Going down to the microscale: new perspectives

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Abstract

Roughly speaking, granular media exhibit three basic scales: the specimen scale, the contact scale, and an intermediate scale made up of a set of adjoining particles. In this lecture, we will discuss this latter scale, in a two dimensional context. More specifically, the granular assembly can be regarded as a two phases medium. Grain column like patterns (force chains) develop within the medium, participating actively to its mechanical strength. These columns are surrounded by grain loops, made up of 3, 4, 5, or 6 grains (larger grain loops are much less frequent). According to the number of constituting grains, the mechanical properties of grain loops are very different. In particular, 6 grains loops are prone to deform, contributing locally to a change in the void ratio. On the contrary, 3 grains loops deform just a little, but resist quite well to a deviatoric stress. According to the initial porosity of the assembly, and depending upon the loading path considered, the nature of grain loops surrounding force chains is versatile, with continuous transition mainly from 3 grains loops to 6 grains loops (or vice versa). This is a new route to investigate from a microstructural point of view why a granular assembly may be destabilized, leading to a localized or diffuse failure pattern. In addition, these ingredients are shown to give rise to a microstructural interpretation of the so-called critical state, according to the failure mode taking place.

Keywords

Granular materials, multiscale approach, micromechanics, microstructure, localized vs. diffuse failure, second-order work.

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