Fracturing of earthquake rupture mechanics on the fault with self-similarity and fault surface heterogeneity

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Abstract

The work of finite fault slip models have been done in several earthquake events. We compiled the finite fault slip models of 19 earthquakes in Taiwan within the magnitude range from M_w=4.56 to 7.69 which include different fault types. We analyzed the distribution of slip on the fault surface to get the scaling relation of slip values, and found the scaling relation can be shown as $\mathrm{Rs} = 10^{\mathrm{a+n(Rd)}}$ (where Rd is (d/dm) as the ratio of slip, d, to the average of the effective slip, dm, Rs is A/Ae as the ratio of the fault area, A, where slip $\mathrm{d} > \mathrm{R_d} \times \mathrm{d_m}$ to the effective area, Ae. The effective area and slip were determined according to the normalization of the autocorrelation of slip in length and width. The fault slip was displayed a self-similar scaling, the scaling exponent values (*n*) are within *n*=0~-1.1 which can be relative with fractal dimension of fault slip system. The scaling exponents (*n*) also can be seen as a measure for the roughness degree of the slip distribution on the fault surface. For lower values of *n*, the gradient of the slip distribution increases, and the slip models become more heterogeneous. Based on the definition of asperity as Sa(d/d_m>1.5), we also got a scaling relation between asperity and magnitude as Sa(d/d_m>1.5)=1.27*Mw*-6.49. As found in several large earthquakes, we also observed that Sa is about 20% of Ae, where Sa is the area with the slip larger than 1.5 times of the mean slip. Very intriguing feature on the relationship of the average area ratio of the examined earthquakes (M~4.5-7.6) for Rs as function of Rd follows a fractal dimension of about 0.5, as $\log\mathrm{Rs} = 0.428\mathrm{Rd} - 0.078$. This fractal dimension might bring some hints in understanding of earthquake rupture mechanics on fault fracturing.

Keyword: finite fault slip model; self-similar scaling; asperity; heterogeneity

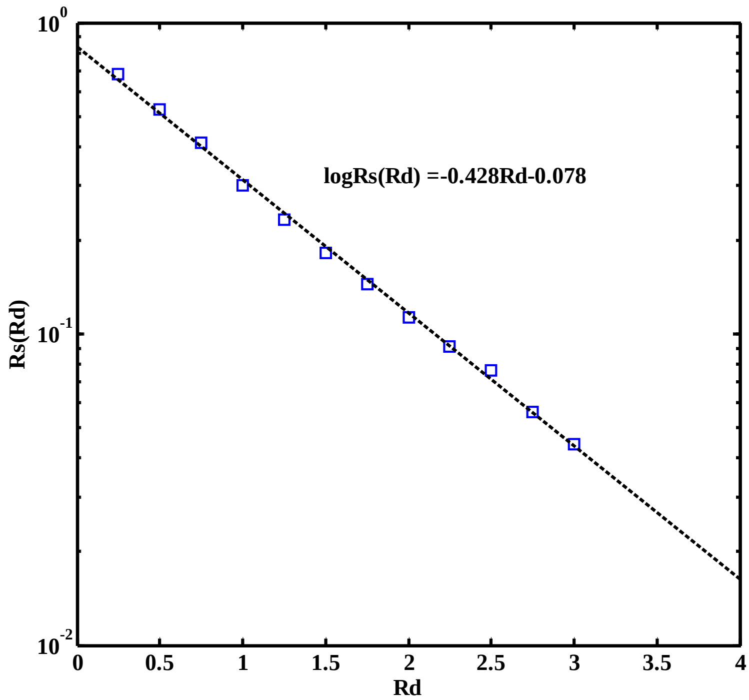

Figure 1. The correlation between the average area ratio of the examined earthquakes (M~4.5-7.6) for Rs to Rd. Rs is the ratio of the fault area where slip $d > R_d \times d_m$ to the effective area, and Rd is the ratio of slip to the average of the effective slip.