On the critical state of granular material: the role of grain shape

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Granular materials behave differently from usual solids, with many salient features such as dilatancy, anisotropy, pressure and density dependence, and nonlinear elasticity. Properly predicting the behavior of granular materials remains an area of considerable uncertainty and difficulty. The complexity originates mainly from the particulate nature of the material: that is, a granular material can exist over a range of densities at constant stress and the spectrum of states corresponds to a variety of responses ranging from flow-type failure to strain hardening. From the microscopic perspective, the overall macroscopic response of a granular material is highly dependent on the packing patterns and interactions of the constituent particles which are, further, closely related to particle characteristics such as shape and size. This paper presents several important finings on the relationship between critical states of granular materials and their grain shapes. The critical state of a granular material is defined as an ultimate state of shear failure at which the material deforms continuously under constant stress and constant volume. The relationship corresponds to the most fundamental aspect of the mechanics of granular materials.

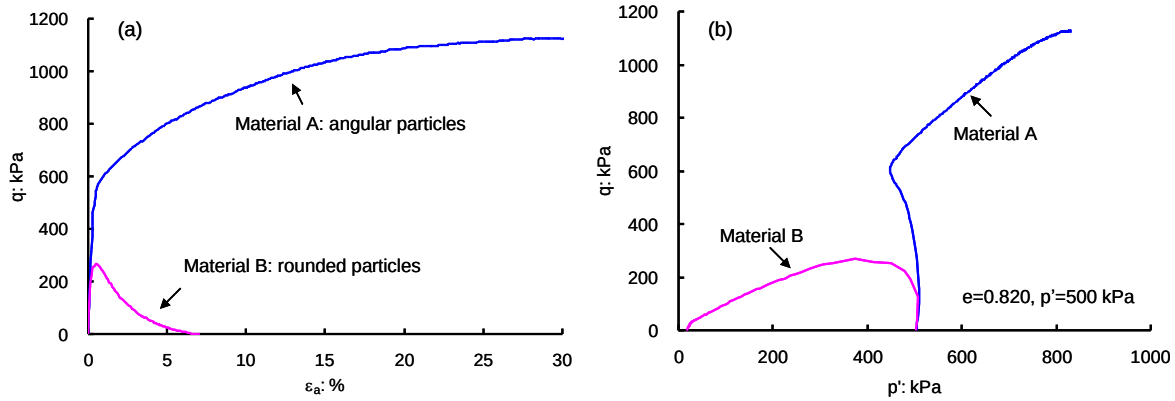

Figure 1. Shear behavior of two materials with different grain shapes under the constant-volume condition in triaxial stress space: (a) deviatoric stress versus axial strain; (b) deviatoric stress versus mean normal stress

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References

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