Public Abstract
First Name:Rani
Middle Name:
Last Name:Jaafar
Adviser's First Name:William
Adviser's Last Name:Likos
Co-Adviser's First Name:
Co-Adviser's Last Name:
Graduation Term:SS 2012
Department:Civil Engineering
Degree:PhD
Title:PREDICTING MACROSCALE RESPONSE OF UNSATURATED SANDS FROM MICROSCALE ANALYSIS AND SIMPLE GEOTECHNICAL TESTING

A large portion, if not the majority, of conditions encountered in geotechnical engineering practice involves unsaturated soil. Practical problems include precipitation-induced slope stability failures, expansive or collapsible soils, contaminant transport in the vadose zone, bearing capacity and settlement of shallow foundations, seepage through landfill covers and liners, excavation, and borehole stability. Despite the importance of unsaturated soils in geotechnical engineering practice, implementation of the mechanics of unsaturated soil remains limited. Although considerable research has been developed in recent years, continuing advances are crucial to fully incorporate the mechanics of unsaturated soil into engineering practice.
Modeling or measurements of the pore water fabric in unsaturated granular media would bridge the gap in our knowledge and provide answers to critical unresolved issues in our fundamental understanding of unsaturated soil behavior. This study introduces (i) new frameworks for estimating the soil-water characteristic curve (SWCC) and the hydraulic conductivity function (HCF) of granular porous media using relatively simple experimental measurements and theoretical pore-scale geometric considerations, (ii) a new approach for using X-Ray tomography as a nondestructive and noninvasive tool in measuring the SWCC and volume properties, and (iii) new correlation methods for determining the strength parameters of unsaturated granular porous media from conventional fall cone and SWCC measurements. SWCCs are most effectively predicted along the capillary and funicular saturation regimes (S > 20%) with more deviation observed along the pendular regime (S < 20%). Air-Entry pressure is predicted within an average error of 8%. Hydraulic conductivity is effectively predicted along the entire saturation range (capillary and funicular regimes) with average R2 values of 0.92 and 0.95 for the saturated and unsaturated predictions, respectively. X-Ray CT measured retention curve is effectively determined along the drying and wetting path along the capillary, funicular, and pendular regimes, with the air-entry pressure and porosity determined within 8% and 2%, respectively. Fall cone penetration to direct shear strength and SWCC to direct shear strength correlations are established and frameworks for estimating the apparent cohesion, effective angle of internal friction, and Bishopâ€™s effective stress parameter are presented.