

EGU21-1114

<https://doi.org/10.5194/egusphere-egu21-1114>

EGU General Assembly 2021

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



A micromechanically calibrated numerical model reproducing earthquake cycle in the lab

Guilhem Mollon^{1,2}, Jérôme Aubry², and Alexandre Schubnel²

¹Université de Lyon, LaMCoS, INSA-Lyon, CNRS UMR5259, F-69621, France (guilhem.mollon@insa-lyon.fr)

²Laboratoire de Géologie, École Normale Supérieure/CNRS UMR 8538, PSL Research University

In this communication, we present a novel numerical framework which consists in a direct coupling between a discrete micromechanical modelling of rock damaging processes and a continuous modelling of elastic deformation and acoustic waves. It includes a polygon-based conforming Discrete Element Method (DEM) with a cohesive zone model (CZM, [1]) for the discrete part and a meshfree formulation for the continuum part. This framework is applied to the numerical reproduction of sawcut triaxial tests performed in the lab on marble samples under seismogenic conditions [2]. Realistic boundary conditions (in terms of the elasticity of the loading system, of the absorption of the elastic waves and of the fluid pressure applied on the lateral boundaries) are introduced. Constitutive laws (in the continuum part) and micromechanical parameters (in the discrete part) are calibrated by performing independent simulations based on experimental results found in the literature [3].

Upon loading, this model provides information on the system behavior that nicely complement the experimental data, such as (i) the progressive damaging of the contacting surfaces, leading to the emission of granular matter in the interface, to the formation of a gouge layer, and to a modification of the interface rheology, (ii) the space and time distribution and statistics and the detailed kinematics of the slip events related to the interface evolution, and (iii) the acoustic wave emission and propagation in the medium associated with such events.

The model shows that, depending on the experimental conditions (confining pressure, loading rate, surface roughness, etc.), and without relying to any prior choice of slip- or rate-dependent friction laws, a large number of sliding regimes can emerge from this system. This includes large stress drops, regular stick-slip, or stable sliding. This model thus provides an unprecedented view of both local and global phenomena at stake during lab earthquakes, at sampling rates in both space and time which remain out of reach for experimental instrumentation.

[1]. Mollon, G. (2015). "A numerical framework for discrete modelling of friction and wear using Voronoi polyhedrons", *Tribology International*, 90, 343-355

[2]. Aubry, J. (2019). "Séismes au laboratoire: friction, plasticité et bilan énergétique", PhD Thesis, Ecole Normale Supérieure.

[3]. Fredrich, J. T.; Evans, B. & Wong, T.-F., (1989). "Micromechanics of the brittle to plastic transition in Carrara marble", *Journal of Geophysical Research: Solid Earth*,

