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Dynamics Rupture of Dipping Faults: Effects of Strength Excess and Critical Slip on the Near Source Ground Motion

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The effects of strength excess and critical slip on the near source ground motion of dipping faults that break the free-surface are studied. Numerical simulations of the dynamic rupture process of an idealistic dipping fault with constant fracture surface energy are developed. From our results, the frequency content of the ground motion is related to the rupture propagation velocity, a high rupture velocity producing higher frequencies than a slow velocity. The problem is studied using the Discrete Element Method (DEM). The DEM consists in the representation of solids modeled by an array of normal and diagonal elements linking lumped nodal masses. The numerical solution is developed for near-field elastodynamic motion coupled to frictional sliding on a pre-existing fault.

The choice of the parameters used for the simulation of the dynamic rupture of a fault is a delicate issue, still subject of debate. The author's experience, nevertheless, suggests that, in general, it is very unlikely that essentially correct simulated response will result from essentially incorrect models or parameters thereof. For the assumption of a slip weakening friction law, we need to define the stress drop, the strength excess and the critical slip along the fault. The stress drop can roughly be defined from the results of the kinematical inversion of ground motion, so we can guess the approximate area of the asperities. The choice of critical slip and the strength is quite difficult, since there is no way to get them directly from observations, and there may various combinations that fit the data. In view of the preceding arguments, it seems that only the area in the stress-displacement diagram, i.e. the effective fracture surface energy is relevant at the level of modeling.

In the present paper we study the effects of strength excess and critical slip on the near source ground motion of dipping faults that break the free-surface. Numerical simulations of the dynamic rupture process of an idealistic dipping fault with constant fracture surface energy are developed. From our results, the frequency content of the ground motion is related to the rupture propagation velocity, a high rupture velocity producing higher frequencies than a slow velocity. The rupture velocity is related to critical slip and the strength excess, that is, small critical slip and small strength excess produces higher rupture velocity than large critical slip and large strength excess.

The elastodynamic field due to an in-plane crack of the dipping fault is studied using the Discrete Element Method (DEM). The DEM consists in the representation of solids modeled by an array of normal and diagonal elements linking lumped nodal masses. A dynamic is performed resolving the simple equation of motion of Newton law of each lumped nodal mass by an explicit numerical integration in the time domain. The numerical solution is developed for near-field elastodynamic motion coupled to frictional sliding on a pre-existing fault.