ANALYTICAL SOLUTION OF DYNAMIC SELF-SIMILAR CRACK GROWTH UNDER DISTANCE-WEAKENING FRICTION

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The relationship between the evolution of slip and weakening of friction is significant for earthquake dynamics and has been estimated by theoretical, experimental, and observational studies. Because dynamic rupture growth during an earthquake seems to be self-similar and slower than the theoretical limit (i.e., Shear or Rayleigh wave) velocity, the fracture energy and the slip-weakening distance, D_c, should be scaled by the current ruptured length. In case of a steady-state pulse-like rupture model, Rice et al. [2005 BSSA] obtained a theoretical approximation of the fracture energy as a function of given stress parameters under a distance-weakening friction model, which mimics a slip-weakening model. Their pulse-like model contributed to the quantification of fracture energy for many pulse-like earthquake ruptures. However, also a self-similar model may be helpful for the quantification in cases of crack-like rupture modes.

In this study, we obtain an analytical solution of a mode-III self-similar dynamic crack model under self-similar distance-weakening friction. The weakening distance can be determined so that slip-rate and stress are finite at the crack tip. As a result of this calculation, we can obtain the dependence of D_c on the rupture velocity and given stress parameters. Actually, D_c and rupture velocity could be estimated on the basis of observational data, while stress parameters are not. Hence, this relationship may contribute to the estimation of fracture energy or stress parameters along very long dip-slip faults, on which mode-III rupture propagation dominates.