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Title: Special Issue on the Advances in Laboratory Experimentation for Unsaturated Soils.

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Introduction:

Unsaturated soils are prevalent in nature and significantly influence the performance of geotechnical infrastructure (e.g., highway embankments, landfills, shallow foundations, trench excavations, natural slopes, etc.) and issues of national defense and security. Infrastructure failures resulting from unsaturated soil issues result in significant economic damages and are becoming an increasing concern as infrastructure ages world-wide. Unsaturated soils are not only critical for geotechnical engineering problems but are also encountered in other geo-related scientific fields, e.g., geophysics, geoenvironmental and geochemical soil sciences.

The understanding and theoretical development of unsaturated soil mechanics and impacts thereof is a very complex problem involving coupled water/air flows and solid skeleton deformations. Experimental techniques required to validate unsaturated soil constitutive models, signal processing algorithms and approaches to measure thermo-hydro-mechanical behavior create the foundational basis for much of the scientific exploration. Often the physical testing of unsaturated soils is highly complex, requiring high quality physical validation that replicates in-situ boundary conditions while controlling and measuring unsaturated soil parameters. Moreover, high quality experimentation can take months to complete a single test, with comprehensive datasets taking a year or longer to compile.

A significant scientific focus over the last two decades has been in the understanding the coupled thermo-hydro-chemo-bio-mechanical behavior of unsaturated soils. However, there has yet to be a comprehensive review and evaluation of the limitations and advantages of unsaturated laboratory equipment, experimental techniques, collections of high-quality unsaturated soil data, and analytical techniques used for data interpretation. As unsaturated soil mechanics is applied to evermore complex problems, the need for collection and critical review of such information has become a necessity.

This special issue of the ASTM *Geotechnical Testing Journal* brings together 18 papers that illustrate recent significant advancements in physical equipment and experimental methodologies used to measure the thermo-hydro-chemo-bio-mechanical properties of unsaturated soils. This collection of papers covers four main topics: thermally controlled unsaturated soil testing, improved methods for measuring mechanical behavior; dynamic response and testing; and osmotic and diffusive testing.

Advances described in this issue in thermally controlled experimentation include new methods to determine the critical soil temperature where coupled heat and moisture outflow is balanced by inward moisture flow induced by the suction gradient as well as modified environmental chambers to investigate higher total suction limits and low stress environments. Papers on improved methods for measuring hydro-mechanical behavior focus on improved unsaturated triaxial testing and novel means to decrease the overall testing time without inducing an experimental bias within the data. Papers investigating the dynamic response and testing of unsaturated soils highlight advances in cyclic loading, characterization of seismic compression and microbial induced desaturation for improved dynamic properties. Papers that

address the nature of osmotic and diffusive testing of unsaturated soils illustrate improvements to vapor equilibrium testing, methane hydrate detection and permeable clay lining experimentation.

The editors of this special issue would like to gratefully acknowledge the efforts of all the authors and peer reviewers of these papers, and the dedication of the publication staff in producing this special issue.