Multiple scattering of waves in random media: Application to the study of the city-site effect

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Long-duration amplifications and spatial response's variability of the seismic records registered during recent earthquakes, like in Mexico City during the September 1985 earthquake, cannot only be explained by the soil velocity model. We propose a means to explain these phenomena by studying the extent of the effect of buildings' diffracted wave fields during an earthquake on the response of a site. The main question is whether the presence of a large number of buildings can significantly modify the seismic wave field. We are interested in the interaction between the incident wave field propagating in a stratified half-space and a large number of structures at the free surface, i.e. **the coupled city-site effect**.

The originality of this work is the study and the characterization of seismic wave propagation regimes in a city using the theory of wave propagation in random media. In the coupled city-site system, the buildings are modeled as resonant scatterers uniformly distributed at the surface of a deterministic, horizontally layered elastic half-space representing the soil. Based on the mean-field and the field correlation equations, we build a theoretical model which takes into account the multiple scattering of seismic waves and allows us to describe the coupled city-site system behavior in a simple and rapid way. The results obtained for the configurationally averaged field quantities are validated by means of 3D results for the seismic response of a deterministic model. The numerical simulations of this model are computed with MISS3D code based on classical Soil-Structure Interaction techniques and on a variational coupling between Boundary Integral Equations for a layered soil and a modal Finite Element approach for the buildings.

This work proposes both a detailed numerical and a theoretical analysis of the city-site interaction. The principal parameters in the study of the city-site interaction are the building resonant frequency distribution, the soil characteristics of the site, the urban density and position of the buildings in the city, as well as the type of incident wave. The main results of the theoretical and numerical models allow us to characterize seismic movement in urban areas (maxima displacement inside the city, scattered

wavefield outside the city, city-site transfer function, etc.).