

9TH ANNUAL UNH GEOTECHNICAL ENGINEERING PEDRO DE ALBA LECTURE

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Unsaturated Soils: From Complex Behavior to Simplified Solutions

Unsaturated soil behavior is, in fact, complex, highly nonlinear, and elastoplastic. However, adoption of unsaturated soil mechanics in the practice of geotechnical engineering can often be accomplished using simplified approaches. Critical to use of simplified models, however, is consistency with the known big-picture behavior of unsaturated soils. Some common protocols and simplified models for implementation of unsaturated soil mechanics in routine volume change and shear strength applications will be briefly reviewed and critiqued. Volume change, arguably the most important and challenging unsaturated soil problem, will be used as the primary application to demonstrate simplified, sound approaches to practice-based testing and modeling of unsaturated soils.

Early laboratory-based research on unsaturated soils revealed complex volume-change response to reduction of soil suction, resulting in development of state surface approaches that could accommodate soil expansion or collapse due to wetting under load. Subsequently, elastoplastic models for unsaturated soils were developed. Unfortunately, in the development of elastoplastic unsaturated soil models, state surface approaches were more or less abandoned. This led to additional challenges in modeling known soil response, and development of some elastoplastic models that are primarily for collapsible or expansive conditions. More recently, Zhang and Lytton (209) presented a modified state surface approach (MSSA) that accommodates elastoplastic volume change of unsaturated soils while retaining important elements of the state surface approach. The MSSA is a relatively simple and unifying approach that accommodates complex volume change response of unsaturated soil, whether the soil exhibits collapse, expansion, or both (Houston and Zhang, 2021). Key features of the MSSA will be presented. Discussions necessarily include some current points of debate in unsaturated soil research, including stress state variables. Stress path based approaches to volume change modeling and some common laboratory tests (e.g. ASTM D4546) will be reviewed within the MSSA elastoplastic framework to explore consistency with known unsaturated soil response.