

Design and Evaluation of Beams with Periodic Material Removal for Vibration Reduction

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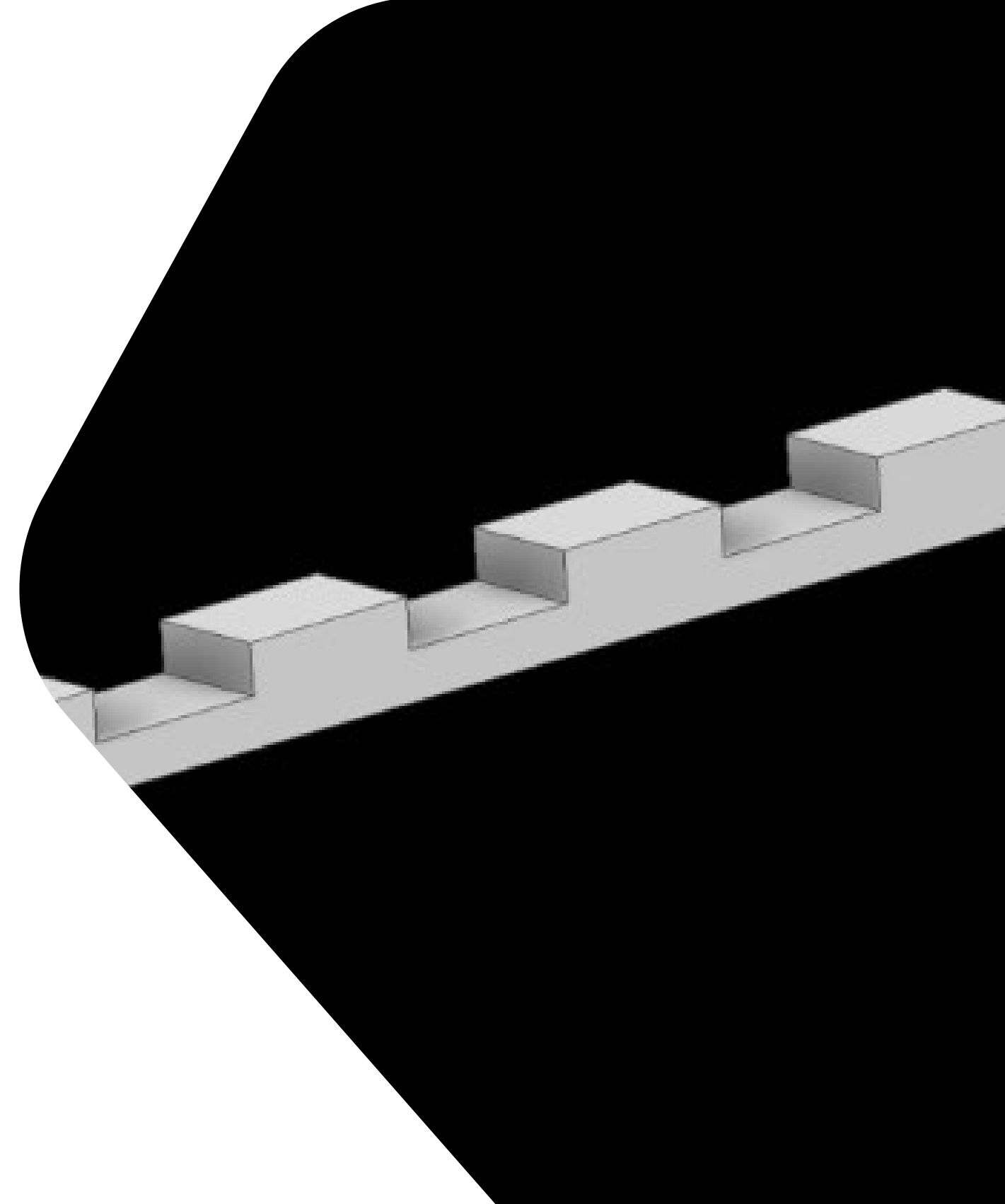


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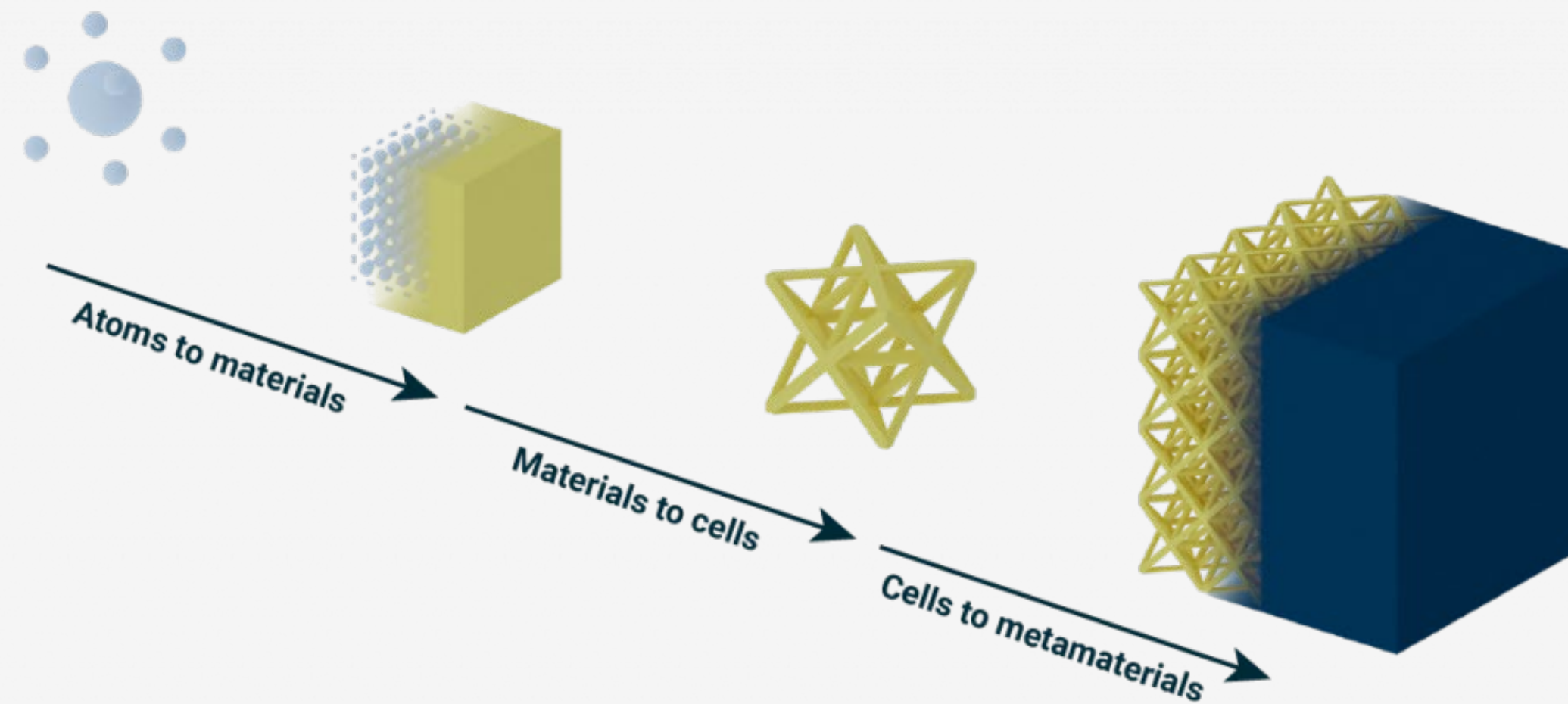
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Meta materials

BandGaps

Previous
Research



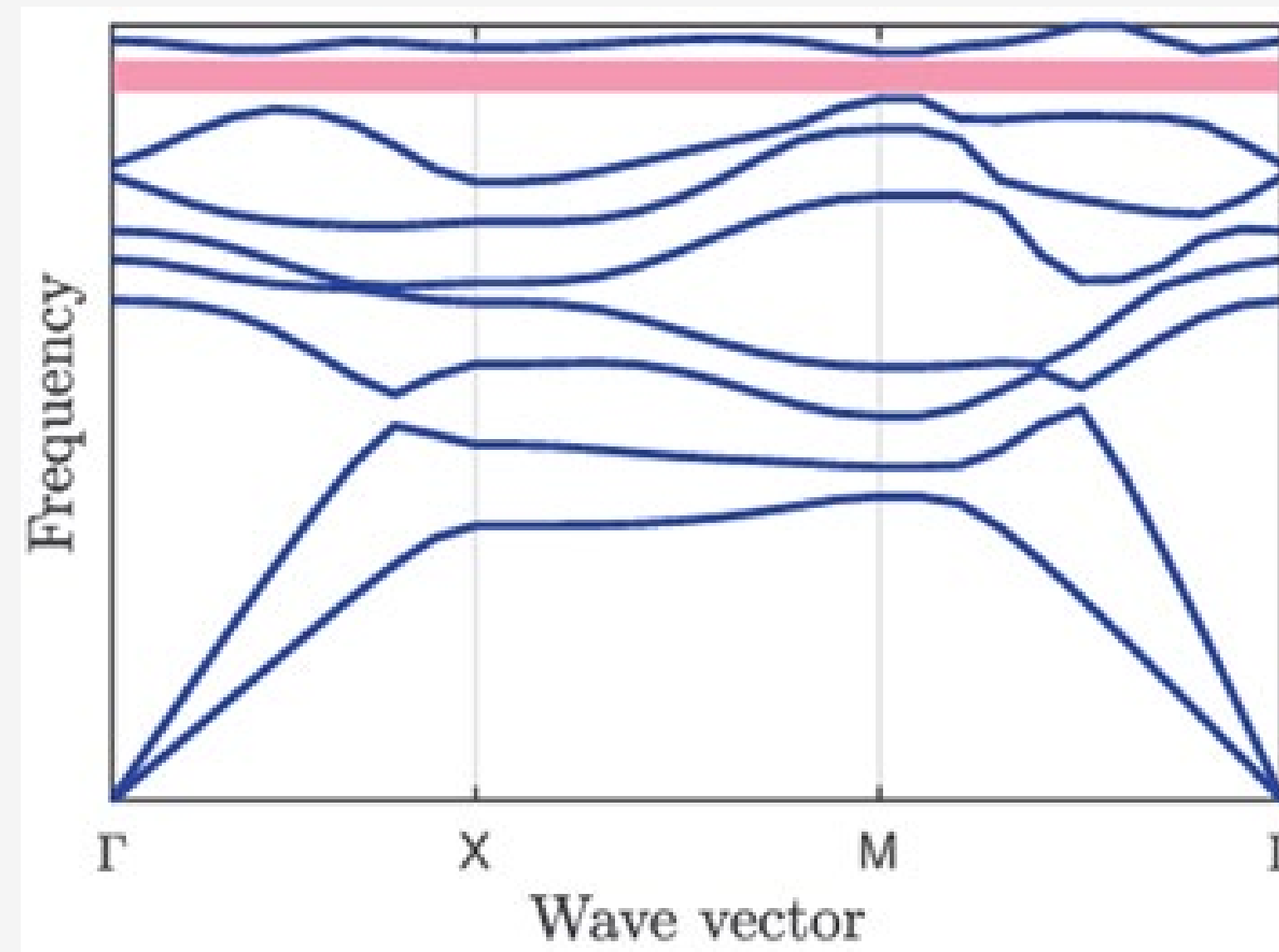
Metamaterials: engineered structures with unique properties not found in natural or composite materials.

