

Two sides of a coin: a critical review, and mathematical and phenomenological study of what we call hydro-mechanical coupling

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ABSTRACT

Unsaturated soil is a complex medium composed of different phases and interfaces. The volume fraction of different phases influences the overall macroscopic behavior of unsaturated soil. On the other hand the porous network of unsaturated soil changes under external loading and is stress level dependent. Therefore, the volume fraction of different phases changes with the stress level and accordingly the topology, connectivity of the porous network, and fluid paths change. This means the mechanical behavior of system is saturation dependent and the hydraulic behavior of the system is stress level dependent. This has been referred to as hydro-mechanical coupling in the literature of unsaturated soil mechanics. There are various studies in the literature which investigate each of these phenomena alone and independently and the connection of the two is not comprehensively looked into. The soil water retention curves for deformable porous media have been explored by various researchers [e.g., 1-3] and the dependency of stress measures on the saturation level has been investigated in some others [4-6]. However, these two phenomena are mutually inter-related and it is also of practical importance to look into saturation dependent stress measures and stress dependent retention properties in a single framework, and not only that, different micro scale and macro scale phenomena are also worth being investigated from this perspective. In this study, a thorough and critical review of current literature on the hydro-mechanical coupling is presented and different phenomenological and mathematical aspects of hydro-mechanical coupling are discussed.

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