Research Highlights

First systematic comparative analysis of lattice geometries in locally resonant sonic crystal plates: PWE/EPWE computational framework with finite element validation

- **First systematic comparative analysis** of five lattice geometries (square, rectangular, triangular, honeycomb, kagomé) for locally resonant metamaterial plates using validated PWE/EPWE framework.
- **Systematic bandwidth evolution mapping** across 15 resonator frequencies (10-150 Hz) reveals geometry-dependent optimal operational ranges and establishes frequency-dependent performance maps.
- **Dual bandgap characterization in multi-resonator systems:** Honeycomb/kagomé achieve broadband multi-frequency attenuation through in-phase and anti-phase resonator coupling modes.
- **Quantitative performance hierarchy:** Triangular lattices achieve 35% superior relative bandwidth (42.51% vs 31.40%) using only 25% of kagomé material; computational efficiency: 1800-5700× speedup over FEM.
- **Engineering design framework** with frequency-dependent lattice selection guidelines for aerospace, automotive, and civil vibration control applications.

Keywords: Locally resonant metamaterial, Flexural waves, Band gaps, Lattice configurations, Semi-analytical method, Frequency-dependent optimization, Low-frequency vibration control