Metamaterials

Band Gaps

Previous
Research

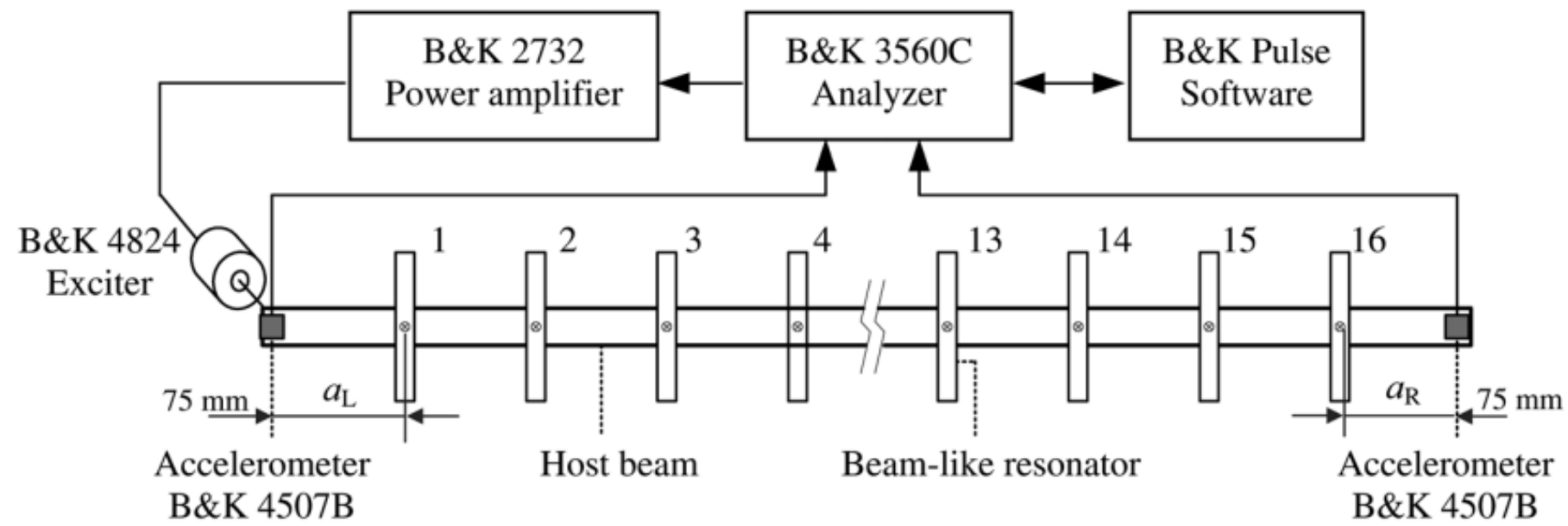
Metamaterials are purposely designed to produce characteristics that a conventional material can't exhibit.



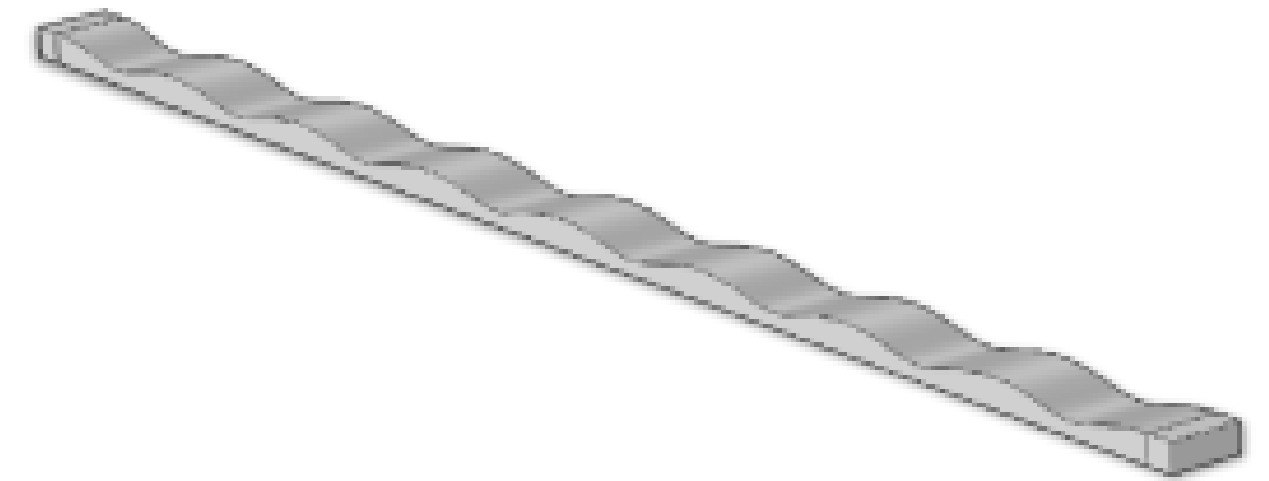
Metamaterials

Bandgaps

Previous Research



Locally resonant beam.



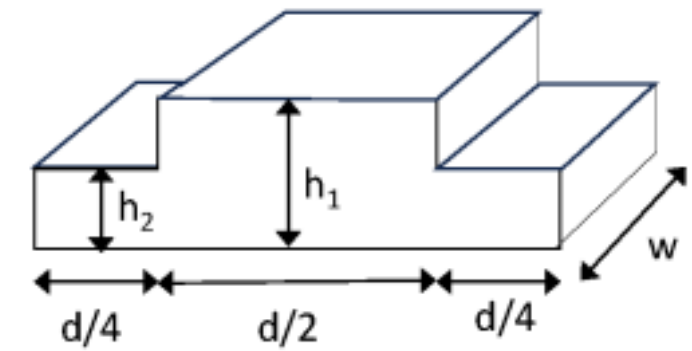
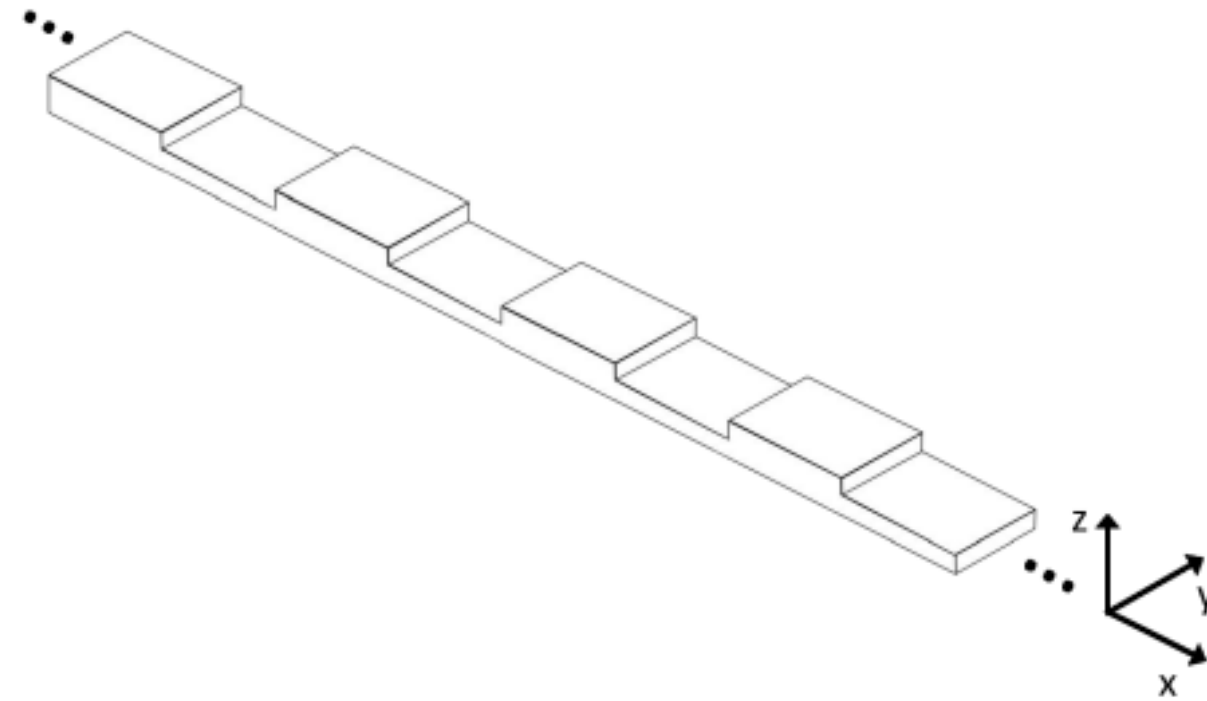
Example of corrugated beam with 8 cells.

OBJETIVE

The objective of this investigation is to demonstrate and characterize the behavior of beams with band gaps created through periodic material removal, offering a simpler alternative for enhanced vibration reduction in engineering applications.

