

Site amplification in Hakuba from microtremor and aftershock observation of the 2014 Northern Nagano Earthquake

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During the 2014 Northern Nagano Earthquake on 22 November, the maximum seismic intensity of 6 lower, buildings in Horinouchi or Mikkaichiba in Hakuba located at about 5km south to K-NET Hakuba were heavily damaged. We then carried out the aftershock observation and microtremor measurements from 24 November to 4 December to investigate the site amplification due to subsurface structure.

We carried out the aftershock observation with 13 temporal stations using accelerometer JEP6A3 with Data logger of LS7000XT and LS8800. We observed about 30 events with the seismic intensity of above 1, the highest peak ground motion was about 30 gal. In Horinouchi and Mikkaichiba, where the damage was heavy, we observed high accelerations and long later phases. The response spectrum shows high value between the periods of 0.5 and 1 second. The spectral ratios to the aftershock observed at the base of mountain in Mikkaichiba shows the peaks in the periods of 0.5 to 1 second.

We conducted microtremor measurements at all aftershock observation stations with the array size of less than 20m and applied SPAC method to estimate Rayleigh wave phase velocity. Near Horinouchi, we also conducted microtremore measurements with the large array size of about 680m at the west and east of Kamishiro Fault. We estimated dispersion curve of phase velocity in the range from about 3 to 30 Hz from the array size of about 20m. It was highest in K-NET Hakuba, and about 100 to 200m/s in Horinouchi and Mikkaichiba. We also estimated phase velocity of more than 1000m/s at above 1 second from large array. The S-wave velocity structures were estimated from an inversion of phase velocity. The layer with the S-wave velocity of 300m/s was less than 10m in K-NET Hakuba, while the layer with the S-wave velocity of below 200m/s was about 10m depth and about 50m thickness of the layer with 400m/s. The S-wave velocity structure obtained from the analysis of large arrays revealed that it was deeper in the west of the fault than the eastern part. The depths to the layer with the S-wave velocity of above 1000m/s were about 700m in the west and about 400m/s in the east. Since the depth to such layer in the KiK-net site, about 1km west to K-NET Hakuba, is below 100m, the heavily damaged area has deep structure in around the region.

We calculated the S-wave site amplification factor using the estimated S-wave velocity structure. The site amplification of shallow structure exhibits a peak at about 0.1 second in K-NET Hakuba, while it was about 1 second in Horinouchi and Mikkaichiba. The comparison between the spectral ratios and calculated site amplifications show similarity in terms of dominant periods. However, the spectral ratios have higher values in general, suggesting the effects of deep structures.

Keywords: 2014 Northern Nagano Earthquake, Site Amplification, Aftershock observation, Microtremors, Kamishiro Fault