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Evaluation of soil-structure interaction by combining deconvolution of building and field earthquake recordings with polarization analysis: application to the Matera experiment (Italy)

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The study of soil-structure or even city-soil interaction is attracting the attention of many researchers, as both numerical simulation results and preliminary results from empirical data indicate their significant effect in determining the level of seismic hazard.

In this study, the wave field radiated from a building to its surroundings, which is due to the interaction of the building with the ground, is identified and extracted using a novel approach. The proposed approach, which is valid for seismic data analysis, combines deconvolution and polarization analysis. It consists of four steps: (1) estimation of building resonance frequencies, (2) deconvolution of seismic recordings of sensors installed in a building and in the surrounding environment, (3) identification of seismic phases, reconstruction of seismic phases, reconstruction of the signal transmitted from the building to the surrounding environment and estimation of its energy, and (4) polarization analysis.

The application of the approach to recordings of an M4.6 earthquake collected by sensors installed in a building and on a nearby athletic field in Matera, Italy, showed that the particle motion of the wave field radiated from the building to the ground was mostly linearly polarized in the radial and transverse planes, while a clear elliptical polarization was observed only in the horizontal plane.

The analysis showed that the wave field radiated from the building and recorded on the ground could be dominated by unconventionally polarized surface waves, i.e. quasi-Rayleigh waves or a combination of quasi-Rayleigh and quasi-Love waves. The results indicated that the energy transmitted from the analyzed vibrating building to the surrounding environment was significant and decreased ground shaking due to the out-of-phase motion between the incoming seismic wave field and that radiated from the building.