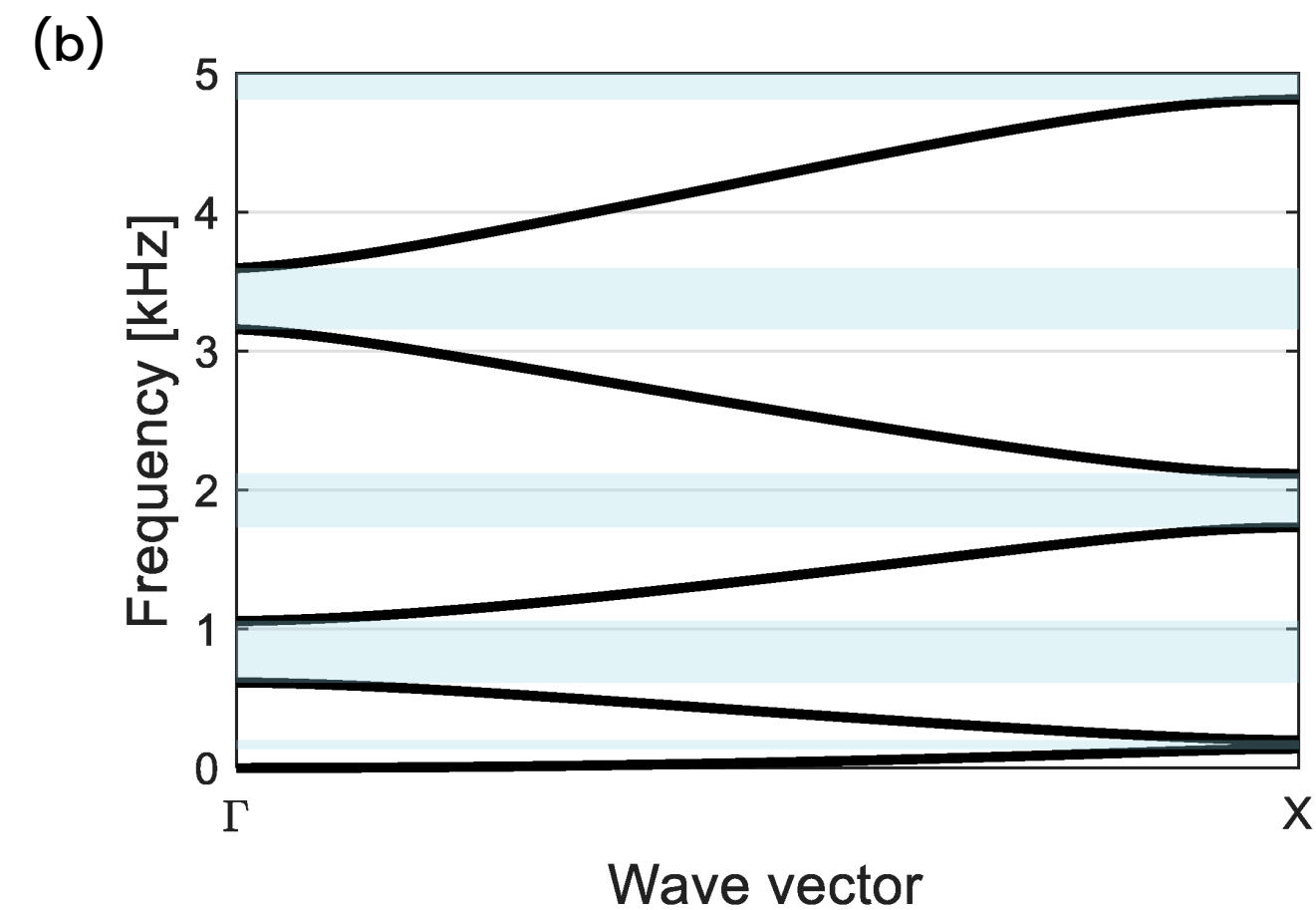
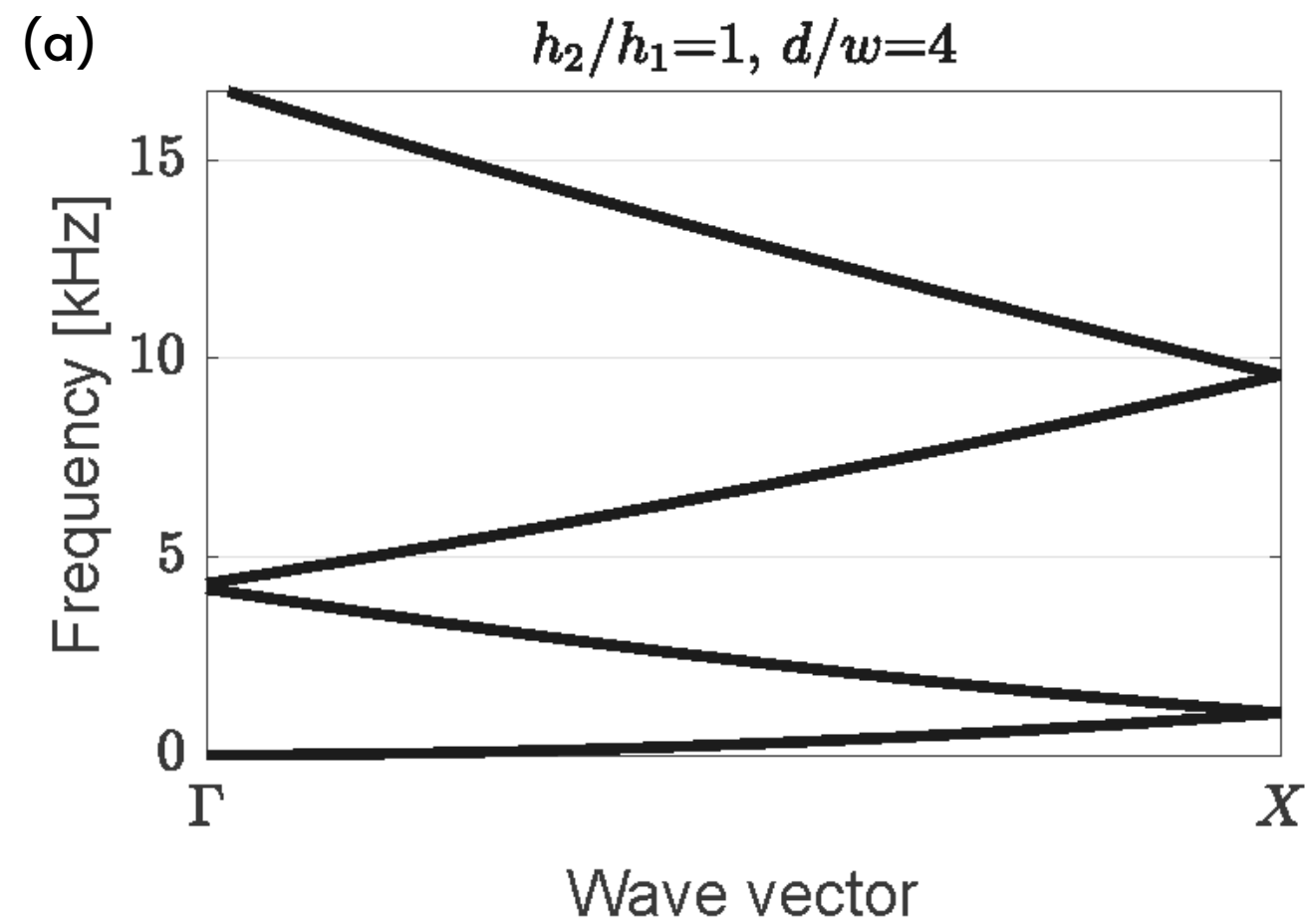
Periodic Beam

- W : width
- h_1 : base thickness
- h_2 : reduced thickness
- d : unit cell length



