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An Innovative Seismic Isolation Strategy Based on Hier-archical Large-Scale Metamaterials

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The design of buildings and structures capable of withstanding large scale vibrations has been the focus of researchers for many decades. This is particularly important for strategic facilities such as hospitals, skyscrapers, long span bridges, etc. Among all the possible sources of vibrations, earthquakes are the most devastating. Seismic waves are superposition of inhomogeneous acoustic waves with various wavelengths, comprising longitudinal and shear bulk waves, and surface acoustic waves (SAWs), including Rayleigh and Love waves. SAWs are the most destructive because of their low frequencies, low attenuation, and large amplitude. In fact, SAWs travel and decay slower than BWs, resulting in the main cause for partial or even total collapse of buildings and structures [1].

Although a variety of isolation systems (passive, active, hybrid and semi-active) have been developed and shown to be effective in tests, some problems still exist with these systems and a commonly accepted method for the design of seismic-resistant buildings and structures has not been developed up to now. To overcome such limitations, several approaches based on phononic crystals and metamaterials have been proposed [2-4].

Here, we numerically investigate via Finite Element Analysis the feasibility of an innovative passive isolation strategy for seismic waves based on large-scale hierarchical metamaterials (LSHM). The band structures of LSHM operating in the seismic frequency range are reported. A comparative study on the band structures of fractal seismic metamaterials with different levels shows that hierarchy allows to lower the frequency of the band gaps.The vibration modes at the bandgap edges are computed and analyzed to clarify the mechanism of widening BG nucleation. Results prove the strategy to be practical for civil structures, demonstrating considerable attenuation of surface acoustic waves.

References

[1] R. Villaverde, Fundamental Concepts of Earthquake Engineering, Taylor & Francis Group (2009).
[2] S. Brûlé, E. H. Javelaud, S. Enoch and S. Guenneau, Phys. Rev. Lett. 112,133901 (2014).
[3] A. Colombi, D. Colquitt, P. Roux, S. Guenneau and R. V. Craster. Scient. Rep. 6, 27717 (2016).
[4] M. Miniaci, A. Krushynska, F. Bosia and N.M. Pugno, Large scale mechanical metamaterials as seismic shields, New J. Phys. 18, 083041 (2016).