Shallow subsurface structure estimated from dense aftershock records and microtremor observations in Furukawa district, Miyagi, Japan

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Severe structural damages due to ground motions were occurred in some limited areas of Tohoku and Kanto regions, northeast Japan, during the 2011 off the Pacific coast of Tohoku earthquake. Furukawa district in Miyagi prefecture was one of the most significant damaged areas (Goto and Morikawa, 2012). Frequency contents of ground motion records at K-NET MYG006 and JMA Furukawa stations, where are located in Furukawa district, are similar to ones of JMA Kobe and JR Takatori records during the 1995 Kobe earthquakes. It indicates that ground motions in Furukawa district were effective against the structures (Goto and Morikawa, 2012). Significant damages were locally observed within about 1.0 x 0.5 km^2 areas, which is center of the downtown.

In order to investigate the reason why the damage was concentrated into very limited area, Goto et al.(2012) established a temporal network of seismometers in the downtown area, namely Furukawa Seismometer Network (FuSeN). FuSeN consists of more than 30 accelerometers with a spatial interval of about 100m, which is one of the densest seismometer networks in the world. The observed peak ground acceleration (PGA) and velocity (PGV) indicate that ground motions are greatly amplified in the significantly damaged area (Goto et al., 2012). It is considered that difference of the amplification is mainly caused by difference of the shallow subsurface structures. Inatani et al.(2013) estimated the shallow ground structure based on the ground motion records obtained by FuSeN. Thicker surface soil is estimated at the sites with the larger amplifications. It suggests that the subsurface structure in the local region was very important factor to cause the structural damage by ground motions.

Inatani et al.(2013) used relative transfer functions obtained from the ground motion records, whereas it constrained only the relative differences of velocity structures. In addition, the resolution is limited in the scale of spatial intervals among the sensors in FuSeN. For this purpose, single-site observations and array observations of microtremor may be helpful to improve the subsurface structure in Furukawa district. We carry out extreme dense single-site observations of microtremor in order to obtain the densely distributed dataset, and array observations of microtremor to identify the S-wave profile. Both results are merged to model the subsurface structure. We, then, update the subsurface structure in Furukawa district, and discuss contribution to the site amplification. The array observations estimated phase velocity of Rayleigh wave at three sites, and S-wave velocity models were established. The single-site observations estimated the peak period distribution of surface layer on the basis of H/V spectral ratio. We then revised the shallow subsurface structure on the basis of the microtremor results and ground motion records of FuSeN. The model implies that slower S-wave velocity and deeper surface layer to the basement are estimated around the southern area. Distribution of averaged value of the transfer functions in 2-4Hz agrees well with the damage area.

- References

1. Goto, H. and Morikawa, H., 2012, Ground motion characteristics during the 2011 off the Pacific coast of Tohoku earthquake: Soils and Foundations, 52, 769–779.

2. Goto, H., Morikawa, H., Inatani, M., Ogura, Y., Tokue, S., Zhang, X.R., Iwasaki, M., Araki, M., Sawada, S., and Zerva, A., 2012, Very dense seismic array observations in Furukawa district, Japan: Seism. Res. Lett., 83, 765-774.
3. Inatani, M., Goto, H., Morikawa, H., Ogura, Y., Tokue, S., Zhang, X.R., Iwasaki, M., Araki, M., Sawada, S., and Zerva, A., 2013, Shallow subsurface model at Furukawa district based on very dense seismic array observations, Journal of JSCE A1, 69, I_758-766 (Japanese with English abstract).

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