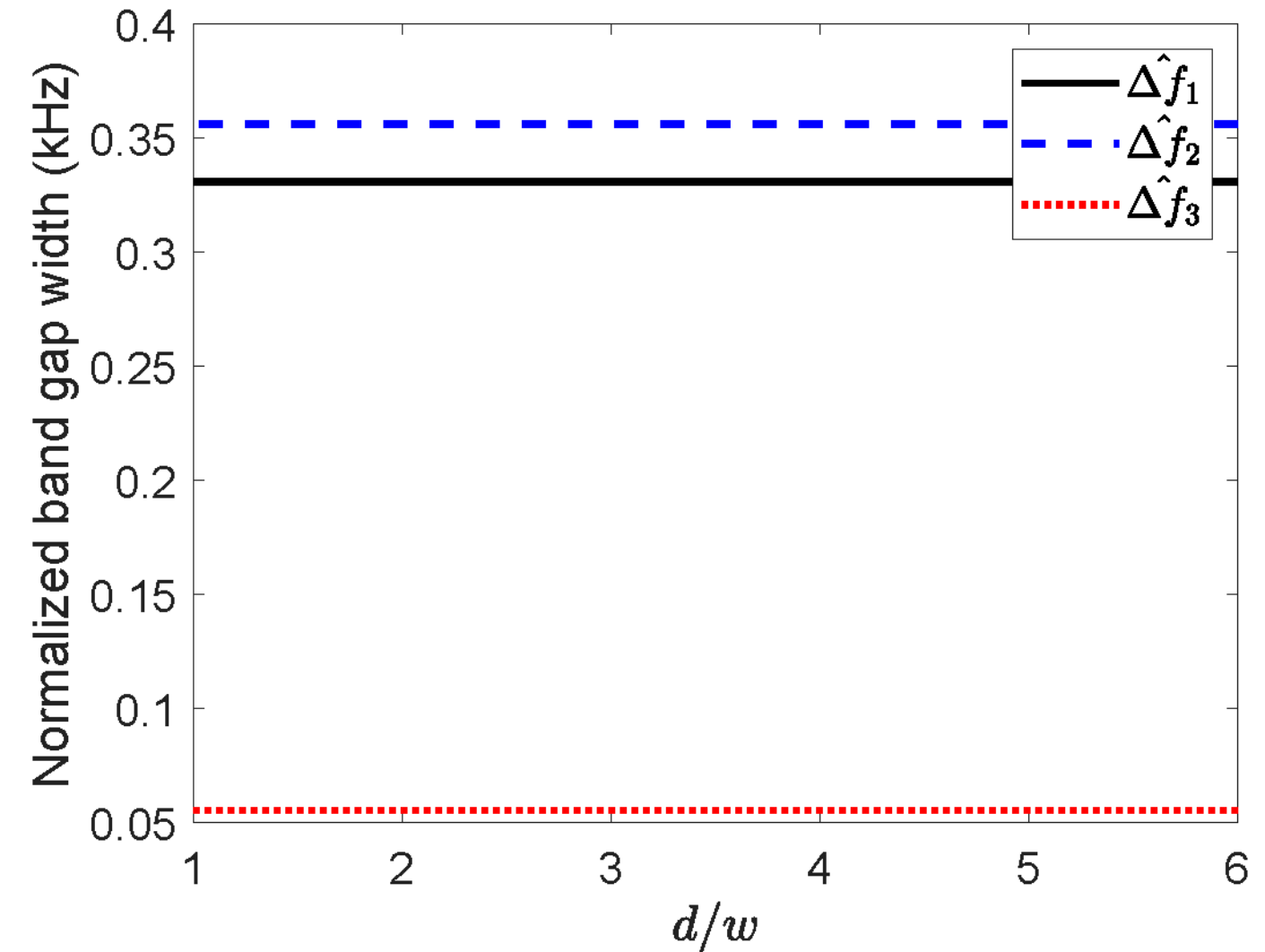
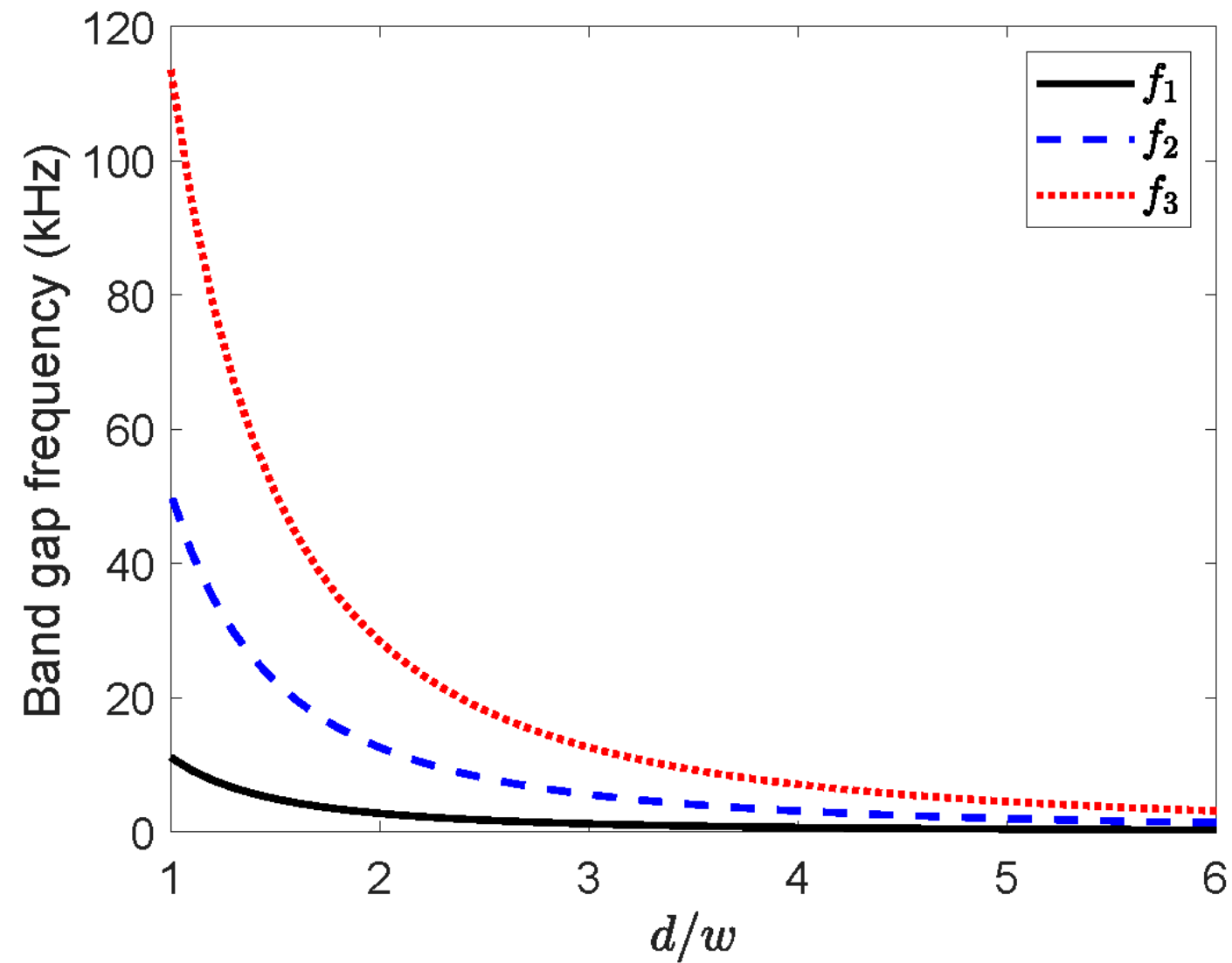
Schematic representation of the beam with periodic material removal.

Numerical results for infinite periodic beams



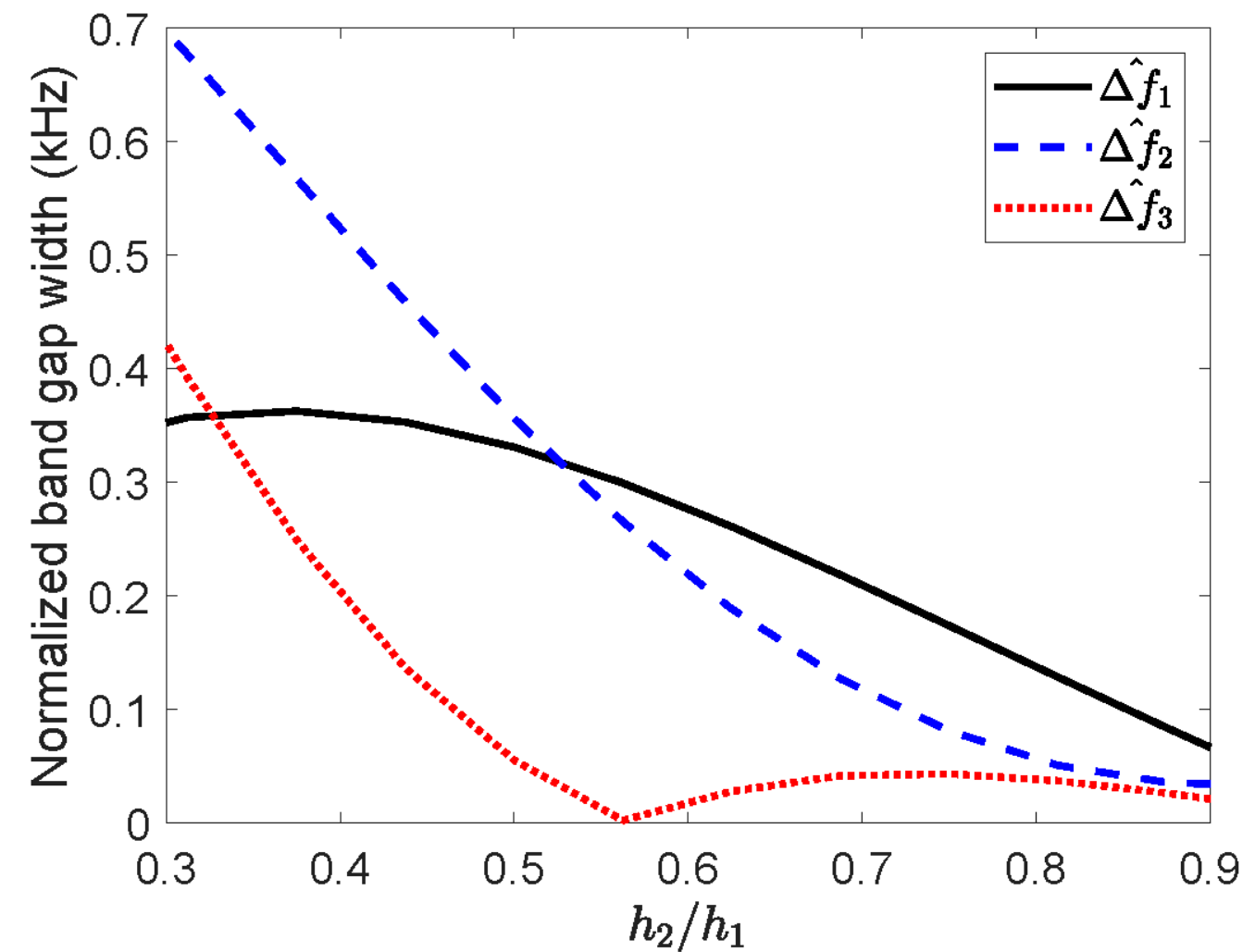
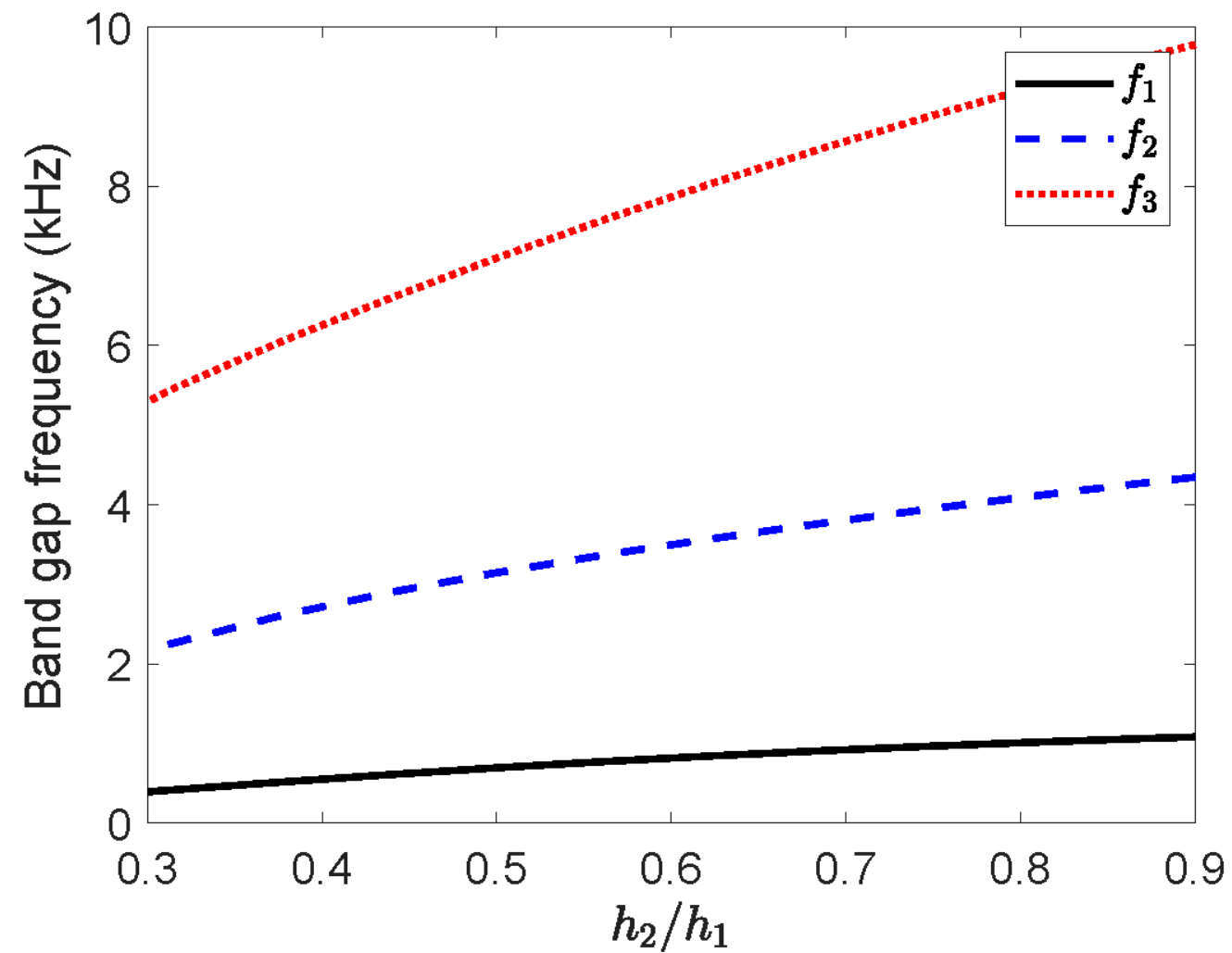
Band diagram obtained for a uniform beam (a) and for a beam with periodic material removal (b).

