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Numerical Study on One-Dimensional Aperiodic Foundations for Seismic Isolation of Structures

Sanjay Kumawat[1], Sumiran Pujari[2], Manish Kumar[3], Arghadeep Laskar[4]

[1]Ph.D. student, Department of Civil Engineering, IIT Bombay
[2]Assistant Professor, Department of Physics, IIT Bombay
[3]Assistant Professor, Department of Civil Engineering, IIT Bombay
[4]Associate Professor, Department of Civil Engineering, IIT Bombay

Abstract

The concept of frequency band gaps in the wave propagation physics of crystalline solids has suggested the possibility of attenuating and filtering seismic waves with the provision of a periodic foundation. One-dimensional periodic foundations are basically an ordered arrangement of material layers of constant thickness repeated in a particular sequence. The periodicity of these foundations prevents the destructive seismic waves from reaching the superstructure. Despite numerous benefits of these foundations over conventional earthquake-resistant design techniques, past research has highlighted the limitation with the starting frequency and range of frequency band gaps over which these can be effective for seismic applications. The periodic foundation intended for seismic application needs to have a low starting frequency and wide frequency bandgap (typically between 0 Hz and -20 Hz). However, it has been observed the reduction in the starting frequency is accompanied by a reduction in the bandgap as well. This paper proposes the idea of using an aperiodic, instead of the periodic, arrangement of material layers in such foundations that can result in wider attenuation frequency ranges including a better lower starting frequency closest to earthquake ground motion. The aperiodicity refers to the irregularity induced due to the varying thicknesses of alternate rigid and softer layers arranged in the foundation. The idea is to take advantage of Anderson's theory of localization in disordered systems. A detailed comparative study has been carried out on periodic and aperiodic foundations and the possibility of reliable outcomes for the application in seismic isolation has been discussed.

Keywords: Aperiodic foundations, Anderson's theory, Phononic crystals