GeoSystems Seminar - This Friday February 1st @ 11:00 in SEB 122

A Unified Effective Stress for Variably Saturated Soils

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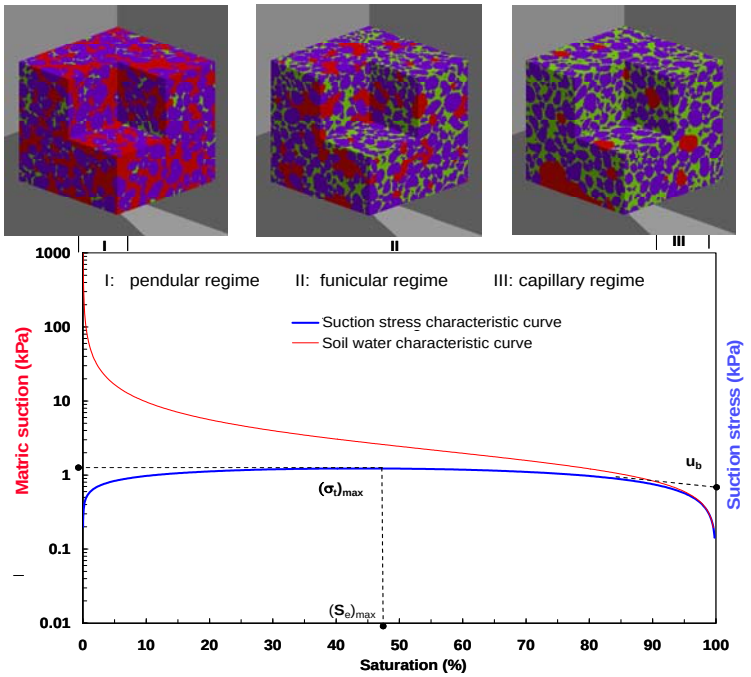
Abstract A unified effective stress concept based on the suction stress characteristic curve (SSCC) for variably-saturated soil is discussed. Particle-scale equilibrium analyses are employed to distinguish three types of interparticle forces: (1) active forces transmitted through the soil grains (Terzaghi's); (2) active forces at or near interparticle contacts (physicochemical); and (3) passive, or counterbalancing, forces at or near interparticle contacts (Born's and steric). It is proposed that the second type of forces, which includes physicochemical forces, cementation forces, surface tension, and the force arising from negative pore-water pressure, can be conceptually combined into a macroscopic stress called suction stress. Suction stress is an internal stress that is completely balanced by Born's repulsion and is independent of the external or total stress. Suction stress characteristically depends on degree of saturation, or soil suction, thus paralleling well-established concept of the soil–water characteristic curve in soil physics. The existence and behavior of the SSCC are experimentally validated by considering unsaturated shear strength and volumetric behavior data for a variety of soil types in the literature. The characteristics and practical determination of the SSCC are demonstrated. A closed form equation for predicting the suction stress for all soils is found. A case study of shallow landslide initiation induced by heavy rainfalls in Seattle area illustrates that variation in suction stress can well reconcile the spatial and temporal characteristics of the event. Suction stress provides a potentially simple and practical means to describe the state of stress in unsaturated soil.



Biographical Sketch Ning Lu is professor of civil and environmental engineering at Colorado School of Mines (CSM) and the director of the joint CSM/USGS Geotechnical Research Laboratory in Golden, CO. He is a recipient of *ASCE 2007 Norman Medal* and the recipient of *ASCE 2010 Croes Medal*, and an elected fellow of *Geological Society of America* and *American Society of Civil Engineers*. His current research focuses on developing a unified coupled hydro-mechanical framework for variably saturated porous media and applying it to rainfall-induced landslide analysis. He is the senior author of widely used textbook *Unsaturated Soil Mechanics* (John Wiley and Sons, 2004) and *Hillslope Hydrology and Stability*, (Cambridge University Press, 2012). He can be reached via ninglu@mines.edu.