A study on construction and verification of 3-D basin structure model for strong ground motion estimation in the Ohmi basin, Japan

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We propose a three dimensional sedimentary basin structure model and verify this three dimensional model by strong ground motion simulation in the Ohmi basin, Shiga prefecture, Japan. High population areas in Shiga prefecture are located in the Ohmi sedimentary basin, belt-like zone between mountain foot and Biwa lake shore. Basin effects, such as ground motion amplification, basin-induced surface waves, and basin-edge effect, are important for estimating ground motions of population area in Shiga prefecture. We collected geophysical exploration data and conducted additional surveys to compose a three dimensional sedimentary structure model in the area. The underground structure model was verified with forward waveform simulation of observed ground motions of moderate-size earthquakes.

There are many seismic reflection surveys conducted to search natural resources in the lake Biwa. On the contrary, underground structure information in land area is limited. Here, we conducted microtremor array surveys in five areas to obtain S-wave velocity structure. We also referred three seismic reflection survey data, conducted by Shiga National Highway Office to cover scarce information zones. First, we composed a three dimensional bedrock depth model in the Ohmi basin. Geologically assumed underground structure model is useful for the area where any geophysical explorations were not conducted, we referred schematic cross section assumed from surface geological information. We employ a modeling method with a sequence of 2-D 3rd order Spline functions as used in modeling the Osaka sedimentary basin [Kagawa et al.(BSSA, 2004)].

We assumed horizontally stratified layers for the sediment referring seismic reflection profiles in the area. In this modeling, the shallower bedrock surface area has slower average S-wave velocity of the sediment from surface to bedrock. This might cause that large amplification would be occurred in the area where the sediment is thinner, like basin edge, because of the high impedance contrast between the sediment and the bedrock.

Next, we simulated wave propagations of two moderate-size earthquakes using three dimensional finite difference method with the proposed basin structure model. One is MJ 5.1 earthquake occurred in the west coast area of the lake Biwa, and the other is MJ4.2 event in the north-east portion of Shiga prefecture. In the calculation area, there are many ground motion records not only by the national strong ground motion network (K-NET), but also by the fifty-one seismic intensity observation sites maintained by Shiga prefecture. The simulated waveforms show typical characteristics of the observed wave traces both in amplitudes and durations. However, the model could not explain well about some phases in the observed records.

A three dimensional basin structure model proposed in this study has already been used for a project to estimate strong ground motions in Shiga prefecture for earthquake disaster mitigation. Fortunately we could use acceleration waveforms recorded by seismic intensity meter carefully maintained by Shiga prefecture. Denser ground motion records can help to evaluate the applicability of the underground structure model for ground motion simulation of the scenario earthquake. We should continue gathering additional exploration data and revising the basin structure model for more accurate ground motion estimation in the area.

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