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Characteristics of long-period ground motion in the Tokyo bay area

Sadanori Higashi^{1*}, Tomiichi Uetake², Hiroaki Sato¹

¹CRIEPI, ²TEPCO

It is well known that the long-period seismic ground motions at a period of several to more than a dozen seconds are predominant in the Kanto plain. We have compared the observation records of the broadband strong-motion seismometers installed in the thermal power plants in the Tokyo Bay area with the three-dimensional seismic simulations. We pointed out the possibility of the relation between the focal depth and the thick sedimentary basin in Sagami bay affects the later arrivals of the E-off Izu peninsula earthquakes with a magnitude of 5 occurred in 2006.

In this report the off Ibaraki Prefecture earthquake occurred on May 8, 2008 was used for investigating the characteristics of long-period seismic motions in the Kanto plain. We used an underground structure model with the range of longitude 138.2-142.0 degrees east and latitude 34.5-36.5 degrees north of the Headquarters for Earthquake Research Promotion (2009). We performed three-dimensional simulations by using a finite difference method with the grid point interval of 400m in horizontal direction and 100-400m in vertical direction. The duration of the calculated velocity waveforms are 300 seconds, which are 30,000 steps with an interval time of 0.01 seconds. We compared the waveforms with the velocity records at a frequency range of 0.08 to 0.12 Hz, which is 7 to 12 seconds in period.

We assumed two cases of the source models of the off Ibaraki Prefecture earthquake of 2008 as a point source. One is the deep source model at a depth of 50km derived from the JMA hypocentre with a F-net mechanism and the other is the shallow source model derived from JMA CMT mechanism at a depth of 28km. We also assumed two cases of the Q-values at each layers of the underground structure model. One is the original value of $Q=Vs/5$ and the other is $Q=Vs/2.5$. We introduced the Grave(1996)'s Q-value model in the finite difference method and the reference frequency was 0.1Hz.

From the results of the comparisons between the two Q-value models with a deep hypocenter, no significant changes in amplitudes and later phases were seen in the frequency range of 0.08-0.12Hz. The calculated waveforms at IBR018 and IBRH20, which are the nearest the hypocentre, and from CHB004 to the observation stations in the eastern side of the Tokyo bay area are underestimated and are 1/3 to 1/4 in amplitude compared with the observed waveforms. Especially the later arrivals with large amplitude observed at the eastern bay area were not reproduced. On the other hand, the reproducibility at the western bay area is considerably better than the eastern area.

The results of the two kinds of different hypocenters showed great differences in amplitude and wave groups. It seems that the shallow case generally showed a better agreement with the observation. Yamanaka(2008) determined the focal depth of the off Ibaraki Pref. earthquake at 19km from the teleseismic analysis in NGY seismology note No.7. The focal depth might be shallower than 50km. However, the influence of the source process remains unsolved because we assumed the point source despite of $M=7.0$.

Keywords: Long-period seismic ground motion, Kanto plain, Sedimentary basin, Three-dimensional simulation, Broadband strong motion observation, Off Ibaraki Pref. earthquake in 2008