Verification toward large-scale ground motion calculation using the supercomputer Fugaku: Benchmark test on a structure model with surface topography and a sedimentary basin

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The Supercomputer Fugaku started full-scale operation on March 2021 and the Ministry of Education, Culture, Sports, Science and Technology established the Program for Promotion Researches on the Supercomputer Fugaku. In “Large-scale numerical simulation of earthquake generation, wave propagation and soil amplification”, one of the projects in the program, a large-scale finite element method (FEM) called E-wave FEM (Ichimura et al., 2009, 2014, 2015) have been developed to apply the method for earthquake ground motion simulation of a future giant subduction zone earthquake for a damage evaluation.
Earthquake ground motion simulation considering a complex 3D velocity structure is also useful for evaluating input ground motions for seismic design for high-rise and/or base-isolated structures with long natural periods. Currently, in most case the finite difference method (FDM) is used for such evaluation because of the simplicity of the method. On the other hand, FEM has an advantage that it can precisely model a complex structural boundary including surface topography, but it is less frequently used because of the high computational cost and time-consuming mesh generation process. However, recent developments of supercomputers, fast calculation algorithm, and automatic robust mesh generation tools (Ichimura et al., 2009, 2014, 2015) are compensating these shortcomings and utilizing FEM for evaluating input ground motions for seismic design is expected.
Therefore, we have been performing verification of E-wave FEM and FDM. We performed benchmark tests using a structure with surface topography or a sedimentary basin (Kobayashi et al., 2021a, AIJ annual meeting; 2021b, JAEE annual meeting). Here, we performed a benchmark test using a structure model with surface topography and a sedimentary basin (Figure. 1). First, we performed simulations using typical mesh or grid size considering the seismic velocity of the model. The results of the two methods generally agreed with each other but there were small differences. Thus, we additionally performed the simulations while ignoring the inelastic attenuation or changing the mesh/grid size. We will report the details of the model condition and the results of the additional simulation in the presentation.

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Keywords: Earthquake ground motion simulation, Finite element method, Finite difference method, Benchmark test

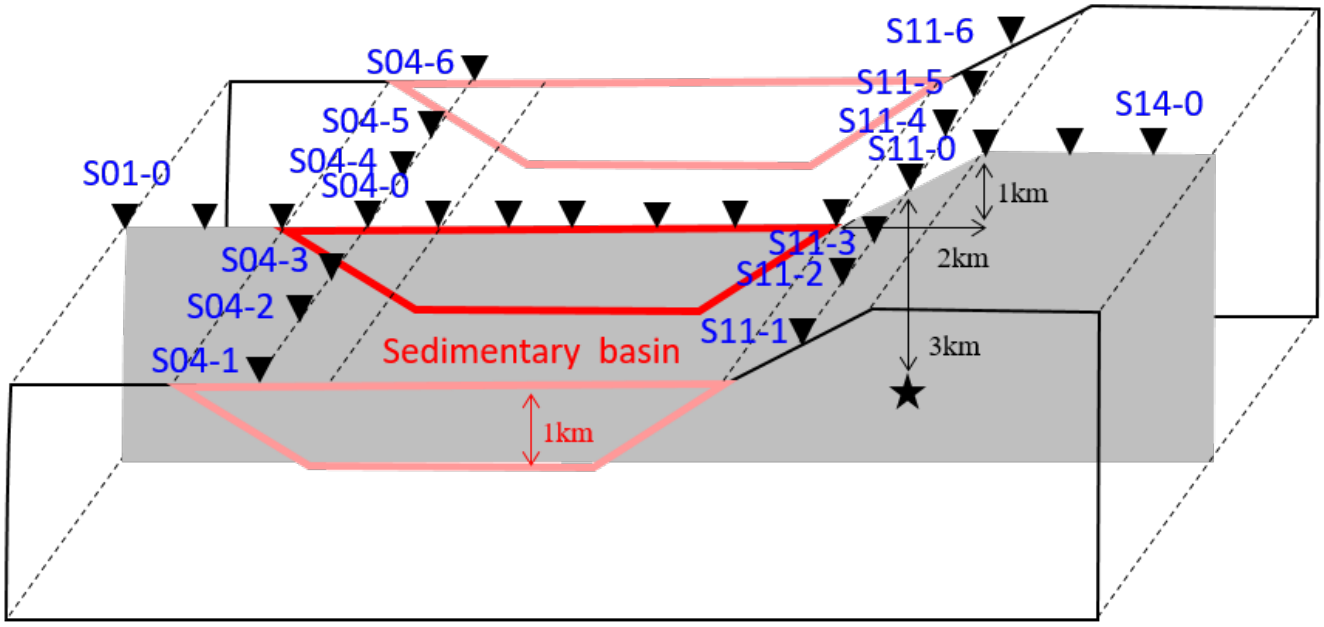

Figure 1. Schematic figure of the model

