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Basin and crustal structure model for estimation of long period ground motion

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Effects of sedimentary basin and crustal structure model on long period ground motion estimation are discussed in this study. Surface waves are dominant in the long period ground motions, they affect on the far field sedimentary basins, and in turn they are strongly affected by the propagation path and local ground conditions. Structure models of crust and sedimentary basins between the source fault and a target site take important role to estimate the long period ground motions.

We show a model of sedimentary basin and crust in South West Japan. An idea of multi-spline function is used for modeling layer boundary depth distributions from exploration results. It can generate depth structure at any modeling point. Physical parameters are assumed uniform in each layer; however, fluctuation of each parameter is required to be introduced as next step. Another alternative is to apply a grid modeling that can be directly used for 3-D finite difference calculations. The grid modeling is effective in case that we have much more information about the sedimentary and crustal structures. We discussed the merits and demerits of the two types of modeling techniques.

We checked the effect of water layers (and/or topography of sea bottom) for simulations of the Tonankai and Nankai earthquakes assumed in near future. Supposing focal depths of asperities of the earthquakes, the effect of water layer on the ground motions in inland area is not so large. This assertion contributes to economize computer resources for simulating the plate boundary earthquakes. Effect of inland topography is also important to consider. Usually we assume a simple flat surface - irregular layer boundary model without surface topography. Another alternative to treat this problem is to combine the flat surface and the boundary layers having depths corrected for topography in mountain area. It can be easily realized using DEM (Digital Elevation Map) database. Effectiveness of such modeling should be confirmed through the wave propagation simulation comparing with the observed waveforms.

Amplifications by surface alluvial layers are usually explained by empirical relationships based on AVS30 (Average Velocity of Shear wave down to 30m). However, long period amplifications are considered to be different from the empirical relationships. It is better to evaluate layered response accurately, using model structures. In case of deep sedimentary basins, predominant period of surface layers may exceed one second, considering nonlinear site response. We can use information of the borehole database for modeling shallow sedimentary structure. In some regions, huge databases of borehole information are developed recently. However, the data of PS logging are rare and the data of nonlinear soil response are extremely rare in the databases. In addition, we have to be careful selecting borehole data, especially in the bay area. Many of them are based on the original soil structure before the reclamation; we cannot use such data. Using well combined shallow and deep sedimentary structure models we can simulate a spectral site response that agrees well with the observed ground motions. Vertical wave propagation is usually assumed for site response evaluation, however laterally propagating surface waves take important role in long period ground motion. Last phenomenon also should be considered.

Integrating the studies above, we resume the present stage of the sedimentary and crustal structure modeling for long period ground motion estimation. We also mention future necessary tasks to make more accurate structure modeling for ground motion simulations.