

## Characteristics of long-period strong ground motion in the Keihin-area during the 2011 Tohoku earthquake

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The velocity response spectra of 5% damping calculated from the observed data in the Keihin area during the 2011 Tohoku Earthquake had no significant peak at period of around 8 s and had peak over 100cm/s at period of around 3 s. The acceleration seismograms had spindle-shaped envelope and peak accelerations were recorded about 120 s after S-wave on-set. The maximum velocity response at period of around 3 s was recorded in the first half part of waveforms. It is important to realize the difference of wave propagation characteristics between in the first half part and the later part of the waveforms. In this article, the propagation characteristics of long-period strong ground motions during the 2011 Tohoku Earthquake were studied by semblance analysis using the data observed in the Keihin area.

Sixteen strong motion observatories in the Keihin area were used for array analysis. The major axis of the array area is about 18 km and minor axis is about 9km. Distance between adjacent observation points is from 0.6km to 5km. We performed semblance analysis using narrow-band pass filtered waveforms and evaluated the phase velocity for each time sections from the peak point of semblance in slowness plane. The center periods of the filters were 1, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15 and 20 s. The length of time window for analysis was 20 s and the time windows were opened every 10 s in wave traces.

The peak semblance values were high for longer period waveforms and were lower value for short period waveforms. The value at period of 1 and 2s were lower than 0.5. The values calculated from large array data were lower than those from small array data. The semblance values in first part of waveform were high but the values in the later part show lower value. The phase velocities in first half part are over 3 km/s for all case. The phase velocities in later part were 1 to 2 km/s and showed the dispersion characteristics. The back azimuths of wave propagation in the first part indicated the epicenter direction but those in later part did not indicate constant direction especially in short period range.

To examine the relation between this dispersion characteristics and underground structure, we calculated phase velocities of surface waves using the underground structure model. The phase velocities evaluated in the first part were faster than phase velocity of the fundamental mode. The phase velocities evaluated for several last time windows in the later part coincided with the phase velocity of the fundamental mode. These characteristics are similar to the results from the data observed the Tokyo lowland area [Uetake (2013)].

Judging from the property of the acceleration waveform and a result of the semblance analysis, the waves caused large response in a period of 2-3 s were more likely to be a body wave not a surface wave of the fundamental mode.

The strong ground motion data used in this study were observed by TEPCO, K-NET of NIED, ERI, JMA, Tokyo Metropolitan office and Yokohama-City. I appreciate these organizations for making the data be available.

Keywords: Long-period strong ground motion, the 2011 Tohoku earthquake, Semblance analysis, Phase velocity, Keihin area