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3-D sedimentary layers model and simulation of seismic motions around the Tachikawa fault zone

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Tachikawa fault is one of the most activity faults in the western part of the Tokyo metropolitan area. Strong motion estimation is necessary to know the possible damage due to rupture of the fault considering effects of geological structure. However, a three-dimensional subsurface structural model is not well tuned in the vicinity of the fault.

In this study, we estimated a three-dimensional structure of deep sedimentary layers around the Tachikawa fault zone using Rayleigh wave phase velocity and horizontal-to-vertical spectrum obtained from microtremor explorations and receiver functions from the obtained records of the K-NET, KiK-net and SK-net. And we simulated seismic ground motions around the Tachikawa fault zone using the three-dimensional finite difference method to validate of a three-dimensional structure of deep sedimentary layers.

To accomplish it, we first conducted the array observations of microtremors at 12 sites around the Tachikawa fault. Rayleigh-wave phase velocity at periods from 0.5 to 5.0 seconds was estimated from a frequency-wave number spectral analysis of the microtremors. We next conducted the observations of microtremors at 268 sites on nine lines across the Tachikawa fault zone. Predominant periods of the H/V spectrum clearly indicated differences of subsurface structure across the Tachikawa fault.

Then, we conducted the joint inversion of the phase velocity and the receiver function to a P and S-wave velocity profile based on the simulated annealing method. P-wave velocities, S-wave velocities and thickness of individual layers are inverted very well, and the S-wave velocities of the inverted profile are 0.5, 0.9, 1.5, 2.4 and 3.2km/s. We constructed a three-dimensional structures of the deep sedimentary layers in this area from integrating the 1-D S-wave velocity profiles at all the stations. The basement depth at hanging-wall side of the Tachikawa fault is larger than that at foot-wall side with a difference of about 1.7km in the 3-D model.

Finally, we simulated seismic ground motions around the Tachikawa fault zone using the three-dimensional finite difference method considering three-dimensional velocity structure down to 50km. The results indicate that the maximum accelerations in simulated waveforms were similar to the observed one.

Keywords: Tachikawa fault zone, array microtremor exploration, Rayleigh wave phase velocity, 3-D sedimentary layers model, 3-Dfinite difference method