Ground motion characteristics during The 2011 off the Pacific coast of Tohoku Earthquake and The 2016 Kumamoto Earthquake

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The 2011 off the Pacific coast of Tohoku Earthquake which caused the Great East Japan Earthquake Disaster, initiated on 14:46 of March 11th 2011. The epicenter was 130 km east of Sendai in the off Miyagi region and the focal depth was 24 km. As a result, the rupture spread to a length of 400 to 500 km and width of 150 to 200 km along the boundary between the Pacific plate and Eurasian plate and became moment magnitude (Mw) of 9.0. The relative slip close to the trench east of the epicenter was about 60 m and made a huge tsunami. On the other hand, it recorded the JMA seismic intensity of 7 in Tsukidate of City of Kurihara in Miyagi Prefecture. This earthquake counted 19,729 causalities, 2,559 missing and 6,233 injured, as of March 1st, 2020. There were 121,996 totally collapsed, 282,941 half destroyed and 748,416 partially damaged houses, and 14,527 public buildings and 92,059 of other structures suffered damage during the earthquake. This catastrophe was caused mainly by the huge tsunami along the shoreline. On the other hand, K-NET Tsukidate (MYG004) station of the Kyoshin Network (K-NET) operated by the National Research Institute for Earth Science and Disaster Resilience recorded JMA seismic intensity 7. Although it recorded a maximum acceleration of 2,700 cm/s/s for the north-south component (about 2.7 times of gravitational acceleration), there were hardly no building damage near the station. This was because the frequency content of the recorded ground motion was about 4 Hz. On the contrary, the K-NET Furukawa (MYG006) station recorded JMA seismic intensity of 6+, but there were collapsed houses because the dominant frequency of the ground motion was about 1 Hz (period of 1 sec). Despite the fact that the earthquake was the largest among the recorded earthquakes around Japan and the highest peak ground acceleration ever recorded, it was found by many researches that damage will not be caused depending on the characteristics of ground motions.

Furthermore, during the mainshock of the 2016 Kumamoto Earthquake, which was the largest JMA magnitude (Mjma) earthquake in this 10 years, JMA seismic intensity (JMA-SI) of 7 was recorded at two stations. Mjma 7.3 is the largest inland active fault earthquake that was recorded. Houses were damaged heavily in Mashiki town of Kumamoto Prefecture, one of the sites where JMA-SI 7 were recorded and the dominant frequency of the ground motion was about 1 Hz. The other site, Nishihara village had not suffered great damage in the central part of the village, but there where damage near the surface rupture of the fault. In Nishihara, the dominant period was about 3 seconds. It was re-recognized that the ground motion with dominant frequency of 1 Hz has the potential of causing great damage to houses. In addition, ground motion with dominant period of 3 seconds which may cause severe damage to base-isolated structures and high-rise buildings has been observed and it has raised a question concerning safety of these types of buildings.

Keywords: The 2011 off the Pacific coast of Tohoku Earthquake, The 2016 Kumamoto Earthquake, Ground motion, Period of 1 second, Building damage

