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The Relation Between Ground Acceleration and Earthquake Source Parameters: Theory and Observations

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A simple relation between the root-mean-square of the ground acceleration and earthquake spectral (or source) parameters is introduced:

$$A_{rms} = (2\pi)^2 \Omega_0 \frac{f_0^2}{\sqrt{\pi\kappa T}\left(1+\frac{\pi\kappa f_0}{1.5^{0.25}}\right)^2},$$

where Ω_0 is the low frequency displacement spectral plateau, f_0 is the corner frequency, κ is an attenuation parameter, and T is the data interval. This result uses the omega-squared model for far-field radiation, and accounts for site-specific attenuation. The main advantage of the new relation with respect to that of Hanks' (Hanks, 1979) is that it relaxes the simplifying assumption that the spectral corner frequency is much smaller than the maximum corner frequency resulting from attenuation, and that the spectrum may be approximated as being perfectly flat between the two frequencies. The newly proposed relation is tested using a composite dataset of earthquake records from Japan, California, Mexico and Taiwan. Excellent agreement is found between observed and predicted ground acceleration for any combination of corner frequencies. Thus, use of the above relation enables the extrapolation of ground motion prediction equation inferred from the frequent small magnitude earthquakes to the rare large magnitudes. This capacity is extremely useful near slow-slip plate boundaries, where the seismic moment release rates are low.

Reference

Hanks, T. C. (1979). b values and $\omega^{-\gamma}$ seismic source models: implications for tectonic stress variations along active crustal fault zones and the estimation of high-frequency strong ground motion, *J. Geophys. Res.* **84,** 2235-2241.