The mathematics of seismic metasurfaces

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Abstract

Although initially developed for optics, the field of metamaterial research has expanded rapidly and now includes the development of novel materials for applications in acoustics and elasticity. Metamaterials, as synthetic composite materials with a structure such that they exhibit properties not usually found in natural materials, now form a highly activing research area across all the physical sciences.

Recently, the applicability of metamaterials to seismology has sparked the interest of geophysicists in the development of novel methods to control surface waves. Given the interest in this emerging area, there is a need to study the properties of the solutions to fundamental canonical problems. We will present some recent results for two relevant problems and develop the theoretical framework for these seismic metamaterials. We will initially consider a periodic array of resonators on an elastic plate providing explicit expressions for the dispersion equation and solutions. This then motivates the more complicated problem of periodic arrays of resonators on elastic half-spaces.

We will analyse the dispersive properties of these structures and present explicit solutions in the metamaterial regime. We will also examine the transmission problem for surface waves and present a novel method for the control of surface waves on elastic solids.