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Response Duration Time Spectra of Ground Motions in Tokyo during The 2011 Off the Pacific Coast of Tohoku Earthquake

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The 2011 off the Pacific coast of Tohoku earthquake (2011.3.11 14:46, Mw 9.0) was the largest of the earthquakes observed in and around Japan. In Tokyo, the duration time of the ground motion became very long and many kinds of damages were generated; ex. indoor damages of high-rise buildings, damages of weak structures or members, soil liquefaction, etc. The foreshocks, many aftershocks, and many other earthquakes induced by the huge main shock have occurred.

In this study, the response spectra and the response duration time spectra of the horizontal and vertical ground motions which were recorded at the engineering bedrock at Etchujima in Tokyo, during the 2011 off the Pacific coast of Tohoku earthquake, its foreshock, aftershocks, and triggered earthquakes, are calculated and investigated. Each record was separated from the ones of the other aftershocks, and was selected on the condition that its noise was less and its duration was long enough. The noises in the frequency components higher than 10 Hz were removed from the record by using the high-cut filter. Then the velocity response spectra S_v [cm/s] and the velocity response duration time spectra TS_v [s] of the ground motions were calculated in the period range between 0.1 and 20 seconds, with the damping coefficient $h=0.05$, the parameters $p_1=0.03$ and $p_2=0.95$.

The fault plane of the main shock expanded enormously along the Pacific coast of Tohoku district and the Japan trench, from the area off Iwate prefecture to the one off Ibaraki prefecture. S_v of the horizontal motions reached 20 to 50 cm/s for the periods longer than 2 seconds. TS_v of the motions exceeded 200 seconds (exceeded 3 minutes) for the periods longer than 3 seconds, and TS_v of the EW motion exceeded 600 seconds (exceeded 10 minutes) for the period of 10 seconds. In comparison with the previous study on the ground motion in Tokyo after the 1923 Kanto earthquake (1923.9.1, M 7.9), S_v for the Kanto earthquake was 1.5 times as much as the one for the Tohoku earthquake, however TS_v for the Tohoku earthquake became much more than the one for the Kanto earthquake for the periods longer than 7 seconds.

Keywords: huge earthquake, Tohoku, Tokyo metropolitan area, earthquake ground motion, duration time, response