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Spatial Variability of Ground Motion Amplification From Low-Velocity Sediments Including Fractal Inhomogeneities with special reference to the Southern California Basins

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The shaking from an earthquake can be dramatically amplified by local site effects, with prominent examples from the 1989 Loma Prieta earthquake in the Marina District of San Francisco and the 1985 Michoacan earthquake in Mexico City. The variation of the soil amplification over short distances (from tens to hundreds of meters) is important for the design of lifelines such as bridges and pipelines, as these structures extend over considerable length parallel to the ground. State-of-the-art area-specific velocity models (such as the Southern California Earthquake Center (SCEC) Community Velocity Model (CVM) V.4.0) insufficiently resolve such small-scale amplification effects.

Toward characterizing the variability of shallow sediment amplification, we have investigated the effects of inhomogeneities with fractal distributions augmented onto the shallow seismic velocity structure derived from the velocity model SCEC CVM V.4.0. Our analysis used SH-wave sources and linear 0-2 Hz 3D visco-elastic finite-difference wave propagation with grid spacings of 25 m or less.

We find that even simple and rather weak fractal stochastic inhomogenities imply significant variations in ground motion amplifications (up to a factor of four), including bands of strong amplification aligned along the average ray path from the source.

We show that these patterns depend strongly on the incidence angle of the main wavefront.

If validated by seismic strong-motion data, our results may motivate efforts to include such variation in area-specific velocity models.