World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Physics-Based Earthquake Source Models for Seismic Engineering: Analysis and Validation for Dip-Slip Faults

Authors : Percy Galvez, Anatoly Petukhin, Paul Somerville, Ken Miyakoshi, Kojiro Irikura, Daniel Peter

Abstract : Physics-based dynamic rupture modelling is necessary for estimating parameters such as rupture velocity and slip rate function that are important for ground motion simulation, but poorly resolved by observations, e.g. by seismic source inversion. In order to generate a large number of physically self-consistent rupture models, whose rupture process is consistent with the spatio-temporal heterogeneity of past earthquakes, we use multicycle simulations under the heterogeneous rate-and-state (RS) friction law for a 45deg dip-slip fault. We performed a parametrization study by fully dynamic rupture modeling, and then, a set of spontaneous source models was generated in a large magnitude range (Mw > 7.0). In order to validate rupture models, we compare the source scaling relations vs. seismic moment Mo for the modeled rupture area S, as well as average slip Dave and the slip asperity area Sa, with similar scaling relations from the source inversions. Ground motions were also computed from our models. Their peak ground velocities (PGV) agree well with the GMPE values. We obtained good agreement of the permanent surface offset values with empirical relations. From the heterogeneous rupture models, we analyzed parameters, which are critical for ground motion simulations, i.e. distributions of slip, slip rate, rupture initiation points, rupture velocities, and source time functions. We studied cross-correlations between them and with the friction weakening distance Dc value, the only initial heterogeneity parameter in our modeling. The main findings are: (1) high slip-rate areas coincide with or are located on an outer edge of the large slip areas, (2) ruptures have a tendency to initiate in small Dc areas, and (3) high slip-rate areas correlate with areas of small Dc, large rupture velocity and short rise-time.

Keywords : earthquake dynamics, strong ground motion prediction, seismic engineering, source characterization
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020