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Capillary Suction Response of Granular Materials from Computed Tomography and Direct Numerical Simulations

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The mechanical and hydraulic response of granular media in partially saturated conditions can be highly intricate and requires proper understanding at the pore scale. The response of partially saturated sands to complex loadings such as projectile penetration necessitates integrating capillary suction in the constitutive model framework. In this study, Soil Water Suction Curve (SWCC) predictions of Ottawa sand were made using attenuation contrast based X-ray Computed Tomography (CT) data and Direct Numerical Simulations using the digital material library package GeoDict. This approach of predicting SWCC is fast and less tedious compared to the existing experimental methods. The pore morphology method and Young Laplace equation were used to simulate the drainage and imbibition processes. The resolution of CT scans is critical in segmentation of pore phase from solid phase, therefore, CT data was acquired at three different resolutions and its effect on SWCC predictions was observed. The drying and wetting behavior of solids depends on the surface roughness and geometry which manifests variation in contact angle. SWCC predictions indicate a significant variation in air entry value of Ottawa sand as contact angle changes. Furthermore, the distribution of wetting phase (water) and non-wetting phase (air) at different saturations is presented. The SWCC predictions obtained in this study can be helpful to model coupling between multiphase flow and mechanical behavior for granular materials such as sands for static and impact problems including projectile penetration studies.

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