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Brittle to ductile transition in a model of sheared granular materials AHMED ELBANNA, XIAO MA, University of Illinois Urbana Champaign —

Understanding the fundamental mechanisms of deformation and failure in sheared fault gouge is critical for the development of physics-based earthquake rupture simulations that are becoming an essential ingredient in next generation hazard and risk models. To that end, we use the shear transformation zone (STZ) theory, a non-equilibrium statistical thermodynamics framework to describe viscoplastic deformation and localization in gouge materials as a first step towards developing multiscale models for earthquake source processes that are informed by high-resolution fault zone physics. We will describe an implementation of this theory in a 2D/3D finite element framework, accounting for finite deformation, under both axial and shear loading and for dry and saturated conditions. We examine conditions under which a localized shear band may form and show that the initial value of disorder plays an important role. In particular, our simulations suggest that if the material is more compact initially, the behavior is more brittle and the plastic deformation localizes with large strength drop. On the other hand, an initially loose material will show a more ductile response and the plastic deformations will be distributed more broadly. We will further show that incorporation of pore fluids alters the localization pattern and changes the stress slip response due to coupling between gouge volume changes (compaction and dilation) and pore pressure build up. Finally, we discuss the implications of our model for gouge friction and dynamic weakening.

Ahmed Elbanna
University of Illinois Urbana Champaign

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