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Estimation of underground structures using microtremors in the southern part of the Osaka Plain

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It is essential to evaluate an underground structure properly or validate previously proposed underground models based on the geological data and/or boring exploration data with observed ground shaking, in order to obtain highly precise estimation of strong ground motions in urban areas.

In this study, we observed microtremors in the southern part of the Osaka Plain in Japan where detailed geological information are comparatively less than the other areas of the Osaka Plain. We calculated H/V spectral ratio of microtremors (HVRM hereafter) from observed data and compared the predominant peak frequencies and amplitudes at these frequencies with theoretical HVRM calculated from our initial model. We searched for the better 1-D structure at each site based on these predominant frequencies and amplitudes.

In our identification approach we used the code that calculates theoretical HVRM for a given underground structure based on a newly proposed theory (Sanchez-Sesma *et al*., 2011). In this theory, HVRM at a site can be expressed in terms of a ratio of the imaginary part of the Green's function components at the site if the site is in the diffuse field.

First we calculated theoretical HVRM from the underground models at three strong motion stations of NIED using the code. By comparing the theoretical HVRMs with the observed HVRMs, we validate the theoretical calculation scheme and our estimation approach for an underground structure. As a result, we found that both theoretical and observed HVRMs show fairly good agreement, except for a site in a hilly zone with highly irregular topography. Therefore it is shown that if an observation point is on an alluvial plain with soft sediments, we are able to identify an underground structure close to the real structure at the point by fitting the theoretical HVRM to the observed HVRM.

Next, we identified both thicknesses and S-wave velocities of underground layers together. We used the grid-search method to identify the best underground structure that yields minimum residual between theoretical and observed HVRMs. As a result, theoretical HVRMs of the proposed models are a better match to those of observed HVRMs in both the predominant frequencies and the amplitudes at these frequencies than theoretical HVRMs of the initial models at all the observation stations.

After finishing our identification, we compared our results to previously proposed studies such as microtremor array observation conducted by the Headquarters for Earthquake Research Promotion, and H/V spectral ratio obtained from Rayleigh-wave ellipticity (HVRR hereafter), in order to validate the appropriateness of the newly proposed theoretical HVRM based on the diffuse field theory.

Finally we further studied a way to apply our identification results for estimation of strong ground motions. Considering the results of our modified underground models, which have different Vs structures at each site (that is, different-Vs models), we identified again underground models with the common Vs values in each layer at all the sites (that is, same-Vs models). As a result we found that we can use the same-Vs models as models for estimation of strong ground motions instead of the different-Vs models since the differences in 1-D amplification characteristics between them seem insignificant.

In this study, following the newly proposed theoretical HVRM based on the diffuse field theory, we could precisely identify the best underground structure by comparing observed HVRM and theoretical HVRM for an assumed underground structure.

We would like to estimate strong ground motions for hypothesized scenarios of earthquakes in future based on the underground structures proposed in this study. We also would like to extend our approach of microtremors for estimation of complex underground structures around faults with much dense sampling in space.

Keywords: microtremors, H/V spectral ratio, Osaka Plain, diffuse field theoy