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Energy Content & Spectral Energy Representation of Wave Propagation in a Granular Chain

Rohit Shrivastava (1) and Stefan Luding (2)

(1) Univeristy Of Twente, MESA+, CTW, Enschede, Netherlands (r.k.shrivastava@utwente.nl), (2) Univeristy Of Twente, MESA+, CTW, Enschede, Netherlands (s.luding@utwente.nl)

Abstract

A mechanical wave is propagation of vibration with transfer of energy and momentum. Studying the energy as well as spectral energy characteristics of a propagating wave through disordered granular media can assist in understanding the overall properties of wave propagation through materials like soil. The study of these properties is aimed at modeling wave propagation for oil, mineral or gas exploration (seismic prospecting) or non-destructive testing for the study of internal structure of solids. Wave propagation through granular materials is often accompanied by energy attenuation which is quantified by Quality factor and this parameter has often been used to characterize material properties, hence, determining the Quality factor (energy attenuation parameter) can also help in determining the properties of the material [3], studied experimentally in [2]. The study of Energy content (Kinetic, Potential and Total Energy) of a pulse propagating through an idealized one-dimensional discrete particle system like a mass disordered granular chain can assist in understanding the energy attenuation due to disorder as a function of propagation distance. The spectral analysis of the energy signal can assist in understanding dispersion as well as attenuation due to scattering in different frequencies (scattering attenuation). The selection of one-dimensional granular chain also helps in studying only the P-wave attributes of the wave and removing the influence of shear or rotational waves. Granular chains with different mass distributions have been studied, by randomly selecting masses from normal, binary and uniform distributions and the standard deviation of the distribution is considered as the disorder parameter, higher standard deviation means higher disorder and lower standard deviation means lower disorder [1]. For obtaining macroscopic/continuum properties, ensemble averaging has been invoked. Instead of analyzing deformation-, velocity- or stress-signals, interpreting information from a Total Energy signal turned out to be much easier in comparison to displacement, velocity or acceleration signals of the wave, hence, indicating a better analysis method for wave propagation through granular materials. Increasing disorder decreases the Energy of higher frequency signals transmitted, but at the same time the energy of spatially localized high frequencies increases.

References

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