Short-period source spectra of the 2007 Noto-hanto earthquake and its aftershocks

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Strong motion records at K-NET and KiK-net stations for the 2007 Noto-hanto earthquake and its aftershocks are analyzed to examine relationship between short-period source spectral amplitude and seismic moment. The earthquakes analyzed here are the mainshock (Mw=6.7) and 10 aftershocks (Mw=3.5-4.7). The stations whose accelerograms are analyzed are located within 15 and 65 km from the epicenter of the mainshock.

We analyze the transverse component records obtained by rotating the two horizontal components. Since S-wave is dominant on the transverse component, the Fourier spectra obtained from the records are regarded as S-wave spectra of transverse component ground acceleration. We take the spectral ratio between Fourier spectra of the main shock and one of the aftershocks to obtain source spectral ratio by removing the effects of radiation pattern, path and site. Thus obtained spectral ratios for the same paired events vary from station to station. This variation is due to some factors which are not perfectly removed by the above procedure, such as the directivity effect, effects of the small difference in focal mechanisms and the small difference in hypocenter locations. Assuming that influence of these factors is removed by taking average of logarithmic amplitudes of the spectral ratios at the stations, we regard the average spectral ratio as the source spectral ratio.

We deal with not the spectral ratio in the low frequency range but the short-period spectral ratio in the frequency range from several Hz to 10 Hz. Judging from the shape of the observed spectral ratio, this frequency range is higher than the corner frequency of the smaller event. If the earthquake sources of the paired events are similar with each other, it is expected that the short-period source spectral ratio becomes the one third power of the moment ratio. However, the spectral ratio of the records is larger than the one third power of the moment ratio in the high-frequency range. The amplitude of short-period source spectrum of the mainshock is too large or that of the smaller event is too small in comparison with the expectation for the omega-square source scaling model.

The relationship between the amplitude of short-period source spectrum and the seismic moment shows that large earthquakes radiate more short-period seismic energy per unit seismic moment than small ones, which suggests a deviation from the similarity of earthquake source. This result is very similar to those obtained by previous studies for earthquakes in the northwestern Kagoshima area, the western Tottori area, the northern Miyagi area and Niigata-chuetsu area. Therefore, it is suggested that the systematic deviation from the similarity is the general property for shallow earthquakes in Japan. An appropriate correction for the deviation from the similarity is necessary when we synthesize strong ground motion for future large earthquakes by the by the empirical Green's function method or the statistical Green's function method.

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