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Estimation of extended source area from vertical PGA saturation during a great earthquake for upgrading the EEW system

Susumu Kurahashi[1*], Masaki Kazuaki[1], Irikura Kojiro[1]

[1]Aichi Institute of Tecnology

1. Introduction

The Earthquake Early Warning (EEW) system by JMA in Japan provides the coordinate of the starting point, the origin time and the magnitude of target earthquakes based on a point source assumption. The seismic intensity at each site is calculated by using an attenuation distance relation and site amplification from the magnitude and hypocentral distance provided from the EEW. However, during large earthquakes, the calculated seismic intensity might be underestimated in comparison with the observed one. Because a large earthquake has not a point but an extended source, the distances from the earthquake rupture area to observed sites are different from the hypocentral distances assuming a point source. In the Tokai area, the calculated seismic intensity might be about one or two scales smaller than the observed one as long as the Tonankai earthquake would occur off Shionomisaki. It is effective to estimate the rupture extension of the large earthquake from real-time observed records close to the rupture area to prevent underestimation of the seismic intensity in the Tokai area. We have examined to estimate the rupture extension of large earthquake from attenuation distance relation peak ground acceleration (PGA) of P-waves. As a result, we can provide the information about the rupture extension before the arrival of the S-waves (Kurahashi et al., 2009). However, the PGA so far used did not exclude the site effect. In this study, we try to obtain site effects of vertical component for estimate absolute saturation levels of PGA near rupture areas. The site effects were defined as the ratio of the observed PGA and the calculated PGA from the attenuation distance relation.

2 Attenuation distance relations of vertical motions

First, we estimated the attenuation distance relations of vertical motions. We used the observed records of the mainshocks and aftershocks in the 2004 Chuetsu earthquake and 2008 Iwate Miyagi nairiku earthquake. The observed records were used within 120 km in hypocentral distance to exclude the influence of the reflected waves from the moho on the motions. Regression equation for attenuation distance relations of vertical motions is expressed as (1). This equation corresponds to a simple point source with geometrical spreading and constant Q. Therefore this equation is appropriate for small earthquakes. The coefficients of regressions were estimated by two step method (Joyner and Boore, 1981). Next, the site effects were calculated the ratio of observed PGA and calculated PGA. As a result, there is no great distinction between the site effects of horizontal PGA and those of vertical PGA. The absolute saturation levels of PGA are obtained from the attenuation distance relations of vertical motions by removing the site effects. Figure1 shows the attenuation distance relations of PGA during the 2004 Chuetsu earthquake correcting the site effects of vertical motions. The absolute saturation levels of PGA during the 2004 Chuetsu earthquake were estimated about 200gal. However, a detailed examination is necessary for determining the absolute saturation levels because the number of data is not many.

$$\log(PGA) = aMw - \log(r) - br + c \qquad (1)$$