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An evaluation of 3-D velocity models of the Kanto basin for long-period ground motion simulations

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Many institutes are involved in constructing and updating the 3-D velocity structure model of the deep sedimentary basins for the seismic disaster mitigation planning in Japan. The 2009 J-SHIS model for the deep sedimentary layers of the Kanto basin was reconstructed using diverse suite of data: the geological data, seismic reflection and refraction surveys, gravity surveys, H/V inversions, deep borehole profiles, and layer boundaries estimated by microtremor exploration method (e.g., Fujiwara et al., 2006). On the other hand, Yamada and Yamanaka (2011) introduced a new model (hereafter YY model) for the deep sedimentary layers of the Kanto basin based on the Rayleigh wave phase velocities at periods from 0.5 to 5 s deduced from the microtremor array observations at more than 250 sites in the area. There exist also other velocity models of the Kanto basin based on refraction data and geological data.

In this paper, we select the 2009 J-SHIS model and the 2011 YY model to evaluate their performance for the long-period ground motion simulation. We simulate waveforms in the period range of 2 to 10 s (0.1 ˜ 0.5 Hz) for two moderate magnitude intermediate depth earthquakes: Mw 5.9, depth 68km (2005/07/23, 16:35, JST); and Mw 5.8, depth 80km (2011/04/16, 11:19, JST), which occurred beneath the Kanto basin, using a 3-D finite difference method. We used strong-motion records at about 600 and 450 sites to evaluate the models for the 2005 and 2011 events, respectively, recorded by the K-NET, KiK-net, and SK-net. For details about the earthquake source parameters, velocity models, waveform simulations, and goodness-of-fit measure, we refer readers to our previous paper (Dhakal and Yamanaka, 2012) and references therein.

We derived the goodness-of-fit (gof) values from the PGVs and Fourier spectra using the algorithm proposed by Olsen and Mayhew (2010). We found that more than 95% of sites belong to the fair fit and above for both the models for the 2005 event, and 85% for the 2011. The J-SHIS and YY models give one class high gof values at about 20%, and 15%, respectively, of about 600 sites used in this study, suggesting that one model performs better than the other at those sites.

In this paper, we extended the goodness-of-fit analysis in our previous paper to the cross correlation measure. We obtained cross correlation at 105 K-NET and KiK-net sites, which are located in the basin, for the 2005 event. The waveforms are shifted to match the S-wave arrivals. We found that, for a time window of 20s, starting from 10s before the S-wave, 76% and 79% of sites belong to the class of fair fit and above for the EW component, which had dominant amplitude over other components, for the J-SHIS and YY models, respectively. On the other hand, for a time window of 70s, starting from 10s before the S-wave, 62% and 51% of sites belong to the class of fair fit and above for the J-SHIS and YY models, respectively.

The above results suggest that the two models perform somewhat differently and need further revision. Also, an improved model can be obtained by integrating the two models.

Acknowledgement
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Reference
Dhakal, Y. P. and Yamanaka, H., 3-D Finite Difference Simulation of Long period Ground Motions for the Performance Analysis of two Subsurface Velocity Models of the Kanto Basin Using Moderate Magnitude Earthquakes,Joint Conference Proceedings, 9th International Conference on Urban Earthquake Engineering/ 4th Asia Conference on Earthquake Engineering, March 6-8, 2012, Tokyo Institute of Technology, Tokyo, Japan.

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