Strong Motion Generation Area and Asperity of Subduction-Zone Earthquakes

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Broad-band ground motion prediction by the Headquarters for Earthquake Research Promotion has been carried out by using characterized source model which consists of asperity and background area in a rupture area. In inland earthquakes, broad-band strong motions with characterized source models are in good agreement with observed seismograms, which suggests that the characterized asperity from the inversion results of long-period strong motions are compatible with the strong motion generation area (e.g. Kamae annd Irikura, 1998; Miyake et al., 2003). However, in subduction-zone earthquakes, strong motion generation area is usually much smaller than asperity area (Murotani et al., 2005) characterized from inversion results of long-period strong motions (e,g., The Headquarters for Earthquake Research Promotion). Here, asperity area is defined as an area which has large slip in a fault plain. Strong motion generation area is defined as an area which has more large slip-velocity in a fault plain. It is important issue to understand the physical relation between them for more appropriate broad-band ground motion prediction.

In this paper, we focus on the 2003 Tokachi-oki earthquake and studied whether asperity area of long-period strong motions is equivalent to strong motion generation area of short-period strong motions in the broad-band periods range such as 0.1-10.0 second for subduction-zone earthquakes by the empirical Green's function method. We adopted characterized asperities of Koketsu et al. (2004) and Honda et al. (2004) from inversion results performed in a period range of more than 5 second. And we adopted strong motion generation area of Kamae and Kawabe (2004), which was estimated for reproduction of broad-band strong motions in the period range of 0.1-10 second by the empirical Green's function method. Then we carried out broad-band strong motion simulation with both asperity area of long-period strong motions and strong motion generation area of short-period strong motions by empirical Green's function method.

As the results, synthesized seismograms with both strong motion generation area of Kamae and Kawabe (2004) and characterized asperity area of Koketsu et al.(2004) are agree well with the observed ones in Tokachi and Hidaka region which is in the direction of forward directivity for rupture traveling direction over all periods(0.1-10.0 second). This reason will be considered that asperity and strong motion generation area are well similar in their area and stress drop. In the Kushiro region, synthesized seismogram with characterizing source model of Koketsu et al. (2004) are underestimated in the long-period more than 1-2 second. This will be considered that there is no asperity in Kushiro side unlike Kamae and Kawabe (2004) and that no background area is taken into account as strong motion generation area.

In the characterized source model of Honda et al. (2004), seismic moment is almost same with that in Koketsu et al. (2004). But stress drop of asperity is one-third of that (as this result, short-period level is almost half of that). Therefore, synthesized seismograms of Honda et al. (2004) are underestimated over all periods at the observed stations. Theses results show some limits of applicability of characterized source model only based on the slip for broad-band strong motion prediction in subduction-zone earthquakes. It is important to introduce criteria of stress drop and effective stress for asperity into characterized source modeling.