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Ground Motion Prediction of Finite Rupture Subduction Earthquakes using the Ambient Seismic Field

VIENS, Loic[1*] ; KOKETSU, Kazuki[1] ; MIYAKE, Hiroe[1] ; SAKAI, Shin'ichi[1] ; HIRATA, Naoshi[1] ; HONDA, Ryou[2]

[1]Earthquake Research Institute, University of Tokyo, [2]Hot Springs Research Institute of Kanagawa Prefecture

The ever-increasing construction of large-scale structures such as high-rise buildings, oil tanks, and suspension bridges requires an accurate prediction of long-period ground motions (4-10 s) for seismic hazard assessment. The slow attenuation with distance of the long-period ground motions combined to possible amplification in sedimentary basins can lead to large damages as those observed during the 1985 Michoacan earthquake (M_w 8.0) where more than 1000 buildings were destroyed in the Mexico city located at more than 300 km from the hypocenter. We focus this study on the Kanto basin where the Tokyo city is located. In the basin and its surrounding, more than 600 stations composed of 3 component seismometers recording continuous data have been selected. These stations are a part of different networks including the Metropolitan Seismic Observation network (MeSO-net), Hi-net and F-net of NIED, the Japan Meteorological Agency (JMA) network, and the Hot Spring Research Institute of Kanagawa Prefecture network. Stations located above the 1923 Kanto earthquake rupture area have been considered as virtual sources and others as receivers. Deconvolution method has been applied between every virtual source and the receivers to extract single force impulse response functions for each pair of stations. As only relative, rather than absolute, amplitude can be extracted with this technique, we calibrated the impulse response function amplitudes using records of a moderate shallow earthquake ($M_w \sim 5$) that occurred close to the virtual sources. Once the amplitude scaled, we show that both impulse response functions and earthquake records have similar phase and amplitude in the period range of 4 to 10 s. Then, we built finite rupture models for $M_w \sim 7$ subduction earthquake scenarios that we discretized in subfaults. For each station considered as a receiver, we show that it is possible to interpolate the calibrated impulse response functions extracted between every virtual source and the receiver to obtain one impulse response function for each subfault. We also took into account the depth and the dip angle of the fault and the rupture propagates radially with a speed of 2 km/s. We confirm that peak ground velocities and durations of our simulated ground motions are strongly amplified in the Kanto basin.

Keywords: Long-period ground motion prediction, Finite rupture subduction earthquakes, Ambient seismic field, Seismic interferometry, Kanto basin