EVOLUTION OF THE SEISMIC FAULT – ASPERITY SYSTEM THROUGH THE LENS OF PIN-ON-DISK EXPERIMENTS

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KEYWORDS
- Friction
- Experiments in tribology
- Wear

ABSTRACT
Hundreds of thousands of earthquakes are recorded each year around the world. Motivated by the large consequences of the biggest earthquakes occurring near populated areas, understanding the mechanisms governing the seismic propagation represents a challenge. A number of uncertainties yet remain concerning the complexity of the fault structure, the constitutive properties of materials or the fault rheology. To address those points, we borrow from the tribological approach the pin-on-disk experiment. The concept of two rough surfaces in contact through a series of fault asperities is downscaled to a single asperity sliding on a rough surface. The single asperity response to shearing induced by sliding and the evolution of friction are studied closely to understand the different stages undergone by the asperity and the consequences on the fault behaviour during co-seismic events.

The downscaled concept of a seismic fault is studied through experimental and numerical tests.

On the one hand, the original experimental apparatus consists in a centimetric pin with a hemispherical extremity representing the fault asperity while a large flat rotating disk stands for the opposite surface of the experimental fault. Both pieces are made in the same carbonate rock with controlled roughness. The experimental downscaled fault is submitted to co-seismic conditions: contact size of 0.1-5 mm, contact normal stress of 10-200 MPa, sliding velocity of 0.01-1 m/s, and sliding distance of 10 - 60 m. A number of high-sampling-rate sensors are used to constrain the observation of the asperity contact during the simulated seismic events. Complete post-mortem analyses of the wear tracks with optical microscopy, SEM and roughness images allow to quantify the regime features and to reconstruct friction scenarios in accordance with the time-series acquired during tests.

On the other hand, a numerical simulation of a single asperity is implemented in the simulation code MELODY. Following results obtain for the simulation of partial melting within granular gouges (Casas et al 2022, Mollon et al 2022) and the simulation of rock degradation (Mollon et al 2021) both during seismic slip, the simulation reproduces a full pin-on-disk sliding contact. Both elements have their contacting degradable parts coded with Discrete Element Method (DEM) in order to allow those part to abrade spontaneously.

The experimental and numerical results pave the way to an enrichment of current fault models, by allowing the future study of the melting/abrasion duality at the scale of the asperity.

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