The effect of bimaterial interface on branching problem of mode II rupture measured by the Coulomb failure stress change

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The fault slips of earthquakes often propagate through complex geometries such as bends, branches and stepovers. Exploring governing factors of such propagation is important for understanding physics of macroscopic rupture process, and various problem of rupture propagation under relatively simple condition have been studied. In addition, these studies are of great significance for disaster prevention to estimate the probability of rupture extension. For example, when fault slip of a mega-thrust earthquake reaches the earthz's surface in the subduction zone, predicting slip behavior in accretionary prism is essential to estimate the magnitude of tsunami excitation. However, even slight complexity makes problems difficult to solve numerically, and many interesting problems still remain unresolved.

In order to deal with rupture propagation in subduction zones for practical problem, it is necessary to model at least two media, free surface, and non-planar geometry or branching fault planes. In this study, we consider the possibility of branching when a mode II rupture propagates on a bimaterial interface in 2D-inplane problem, using the explicit finite element method with split-node, which is mathematically identical to the finite difference method. We assume that the upper half of the medium is slower than the lower half, and introduce an initial crack on the bimaterial interface. Rupture propagates spontaneously on the interface, governed by a slip-weakening law. In this problem, the change of normal stress on the bimaterial interface causes asymmetric rupture propagation, which may have some influence on branching probability. We estimate the probability of branching by the Coulomb failure stress change on the grid points adjacent to the bimaterial interface (the main fault).

We change the angle between the branching fault and the main fault, 10 degree, 20 degree, 30 degree, and fix the direction of maximum compression to 50 degree. The material constant between two media is 10% and 0% for reference. In the result, we find that high angle faults are likely to be ruptured, as suggested by previous studies. In addition, we find that the asymmetry caused by material heterogeneity distort angular pattern of the maximum Coulomb failure stress change, which probably affect branching probability