Numerical results for infinite periodic beams



Central band gap frequency and normalized band gap width as a function of w/d , h_2/h_1 is equal to 0.5.

Numerical results for infinite periodic beams



Central band gap frequency and normalized band gap width as a function of h_2/h_1 , w/d is equal to 4.

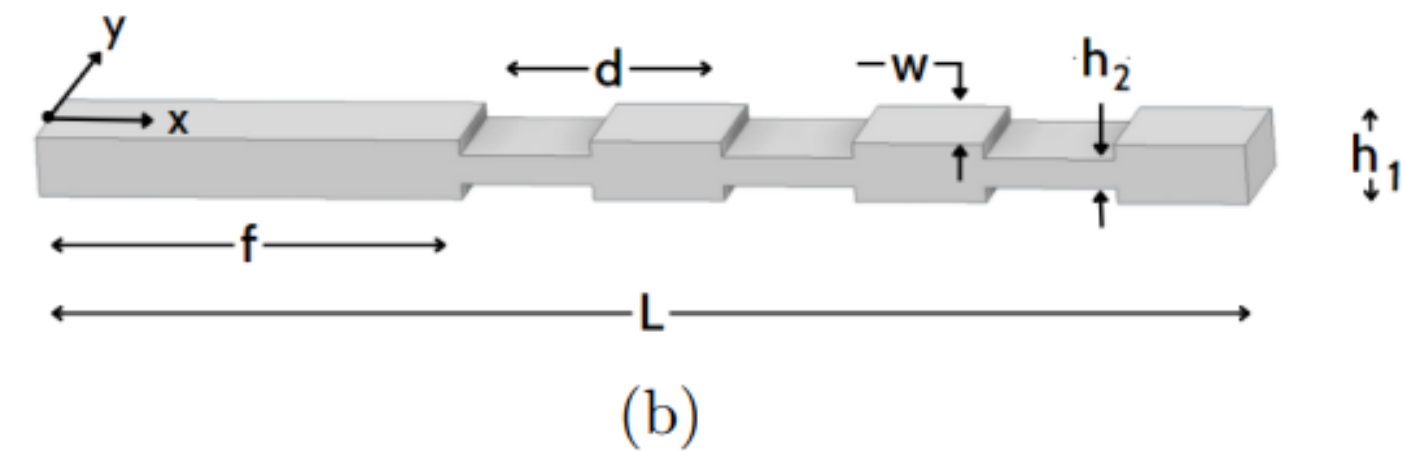
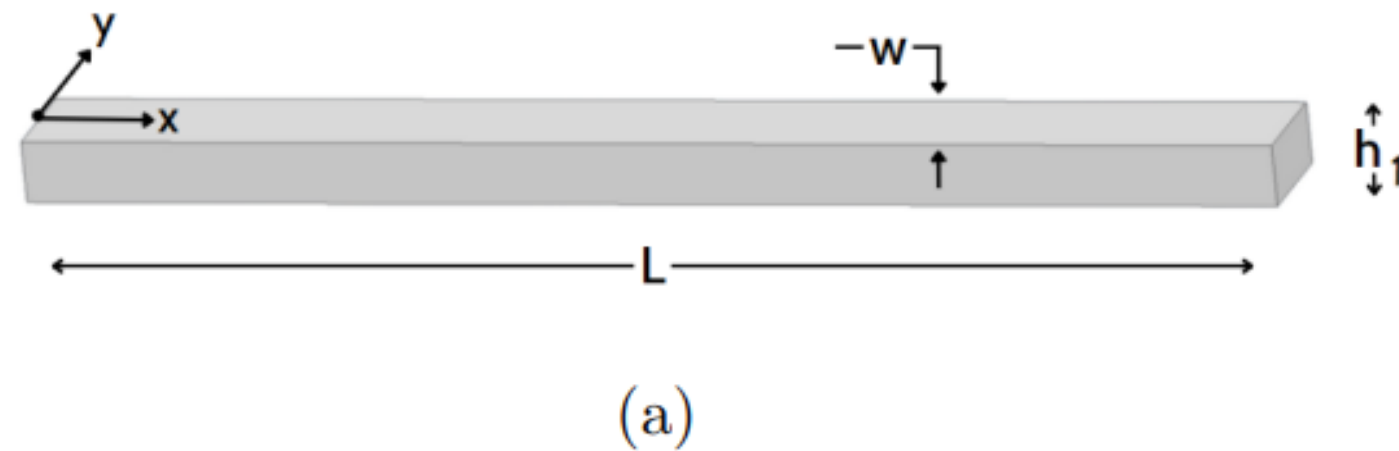
Cantilever beam

Dimensions:

- L : 250 mm
- w : 20 mm
- h_1 : 3.2 mm
- h_2 : 25%, 50% y 75% de h_1
- f : 72 mm
- N° cells: 1- 10

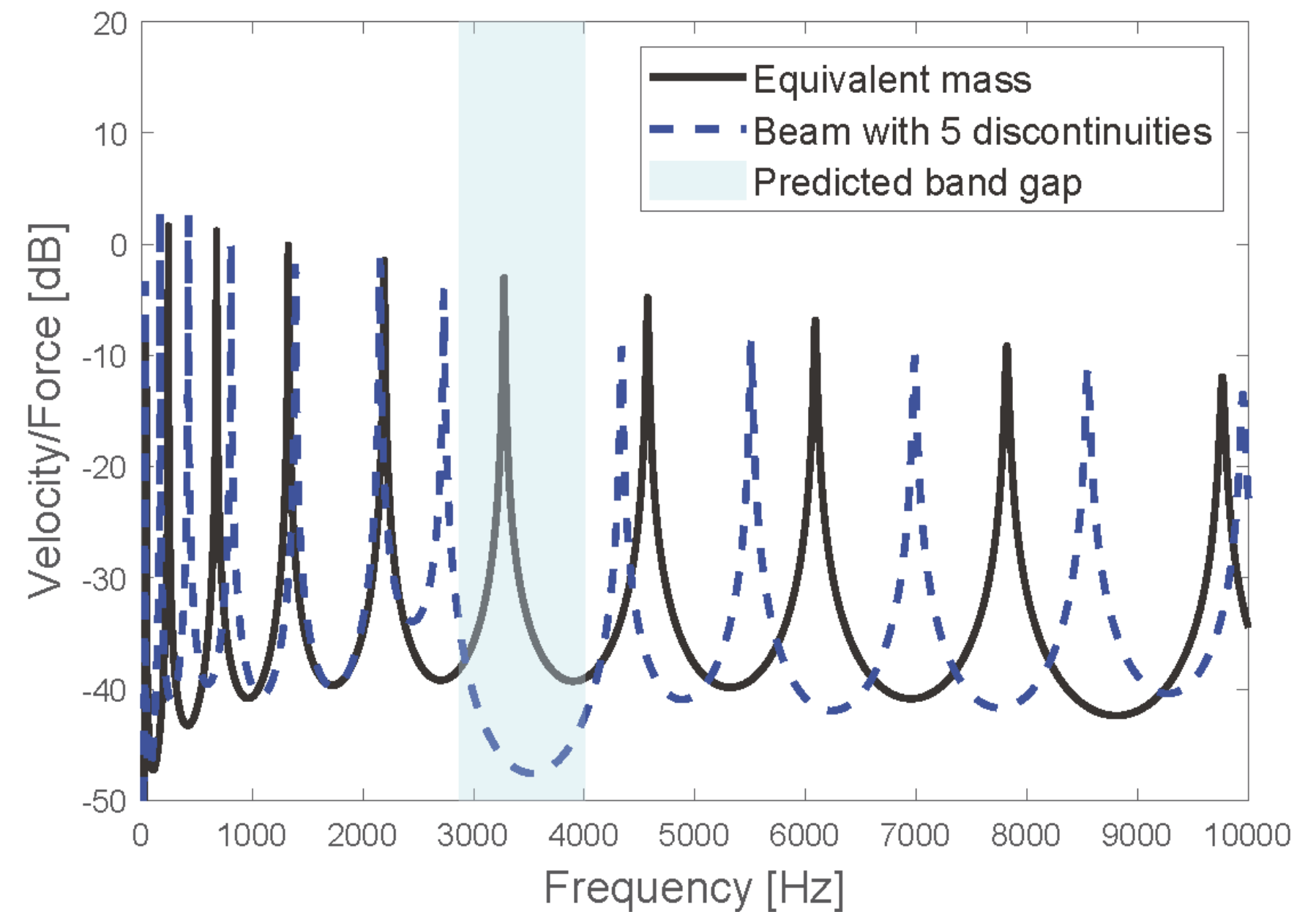
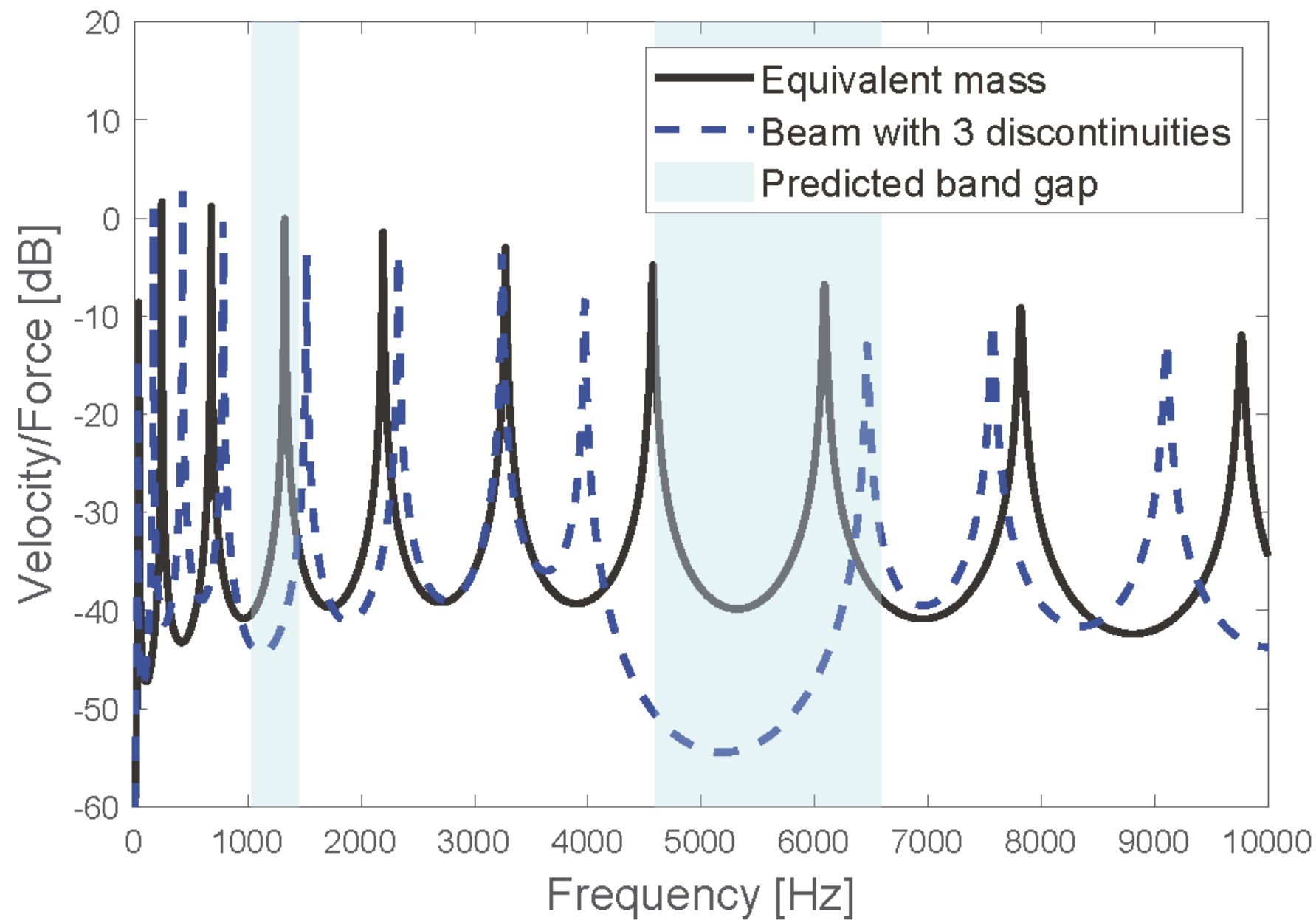
Boundary Condition:

