New Attenuation Relation for Earthquake Ground Motions in Indonesia Considering Deep Source Events

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Abstract

Attenuation relation of the peak horizontal ground accelerations for Indonesia region is developed. The database is compiled for earthquakes with moment magnitudes $M_w \geq 5$ that occurs during 1971 – 2007, which consists of horizontal peak ground accelerations and their 5 percent damped response spectra; the accelerograms are recorded on different site conditions classified as rock, hard and soft soils. Earthquakes with depths up to 150 km are used to attune the equation relevant to subduction, which are the most common earthquake events in Indonesia. The effects of the local site conditions and depth on the attenuation relation are considered simultaneously with the distance and magnitude using a two-stage regression procedure to separate the distance dependence from that of the magnitude.

An iterative partial regression algorithm is proposed to overcome the singularity of the resulting normal equations. It can be observed that the peak ground motions increase with depth for the same magnitude and distance. Considering the soil conditions, it is noticeable that the station coefficients correspond to the soil-type classification varies widely. For the peak ground accelerations, the station coefficients are closely related to the general soil-type classification; while the peak ground velocity have strong relationship with the soil-type classification.

The resulting general attenuation relation is given by

$$\log PGA = 0.212 + 0.513M - \log r_{rup} - 0.001332r + 0.002991h + coef_i^n + \sigma;$$

where PGA (cm/sec^2) is the larger of the peak accelerations in two perpendicular horizontal components, M is the moment magnitude, r_{rup} is the closest distance to the fault rupture, h is the depth of the source, $coef_i^n$ is the coefficient for site conditions, and σ is the standard deviation. The parametric uncertainties associated with the variation in the source mechanisms, paths, and site effects are included in the development of the attenuation relation. The relation can be further improved as much more data become available in the future.

Keywords: Attenuation relation, deep source, subduction, two-stage regression, peak ground acceleration and velocity, uncertainty analysis.

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