Synthetic ground-motion simulation using a spatial stochastic model with slip self-similarity

*Yating Lee[1], Kuo-Fong Ma[1], Ming-Che Hsieh[2], Yin-Tung Yen[2], Yu-Sheng Sun[1]

1. Department of Earth Sciences and Graduate Institute of Geophysics, National Central University, 2. Sinotech Inc., Taipei, Taiwan

Near-fault ground motion is a key to understand the seismic hazard along the fault, and is a challenge by the approach of ground motion prediction equation. We complied finite fault slip models for earthquakes in the Taiwan orogenic belt and global earthquakes to determine the slip distribution self-similarity. Forty-one earthquakes (19 Taiwan earthquakes and 22 global earthquakes) in the Mw = 4.6 - 8.9 magnitude range were examined. The fault slip exhibited self-similar scaling between the rupture slip and area. We applied the slip-distribution scaling to develop a stochastic-slip-scaling source model, a spatial stochastic model with slipped area scaling toward the ground motion simulation. We considered the near-fault ground motion of the 1999 Chi-Chi earthquake in Taiwan, the most massive near-fault disastrous earthquake, proposed by Ma et al. (2001) as a reference for validation. Three scenario source models including the developed stochastic-slip-scaling source model, mean slip model and characteristic-asperity model were used for the near-fault ground motion examination. We simulated synthetic ground motion through the 3D finite-difference scheme and validated these simulations using observed data and the ground-motion prediction equation (GMPE) for Taiwan earthquakes. The mean slip and characteristic asperity scenario source models over-predicted the near-fault ground motion. The stochastic-slip-scaling model proposed in this study is more accurately approximated to the near-fault motion compared with the GMPE and observations. The stochastic-slip-scaling source model can generate scenario earthquakes for predicting ground motion.

Keywords: self-similarity, stochastic-slip-scaling source model,, ground-motion simulation