論文内容の要旨

論文題目　Integrated Velocity Structure Modeling
by Inversions of Multiple Datasets

(多元的インバージョンによる統合化地下構造モデルの構築)

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It is important from the viewpoint of disaster prevention to accurately simulate strong ground motions from a large earthquake. For this purpose, we need detailed information of velocity structures. In this study, we build a procedure to construct an integrated velocity structure model by inversions of multiple datasets such as results of geophysical explorations and observed seismograms of natural earthquakes.

The Kanto basin is the largest sedimentary basin in Japan, where the Tokyo metropolitan area is situated. Several models have been proposed using various kinds of data such as refraction/reflection, borehole, microtremor, and gravity data. For example, Koketsu and Higashi (1992) obtained the topography of the basement using refraction data, and Yamanaka and Yamada (2002) estimated the layered structure using borehole and microtremor data. These studies are based on only a single kind of velocity structure data. On the other hand, Afnimar *et al.* (2002) proposed an integrated velocity structure model by a joint inversion of refraction and gravity data. We first performed this joint inversion, including data from latest large-scale refraction surveys. We then, using this result as an initial model, conducted inversions of data from observed seismograms for an integrated velocity structure model.

In 2002 to 2005 the Special Project for Earthquake Disaster Mitigation in Urban Areas (DaiDaiToku project) conducted large-scale reflection/refraction surveys along the Boso, Tokyo Bay, Sagami, Kanto West, and Northern Kanto lines, and new refraction data were obtained during these surveys. We next estimated the velocity structure by the joint refraction/gravity inversion method of Afnimar *et al.* (2002) including these new data. Borehole data were used as constraints and the Shimosa/Kazusa interface was fixed to the result of microtremor surveys by Yamanaka and Yamada (2002). We have constructed the velocity structure model consisting of the three sedimentary layers

(Shimosa, Kazusa and Miura layers) and the basement, by determining the depths of the Kazusa/Miura and sediment(Miura)/basement interfaces and the basement velocity distribution. We obtained the model by minimizing the residuals of travel times and gravity data, with borehole data used as constraints. Compared with the velocity structure model made by Suzuki (1999) using geological information and borehole data, for the obtained refraction/gravity integrated model, the thick-sediment zone in the Boso peninsula moved to the north, and the sediments became thinner in the southwestern part of the basin and thicker in northwestern part. We then compared with the previous model (Afnimar, 2002) by the joint inversion method, the thick-sediment zone in the Boso peninsula further extends to the north and the bottom of the zone became much deeper.

We then used the obtained layered model from the joint refraction/gravity inversion and *S*-wave velocities from *S*-wave refraction and microtremor surveys as the initial model, and constructed a *S*-wave velocity structure model by the HZ ratio inversion method of Tanimoto and Alvizuri (2006) and Rayleigh wave data. We used long-term continuous observation data at F-net stations of the National Institute for Earth Science and Disaster Research (NIED), but also event data at K-NET stations of NIED, to verify the applicability of the HZ ratio inversion method for the velocity structure modeling in the Kanto basin. We extracted Rayleigh wave dominant parts from observed waveforms, and refined the velocity structure model by minimizing the residuals between observed horizontal/vertical spectral ratios (HZ ratios) and calculated HZ ratios. In this study, for determining the depths of interfaces we converted the calculated velocity correction at each depth into the depth correction at each interface, and reconstructed the velocity structure model as a new initial model, then repeatedly conducted the inversion. From this procedure, we obtained the integrated velocity structure model consistent with the refraction, gravity, borehole, and microtremor data as well as earthquake waveform data.

We finally combined the obtained one-dimensional structure models under the stations of F-net and K-NET widely distributed in the Kanto basin, into the three-dimensional integrated velocity structure model. Compared with the model of the refraction/gravity inversion, the thick-sediment zone in the final model was widened, and the Miura layer (third sedimentary layer) became thicker.

For the validation of the obtained integrated velocity structure model, we conducted a ground motion simulation for a medium-size earthquake. We used velocity seismograms observed at K-NET stations for a moment magnitude 5.7 earthquake, occurred on May 3, 1998, east off the Izu peninsula. The obtained integrated model was combined with the crustal model in Afnimar (2002) and the Philippine Sea Plate model. For the Philippine Sea Plate model, we used the models of Baba *et al.* (2006) and Sato *et al.* (2005) with corrections by the seismicity distribution and sea floor topography around the basin. We computed ground motion waveforms by the voxel FEM of Koketsu *et al.* (2004), and the simulated waveforms fairly agree with the observed ones. In particular, the agreement in amplitudes is found to be improved, if we compare it with the agreement between the observed waveforms and ones simulated for the velocity structure model without the tuning by the HZ ratio method. This improvement confirmed the effectiveness of the HZ ratio method in velocity structure modeling for strong ground motion prediction.