A method for constructing seismic velocity structure model for long-period ground motion evaluation - utilization of Rayleigh-wave dispersion information -

*Kei Masuda[1], Kazuo Yoshimoto[1], Shunsuke Takemura[2]

1.Yokohama City University, 2.National Research Institute for Earth Science and Disaster Prevention

Introduction

For the precise evaluation of long-period ground motions in the Tokyo metropolitan area, detailed sedimentary seismic velocity structure model of the Kanto Basin should be required. Recently, Yoshimoto and Takemura (2014) reported that, in the Kanto Basin, local sedimentary S-wave velocity structure in the vertical direction is practically characterized by using a simple three-parameter function (Ravve and Koren 2006). Takemura et al. (2015) demonstrated the effectiveness of this modeling in long-period ground motion simulations. Adopting this modeling technique, we propose a method for constructing a local sedimentary seismic velocity structure model by using Rayleigh-wave dispersion information from observed long-period ground motions and microtremor surveys, and check the effectiveness of our method based on numerical experiments.

Method for constructing sedimentary seismic velocity structure model

Suppose that the information on Rayleigh-wave phase velocity at a certain site is available from array analyses of long-period ground motions at long-period band (6-8 s) and from microtremor surveys at short-period band (1-3 s). The three-parameter function (parameters: S-wave velocity at the surface, S-wave velocity gradient in the vertical direction, and S-wave velocity increment at a sufficiently large depth) stated above could be reduced to a two-parameter function if we let the third parameter be equal to the S-wave velocity of bedrock (Yoshimoto and Takemura, 2014). Then, by adopting empirical relations among the density, P-wave velocity, and S-wave velocity, we can formulate inversion analysis of local sedimentary seismic velocity structure as a two-parameter problem, which is easily solved by using conventional grid-search technique.

Result of numerical experiments

We conducted a set of numerical experiments of our inversion method to confirm its effectiveness for the construction of sedimentary seismic velocity structure model. Using a sedimentary structure model of the Yokohama seismic observation well (Yamamizu 2004) as the test model, we investigated how many observations of Rayleigh-wave phase velocity are requited to obtain the precise inversion result. In our numerical experiments, for simplicity, we supposed that the Rayleigh-wave phase velocities were fully available at long-period band (6, 7, and 8 s) but limitedly available at short-period band (1 or 2 or 3 s). We used a software package developed by Herrmann (2013) to calculate the dispersion characteristics of Rayleigh wave.

Our numerical experiments demonstrated that when the Rayleigh-wave phase velocity at period of 1 s was available, the distribution of squared-residuals between input and calculated phase velocities showed a most localized pattern of the minimum residuals. This result indicates that, for the use of our two-parameter modeling technique, the information on Rayleigh-wave phase velocity at period of 1 s is very useful to estimate S-wave velocity at the surface. Based on our numerical experiments, we may conclude that the construction of local sedimentary seismic velocity structures for long-period ground motion evaluation could be easily carried out by our inversion method using Rayleigh-wave dispersion information from long-period ground motions and microtremor surveys.

In our presentation, we will discuss the noise stability of our inversion method and its estimation errors.

Keywords: long-period ground motion, sedimentary structure, Rayleigh-wave, phase velocity

