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Real-time site correction based on evaluating relative responses to common reference station for wide area network

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Hoshiba (2013a, JGR) proposed a method for prediction of ground motion based on real-time monitoring, in which hypocenter and M are not required. In this method, site amplification must be corrected in real-time manner. Aoki and Hoshiba (2013, AGU) designed the recursive filters for real-time site correction according to Hoshiba (2013b, BSSA), and predicted the JMA seismic intensity of a station by applying this filter to the observed record at the neighboring station, namely exchanging the site amplification factors with each other. In their experiments, in order to consider the effects of the source and propagation in the observed records at adjacent two sites to be identical, the events whose epicentral distances were greater than 100km were selected. Consequently, they show the accuracy of frequency-dependent site correction is better than that of frequency-independent correction using the scalar value, which indicates the average difference in observed intensities at both stations.

In this study, we regard the average spectral ratio, which can be evaluated from the strong motions simultaneously observed at adjacent two stations without the assumptions of attenuation function and source information, as the relative site amplification (RSF) between these two stations. The RSF between distant two stations are estimated by least squares method, combining RSFs of adjacent stations in the network which consists of adjacent station pairs in wide area (Ikeura and Kato, 2011, JAEE). The method is applied to JMA seismic intensity meter network and NIED strong motion seismograph network (K-net and KiK-net including borehole meters), and we can get the RSFs of the stations which almost cover Honshu and Shikoku islands to the common reference station (JMA Tokyo Chiyoda-ku).

The causal digital filters having similar amplitude property to the RSFs are designed according to Hoshiba (2013b, BSSA) and are applied to the waveforms observed in the 2011 Tohoku great earthquake and 2004 Chuetsu earthquake. Site-corrected waveforms can be regarded as the waveforms simulated observing on the sites having the same amplification factor as the reference station. We compare the distribution of seismic intensity with and without site correction. In the distribution of site-corrected intensity on the ground surface, small-scale heterogeneities found on the distribution without site correction vanish and the smooth attenuation of seismic intensity with distance becomes clearer. Before the site correction, the intensity observed in the borehole generally tends to become smaller than that on the ground surface. However the distributions of site-corrected intensities in the borehole are very similar to the distribution of site-corrected intensities on the ground surface. These results indicate that our site correction method applicable to real-time processing works well.

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Keywords: Site amplification factor, Spectral ratio method, Real-time processing, Strong motion seismograph network in Japan, Prediction of the ground motion