

Long-Period Ground Motion Prediction Equations and Their Application to the Magnitude Estimation of Large Earthquakes

IBRAHIM, Rami^{1*} ; SI, Hongjun¹ ; KOKETSU, Kazuki¹ ; MIYAKE, Hiroe¹

¹Earthq. Res. Inst., Univ. Tokyo

We developed long-period ground motion prediction equations (GMPEs) for peak ground velocities (PGVs) and peak ground displacements (PGDs) in a period range of 5-30 s. We only used strong motion data of KiK-net downhole stations located in layers of shear-wave velocities equal to or greater than 2000 m/s. We confirmed that the site effects due to surface geology for long-period PGVs and PGDs can be ignored at these observation stations. The dataset consists of 20 earthquakes of $6 \leq M_w \leq 9.1$ occurred in and around Japan. Two-stage regression analyses were carried out to derive the GMPEs. We fit the data with bilinear regression lines bending at M_w 7.5. Additional factors of focal depth and earthquake type were found to enhance the fitting with the observed data. Our developed long-period GMPEs predict the PGVs and PGDs of crustal earthquakes are larger than those of inter-plate and intra-plate earthquakes. The attenuation coefficients presented in the current study indicate that the long-period PGVs and PGDs increase by increasing depth.

We used the long-period GMPEs developed in this study to estimate the moment magnitude by fitting observed PGVs and PGDs at period range of 5-30 s with GMPEs. We estimated the magnitudes of the same 20 earthquakes and the 2013 Awaji Island earthquake (M_w 5.8) recorded by downhole accelerometers of KiK-net. The results are consistent with the moment magnitudes from the Global CMT project. The method is useful to estimate the magnitude of giant earthquakes such as the 2011 Tohoku earthquake (M_w 9.1). The proposed method can estimate the moment magnitude quickly if information of source area is available.

Keywords: long-period ground motion, ground motion prediction equation, moment magnitude, PGV, PGD