Parameter study of the magnitude and strong ground motion prediction for the Nobi earthquake by the use of the active fault data

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It has been conducted a variety of discussion in terms of the magnitude prediction of active fault systems with several seismogenic segments that could also produce multi-coupling earthquakes in constructing probabilistic seismic hazard maps and calculating strong ground motion for seismic hazard assessments. For instance, the M8.0 Nobi earthquake of 1891 was considered to be occurred by northwestern part of Nukumi fault, Neodani fault zone and Umehara fault zone with a capability of multi coupling ruptures. Then, we conducted the following three researches in order to discuss the rational evaluation methods of earthquake-scaling prediction: (1) the proposal of the ellipsoid fault model as the examination of parameters such as fault length and the statistic method, (2) the estimation of the location of asperity and the rupture-initiation points by the rupture strength simulation and (3) the quantitative examination by parameter study.

First, we examined the relation between the surface and source fault using the ellipsoid fault model. This model assumes the form of source fault as the ellipsoids not the conventional rectangles under the restriction on the width of the seismogenic layer. Then, the application with the survey datasets (Stirling et al., 2002) was studied by the least squares method. As a result, both of estimated magnitude by the regression formula was 7.2 in Hogoken-Nambu earthquake of 1995 and Tottoriken-Seibu earthquake of 2000). In addition, we applied this result to the comparison map between active faults and observed earthquakes in seismotectonic province to discuss the significance in the frequency-magnitude distribution. As a result, although the magnitude in the rectangle fault model shows the deviancy nearby M6.0, the linear relation of Gutenberg-Richter law was maintained to M7.0 in the ellipsoid fault model.

Next, we conducted the rupture strength simulation by the bootstrap method and calculated the distribution of the average and the variation coefficient. In this simulation, we include the variation of the horizontal direction and value of stress fields and the static coefficient of friction into the rupture strength formula (after Kase et al., 2003). Moreover, we attempted to estimate the location of the asperity and rupture-initiation points. The result indicated that the distribution of rupture strength and the estimated rupture-initiation points were good agreement with the location showing the large slip in the Nobi earthquake of 1891 and points based on assumed fault branching and displacement pattern models (after Nakata and Goto, 1998), respectively. We concluded that the inner or extra fault parameters could be estimated by the consideration of rupture strength and relation between the length of source fault and slip distribution on the fault plane, even if the active fault datasets were insufficiently.

Finally, we conducted strong ground-motion simulation including these results by use the empirical Green's function method. As a result, comparison of different cases using the same model showed an approximately 1.4-fold difference in the maximum horizontal velocities and among the models indicated an approximately 1.7-fold average difference. Then, the asymmetric intensity pattern of the 1891 Nobi earthquake was explained best by the scaling model with 22% asperity by area (after Somerville et al., 1999) with a southeastward rupturing direction at the southeast end of the Nukumi segment. In comparison with the attenuation relation by Si and Midorikawa (1999), it was clarified that the maximum horizontal velocity in several observation points by assuming the 22% model varied from one standard deviation of the attenuation relation. These results suggest that the effect of fault parameters such as seismic moment and stress drop on strong ground-motion simulations is the same or even larger than the effects of parameters such as rupture initiation point.