Source Scaling of Heterogeneous Slip Models for Subduction-Zone Earthquakes

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The scaling laws of the fault parameters based on the heterogeneous slip models are paid to attention again for understanding of the physics of the source and constructing of the source models for strong motion prediction. Somerville et al. (1999) collects the source models of 15 inland earthquakes occurred all over the world, and leads the empirical relations of the rupture area, the average slip, and the asperities area to the seismic moment. On the other hand, Somerville et al. (2002) is compared the empirical relationships from the source models of 10 subduction-zone earthquakes occurred in the plate boundaries in the world with those of the crustal earthquakes. As a result, the rupture area to the seismic moment of the subduction-zone earthquakes was the twice larger than that of the crustal earthquakes. Moreover, because the rupture area and the rigidity are large, the average slip is smaller than that of the crustal earthquake. The ratio of the combined area of asperities to rupture area for inland earthquakes is 22%, and for the subduction zone earthquakes is 25%. It obtains almost the same result as the earthquake of both types.

We collected the heterogeneous slip models for subduction-zone earthquakes that have occurred around Japan since 1923. We apply the slip characterization by following the procedure of Somerville et al. (1999), and compared it with their empirical relationships. As a result, the rupture area to the seismic moment became 1.3 times larger compared with the crustal earthquakes of Somerville et al. (1999), and the average slip in the rupture area to the seismic moment became half of the crustal earthquakes. The combined area of asperities to the seismic moment increased to about 1.2 times that of the crustal earthquakes, and Sa/S for the subduction-zone earthquakes became 20%, and was obtained a little smaller than the crustal earthquakes (22%). The stress drop of the crustal earthquakes calculated from the empirical relationship of the seismic moment and the rupture area by Somerville et al. (1999) is 2.3 MPa. However, the mean value of the stress drop of the subduction-zone earthquakes in this study become 2.0 MPa and is slightly small.

When there are two or more asperities in the rupture area like the subduction-zone earthquakes, the characterization of rectangular asperities is sometimes difficult, and the variability of the size of the characterized asperities is increasing. We investigate the method for characterizing heterogeneous asperities without the constraint of the rectangular shapes using only the data of recent subduction-zone earthquakes such as the 2003 Tokachi-oki, 1996 Hyuga-nada, and 1994 Sanriku-haruka-oki earthquakes. We confirmed that the area slipped 1.5 times or larger of the average slip occupies almost the same rectangular asperities characterized by the method of Somerville et al. (1999).