Numerical modeling of the band structure of tensegrity metamaterials

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Abstract

The research field of linear and weakly nonlinear wave dynamics of acoustic metamaterials is devoting considerable attention to so-called "*phononic band gap*" theory (refer, e.g., to [1-3] and references therein). It is well known that composite materials with periodic variations of the density and/or wave velocity can display band gaps where the propagation of mechanical waves is forbidden [4].

The present work aims to reveal band gaps in tensegrity-based metamaterials and to exploit the possibility of their tuning for the design and test of novel bandgap devices. Attention is focused on the optimal design of 1-D chains of tensegrity units and lumped masses, which are tunable by varying the unit's parameters and initial static precompression of the constituent units (internal self-stress) and the whole structure (external prestress).

The bandgap response of such metamaterials is investigated through analytic and numerical studies. By suitably designing the topological arrangements of soft and hard tensegrity units, the given results highlight that the analysed systems can be effectively employed as novel wave steering devices, sound proof layers and/or vibration isolation devices [5-6].

Keywords: **Tensegrity, prestress, frequency bandgaps.**

References

[1] Lu, M. H., Feng, L. and Chen, Y. F., (2009) Phononic crystals and acoustic metamaterials, Materials Today, **12**, 34-42.
[2] Theocharis, G., Boechler, N., and Daraio, C., (2013) Nonlinear phononic structures and metamaterials, in P.A. Deymier (ed.) Acoustic Matematerials and Phononic Crystals, Springer Series in Solid State Sciences, 173.
[3] Kushwaha, M. S., et al (1993) Acoustic band Structure of Periodic Elastic Composites, Physical Review Letters, **71**(3), 2022-5.
[4] Martinez-Sala, R., et al. (1995). Sound attenuation by sculpture, Nature **378**, 241.
[5] Fraternali, F. and Amendola, A., (2017) Mechanical modeling of innovative metamaterials alternating pentamode lattices and confinement plates, Journal of the Mechanics and Physics of Solids **99**, 259-271.
[6] Amendola, A., Benzoni, G. and Fraternali, F., (2017) "Non-linear elastic response of layered structures, alternating pentamode lattices and confinement plates", Composites Part B: Engineering, **115**, 117-123.