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

SSS37-P09 Room:Convention Hall Time:May 21 15:30-17:00

Long-period strong motion simulation of the 2011 Tohoku earthquake based on revised empirical attenuation relations

SATOH, Toshimi[1*], Izuru OKAWA[2], Takao NISHIKAWA[3], Toshiaki SATO[4]

[1]Ohsaki Research Institute, [2]Building Research Institute, [3]Tokyo Metropolitan University, [4]Shimizu Corporation

Satoh et al.(2010) proposed the method to calculate long-period strong motions in the period range from 0.1 to 10 seconds based on empirical attenuation relations of the acceleration response spectra with 5% damping and the average and variance of the group delay time for development of the design long-period ground motion for long-period buildings. In this study we revise the empirical relations and simulate the long-period strong motions of the 2011 Tohoku earthquake (Mw9.0).

In the revised empirical relations we add 18 subduction-zone earthquakes with M_J>6.5 and focal depth < 60km from August 2007 to May 2011 including foreshocks and aftershocks of the Tohoku earthquake. The JMA 95-type records in the Kanto plane, the Nobi plane and the Osaka plane are added with K-NET and KiK-net records.

The empirical relation of the acceleration response spectra by Satoh et al.(2010) was modeled by only Mw as the source term. In addition the average characteristics of all earthquakes in Japan were modeled in the attenuation factor and the amplification factor at each station. In this study we first develop six cases (case-1 to case-6) of empirical relations. We regard the case-4 as the best case by comparing the long-period strong motions simulated based on six cases of the empirical relations with the restored records of the 1944 Tonankai earthquakes (Midorikawa et al.,2006;Furumura and Nakamura,2006) and the previous long-period strong motions simulated based on the theoretical method or the empirical Green's function method. In the case-4 Mw^2 term and the difference of the amplification factor at each station on deep sediments in the Kanto plane and the attenuation factor and between earthquakes on the boundary of the Pacific plate and the Philippine sea plate are considered and the main shock records are not included. The stations of deep sediments in the Kanto are defined as stations where the natural period of the one-dimensional amplification factors from the seismological bedrock to the engineering bedrock calculated from the model structure by HERP(2009) are greater than 4 seconds based on the study by Satoh et al.(2011). Here we use the revised empirical relations of the average and variance of the group delay time considering the difference of the amplification factor at each station on deep sediments in the Kanto plane and the attenuation factor between earthquakes on the boundary of the Pacific plate and the Philippine sea plate. The simulations by the case-5 and case-6 including the main shock records tend to underestimate the records and the previous simulated waves.

We simulate long-period strong motions of March 9, off the coast of Sanriku foreshock (Mw7.4), March 11, off the coast of Ibaraki largest aftershock (Mw7.8) and the main shock based on the revised empirical relations. The long-period strong motions of both the foreshock and the aftershock are well simulated. For the main shock we set outer-fault parameters based on the source model composed of strong motion generation areas estimated by Satoh(2012) using the empirical Green's function method. Three faults are assumed and the outer-fault parameters are set assuming the cascade model. We first set the static stress drop and calculate the outer-fault area from both the stress drop and the area of the strong motion generation area for each fault. Then the seismic-moment of the outer-fault from the outer-fault area and the static stress drop. As a result the long-period strong motions of the main shock are reasonably reproduced assuming the static stress drop of 3 MPa. However, the strong motions in the period greater than 5 seconds are slightly over estimated. The main reason is that the Mw of three faults are 8.4, 8.8, and 8.1 although the maximum Mw of the data used in the empirical relations is 8.2. We will examine the sensitivities at simulations by considering the upper limit of Mw.

Keywords: long-period ground motions, empirical attenuation relations, the 2011 Tohoku earthquake, simulation, Mw2 term