Special Guest Lecture by:

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Friday, April 7, 2006
Mason 142-A
12:05 to 12:55 p.m.

TOPIC:

"Meso-scale Finite Element Simulation of Strain Localization in Saturated Granular Media"

ABSTRACT:

Deformation bands are one of the most characteristic failure modes in geomaterials such as rock, concrete, and soil. It is well known that appearance of these bands of intense localized deformation significantly reduces the load-carrying capacity of any structure that develops them. Furthermore, when dealing with fluid-saturated geomaterials, the interplay between the contraction/dilation of pores and development of pore fluid pressures is expected to influence not only the strength of the solid matrix but also its ability to block or transport such fluids. Accurate and thorough simulation of these phenomena (i.e., deformation banding and fluid flow) requires numerical models capable capturing fine-scale mechanical processes such as mineral particle rolling and sliding in granular soils and the coupling between porosity and relative permeability. Until recently, these processes could not even be observed in the laboratory, hence numerical models could only interpret material behavior as a macroscopic process and were, therefore, unable to model the very complex behavior of saturated geomaterials accurately.

New advances in laboratory experimentation, such as X-Ray Computed Tomography (CT), allow accurate observation of key parameters associated with material strength and provide the motivation for the development of more realistic models that incorporate information at a scale finer than specimen scale. In this work, we adopt a refined constitutive model based on a meso-scale description of the porosity to simulate the development (location and direction) of deformation bands on saturated samples of sand. 'Meso-scale' here stands for a scale smaller than specimen size but larger than particle size. The effect of meso-scale inhomogeneities in the porosity field (suitably obtained from CT scan data) on the deformation-diffusion behavior of dense sands is studied by casting the meso-scale constitutive model within a mixed finite element framework. Numerical simulations show that meso-scale imperfections are responsible for triggering deformation bands, which tend to strongly influence the direction and volume of fluid flow.