Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS26-05 Room:102B Time:May 21 10:00-10:15

Tsunami simulation using submarine displacement calculated from simulation of ground motion due to seismic source model

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Since fault fracturing due to an earthquake can simultaneously cause ground motion and tsunami, it is appropriate to evaluate the ground motion and the tsunami by single fault model. However, several source models are actually used independently according to whether the ground motion is evaluated or the tsunami, because of difficulty in evaluating both phenomenons simultaneously.

Many source models for the 2011 off the Pacific coast of Tohoku Earthquake are proposed from the inversion analyses of seismic observations or from those of tsunami observations. Most of these models show the similar features, which large amount of slip is located at the shallower part of fault area near the Japan Trench. That indicates that the ground motion and the tsunami can be evaluated by the single source model.

In this study, we try to carry out the tsunami simulation using the displacement field of oceanic crustal movements, which is calculated from the ground motion simulation of the 2011 off the Pacific coast of Tohoku Earthquake. First, the large-scale ground motion simulation based on the voxel type finite element method is performed for the whole eastern Japan. The fault model based on the teleseismic body wave, which is constructed by the Japan Meteorological Agency, is assigned to the source region. The synthetic waveforms by the simulation are generally consistent with the observation records of K-NET and KiK-net. Next, the tsunami simulation is performed by the finite difference calculation based on the shallow water theory. The initial wave height for tsunami generation is estimated from the vertical displacement of ocean bottom due to the crustal movements, which is obtained from the ground motion simulation mentioned above. Although the results of tsunami simulation show that synthetic waveforms are fairly consistent with the observations of the GPS wave gauges, the comparisons of synthetics and observation show that the tsunami simulation in this study underestimates the maximum wave height in most observing stations.

Although the results of these simulations generally indicate the possibility that a phenomenon of tsunami can be evaluated using the source model from seismic analysis, there remain difficulties in evaluation of the tsunami maximum wave height, which is one of the most important issues in disaster prevention.

Keywords: the 2011 off the Pacific coast of Tohoku Earthquake, tsunami, ground motion, source model, simulation