- FREE- FIXED BEAM



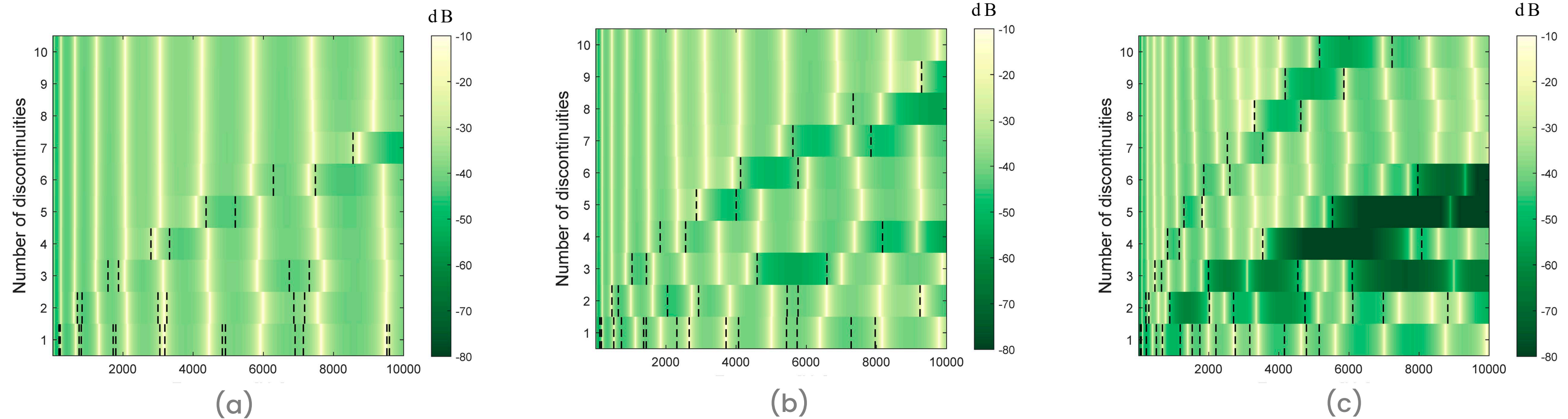
A uniform beam model. (b) A beam model with three discontinuities. The clamped zone is at the left end, while the right end is free.

Results



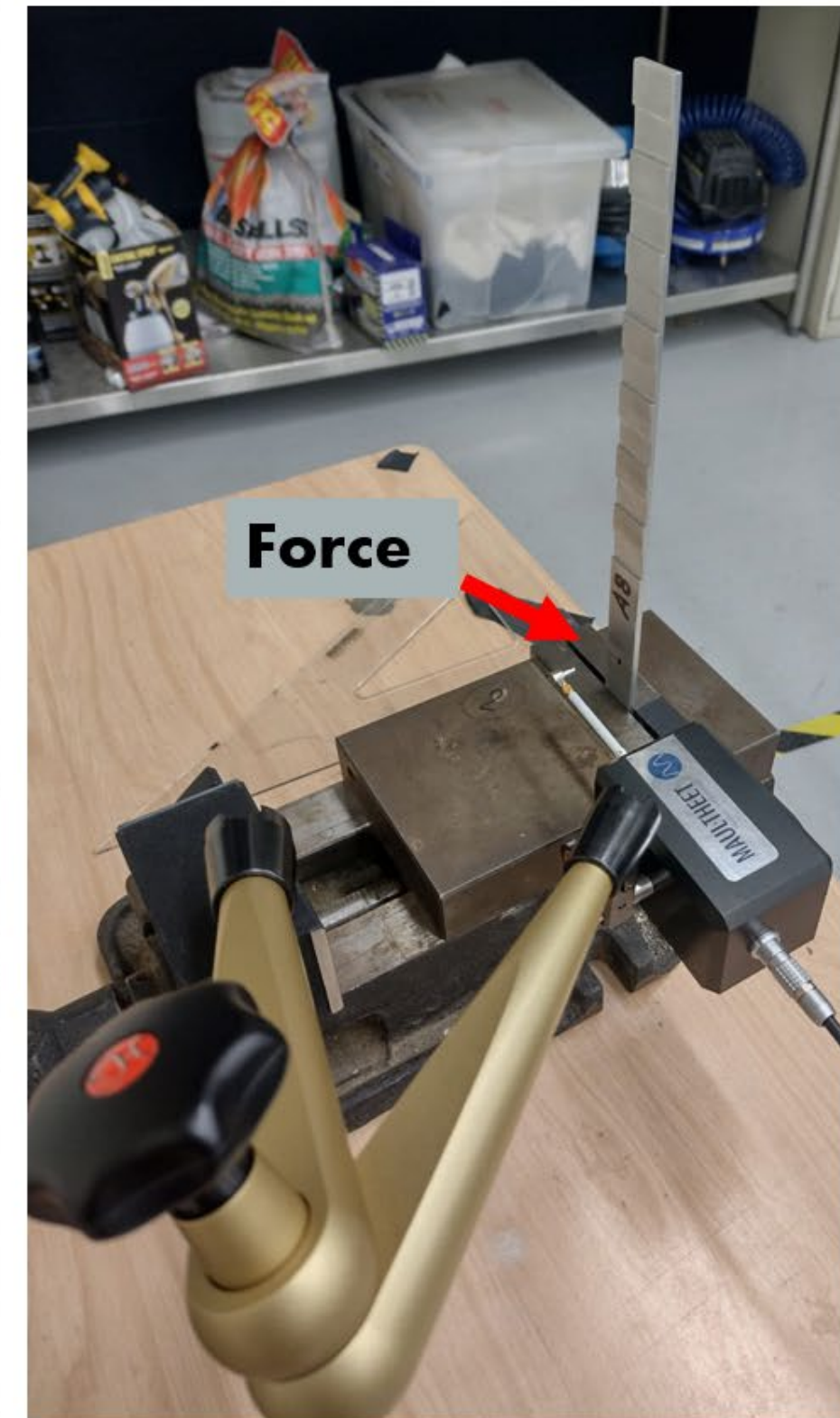
FRFs at the free end of a beam with three and five structural discontinuities.

Numerical results for the cantilever beams



FRFs (dB re 1 m/s/N) of aluminum beams as a function of the numbers of discontinuities and frequency for (a) 25% thickness removal, (b) 50% thickness removal, and (c) 75% thickness removal.

