A mechanism of velocity strengthening in high speed friction: a Discrete Element Method approach

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Frictional behavior of gauge is important to the understanding of the faulting dynamics and has been one of the major interests in solid earth mechanics. Although several laws are known at present, the most cerebrated one is the rate-and-state dependent friction law (RSF). The RSF law is valid for a wide range of strain rate, whereas some deviations have been found for larger strain rates. That is, the tendency of velocity strengthening has been observed there. In order to clarify the nature of the velocity strengthening, we study the rheology of high speed deformation of gauge layers by numerical simulations.

We adopt discrete element method and simulate 10,000 gauge particles subjected to simple shear. We found that the friction coefficient increases gradually (quarter the power of the strain rate) in high speed friction. Note that this velocity strengthening cannot be described within the RSF framework. We discuss the mechanism of the velocity strengthening and its relevance to the nature of seismic slip.