Estimation of earthquake ground motions on the ground surface at MeSO-net stations

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In the past national project of Japan, “Metropolitan Seismic Observation network” (hereinafter, referred to as “MeSO-net”) was constructed for the investigation of the tectonic plate structures and earthquake ground motions in the Tokyo metropolitan area around ten years ago. The MeSO-net has about 300 stations with sensors installed around 20 meters underground in the area. Also, they are spatially distributed at intervals of 2 to 5 kilometers in the area.

In recent years, we have worked a subproject of “acquisition of spatially very-high-resolution earthquake observation data and development of the database by private-public partnerships” as a member in a national project or “Tokyo Metropolitan Resilience Project [https://forr.bosai.go.jp/e/].” As one of the topics, we have tackled estimation of seismic ground motions on the ground surface based on bore-hole seismic records observed at each MeSO-net station.

The point is as follows. First, a seismometer is installed on the ground surface at each MeSO-net station during two to three months and some earthquake observation records are obtained in addition to the bore-hole records at each MeSO-net station. And then, an observed frequency response function is obtained by calculating Fourier spectral ratios of records on the ground surface to ones in the bore-hole. Also, calculating JMA seismic intensity scale from records on the ground surface and ones of the bore-hole, increment of that is obtained. Secondly, a miniature and centerless array microtremor measurement is performed at each MeSO-net station. This method of measurement can be adopted principally for estimation of an S-wave velocity structure in the surface ground. It consists of 4-point miniature array with a radius of 60 centi-meters and 3-point centerless array with around 10 meters on a side. An S-wave velocity structure is estimated based on a disperse curve of a phase velocity and an H/V spectral ratio calculated from microtremor data. Then a transfer function can be obtained using 1-dimensional multiple reflection theory based on the S-wave velocity structure at each MeSO-net station. Finally, an S-wave velocity structure can be enhanced by tuning a transfer function based on an observed frequency response function at each MeSO-net station and the existing S-wave velocity structures and other geotechnical information can be enhanced based on S-wave velocity structures at MeSO-net stations.

In this project, we will develop the system for estimation of earthquake ground motions based on bore-hole seismic records by means of some amplification factors mentioned above. In this presentation, we will report on the results in the analyses of earthquake observation data and microtremor measurement ones at this moment.