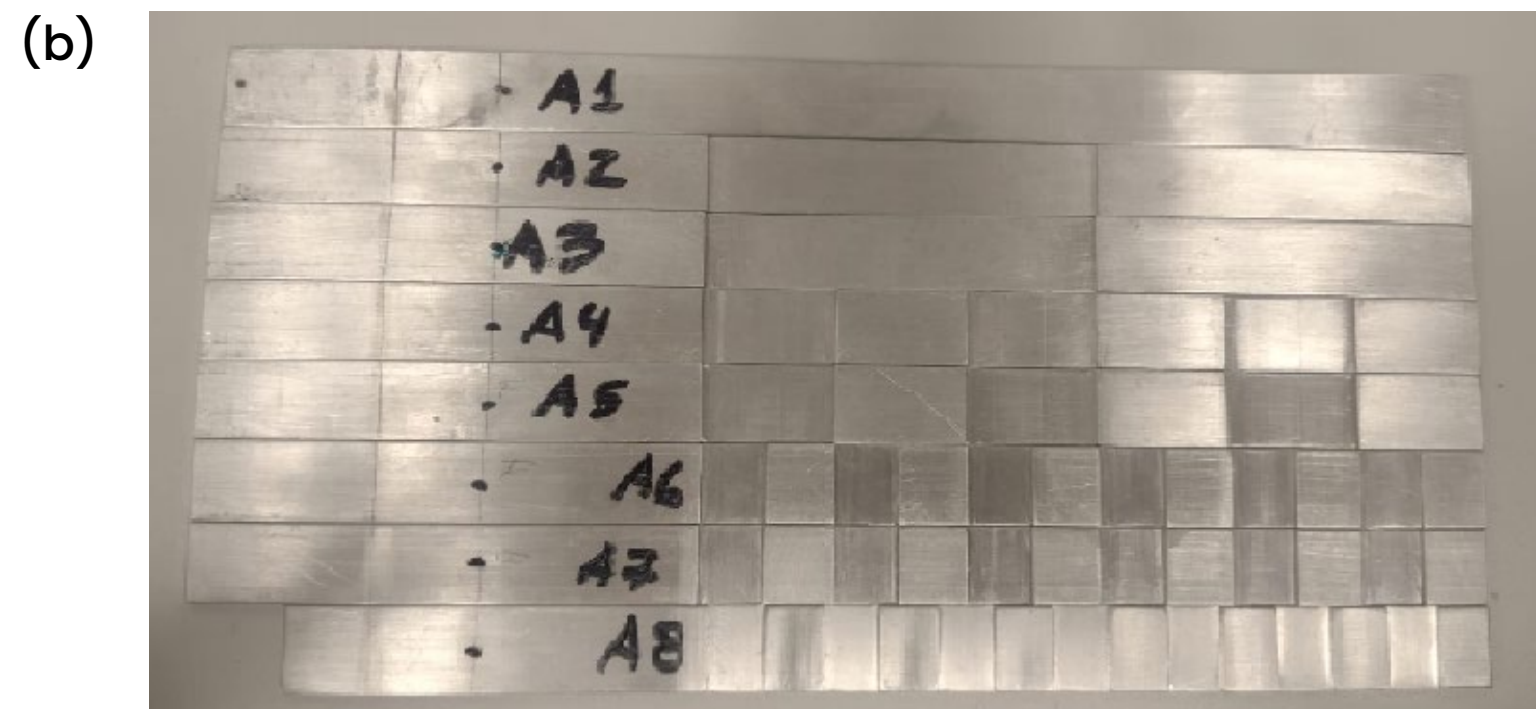
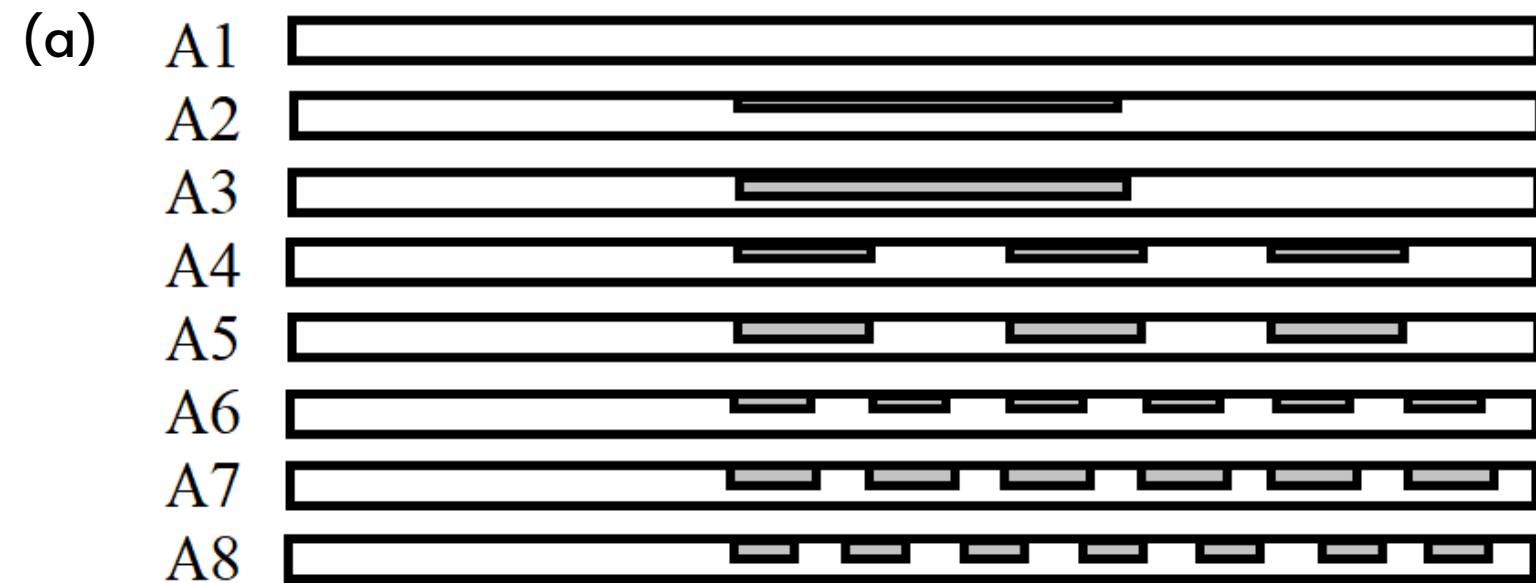
Experimental setup



Experimental Setup.

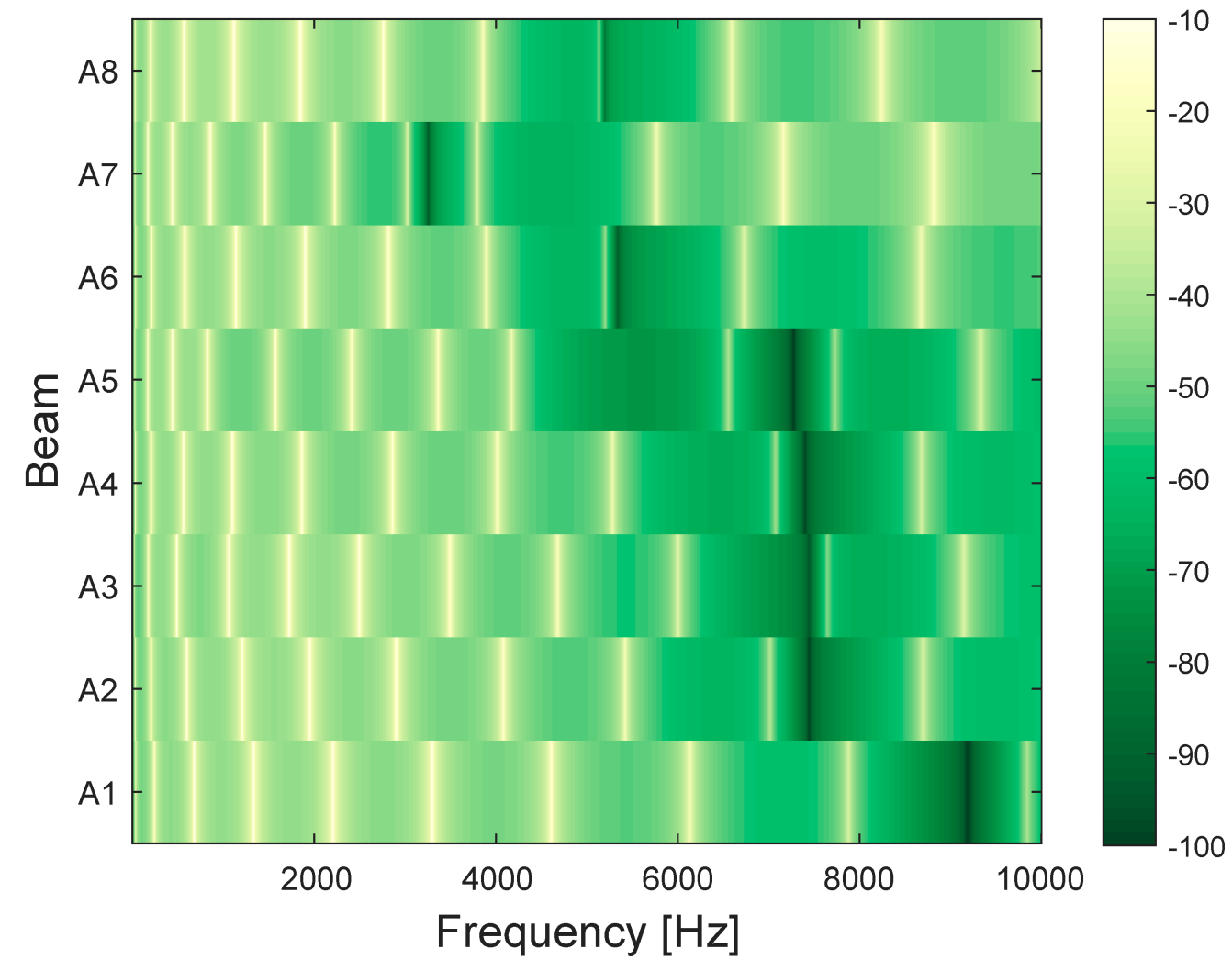
Aluminum Beams

- Number of discontinuities: 0, 1, 3, 6, 7
- Removal: 0%, 25%, 50% y 60%
- Length: 251 mm
- Width: 19- 20 mm
- Thickness h1: 3.2 mm
- Nodes: 251- 252

