Some examples of existing seismic metamaterials

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Abstract

A paradigm shift has occurred in the past five years on seismic wave control with large scale metamaterials with potential applications in seismic protection of urban infrastructures.

The concept is based on the idea that the urban soils are so modified by all types of buried structures that it becomes realistic to reconsider them as a composite and structured medium with specific mechanical properties.

The seismic metamaterials represent an additional and unconventional solution for the seismic protection of the lifelines, aiming to maintain the operability and the functionality in stage immediately after a strong earthquake.

We present some novel methods and approaches to reduce the seismic wave effects on urban infrastructure, by applying the metamaterials properties, which are based on the negative values of the Bulk Moduli K and G; the Young Modulus E, of longitudinal elasticity, as well as on the negative mass density. The negative values for the mass density are obtained with the help of the local resonance of the elementary cells that lead to very dispersive properties of the metamaterials.

Another way of getting such exotic phenomena are by using the auxetic metamaterials, characterized by negative value of the Poisson coefficient.

Furthermore, the concept of Metacity, based on the quasi-conformal transformations in the elasticity equation is also a new solution for seismic protection of a dense urban fabric. Also, a promising method for seismic protection is the creation of an artificial anisotropy by including, within the soil, some elements of different geometries, which are either full or empty. We might also consider lakes and underground water tanks or lifelines.