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Improvement of Three-Dimensional Velocity Structure Model of the Osaka Sedimentary Basin

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1. Introduction

In the Osaka sedimentary basin, southwest Japan, the three-dimensional velocity structure has been modeled by many studies (e.g., Kagawa et al., 2002; Horikawa et al., 2003; Osaka pref., 2005; Iwata et al., 2008) based on the geophysical and geological surveys and waveform modeling. For reliable and detailed strong motion prediction, precise or reasonable basin velocity structure model is indispensable because of its remarkable effects on the strong ground motions. We improved the basin velocity model by adding new observations and applying newly developed methodology to describe the model (Sekiguchi et al., 2012, 2013) under the Comprehensive Research Project on the Uemachi Fault Zone by MEXT. In this presentation, we report the improvement of the three-dimensional velocity structure model of the Osaka sedimentary basin.

2. Observations and Analyses

We have conducted the microtremor array observation for obtaining phase velocities at 6 sites in southern part of the Osaka basin (Yoshimi et al., 2012), single-station microtremor observation for obtaining H/V spectra at 100 strong motion stations (Asano et al., 2012a), continuous microtremor observation at 15 stations and seismic interferometry (Asano et al., 2012b), and the reflection survey along 2 lines (Iwata et al., 2012, 2013). We also collected strong motion records from seismic intensity observation network by Osaka prefectural government and other strong motion networks (CEORKA, K-NET, KiK-net, etc.), and used them to estimate PS-P travel time by the receiver function analysis (Horikawa, 2012) and to compare with the synthetic waveforms of moderate size events (Sekiguchi et al, 2012). We found that the velocity structure model needed improvement especially in the southeast of the basin, southern part of the Osaka Bay area, and northern edge of the basin.

3. Improvement of Vp and Vs Relationships

The P-wave velocity profile in Horikawa et al. (2003) is estimated by the empirical relationships among age of sediments, burial depth, and P-wave velocity. The age of sediments is estimated by the interpolation of six key layers (Ma10, Ma3, Ma-1, Fukuda tephra, Gauss-Matsuyama reversal, and top of Kobe group) and bedrock depths. We confirmed the empirical relationships proposed by Horikawa et al. (2003) by comparing the P-wave reflection survey data. The S-wave velocity and density profiles are estimated from the porosity and the P-wave velocity with the Gassmann's (1951) equations. The porosity is empirically given by the P-wave velocity and the burial depth following Matsumoto et al. (1998). We reviewed previous studies on the relationship between P-wave and S-wave velocities of the Osaka group, and found that the empirical relationship proposed by Nakagawa et al. (1996) fits well the PS logging data in the Osaka basin. In our final model, the P-wave velocity is given by the empirical relationship of Horikawa et al. (2003), the S-wave velocity profile is given from its P-wave velocity by the empirical relationship of Nakagawa et al. (1996), and the density is given based on Gassmann's equations.

We also include a new correction parameter of burial depth describing the effect of the erosion of the Osaka group. The S-wave velocity profile at near surface is improved especially in the southeast of the basin judging from the observed high frequency phase velocity of the microtremor survey.

4. Revising the Bedrock and Key Layer Model

After reconstructing the initial model following the method proposed by Sekiguchi et al. (2013), we revised the bedrock and key layers depths to fit the observed phase velocities, dominant period of H/V spectral ratios, and PS-P travel times. We will check the improved model based on the three-dimensional ground motions simulations of the moderate size events and the inter-station Green's functions.

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Keywords: S-wave velocity, strong ground motion prediction, Uemachi fault, H/V spectra, ambient noize survey, receiver function analysis