Validation of Attenuation Relationships for Velocity Response Spectra, Comparing with Observed Records

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An attenuation relationship for velocity response spectra has been proposed for wide range of period and distance by Noda *et al.* (2016), which is referred to as N2016 model hereafter. The optimum functional form of attenuation relationship was determined from observed records by using AIC. In this study, in order to validate the obtained relationship, we compare its result with observed one or with other previous studies.

For the comparison, we select two inter-plate earthquakes (the 2003 Tokachi-oki and the 2011 Tohoku-oki), three intra-plate earthquakes (the 2003 Miyagi-oki, the 2004 off the Kii peninsula, and the 2011 Miyagi-oki), and three crustal earthquakes (the 2000 Western Tottori, the 2005 west off Fukuoka, and the 2008 Iwate-Miyagi Nairiku). These events have magnitude lager than Mw6.6, and we can use a lot of observed records from K-NET and KiK-net. As previous studies, we select attenuation relationships obtained by Uchiyama and Midorikawa (2006), Satoh (2008, 2010), and Morikawa and Fujiwara (2013). Since these previous models are constructed for acceleration response spectra, we transform predicted amplitudes calculated from the previous models into pseudo-velocity response spectra. We calculate velocity or pseudo-velocity response spectra at free surface by multiplication of site amplification factors revealed by each researcher, and then compare them with observed velocity response spectra, for period ranging from 0.1 to 5 sec, within applicable range of each model.

The spectral amplitudes predicted by N2016 model agree well with the observation over a wide range of distances, up to farther than 200km. Furthermore, the dispersion of residuals between the predicted and observed amplitudes is very small over a wide range of periods, from 0.1 to 5sec. On the other hand, though the previous models explain well short-period components of the observed response spectra for distances shorter than about 150 km, the dispersion of residuals between observed and their predicted amplitudes increases with distance. The good agreement between observation and N2016 model is mainly for two reasons: (1) effectivity of attenuation terms proportional to depth of subducting slab, (2) regarding coefficients of attenuation terms proportional to logarithm of distance as unknown quantities for each period. The latter suggests that we cannot assume a priori that the coefficients are 1.0 in the Japan Islands. We can attribute the small dispersion of N2016 model to effectivity of site amplification terms, which is obtained from residuals for each period, at each station.

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