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Multi-scale analysis of strain localization within granular materials.

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In cohesive materials, brittle faulting is associated with shear strain localization. Faulting is a complex phenomenon involving the interaction and the coalescence of numerous fractures, and characterized by the divergence of the associated correlation length upon macroscopic failure. Deformation of granular media is also characterized by strain localization. Here, we explore, from discrete element method (DEM) simulations, strain localization within a 2D granular cohesionless material loaded biaxially. We analyze the scaling properties of the continuous strain rate field along the loading path in order to track the evolution of the correlation length. Two distinct critical behaviours can be identified. First, a divergence of the correlation length on the first deformation invariant, i.e. the divergence, is reported at the onset of the macroscopic dilation. Secondly, a divergence of the correlation length on the second deformation invariant, i.e. the shear, is also reported at the vicinity of the peak load. This shows that scaling properties emerge from long range interactions within an assembly of rigid frictional disks, and argue for a critical point interpretation of both macroscopic dilation and final failure. Finally, similar biaxial simulations on granular assemblies with various levels of cohesion allow to explore the physics of strain localization from granular media to cohesive materials.