Development of the Simulation Technology for Strong Ground Motion Applicable to High Frequency Component in a Basin Area

Project Representative

Hongjun Si

Kozo Keikaku Engineering Inc.

Authors

Reiko Tajima[*1], Yusuke Saijo[*1], Toshiyuki Masatsuki[*1], Hongjun Si[*1] , Yuichi Hirokawa[*2]

＊1 Kozo Keikaku Engineering Inc.

＊2 Japan Agency for Marine-Earth Science and Technology

Abstract

It is effective in mitigating earthquake disaster to predict strong ground motion from theoretical seismic wave simulation, and to take countermeasures against the results. Also the waveform simulation covering the broadband frequency range is recently required to perform precise estimation of strong ground motion. The long-period ground motions generated by moderate to large earthquakes are especially remarkable in large plains and basins, such as the Kanto Plain. It is desirable to calculate the seismic wave propagation by a theoretical method using an accurate seismic source model and a realistic 3-D structural model. However it is difficult to perform the simulation using normal PC cluster system due to the limitation of computing ability. In addition the calculation of short-period seismograms ($f \geq 1$ Hz) which affect damage during strong-motion earthquakes becomes difficult to explain the observed waveforms because of effects of small fluctuations of physical properties in the lithosphere and the complicated scattering in the surface structure during wave propagation.

In fiscal 2009 and 2010 we ported the parallel code of Finite-Difference method, k-fdm3d, for numerical simulation of seismic wave propagation based on the physics of seismic source and elastic wave theory to the Earth Simulator, and performed code tuning to adopt the large-scale simulation. Using the code we carried out large scale simulations of seismic wave propagation for a scenario earthquake on the Uemachi Fault (M 7.5) in the Osaka Basin and the 1923 Kanto earthquake (M 7.9) in the Kanto Plain.

In this fiscal year we performed the simulation ($f \leq 2$ Hz) for the moderate earthquake (Mw 4.6) using a 3-D structural model which has stochastic random heterogeneity in the lithosphere for both crust and mantle structure with fluctuations of seismic velocity and density that enhance the scattering of high-frequency signals in the Kanto Plain, to improve the calculation precision of short-period ground motion. We also examined a solution to instability in the numerical calculation of wave equation which was occurred during last fiscal year's project to obtain the analysis know-how.

Keywords: Wave Propagation, Finite-Difference Method, the Kanto Plain, Random Medium