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Optimization of 3D Phononic Band Gap Lattice Structures

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In [1] we presented a feature mapping approach, combining techniques of parametric shape optimization and density based topology optimization for two dimensions. Horizontal and vertical stripes are mapped in an differentiable way to a regular pseudo density field. Solid and void are modelled by the pseudo density field without the need for remeshing during the optimization. The position and thickness of the structures are finely parametrized and strictly controllable within the optimization problem.

Phononic Band gap structures suppress transmission of elastic waves for a maximized wide frequency range. The first optimization of periodic base cells which exhibit these properties by topology optimization has been achieved in [3] by distribution strong material within a matrix of softer material. In [2] we extended the approach of Sigmund and Jensen to design lattice structures showing a wide phononic band-gap without requiring the soft matrix material to support the structure. The structure has then been transformed manually to a 3D model and printed by additive manufacturing. The strong band gap behaviour has been verified by physical experiments.

In this work he have extended our feature mapping approach to three dimension. Horizontal, vertical and lateral structures are finely parametrized for location in space and thickness. Optimization results for phononic band gaps, suppressing waves of fixed and arbitrary directions, are presented.

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