A. Bizzarri

I.N.G.V. – Bologna

SLIP COMPLEXITY AND FRICTIONAL HETEROGENEITIES IN DYNAMIC FAULT MODELS

The numerical modeling of earthquake rupture requires the specification of the fault system geometry, the mechanical properties of the media surrounding the fault, the initial conditions and the constitutive law for fault friction. The latter accounts for the fault zone properties and allows the description of processes of nucleation, propagation, healing and arrest of a spontaneous rupture. In this study we solve the fundamental elasto – dynamic equation for a planar fault, adopting different constitutive equations (slip – dependent and rate – and state – dependent friction laws).

We show that the slip complexity may be complicated by different causes. The spatial heterogeneities of constitutive parameters are able to cause the healing of slip, like barrier – healing or slip pulses. Our numerical experiments show that the heterogeneities of the parameter *L* affect the dynamic rupture propagation and weakly modify the dynamic stress drop and the rupture velocity. The heterogeneity of *a* and *b* parameters affects the dynamic rupture propagation in a more complex way: a velocity strengthening area ($a > b$) can arrest a dynamic rupture, but can be driven to an instability if suddenly loaded by the dynamic rupture front. Our simulations provide a picture of the complex interactions between fault patches having different frictional properties.

Moreover, the slip distribution on the fault plane is complicated considering the effects of the rake rotation during the propagation: depending on the position on the fault plane, the orientation of instantaneous total dynamic traction can change with time with respect to the imposed initial stress direction. These temporal rake rotations depend on the amplitude of the initial stress and on its distribution. They also depend on the curvature and direction of the rupture front with respect to the imposed initial stress direction: this explains why rake rotations are mostly located near the rupture front and within the cohesive zone, where the breakdown processes take places.

Finally, the rupture behavior, the fault slip distribution and the traction evolution may be changed and complicated including additional physical phenomena, like thermal pressurization of pore fluid (due to frictional heating). Our results involve interesting implications for slip duration and fracture energy.