Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Scaling laws for stress and energy for an interface with strong rate weakening friction

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ABSTRACT

Strong rate weakening friction has been hypothesized to play an important role in the dynamics of fault zones at seismic slip rates. Here, we explore its implications on the scaling of different mechanical quantities. These include the average prestress, the average stress drop, the frictional dissipation, and magnitude number statistics. We idealize the frictional interface as a series of sliders that are being pulled from one edge under displacement controlled boundary conditions. The friction for each block decreases inversely with the block slip rate. The system response is governed by three parameters: the system elastic modulus, the loading rate, and the rate of frictional weakening. We have found that the average stress before rupture as well as the frictional dissipation decrease with increasing rupture size. We have also observed a transition from a macroscopic plastic response to a macroscopic brittle response as the system parameters vary. We discuss the implications of our results on size effects in nominal strength for solids with frictional interfaces.