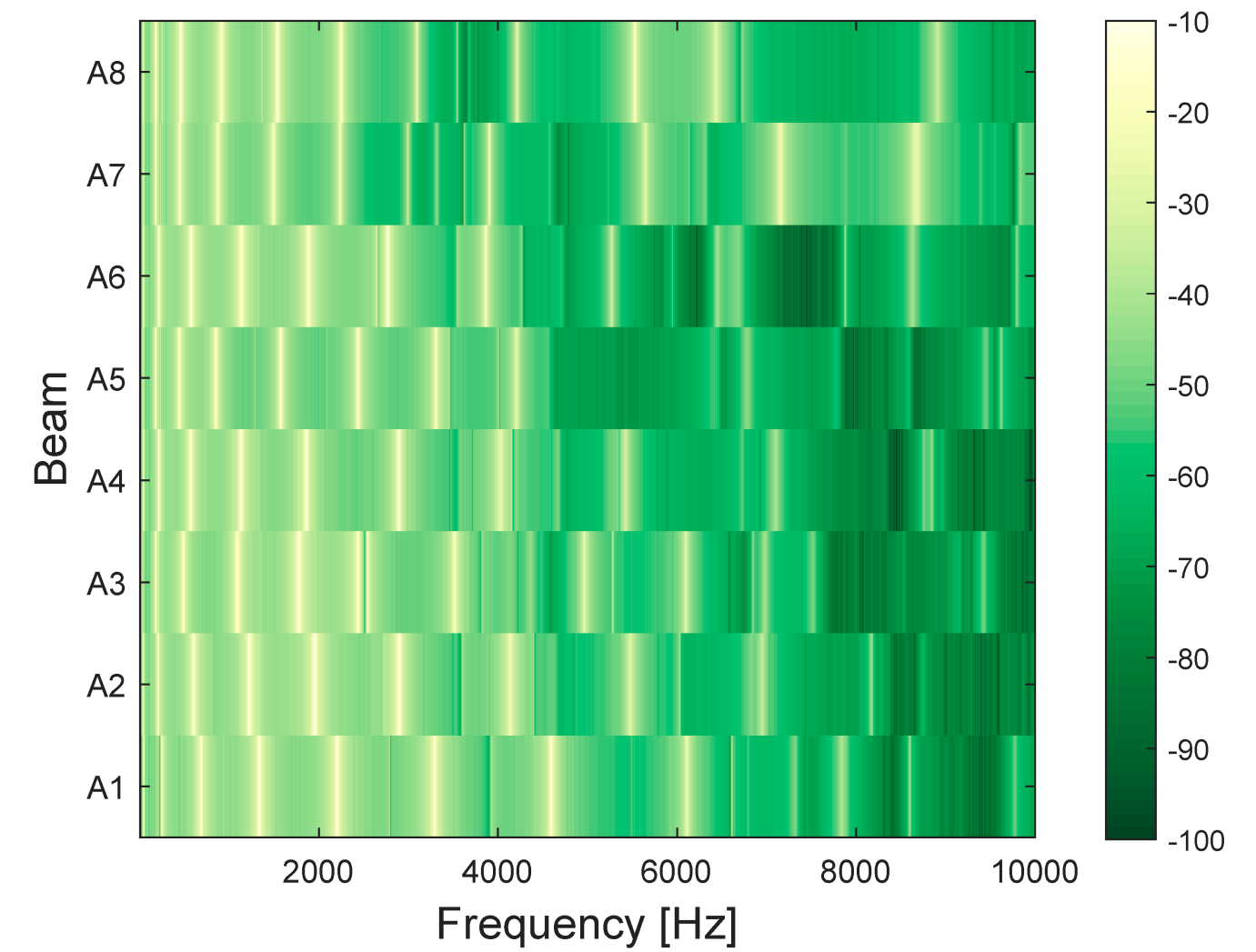


Manufactured aluminum beams:
a) schematic representation, b)
pictures.

Nu m e r i c a l

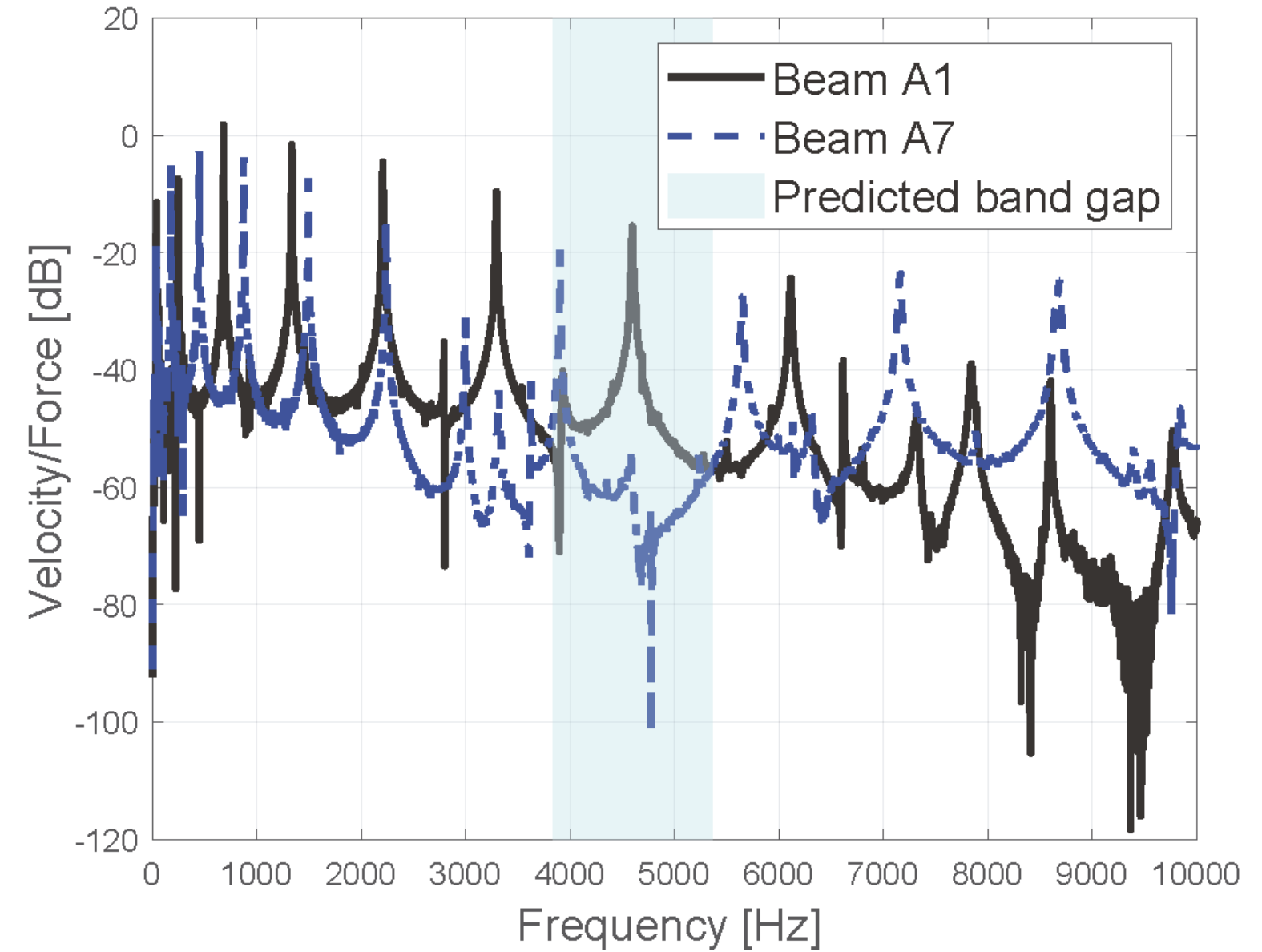
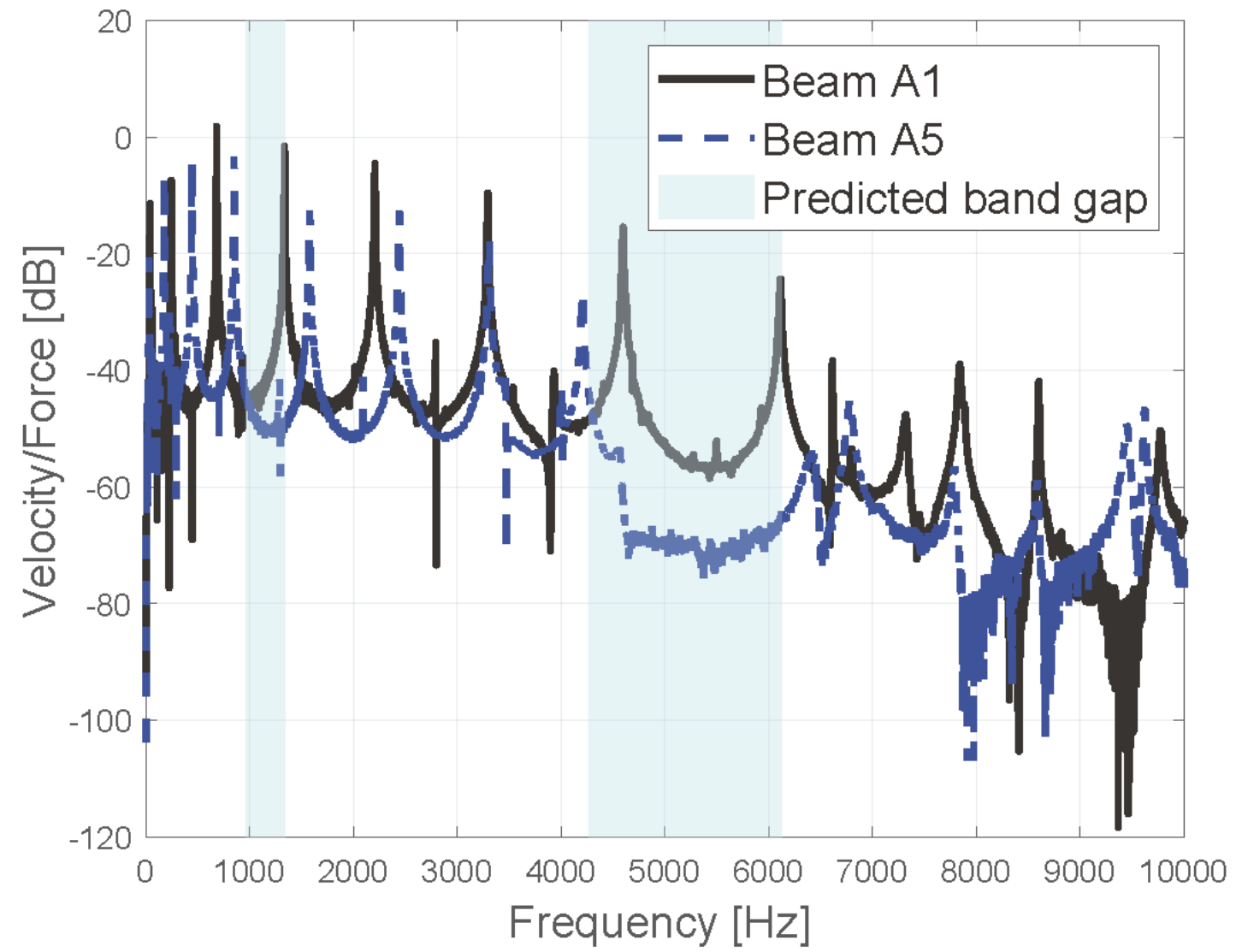


M e a s u r e d



Average FRFs (dB) of the cantilever beams under investigation.

Results



Conclusions



- This study introduces a simplified approach to generating band gaps via periodic material removal .
- Cell periodicity and thickness contrast are crucial in determining the properties of the band gaps .
- It successfully validates the theory of band gaps in finite beams and demonstrates their practical realization through variations in discontinuities and material thickness .