Development of Physics-based Ground Motion Simulation in A Hybrid Approach and Applications to Seismic Hazard Assessment in Taiwan

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Damages to engineering structures by an earthquake depend on the entire time history of the ground motion, which is affected by a number of factors including source-rupture process, seismic-wave velocity structure, topographic relief, and local site condition. To quantitatively assess these effects to ground motion, physics-based ground motion simulation is a powerful tool which enables rigorous modeling of each effect and their coupling. In this study, we present a recent-developed physics-based ground motion simulator in generating broadband seismograms for seismic hazard assessment. The simulator is essentially based on a hybrid approach in which long-period synthetics are calculated by the efficient 3-D strain Green’s tensor (SGT) and short-period synthetics are modeled by the stochastic method. Physical effects of (1) source slip distribution, (2) seismic wave propagation, (3) surface topography and (4) site amplification are taken into account. This hybrid approach has been validated by the 2016 M_W6.6 Meinong earthquake in southern Taiwan and reveals good potential for engineering applications. We also carried out simulations to model rupture scenarios of seismogenic structure and subduction zone sources. Output full waveform and ground motion parameters, e.g. peak ground acceleration (PGA) and 1.0-s-period spectral acceleration (SA1.0), have been further implemented to risk estimation, and even earthquake drill. Our result shows the ground motion simulator has the potential for earthquake scenario modeling and hazard assessment.

Keywords: Ground motion simulation, Seismic hazard assessment, Strain Green’s tensor, Stochastic method