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Extended Boundary Integral Equation Method (XBIEM) for Rupture Dynamics Interacting with Medium Interfaces - Mode III Implementation in a Bimaterial -

Tetsuya Kusakabe and Nobuki Kame
Earthquake Research Institute, the University of Tokyo, Tokyo, Japan (kusaka@eri.u-tokyo.ac.jp)

We developed a code for dynamic rupture propagation interacting with medium interfaces using extended boundary integral equation method (XBIEM). XBIEM has been recently proposed by Kame and Kusakabe (2012) as a versatile method of non-planar crack growth analysis in an inhomogeneous medium consisting of homogeneous sub-regions, but it has been just applied to a simple planar interfacial crack problem in its validation test. Here we applied it to simulate 2D mode III rupture propagation across the medium interface of a bimaterial in order to elicit the effects of medium contrast on the dynamics.

Firstly, we introduced a new implicit time-stepping scheme for instantaneously interacting boundary elements on the crack and medium interface. Such interactions only appear in rupture's crossing the interface. Otherwise we can use the explicit scheme as employed for BIEM in a homogeneous medium.

Secondly, the validation tests were carried out by comparing the XBIEM results with the BIEM solution for problems of the wave propagation and the dynamic rupture in a homogeneous full-space. It was found out that the discretized interfaces worked well for both problems.

Finally, we simulated dynamic rupture propagation on a planar fault embedded in a bimaterial with an inclination angle θ. We assumed a slip-weakening law with homogeneous properties over the fault independent of the material contrast. When rupture propagated from a rigid to a compliant side, the slip became larger and it tended to be larger for the smaller θ as compared with a homogeneous medium whose elasticity is identical to the lower side of bimaterial. For cases with the opposite material contrast, the slip was suppressed and it got smaller for the smaller θ. The tendencies of the rupture before crossing the interface may be understandable in terms of two extreme cases: rupture approaching a free surface (the slip is highly amplified) and rupture approaching a fixed boundary (it is largely decreased). The dynamics after crossing the interface was very easy in our cases; the stress drop was assumed to be homogeneous and the larger/smaller slip thus occurred in the compliant/rigid half-space. These qualitative agreements also supported our code.