The ratio PGA/PGV and strong ground motion prediction

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1. Introduction

Strong ground motion prediction is based on the waveform calculation from physical source models. The procedure is as follows; First, physical parameters such as fault shape, extent, and location, displacement, stress release, and seismic moment on and off asperities, rupture initiation and propagation are set up. Second, entire fault is divided into small elements, and low frequency level, corner frequency, and high-frequency decay rate of the element spectrum are modeled. Finally, all the elemet radiations are summed up after distance effects are accounted. Appropriate physical prameters are essential in order for calculated seismograms to match the observed. Furthermore, practical calculation is affected by random fluctuations of slip angle or rupture time, element fault size, correction function and rise time. Optimum choice of random time series is important when stochastic method is employed. To measure the validity, amplitude spectrum is compared with the observed or model (Masuda and Yokota, 2008), or amplitude is compred with the empirically expected value (CDMC, 2001, Masuda and Yokota, 2007,2008). Predicted amplitudes are used for loss estimate of structures, and different index of PGA, PGV, or seismic intensity is reffered to accordint to type of structure. Is this paper we analyze the observed range of PGA/PGV ratio as function of magnitude, distance, and subsurface structure at observation point, and discuss the effect of parameters such as element fault size, rise time on calculated waves to reproduce the observed.

2. Observed range of PGA/PGV

The ratio PGA/PGV of S waves is measured from the main shocks and aftershocks which occurred in land and plate boundaries. Observed records of JMA, K-NET and KiK-net are used. Analyzed earthquakes are 2000 Tottori earthquake, 2003 Northern Miyagi earthquake, 2003 Off Miyagi earthquake, 2003 Off Tokachi earthquake, 2004 Chuetsu earthquake, 2005 Off Fukuoka earthquake, 2005 Off Miyagi earthquake, 2007 Off Noto Peninsula earthquake, 2007 Northern Mie earthquake, 2007 Off Chuetsu earthquake, and 2008 Iwate Miyagi in-land earthquake. Magnitude ranges from 3 to 8, and distance rages from several to several hundred kilometers.

The observed ratio PGA/PGV gradually increases with distance up to 100km from the source, and beyond 100km it rapidly decreases with distance. Amplitudes of near- and intermediate-field terms compared to the far-field amplitude are relatively larger near the source than in far-field, which results that the long period amplitude is relatively larger. Thus the ratio increases near the source. Beyond 100km, the effect of inelastic attenuation decreases the high frequency content, and thus the ratio rapidly decays.

At the same distance, the ratio PGA/PGV is larger for smaller earthquakes. Higher corner frequency of smaller earthquake results in higher value of the ratio.

3. Calculation parameters and PGA/PGV

The ratio of PGA to PGV is an important index for the validity check of strong ground motion prediction, as well as spectrum shape and absolute amplitude. We investigated the effect of various parameters on the PGA/PGV ratio.

A low fmax decreases the ratio of PGA to PGV, since the high frequency content of the spectrum gets smaller. For a large distance, as the effect of inelastic attenuation dominates, it is noted that too small Q value leads to a too small ratio. When the entire fault is divided into a large number of pieces, the size of element fault being small, the radiation from the element contains much of high frequency content, and thus the ratio of PGA to PGV increases. A large rise time leads to a small ratio of PGA to PGV.