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Time and space evolution of R-bands in a dense granular material, relation to the evolution of the entire fault gouge.

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Fault zones are usually composed of a granular gouge, coming from the wear material of previous slips. This granular layer plays a key role in the way elastic energy is released during sliding and highly contributes to friction stability. Once considering a mature enough fault zone that has already been sheared, different types of infill materials can be observed, from mineral cementation [1] to matrix particles that can fill remaining pore spaces between clasts and change the global rheological and frictional behavior. We aim to understand the influence of matrix characteristics on slip mechanisms and gouge rheology (Riedel bands formation) by employing the Discrete Element Method. We consider a direct shear model without fluid in 2D, based on a granular sample with a matrix created by a dense assembly of small hexagonal cells ($\Phi \sim 20 \mu m$). This work is seen as the first step towards simulations considering a mixture between angular grains surrounded by matrix cells representing a matrix of fines. A wide range of Riedel bands kinematics was observed for a variation of gouge parameters such as inter-particle friction [2], stiffness, size of particles or gouge thickness participating in the orientation angle of the Riedel bands and Riedel structure and so in the stability of the gouge [3]. The focus is then made on a proposed method to couple the global evolution of the entire gouge to the behavior of each Riedel and Y band that appeared during shearing. First of all, it is possible to observe both global and local variations of Riedel band activation with a different orientation angle depending on whether the observed zone is in the center of the gouge or close to rock walls. The temporal and spatial evolution of inner sliding within Riedel bands is recovered to have a precise idea of when, where, and how does each band forms. Finally, the energy contribution of each Riedel band is computed and connected to the entire gouge kinematics. Primary bands and secondary bands appear together, but primary bands grow faster, giving spaces to secondary bands at friction peak. These secondary bands have a huge energetical contribution within the shearing during the slip weakening part followed by the Y bands evolving progressively until steady-state.

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