Estimation of S-wave velocity structures of an irregular ground using H/V spectral ratio ~Case study in the middle coast of Miyazaki prefecture~

*Kyosuke Okamoto[1], Seiji Tsuno[1], Masahiro Korenaga[1]

1.Railway Technical Research Institute

S-wave velocity structures have been estimated from dispersion curves of phase velocity, H/V spectral ratios, etc., using microtremor exploration technique. However the estimations are originally based on the assumption that underground structures have stratified horizontally. So, if structures have irregular, e.g., layers incline or discontinue, the structures estimated under the assumption of horizontal stratification have errors to some extent due to perturbation of wave filed at the irregular. On the other hand, it has been known that seismic waves are likely to be amplified at the irregular structures since the various seismic waves interfere with each other. So, accurate estimation of the irregular structures is needed for disaster prevention. Seismic reflection and boring surveys are powerful tools to estimate the irregular structures since boundaries of the structure are directly imaged. However sometimes they have difficulties in cost and space for their application, especially surveys of a wide range of areas are limited. Here, we focus on H/V spectral ratios, which are relatively easy to measure a wide range of areas with a small budget, to estimate a dipping structure.

In this study, we applied microtremor explorations and observed earthquake ground motions (from Sep. to Nov., 2015) along Miyazaki maglev test line (Railway Technical Research Institute), where an irregular structure has been estimated by a preceding study, to examine the applicability of microtremor expirations to irregular structures. The microtremor explorations and the observations of earthquake ground motions were conducted at 8 points with about 290m intervals along a 2km survey line, whose center is the irregular point. We estimated S-wave velocity structures at each observation points by the SPAC method, and confirmed that the dipping structure exists at the location pointed out by the preceding study. We validated the structures estimated at each observation points by checking the similarity of the converted seismic waves on the basement. We also confirmed that the theoretical H/V spectral ratios of the observation points calculated by the multiple reflection theory agree with the observed H/V spectral ratios well. It suggests that H/V spectral ratios can illuminate the dipping structure. However, the theoretical and observed H/V spectral ratios disagree with largely each other around the edges of the dipping structure. One of the causes of this disagreement is that a complex wave filed is produced by reflecting waves, higher modes of surface waves, etc., at the dipping structure, and it cannot be accounted by the assumption of horizontal stratification.

To examine the original locations of the disturbance in the wave field, we synthesized the wave field using a numerical simulation using the estimated structure model. We divided the synthesized wave at the edges of the dipping structure into surface wave and the others (reflections, refractions and etc.), then, we calculated the original locations of the latter waves based on the method of back propagation. As a result, it was revealed that part of the dipping structure within one-wavelength from the issued receiver (here, the receiver at the edges) gives major effect in terms of the disturbance. We also confirmed that the H/V spectral ratio calculated using the divided surface wave agrees to the theoretical H/V spectral ratio, which is based on the assumption of horizontal stratification. It implies that the disturbance in wave fields (reflections, refractions, etc.) perturb the observed H/V spectral ratios.

In this study, we interpreted using a 2-D model. As a further discussion, it is necessary to consider 3-D effects.

©2016. Japan Geoscience Union. All Right Reserved.

Keywords: microtremor exploration, Earthquake ground motion, dipping structure

©2016. Japan Geoscience Union. All Right Reserved.