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Long-period Ground Motion in Tokyo Bay Area Observed from the M7 Class Events in the North of Nagano Prefecture, Japan

UETAKE, Tomiichi[1*]

[1]Tokyo Electric Power Company

The earthquake of Mj6.7 occurred in the north of Nagano prefecture on November 22, 2014 (the 2014 event) and seismic intensity 6- in Japan Meteorological Agency (JMA) scale was observed in the northern part of Nagano prefecture. Around the north of Nagano prefecture, the earthquake of Mj6.7 occurred at Niigata - Nagano border on March 12, 2011 (the 2011 event). These shallow events have the same magnitude in JMA scale, similar source mechanism, and the geometric relation between the epicenters and the Tokyo bay area are similar. It was expected that the ground motion observed in Tokyo bay area during these events showed similar characteristic. This article reports the ground motion characteristics of both events in the Tokyo bay area.

The records of the broadband velocity type seismometers (VSE-355G3) installed in the thermal power stations on Tokyo Bay shore, K-NET and KiK-net in Kanto district were used for the analysis of ground motion characteristics. The 2011 event occurred at Niigata - Nagano border was estimated as magnitude 6.7 event with focal depth of 8 km by JMA. According to the analysis result of F-net, the source mechanism of the event is reverse fault with the northeast - southwest strike direction, Mw is 6.2 and focal depth is 5 km. The 2014 event occurred in the vicinity of Kamishiro fault was estimated as magnitude 6.7 event with focal depth of 5 km by JMA. According to the F-net result, the source mechanism is similar to that of the 2011 event, Mw is 6.3 and focal depth is 5 km. The epicenter distance and back azimuth of the 2011 event from the Shinagawa observation station are 184 km and 325 degree, respectively. Those of the 2014 event are 206 km and 305 degree, respectively. It seems that the seismic wave from these events were propagated from the approximately same direction.

In the velocity seismograms of the 2011 event, remarkable later arrivals with predominant period of five seconds were recognized in both of horizontal components and vertical component except Yokosuka observatory. In addition, the appearance time of this phases in the seismograms of the Chiba station on the ease side of the Tokyo bay was later than that of Shinagawa station on the west side of the bay. We can confirm that this wave packets propagates from the Western mountainous to the Kanto basin by making paste up figures using K-NET and KiK-net records. For all stations on the Tokyo bay shore except Yokosuka station, the remarkable peak was recognized at 5 seconds in horizontal and vertical components of the velocity response spectra with 5 % damping. The remarkable later arrivals like in the records of the 2011 event was not recognized in the records of the 2014 event, but consecutive later arrivals with predominant period of 8-10 seconds were recognized. These later phases also propagate from the west to the east in the basin. There was no station where the significant peak of five seconds was recognized in the velocity response spectra with 5 % damping. But the peak in velocity response spectra was recognized at period of 7 to 8 seconds in horizontal component for Ooi and Shinagawa stations on the west side of the Tokyo bay and between Anesaki and Chiba on east side of the bay.

The ground motions in Kanto Mountains were studied to examine the property of the incident wave to the Kanto basin. Remarkable later pulses were confirmed in the velocity seismograms of the 2011 event. In velocity response spectrum with 5 % damping, the significant peak was recognized at period of five seconds. Because the horizontal motion was different 90 degrees in phase with vertical motion in this later arrivals, it was estimated that this later arrivals were Rayleigh waves. On the other hand, no special later arrival was recognized in the velocity seismograms of the 2014 event. It is thought that the difference of incident wave to the basin between the 2011 event and the 2014 event caused the difference of ground motion in the Tokyo bay area.

Keywords: Long-period Ground Motion, Surface Waves, Later-phases, Tokyo Bay area, Velocity Response Spectrum