optimization strategy for the design of such systems
- Demonstrate the proof of concept using laboratory experiments

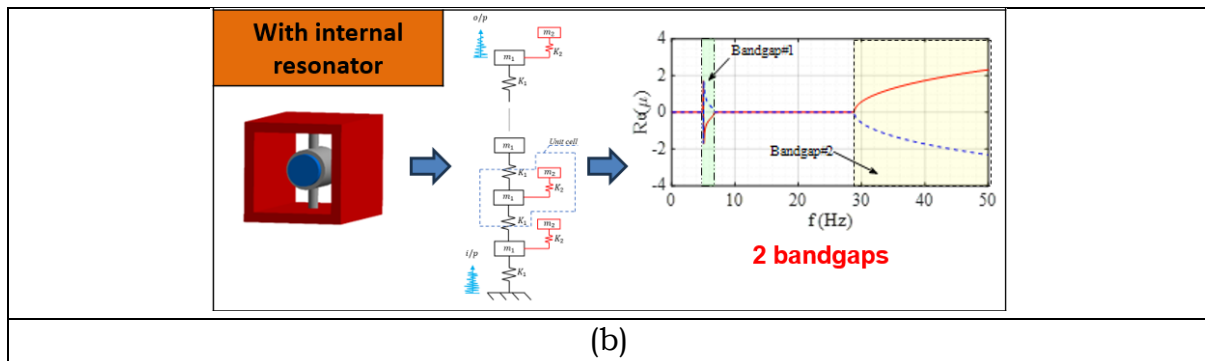
Deliverable: Metamaterial-based periodic systems for vibration isolation

Significant Achievements:

Major achievement has been the successful design and validation of a resonating periodic metamaterial-based vibration isolation system that significantly outperforms conventional elastomeric isolators. By leveraging the geometric and material properties of metamaterials, periodic structures with tailored unit cells were developed to exhibit unique bandgap characteristics, effectively filtering out undesirable vibration frequencies. Analytical dispersion relations were derived using the Floquet–Bloch theorem and verified through finite element simulations, ensuring theoretical and computational consistency. Multiple configurations of periodic structures were explored, and their optimal geometries were identified using meta-heuristic optimization algorithms. The resulting metamaterial control scheme demonstrated efficient broadband vibration isolation, enabling protection of structures and critical components across a wider frequency range than traditional systems. This achievement establishes a robust foundation for next-generation vibration mitigation technologies adaptable to diverse engineering applications.

One or two relevant pics/flowcharts:





Bandgap characteristics of a simple unit cell (a) Without any internal resonator and (b) With an internal resonator

Potential applications:

Successful completion of this research is expected to open a new dimension to control vibrations in a wide array of areas. In particular, potential applications include:

- Industries to isolate machinery, pipelines, etc., from harmonic and other excitations.
- Aerospace sector to isolate payload from shocks generated during launch operations.
- Defense sector to protect sensitive equipment and personnel from shock loads due to explosions and blasts

Protecting and isolating structures, machinery, and sensitive equipment from vibration in general leads to improved safety, reduced structural damage, and increased comfort in various settings.

Team:

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