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# Simulation of High-Frequency Rotational Motion in a Two-Dimensional Laterally Heterogeneous Half-Space

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The seismic waves responsible for vibrating civil engineering structures undergo interference, focusing, scattering, and diffraction by the inhomogeneous medium encountered along the source-to-site propagation path. The subsurface heterogeneities at a site can particularly alter the local seismic wave field and amplify the ground rotations, thereby increasing the seismic hazard. The conventional techniques to carry out full wave field simulations (such as finite-difference or spectral finite element methods) at high frequencies (e.g., 15 Hz) are computationally expensive, particularly when the size of the heterogeneities is small (e.g., <100 m). This study proposes an alternative technique that is based on the first-order perturbation theory for wave propagation. In this technique, the total wave field due to a particular source is obtained as a superposition of the 'mean' and 'scattered' wave fields. Whereas the 'mean' wave field is the response of the background (i.e., heterogeneity-free) medium due to the given source, the 'scattered' wave is the response of the background medium excited by fictitious body forces. For a two-dimensional laterally heterogeneous elastic medium, these body forces can be conveniently evaluated as a function of the material properties of the heterogeneities and the mean wave field. Since the problem of simulating high-frequency rotations in a laterally heterogeneous medium reduces to that of calculating rotations in the background medium subjected to the (1) given seismic source and (2) body forces that mathematically replace the small-scale heterogeneities, the original problem can be easily solved in a computationally accurate and efficient manner by using the classical (analytical) wavenumber-integration method. The workflow is illustrated for the case of a laterally heterogenous layer embedded in a homogeneous half-space excited by plane body-waves.