Fragmentation and shear band formation by slow compression of brittle porous media

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ABSTRACT

Localized fragmentation is an important phenomenon associated with the formation of shear bands and faults in granular media. It can be studied by empirical observation, by laboratory experiment or by numerical simulation.

Here we investigate the spatial structure and statistics of fragmentation using discrete element simulations of the strain-controlled uniaxial compression of cylindrical samples of different finite size. In our DEM the microstructure of particulate materials is generated by sedimenting spherical particles in a container. The particles are coupled by beams which represent the cohesive breakable contacts of material elements [1,2].

As the system approaches failure during compression damage localizes in a narrow shear band or synthetic fault 'gouge' containing a large number of poorly-sorted non-cohesive fragments on a broad bandwidth of scales, with properties similar to those of natural and experimental faults. We determine the position and orientation of the central fault plane, the width of the shear band and the spatial and mass distribution of fragments [3].

The relative width of the shear band decreases as a power law of the system size and the probability distribution of the angle of the central fault plane converges to around 30 degrees, representing an internal coefficient of friction of 0.7 or so. The mass of fragments is power law distributed, with an exponent that does not depend on scale, and is near that inferred for experimental and natural fault gouges. The fragments are in general angular, with a clear self-affine geometry. The consistency of this model with experimental and field results confirms the critical roles of pre-existing heterogeneity, elastic interactions, and finite system size to grain size ratio on the development of shear bands and faults in porous media [3].

REFERENCES

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