Accurate evaluation of ground motion and tsunami due to the synchronization occurrence of the Nankai-Trough earthquake

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1.Introduction

The influence of the synchronization occurrence of the Nankai Trough mega-thrust earthquake is not simply in extending the earthquake disaster area along the earthquake source region. When the source magnitude exceeds M8.0 due to the synchronization occurrence of the earthquake, the radiation of long-period ground motions of more than 6-12 sec should be strengthened very significantly, causing serious impacts on large-scale constructions such as high-rise buildings etc. The subsidence of the coastline caused by the large earthquake also expands tsunami damage. Therefore it is important to conduct broadband simulation of seismic wave propagation including long-period ground motions and the earthquake diastrophism. Moreover, the cooperation of the seismic ground motion simulation and the tsunami simulation is indispensable for a highly accurate evaluation of the earthquake generated tsunami.

2.An integrated simulation of ground motion and tsunami

We newly developed an integrated simulation of ground motion and tsunami. Firstly the seismic wave propagation in 3-D heterogeneous structure and resulting deformation of sea floor are calculated by solving equation of motions. Then the result of simulation in terms of the resulting spatial-temporal deformation of the seafloor is used as input motion of tsunami simulation that solves 3-D Navier-Stokes (N-S) equations. By employing an appropriate boundary conditions at sea surface, the above two finite-difference method (FDM) simulations of ground motion and tsunami can be connected very easily. For large-scale simulations, a parallel calculation code based on the domain-partitioning procedure was developed, and it calculated on the Earth Simulator and the T2K Opening Super Computer at The University of Tokyo. In most tsunami simulation, the sea-level change, that is, an initial tsunami is assumed to be identical to the sea bottom deformation. However, in our simulation the initial tsunami at sea surface due to sea bottom change can be simulated accurately by solving 3-D N-S model. Then the spreading of tsunami in surrounding regions as time increase can be simulated accurately by the 3-D tsunami simulation.

3. Ground motion and tsunami simulation for the 1944 Tonankai and 1707 Hoei earthquake

Long-period ground motions and the tsunami of the 1944 Tonankai (M7.9) and the 1707 Hoei earthquake (M8.4) were evaluated. The earthquake fault model derived by Yamanaka (2004) and Annaka (2003) is based on the analysis of strong ground motion and the tsunami data, respectively.

The level of long-period ground motions developed by the synchronization occurrence of the Nankai trough earthquake (Hoei event) greatly enhance the level and the duration of the long-period ground motions at period of about 3-6s which is at least twice or more longer in the area of Nagoya. Moreover, the area of the subsidence and the amount of the upheaval level is twice or more besides over a wide range from Shikoku on Suruga Bay along the Pacific coast of the source region. Therefore, a huge tsunami is expected to occur along the area from the Hyuga-nada to Kanto region.

The distribution of the bottom deformation obtained by the 3-D ground motion simulation is compared with the conventional modeling using a homogeneous half-space model. It is found that the area of the upheaval and the subsidence on the bottom is much localized and complicated using the 3-D structural model of the Nankai Trough. The propagation of tsunami in deep sea of the Nankai Trough produces significant dispersion in the tsunami waveforms. However, such dispersion of tsunami cannot be correctly simulated by the conventional tsunami simulation based on the long-wave (shallow water) theory.