Universal features of anticrack nucleation in porous brittle solids

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ABSTRACT

Characterizing the nucleation of anticracks in porous materials under compression is a great challenge and has been the subject of several investigations in different fields, from earthquake science, rock mechanics to avalanche research [1]. Yet, the conditions for the nucleation of anticracks still remain poorly known, especially under mixed-mode loading. In this study, we have conducted DEM simulations of very loose, cohesive, granular assemblies with initial configurations which are drawn from Baxter's sticky hard sphere (SHS) ensemble. The SHS model is employed as a promising auxiliary means to independently control the average coordination number z_c of cohesive contacts and particle volume fraction φ of the initial states. We focus on discerning the effect of z_c and φ on the elastic modulus, yield surface and plastic flow of the samples. Uniaxial compression simulations revealed a universal scaling behavior of the elastic modulus and the strength, which both scale with the cohesive contact density $\nu_c = z_c\varphi$ of the initial state according to a power law. In contrast, the behavior of the plastic consolidation curve is shown to be independent of the initial conditions [2]. Furthermore, mixed-mode loading allowed us to evaluate the yield surface of the samples which can be approximated by an ellipsoid. The results suggest a universal form of the yield surface after a suitable rescaling of stress coordinates by the contact density. Evidence is provided that such porous solids follow an associative plastic flow rule. Our model contributes to improve the parametrization of continuum anticrack models for porous cohesive materials such as snow for avalanche simulations.

REFERENCES

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