Geophysical Research Abstracts
Vol. 20, EGU2018-7793, 2018
EGU General Assembly 2018

Attenuation of Rayleigh-like waves in Granular Media via Resonant Metabarriers

Rachele Zaccherini (1), Antonio Palermo (2,4), Vasilis K. Dertimanis (1), Sebastian Krödel (3), Alessandro Marzani (2), Chiara Daraio (4), and Eleni N. Chatzi (1)

(1) Department of Civil, Environmental and Geomatic Engineering, ETH Zürich, Zürich, Switzerland (zaccherini@ibk.baug.ethz.ch, v.derti@ibk.baug.ethz.ch, chatzi@ibk.baug.ethz.ch), (2) Department of Civil, Chemical, Environmental and Materials Engineering - DICAM, University of Bologna, Bologna, Italy (antonio.palermo6@unibo.it, alessandro.marzani@unibo.it), (3) Department of Mechanical and Process Engineering, ETH Zürich, Zürich, Switzerland (skroedel@ethz.ch), (4) California Institute of Technology, Division of Engineering and Applied Science, Pasadena, CA (daraio@caltech.edu)

The advent of metamaterials, artificial composite structures engineered with unusual features not found in nature, has encouraged the development of numerous applications for the control of wave propagation in different fields, from electromagnetics to acoustics, and more recently up to the seismic protection domain. Especially after the development of seismic monitoring technologies of the last decades, which allowed for a thorough recording of earthquakes worldwide, the scientific community started to investigate the possibility of exploiting the exotic properties of metamaterials to influence the propagation of dangerous seismic waves, thus proposing novel ways for shielding civil infrastructures from seismic vibrations [1]. Recently, experimental studies have revealed how a barrier of surface resonators, the so-called metabarrier, can affect the propagation of seismic Rayleigh waves in homogeneous media, redirecting their path into the bulk thus attenuating seismic energy at the surface [2, 3]. Homogeneous media, however, exhibit properties that are rather different to those of natural soils. Unconsolidated granular materials with a power-law elastic profile, which originates from their gravitational compaction, allow accounting for some features typical of natural soils. Our previous experimental studies revealed how surface resonators embedded in a granular medium to form a metabarrier, do not lead to a complete Rayleigh wave delocalization due to the gravity-induced stiffness gradient [4]. Nevertheless, a precise quantification of surface wave energy attenuated by the insertion of surface resonators remains unchartered.

In this work, we investigate the efficacy of such engineered structures in attenuating seismically induced ground motion. Our study shows how the mismatch between surface resonators and the pure soil, together with the hybridization mechanism caused by local resonances, lead to the halving of particle displacements at the surface. We highlight that the obtained results do not rely on the nature of the used granular material and can thus be extended to any medium featuring a power-law-like elastic profile, as for instance stratified soils at the seismic surface waves scale [5].

References

[1] G. Finocchio, O. Casablanca, G. Ricciardi, U. Alibrandi, F. Garescı, M. Chiappini, and B. Azzerboni, Appl. Phys. Lett. 104, 191903 (2014).
[2] A. Palermo, S. Krödel, A. Marzani, and C. Daraio, Sci. Rep. 6, 39356 (2016).
[3] A. Colombi, D. Colquitt, P. Roux, S. Guenneau, and R. V. Craster, Sci. Rep. 6, 27717 (2016).
[4] A. Palermo, S. Krödel, K. H. Matlack, R. Zaccherini, V. K. Dertimanis, E. N. Chatzi, A. Marzani, and C. Daraio, submitted to Phys. Rev. Appl.
[5] L. Y. Faust, Geophysics 16, 192 (1951).