Fabric states and plastic behavior of granular materials

Farhang Radjaï[1] and Stéphane Roux[2]

[1]*LMGC, CNRS-Université Montpellier 2**

[2]*LMT-Cachan, ENS de Cachan/CNRS/UPMC/PRES UniverSud Paris*

The plastic behavior of granular materials is governed by unilateral contact interactions and steric exclusions. These features are thus essential in modeling the internal friction, dilatancy and fabric states. We present a general framework for fabric evolution with the guiding idea that a physical plastic model of granular materials should be based in the first place on low-order parameters pertaining to the granular microstructure but accounting more or less strictly for steric exclusions as well as the mechanical equilibrium of the particles. We introduce a fabric tensor that, by combining the coordination number and fabric anisotropy, allows for a simple tensorial representation of the fabric states by means of Mohr circles. We discuss how low-order fabrics are induced by homogeneous shearing. Finally, a model is introduced for the evolution of fabric states with the strain-rate tensor. This model predicts the existence of a steady state, which provides in this way a geometrical interpretation of the critical state as a "saturated or "jammed state, and an exponential evolution of the fabric variables during transients. It also predicts the range of accessible fabric states and an upper bound on the fabric anisotropy. By means of numerical simulations, we show that this model fits correctly the data the under complex loading paths.

*Electronic address: franck.radjai@univ-montp2.fr