Characteristics of long-period ground motion in Tokyo Bay area evaluated from deep earthquake data

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The deep earthquake with Mj=6.7 occurred in Kyoto-Oki region on July 16, 2007 and its hypocenter depth was 374 km. The seismic intensity distribution of this event showed the zone of abnormal seismic intensity and many strong motion records were retrieved in the Kanto district. The incident wave to a basin from a deep event is considered a body wave and the difference of radiation pattern coefficient is small for large area. These points are advantageous for relative site effect evaluation.

The Tokyo Electric Power Company has performed earthquake observation at thermal power stations in the Tokyo bay area using wide-band velocity type strong-motion seismometer (VSE-355G3). The recording time of the data were from 400 to 600 seconds for all stations. This recording time was about 2 to 3 times longer than that of K-NET or KiK-net data. The long duration of velocity seismogram was due to long period later arrivals. The acceleration waveform made from the velocity waveform by differential calculation had no significant later arrivals and its duration was about 120 seconds.

The rock site data of F-net and KiK-net in mountain area around the Kanto district were checked to examine the incident waveform to the Kanto basin. The data of velocity type strong motion seismometer (VSE-355G3) of F-net were used and the acceleration data of KiK-net were used after integration with low-cut filtering of 0.05 Hz. The velocity waveforms observed in the Tanzawa and Kanto mountain areas show simple pulse with apparent period of 7 to 8 seconds. The record at the station located in coastal region of Pacific Ocean was rich in the short-period components. Although the short-period component were different, no significant later arrivals and short duration were common in rock site motions. This suggests that the later arrivals observed in the basin were estimated to be generated by the Kanto basin.

To study the effects of the duration of analytical time windows on spectral characteristics, the five time windows with duration of 60, 120, 240, 360, 480 seconds from 1 second ahead of S-wave onset were used for calculation of response spectra with damping 5 % and velocity Fourier spectra. The results were as follows.

(1) In period range lower than 4 seconds, the both response and Fourier spectra calculated from the duration of 60 seconds are almost the same as that of longer duration cases.

(2) At Yokosuka and Minami Yokohama stations, the response spectra in all cases are almost same in the period range from 2 to 20 seconds. The Fourier spectra for the duration of 60 seconds are a little smaller than the other cases.

(3) At Goi and Chiba stations, the spectral level in period range from 6 to 8 seconds are as larger with duration of the windows and the response value from duration of 240 second was the twice of that at the station in west side of the Tokyo bay. The response value for duration of 60 seconds was lower than other stations. For these stations, the long duration record was needed to calculate proper response at longer period range. The response value at period of 7 seconds from duration of 240 seconds was three times as that of 60 seconds, this difference was ten times for Fourier spectrum. The long-periods later arrivals contribute this phenomenon.

(4) At other stations, the spectra calculated for the duration of 60 seconds are little smaller than that of other duration cases.

The spatial distribution of duration dependency in period range over 4 seconds shows that the later arrivals excited in the Kanto basin make the long duration waveforms in the east side of the Tokyo bay rather than the west side of the bay.

The data used in this study were observed by Tokyo Electric Power Company and National Research Institute for Earth Science and Disaster Prevention.