

## Investigation of azimuthal dependence of site responses in the Kanto Basin, using earthquake observation data

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Recently, several seismic observation networks have been installed in the Kanto Basin, such as K-net, KiK-net, SK-net and MeSO-net. Especially, MeSO-net (Sakai and Hirata, 2009) installed with an interval distance of about 5 km has high densely covered the Tokyo Metropolitan Area with more than about 250 stations. Large ground motions of the Kanto Basin for long periods were observed by these networks, during the 2011 off the Pacific coast of Tohoku Earthquake, Japan (Mw 9.0). Tsuno et al. (2011) reported complex distributions of earthquake ground motions observed in the Tokyo Metropolitan Area. However the observed ground motions for long periods seem to be small in contrast with those prospected by the scale of the main shock (Mw 9.0). Since the main shock occurred in the Tohoku Region on March 11, 2011, a lot of aftershocks including those with the small scale of magnitude occurred mainly in the East Japan due to the huge scale of the main shock. Also, earthquake ground motions induced by several aftershocks of more than Mj 6 were observed in the Kanto Basin. To investigate azimuthal dependence of site responses excited in the Kanto Basin, therefore, we evaluated the characteristics of ground motions in the Kanto Basin for different moderate aftershocks of the 2011 off the Pacific coast of Tohoku Earthquake.

We selected 5 aftershocks of the same scale (Mj 6.4 to 6.7) occurred in the different azimuth for the Kanto Basin. Also, the epicentral distances from the Kanto Basin for these events were around 200 km. The aftershock events used in this study were as follows: the Northern Nagano Prefecture Earthquake (March 12, 2011, Mj 6.7), the off Ibaraki Prefecture Earthquake (March 13, 2011, Mj 6.4), the Eastern Shizuoka Prefecture Earthquake (March 15, 2011, Mj 6.4), the Fukushima Prefecture Earthquake (April 12, 2011, Mj 6.4) and the off Fukushima Earthquake (July 31, 2011, Mj 6.5). At first, we confirmed the stability of ground motions observed in the seismic bed rock at Shimosa (CHBH04), Iwatuki (SITH01) and Koto (TKYH11) where the borehole stations by KiK-net were installed. To remove the effects of source and pass for different earthquakes, we obtained spectral ratios of underground motions on surface to the averaged ground motions by three stations in the bed rock. The site responses estimated by 5 different events were similar for periods of 1 and 0.5 seconds at the central stations in the Tokyo Metropolitan Area. However, the site responses were clearly different for periods of 5 and 8 seconds. The site responses obtained by the Northern Nagano Prefecture Earthquake and the Eastern Shizuoka Prefecture Earthquake were larger than those obtained by other earthquakes, in spite of the largest ground motions in the bed rock observed by the off Ibaraki Prefecture Earthquake. For example, site response for all the periods at TKY007 (Shinjyuku by K-NET) was almost same for the off Ibaraki Prefecture Earthquake, the Fukushima Prefecture Earthquake and the off Fukushima Earthquake. On the other hand, the site response for a period of 5 seconds obtained by the Northern Nagano Prefecture Earthquake and the Eastern Shizuoka Prefecture Earthquake were extremely larger than those obtained by other earthquakes by around 4 times.

We confirmed the azimuthal dependence of local site responses in the Kanto Basin, using the different moderate earthquakes of Mj 6.4 to 6.7. The ground motions for periods of 5 to 8 seconds in the Tokyo Metropolitan Area were largely excited by the Northern Nagano Prefecture Earthquake and the Eastern Shizuoka Prefecture Earthquake. To evaluate and/or predict ground motions for long periods in the Kanto Basin induced by the Tokai Earthquake, which is supposed to occur in the Southern Shizuoka for the near future, we need to understand more clearly the azimuthal dependence of local site responses in the Kanto Basin.

Keywords: Ground motions, Azimuthal dependence, Site response, Kanto Basin, aftershock recordings, 2011 off the Pacific coast of Tohoku Earthquake