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3D DEM study of stick-slip behavior in partly saturated granular materials

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In the central part of faults, granular material is produced due to wear called fault gouge. During shearing, the fault gouge stores energy in the course of the stick phase, which can be suddenly released resulting in a stick-slip dynamics. The sudden release of accumulated energy leads to a drop in macroscopic friction coefficient, defined as ratio between shear stress and confining stress and to a sudden increase in kinetic energy of particles. Partial saturation of granular fault gouge with water can alter this dynamic stick-slip behavior. We use 3D discrete element method (DEM) simulations to study stick-slip dynamics in a wet granular fault gouge. The DEM model takes the presence of moisture into account introducing cohesive forces due to the presence of capillary bridges between the particles. We also consider viscous forces resistant to particles motion. Results show that in wet granular gouge, the macroscopic friction level attained during shearing is higher than in the dry state. The cohesive forces due to surface tension and Laplace pressure tend to maintain the contacts longer leading to longer and more stable stick phases, or higher recurrence times between successive slip events. This means that more energy can be stored leading to larger slip events characterized by larger drops in friction coefficient and larger thickness compaction. Our results are in line with experimental results on granular gouge of glass beads.