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SSS37-11 Room:303 Time:May 21 11:45-12:00

Long Period Ground Motion Simulation of the 2011 off the Pacific coast of Tohoku earthquake (Mw9.0)

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1. Introduction

On 11 March 2011, Japan was struck by a massive Mw 9.0 subduction zone earthquake whose epicenter was off Miyagi Prefecture in the Tohoku region (the 2011 off the Pacific coast of Tohoku earthquake).The seismic ground motions of this earthquake caused severe damage and casualties over a wide area from Tohoku into the Kanto region. The long-period ground motions associated with this earthquake had less effect on high rise buildings than one would expect from the scale of the event. Nevertheless, skyscrapers suffered some ceiling collapses and damage to internal furnishings, elevators and other equipment. It is important to estimate the amplification characteristics, attenuation characteristics and other propagation parameters of the long-period ground motions associated with this earthquake to investigate measures that can be taken against such ground motions in future huge earthquakes. Our objective of this study is to investigate how well the observed long-period ground motions during the earthquake are reproduced using our source model (Kawabe et al., 2011) and the 3D subsurface structure model proposed by the Headquarters for Earthquake Research Promotion (HERP).

2. Ground Motion Simulation

We used our source model (Kawabe et al., 2011) composed of five strong motion generation areas (SMGAs) located on the sea off Miyagi, south Iwate, Fukushima and Ibaraki Prefectures. The effective period of our source model was 0.1 to 10 sec. We used the subsurface structure model presented on the HERP website (HERP model). The subsurface model was used in the 2009 version of the Long-Period Ground Motion Hazard Map published by HERP. Ground-motion simulations were performed using the 3D finite-difference procedure presented by Pitarka (1999). The algorithm is accurate to fourth order in space and second order in time. The finite-difference model covers an area of 412 km (east-west direction) $*$ 471 km (north-south direction), and extends to a depth of 100 km. The grid spacings were 0.3 km horizontally and 0.1 to 0.6 km vertically, and the time step was 0.0075 sec. The effective period of the simulation was 3 to 10 sec. because of the values of the finite-difference grid spacing, the physical parameters of the subsurface structure model and the effective period of our source model.

3. Results

Figure 1 compares the observed waveforms with the synthetic waveforms. Overall, the propagations of seismic ground motion (such as the arrival time and duration) from the north into the Kanto basin were reproduced. A more detailed look at these results indicates that the amplitude of the principal motions and shape of the wave packet are reproduced from station MYGH12 in Miyagi Prefecture to IBR012 in Ibaraki Prefecture, but the amplitude of the later phase of the synthetic waveforms is somewhat lower than that of the observed ones. The synthetic waveforms of the NS component of the principal motions are overestimated for all of the observation stations in the Kanto basin south of the SIT010 station in Saitama Prefecture. However, the velocity amplitudes of the EW and UD components correspond well to the observed values. The later phase amplitudes of the synthetic waveform are lower than the amplitudes observed at the stations in Kanto basin. One possible reason for this is that the source model was composed of only five SMGAs, the radiation of ground motions from the other source region was not assumed. It is also possible that the attenuation parameters in the sedimentary basins might be incorrect. These factors will be investigated in a future study.

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Keywords: 2011 Tohoku-Chiho Taiheiyo-Oki Earthquake, strong ground motion, source model, strong motion generation area, finite difference method

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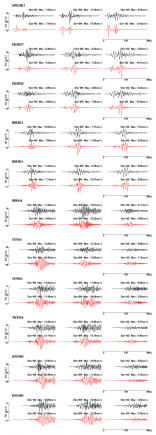

Figure 1 Comparison of Observed (Black Lines) and Calculated (Red Lines) Waveforms for Finite-Difference Simulation (Band Pass Filter: 0.1–0.33 Hz).