Ground motion prediction for the Nankai & Tokai earthquake - Seismic slip distribution based on seismic intensity data

Katsuhisa Kanda[1], Masayuki Takemura[1], Tatsuo Usami[2]

[1] Kobori Res. Comp., Kajima Corp., [2] Non

1) Objectives

The Nankai and Tokai Earthquakes have been predicted for their occurrence in the near future. However, the detailed information such as magnitude and fault mechanism of imminent earthquakes is not so clarified. At present, we have no idea concerning the characteristics of earthquake except historical earthquake data.

The slip distribution of the Showa-Tonankai Earthquake in 1944 and the Showa-Nankai Earthquake in 1946 was studied based on the waveform inversion analysis with tsunami and geodetic data (e.g. Tanioka and Satake, 2001). Since these earthquakes have been occurred recursively in some interval, their historical data should have important information to solve the characteristics of earthquakes in the future. However, there are no detailed tsunami and geodetic data for old earthquakes occurred before Meiji era. It is necessary to look for a different method.

As for Ansei-Tokai and Ansei-Nankai Earthquakes in 1854, the seismic intensity data was evaluated based on the old documents concerning earthquake damage. These data are quite significant to know the ground motion distribution and useful to identify the fault characteristics.

This study shows the inversion methodology of seismic slip distribution based on seismic intensity distribution data and shows the analytical results for the Ansei-Tokai and Ansei-Nankai earthquake. The seismic slip distribution of the Showa-Tonankai and Showa-Nankai earthquakes from the same method is compared to the past results based on tsunami waveform inversion.

2) Analytical methodology

The seismic intensity is estimated from attenuation equation in terms of logarithms of hypocentral distance. The attenuation equation is obtained from regression analysis with the seismic intensity data of recent moderate earthquakes. The fault area is divided into small sub-regions weighted with radiated energy, and the equivalent hypocentral distance adopted for the expansion of seismic fault is estimated (Ohno et al., 1993).

The optimized radiation energy of each sub-fault is calculated using the minimum square sense method to minimize the error of evaluated seismic intensities compared to observed value. The constraint condition is applied so that the radiated energy does not vary rapidly among neighbor sub-faults. The relative seismic intensity is utilized in order to consider the amplification of surface soil. It is evaluated as the average value of observed seismic intensity minus estimated intensity from attenuation equation from measured seismic intensity data of recent moderate earthquakes, and it shows the amplification of ground shaking at each point. The estimated radiated energy is supposed to be corresponding to seismic slip distribution.

3) Analytical results

The slip distribution of the Showa-Nankai Earthquake obtained from the present method corresponds to that from tsunami waveform inversion. It shows three areas of large slip known as asperities at the west of Kochi, the Kii channel and the south of Kii peninsula in the seismic fault. The result of the Ansei-Nankai Earthquake shows similar slip distribution except significant asperity at the south of Kii peninsula. It is supposed that Nankai earthquakes with the similar slip distribution recur in some interval.

It is indicated that there is some discrepancy in the fault mechanism of the Tokaido earthquakes between the Showa-Tonankai Earthquake and Ansei-Tokai Earthquake. The asperities of the Showa-Tonankai Earthquake are located along the coastline of Mie through Hamamatsu, but the Ansei-Tokai at the coast area of Suruga Bay.