Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SSS28-P02 Room:Convention Hall Time:May 24 17:15-18:30

BIEM simulation for dynamic earthquake rupture that intersects with a bimaterial interface

HIRANO, Shiro[1*], Teruo Yamashita[1]

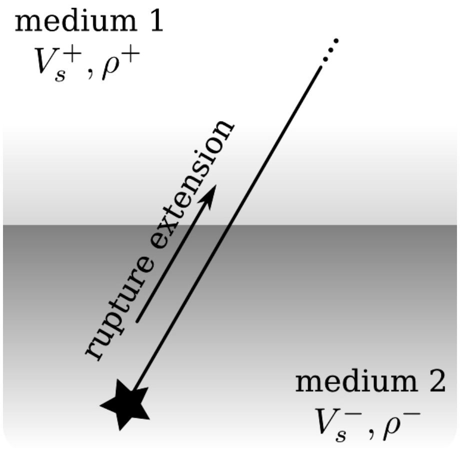
[1]Earthquake Research Institute, University of Tokyo

Recently, seismic observations are getting more precise and have revealed heterogeneous structure near faults. For example, Kato et al. (2006, JGR) imaged the seismic structure in the source region of the 2004 Chuetsu earthquake and concluded that faults of the main shock and some major aftershocks are located near of material interfaces where seismic wave velocities change discontinuity. Moreover, Naoi et al. (2011, BSSA) analysed dynamic behaviour of a M2 earthquake that occurred in 2007 near a pre-installed observational network at the deep gold mine of South Africa and concluded that rupture extension of its fault stopped at very close to a material interface. Considering heterogeneous structures that exist universally in the Earth's crust, dynamic earthquake rupture will be affected by the existence of material interface. If fault intersects with the interface during its growth, the effect of material interface will be significant. The observational studies described above might support them.

On the other hand, almost all dynamic rupture simulations for understanding fault mechanics are based on an assumption that rupture propagates in a homogeneous medium or along a material interface. That is to say, past studies have not treated intersection of dynamic rupture behaviour with material interfaces. This might be due to difficulty and immaturity of numerical techniques to simulate dynamic rupture behaviour. A front of dynamically extending fault radiates strong perturbation of stress, so that quite high accuracy is required for the simulation. Additionally, faults are sometimes non-planar and this should be taken into account. In a framework of elasticity, one of the best techniques that meets these requirements is the Boundary Integral Equation Method (BIEM) developed by Tada and Yamashita (1997, GJI). BIEM requires analytical expression of non-hyper singular response function of an ambient system generated by slip of each discretized fault element. Previous studies, however, have derived the response function only for an infinite homogeneous medium.

In this study, we consider the intersection of dynamic rupture behaviour with material interfaces. First, in order to do so, we derive the non-hyper singular response function of two welded elastic 2-D half-spaces, which is referred to as "bimaterial", due to an anti-plane dynamic crack. Difficulty of the derivation of response function is resolved by treating 2-D Green's function as complex function and using the Cagniard de-Hoop's method. This analytical solution can be considered as a response of bimaterial when uniform slip rate is given on a finite planar fault. Hence this solution itself can be employed as a benchmark for a numerical simulation of a fault with uniform slip rate embedded in bimaterial. Next, we actually execute BIEM simulation by using this solution. We find that a distinct phenomenon appears on the fault after the rupture front intersects with the interface. In other words, a significant slip rate change occurs at the intersection and it propagates back towards the rupture nucleation point. Especially, on the case that the rupture extends towards more rigid material from more compliant material, this perturbation can be seen as temporal reduction of slip rate. Considering velocity weakening friction law, this implies that fault behaviour could be complex because the reduction of slip rate generates increase of friction, so that slip may stop after the rupture front intersects with the interface.

Keywords: fault, dynamic rupture, bimaterial interface, Boundary Integral Element Method, numerical simulation


medium 1
V_s^+, ρ^+
rupture extension
medium 2
V_s^-, ρ^-