

Propagation of long-period ground motion in the Tokyo lowlands, Japan during the 2011 Tohoku Earthquake

Tomiichi Uetake^{1*}

¹Tokyo Electric Power Company

The studies about strong motion data obtained from past earthquakes in the Tokyo metropolitan area suggested that the long-period ground motions with period of about 8 s would be excited during the large earthquakes. Although, the response spectra calculated from the data of the 2011 Tohoku Earthquake had no significant peak at period of around 8 s. In this period range, the excellent peak of response spectra was assumed to be strongly affected by the excitation of the fundamental Love waves. UETAKE(2012) suggested that the higher mode surface waves were predominant over the fundamental mode in the long period ground motions of the Keihin area during the 2011 Tohoku Earthquake. In this article, the propagation characteristics of long-period ground motion in the Tokyo lowlands are studied using K-NET data during the 2011 Tohoku Earthquake.

Fifteen K-NET stations in the Tokyo lowlands were used for array analysis. The diameter of the array is about 10 km and minimum station distance is shorter than 1 km. The acceleration seismograms had spindle-shaped envelope and peak ground accelerations were recorded about 90 s after seismic wave on-set. The velocity response spectra with 5% damping showed flat feature in period of over 5 s, but response value was scattered between 30 and 80 cm/s at 5 s, and between 30 and 50 cm/s at 10 s. We performed semblance analysis using a narrow-band pass filtered waveforms in transverse component and evaluated the phase velocity for each time sections. The center periods of the filters are 5, 6, 7, 8, 9, 10, 12, 15, and 20 s. The length of time window for analysis was 40 s and the time windows were opened every 20 s in wave traces.

The peak values of semblance in first half part of waveforms are high but the values in the second half part are lower value in according with the period and in proportion to the start time of analytical windows. The semblance values of period 8 s in front part are over 0.8 but go down to 0.5 in later part. The phase velocities in first half part are over 3 km/s in every period. The Phase velocity in second half part shows the dispersion characteristics. The value at 10 s is 2.5km/s and the value in 7s is 1.4 km/s. The back azimuths of wave propagation in the first half part indicate that the seismic wave propagated from the epicenter direction. The back azimuths of several windows in second half part indicate the wave propagate from opposite direction of the epicenter. In second half part, the distribution of semblance value in the slowness plane has some peaks with low value.

To examine the relation between this dispersion characteristics and underground structure, we calculated phase velocities of the Love waves using the underground structure model for the center of array. The phase velocities evaluated in the first half part are faster than phase velocity of the fundamental mode and near to the velocities of higher modes. The phase velocities evaluated in the second half part coincide with the phase velocity of the fundamental mode.

Keywords: Long-period ground motion, the Tokyo lowlands, the 2011 Tohoku Earthquake, Array analysis