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Rate-dependent friction associated with frictional bridges

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The presence of multiple asperities in the contacting fault surfaces produces sliding resistance associated with the contact between asperities of the opposite sliding surfaces. The pairs of contacting asperities essentially work as frictional bridges: the fault sliding can only proceed when all bridges are broken, that is the corresponding pairs of asperities are either broken or their resistance is overcome by one asperity climbing over its counterpart. Furthermore, each step of sliding produces new pairs of contacting asperities forming new frictional bridges independent of the previous ones. The number of new bridges is usually high. We assume it to be proportional to the sliding velocity. The condition of producing a step of sliding is the failure of all the bridges resisting to the sliding in the area associated with the sliding step. Each bridge is characterised by a different strength (either the actual asperity strength or the force needed to make one asperity to climb over its counterpart). Given the large number of bridges involved in each step, this condition can be expressed in terms of the distribution of the maximum strengths. Using the theory of order statistics, we obtained a logarithmic dependence of the resulting friction coefficient upon the sliding velocity, which is observed in the experiments. Thus, our model suggests a new interpretation of the experimentally observed rate-dependent friction. The model parameters are associated with the parameters of bridge distribution, which are related to the morphology of the sliding surfaces.

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