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Simulation of Spatially Varying Ground Motions at Site with Stochastic Soil Layers: A Case Study in Nw Algeria

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Abstract - Seismic design of common engineering structures is based on the assumption that excitations at all support points are uniform or fully coherent. However, in lifeline structures with dimensions of the order of wavelengths of incident seismic waves, spatial variation of seismic ground motions caused by incoherence effects and stochasticity in the characteristics of the surface layers may introduce significant additional forces in their structural elements. The physical characterization of the seismic spatial variation and the realistic simulation of the spatially variable ground motion random field become then vital to the success of performance-based design of these extended structures. This paper presents simulation of spatially varying earthquake motions at the free surface of a homogeneous layered stochastic soil site in the epicentral region of the El-Asnam Earthquake in Algeria, considering incoherence, wave passage and site effects. Lagged coherency functions at bedrock have been estimated by simulating ground motion field (around Sogedia Factory) corresponding to the 1980 El-Asnam Earthquake. Considering randomness in the thickness of soil layers overlying the bedrock in the study area, an analytical approach has been used to evaluate lagged coherency functions at the surface. Soil proprieties are assumed to vary laterally with a Gaussian distribution. The critical parameter controlling wave passage effect is the apparent propagation velocity of shear waves across the array and is estimated by using frequency–wave number spectrum analysis. It is observed that the simulated spatially variable surface ground-motion time histories at different locations are compatible with the properties of the target (predictive) random field, i.e. assumption of site homogeneity by conserving the same energy as the reference surface motion and its model of spatial coherency function.

Keywords: Ground motion simulation; ground motion spatial variation; random soil