

Analysis of strong-motion acceleration records based on the Generalized Pareto distribution

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Owing to K-NET and KiK-net managed by NIED, high-quality strong ground motion data have been accumulating in Japan in these two decades. Analyzing these data set, I investigate the upper limit of ground accelerations of near-field strong motion records in Japan. I apply the Generalized Pareto distribution (GPD) to amplitude distributions of ground accelerations exceeding given threshold levels, and estimate the parameters of GPD. Especially, the shape parameter of GPD is very important for this purpose. If the shape parameter is negative, an upper limit exists in the distribution. If the shape parameter is greater or equal to 0, there is no upper limit.

Among the strong motion database from K-NET and KiK-net, I select 98 strong motion records whose peak ground accelerations exceed 1g. I finally use 77 strong motion records after eliminating records contaminated by other events like aftershocks and those whose duration times are too short to have enough data. Positive values and negative values of ground accelerations are independently analyzed. I use the absolute value for the negative amplitude. Changing the threshold value of ground acceleration from 10 to 300 gal, I fit GPD to the data exceeding the threshold, and estimate the minimum threshold over which the estimated parameters of GPD (the shape parameter, the scale parameter, and the mean excess) will not change much. I also confirm the goodness of fit of GPD by checking P-P plots and Q-Q plots visually.

GPD explains amplitude distributions of 77 acceleration records. For the positive amplitudes of accelerations, 48 records show the upper limits. For the negative amplitudes of accelerations, 53 records show the limits. In total, about 70 % records show the limit in ground accelerations. The range of the limit is mostly smaller than about 6000gal. However, a few results with very small negative shape parameters suggest much larger limits. These results should be regarded practically as no limits. For the rest of about 30 % records, the existence of the limit is not statistically supported. However, there should be the upper limit in ground accelerations from the viewpoint of physics. So it is necessary to clarify reasons why about 30 % records do not suggest the upper limit in ground acceleration.

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