NUMERICAL MODELLING OF SEISMIC RESPONSE AT SITES WITH PRONOUNCED TOPOGRAPHY

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Concentrated earthquake damage at sites with pronounced topography has been reported in literature over last several decades, and attempts have been made to include topographic effects in earthquake hazard mitigation policies. Recent empirical studies conclude that the strong systematic amplifications observed at sites with pronounced topography are often correlated with ground motion directionality and primarily controlled by subsurface velocity structure, rather than the shape of the topography. However, a unique physical mechanism explaining the strong directional amplifications has not been discovered yet. In this contribution, 3D numerical modeling of local seismic response at a number of elevated (and instrumented) sites in Switzerland and Japan is presented. The joint effects of the terrain geometry and available velocity gradients are investigated by finite difference method. 3D seismic velocity models are developed by combination of measured shear wave velocity profiles and digital elevation models. Different methods of seismic wave-field generation for the site response analysis are tested and compared. Especially, the response based on a random forcing approach (i.e., ambient vibration response) is compared with the plane wave response. The synthetized ground motions are processed and compared with the observations. In particular, the directionality patterns obtained by polarization analysis are compared, as well as the synthetic amplification functions are compared with the empirical ones relative to a well-defined reference rock profile. The origins of the observed directionality are discussed.