

Variations in strength and predominant period of long-period ground motions around the northern Kanto sedimentary basin due to epicentral directions

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Introduction

In the Kanto sedimentary basin, long-period ground motions are frequently observed and those predominant periods are affected by the bedrock depth of sedimentary basin (e.g., Yoshimoto and Takemura, 2014). Furthermore, excitation of long-period ground motions varies by epicentral directions of earthquakes (e.g., Yuzawa and Nagumo, 2012). In spite of these observational findings, less well known are the excitation characteristics of Love and Rayleigh waves, which cause long-period ground motions in the basin. Thus, in this study, we analyzed horizontal and vertical waveforms collected from stations of K-NET, KiK-net, and SK-net to investigate the characteristics of strength and predominant period of long-period ground motions during earthquakes with different epicentral directions.

Analyzed earthquakes and analytic method

We analyzed eight shallow moderate-to-large earthquakes (Mw 5.8–6.9) having a wide coverage of epicentral directions. The CMT solutions of these earthquakes by F-net indicated that hypocentral depths were shallower than 8 km and source mechanisms were reverse or normal fault types. To analyze long-period ground motions which appeared after the arrival of S waves, we selected waveforms using the following recording conditions: a) at epicentral distances shorter than 150 km, waveforms recorded at least 100 s from earthquake origin time; b) at epicentral distances longer than 150 km, waveforms recorded over 150 s in total length or 200 s from earthquake origin time. We calculated Fourier spectra of velocity waveforms to investigate strength and predominant period of long-period ground motions observed in the Kanto basin.

Variations of long-period ground motions due to epicentral directions

Comparison between horizontal- and vertical-component Fourier spectra revealed that, for all earthquakes, the magnitude of horizontal amplitude spectra dominated over that of vertical amplitude spectra, and horizontal predominant period was longer than vertical one, suggesting the dominance of Love waves over Rayleigh waves in the Kanto sedimentary basin. As for the predominant period, clear bedrock depth changes were observed for both components: the deeper bedrock depth, the longer predominant period. In a strict sense, this relationship held only in the area where the bedrock depth was shallower than 2 km, but otherwise the predominant period became almost constant values (Horizontal: 6.3 s, Vertical: 4.8 s) in deep (> 2 km) bedrock area. These observations were also consistently explained by assuming the dominance of Love waves over Rayleigh waves.

Analysis of the amplitude and the predominant period of long-period ground motions during The Mid Niigata prefecture Earthquake in 2004 (NW event) and the earthquake in Hamadori region of Fukushima prefecture on April 11, 2011 (NE event) revealed that the observed spectral amplitudes were almost the same for these earthquakes but the predominant periods were clearly different between these earthquakes: predominant periods of horizontal- and vertical-component observed at deep (> 2 km) bedrock area were approximately 6.6 s and 5.2 s, respectively, for NW event, and were 5.6 s and 4.6 s, respectively, for NE event. This observation suggested that the excitation of both horizontal and vertical long-period ground motions was affected by the difference in epicentral directions.

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