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Finite element modeling of stick-slips on a solid surface with many asperities

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Friction is the tangential force resisting the relative motion of solid surfaces or material elements sliding against each other. Since all real surfaces have topography (or roughness) in the microscopic view, they touch at a few points or asperities, when they are brought together. Hence, macroscopic friction is regarded to be the sum of interacting forces at such microscopic asperities. For an contacting asperity, we consider the additional deformation at the area surrounding the asperity. In such a case, depending on the deformation amount, the real area of contact at the asperity will largely increase or decrease. Such a change in contact state at the asperity affects not only the interacting force at the asperity but also the macroscopic friction. Furthermore, it is expected that friction between solid surfaces has a possible dependence on materials, since the deformation of the solid material is strongly depend on their properties (rigidity, viscosity, etc.). The effects of the deformation and property of materials on friction, however, have not been explicitly included in many existing friction laws.

Therefore, in this study, we examine these effects on macroscopic friction through a finite element modeling of stick-slips on a solid surface with many asperities. As a tentative result, the calculation with 50 asperities repeats stick-slips with various sizes, though the maximum number of asperities which break in an event is much smaller than 50. Hence, the macroscopic friction is almost constant, and steady slip motion of two blocks is generated.

In the presentation, we will show the detail of our finite element modeling and calculation results with various material property or asperity distributions.