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A FINITE DIFFERENCE ALGORITHM TO MODEL A FULLY 3 – D DYNAMIC RUPTURE GOVERNED BY DIFFERENT CONSTITUTIVE LAWS

In the last decades large effort has been expended to realize numerical algorithms for solving the fundamental elastodynamic equation to model earthquake ruptures. Two class of methods have been extensively implemented and used: the Boundary Integral Equation (BIE) and the Finite Difference (FD) approaches. In Bizzarri et al. (2001) we have compared 2 – D in – plane solutions to discuss the main differences existing between these two different numerical strategies.

In this work we present a new FD numerical method to solve the fully dynamic spontaneous problem for a truly 3 - D rupture on planar faults. We implement the Traction – at – Split – Nodes of Andrews (1999) fault boundary condition for a system of faults, either vertical or oblique. For each fault we can assume different constitutive laws: we can use a slip – weakening law to prescribe the traction evolution within the breakdown zone or a rate – and state – dependent friction law, which involve the choice of a governing relation for the state variable. We have implemented a 3 – D version of the Rosembrock Stiff Integration, generalizing that previously used in our 2 – D model, and we have included the free surface effect.

In our numerical procedure the initial shear stress is not necessarily imposed in only one spatial direction and the two components of slip, slip velocity and traction can vary during the dynamic crack propagation. Such components are coupled together in order to satisfy, in norm, the adopted governing law, and therefore they allow for dynamically controlled rake variations. We can also model faults with spatially heterogeneous distributions of constitutive parameters in order to simulate crack arrest and the healing of slip.