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Strong ground motion prediction of the Uemachi fault zone using dynamic rupture scenarios

Yuko Kase[1*], Haruko Sekiguchi[2]

[1]AFERC, AIST, [2]DPRI, Kyoto Univ.

Strong ground motion prediction needs realistic earthquake scenarios with characteristics of earthquakes occurring on source faults. We have proposed that physically reasonable dynamic rupture models under a fault geometry and stress fields based on geological or geomorphological data are used as earthquake scenarios for strong ground motion prediction. We apply our method to possible sources of earthquake occurring on the Uemachi fault zone using 3-D geometry of the fault plane and average uplift rate distribution along the fault trace based on the Comprehensive Research on the Uemachi Fault Zone, and calculate ground motion distributions.

The Uemachi fault zone runs just underneath the central part of Osaka plain, extends about 48 km, and the fault plane dips about 60 degrees to the east in the seismogenic zone. The stress conditions for dynamic rupture simulations are presumed based on a large-scale slip distribution on the fault and small-scale heterogeneities of static stress drop. First, a spatially varied cumulative slip distribution along the strike of the Uemachi fault zone was estimated from reflection surveys, borehole data, the subsurface structure model of the Osaka sedimentary basin (Horikawa et al., 2003), and the detailed topography around the fault trace. The borehole data at a site along the fault showed that the vertical slip on the earth's surface due to the last event was about 1.3 m (Kondo et al., in this meeting). Combining these data, we presume a prototype of the slip distribution along strike. A slip distribution along dip is modeled through simulations of spontaneous ruptures under vertically depth-dependent stress conditions to realize spontaneously stopping rupture near the bottom of the seismogenic zone. The large-scale heterogeneous slip distribution is composed of the slip distributions along strike and dip. Second, a stress change caused by the large-scale heterogeneous slip on a 3-D geometry of the fault plane (Kimura et al., 2012), which is a large-scale heterogeneous distribution of static stress drop, is calculated by the formulation of Okada (1992). Onto the large-scale static stress drop model, we add fractal heterogeneities in small-scale created from different random numbers. Finally, the strike and dip components of stress drop are converted to shear and normal stresses, assuming that the heterogeneity of stress drop is caused by a local geometry of the fault plane. We calculate dynamic rupture processes by the finite-difference method (Kase, 2010), assuming the slip-weakening friction law. We run the rupture simulations, changing hypocenter locations within relatively high stress drop area on the fault. The ruptures propagate not smoothly, and some regions remain locking. The rupture area and rupture time on each point depend on the stress model and the hypocenter location. The calculated earthquake scenarios are slightly smaller (Mw6.5-7.0) than an earthquake (Mw 7.1) presumed from the fault length based on "Recipe" of HERP. Predicted ground motion due to one of the largest scenarios is large especially in the northern part of the fault system where slip is relatively larger. The ground motion level along the fault in the northern area exceeds 100 cm/s.

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