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Ishimoto-Iida Law at CEORKA Network

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We propose the Ishimoto-Iida law as a statistic tool for a large strong motion waveform database. We demonstrate that the Ishimoto-Iida law is applicable to statistics of PGV at Committee of Earthquake Observation and Research in the Kansai-Area (CEORKA), a velocity-type strong motion network in western Japan.

Amount of strong motion waveforms has increased significantly in the last two decades, which is consequence of recent rapid expansion of observation networks. Such abundance of waveform data enables us to study and understand aspects of the strong motion propagation statistically, the results of which include published attenuation relation formulae and empirical relationship among ground motion parameters such as intensity and PGV or PGA. Here we revaluate and propose Ishimoto-Iida law [Ishimoto and Iida, 1939] to investigate strong motion statistically. Ishimoto-Iida law expresses relationship between the observed amplitude and total number of observations in any station and time period. Similar to Gutenberg-Richter law (GR law), which expresses the relationship between the magnitude and total number of earthquakes in any given region and time period, Ishimoto-Iida law is a power law. Definition of earthquake magnitude often include amplitude of seismogram as one of the terms, and when GR law governs the seismicity in the area, we would expect that Ishimoto-Iida law holds at stations in that area, at least qualitatively. It is not straightforward to relate GR and Ishimoto-Iida laws quantitatively, and we need to incorporate knowledge of source spectra, propagation and site effects. Investigating Ishimoto-Iida law also provides an opportunity to compare the observed and predicted statistics of the strong motion at particular site under consideration, which could be used to test some aspects of recipe for strong motion prediction.

We used all the strong motion records recorded at CEORKA network between 1993 and 2010 that are tied to JMA earthquake unified catalog. We calculate the horizontal peak ground velocity (PGV) for each record, and analyze the frequency distribution and cumulative frequency distribution of the PGV. When all the observation from the network is combined, the amplitude-frequency diagram has a linear portion in log-log plot, which indicates that the power law, Ishimoto-Iida law, is realized at CEORKA. Amplitude-frequency relations at each station exhibit similar power low, but power in the Ishimoto-Iida law is not a constant within this network.

We model the observed Ishimoto-Iida law using the distance-attenuation relation, the site amplification factor, and the JMA unified hypocenter catalog. Existing attenuation relations are derived from the regression analysis of waveform records of large magnitude events, and we try to use the same relation by extrapolating to smaller events. We used both Shi and Midorikawa [1999] and Kanno *et al.* [2006], but neither relation predicts the observation well. Our current scheme tends to over-predict PGV when the observed PGV is small, and is not successfully predicting observed power of Ishimoto-Iida law.

Keywords: strong motion, seismic wave propagation, site effects