Hydromechanical behavior of unsaturated granular materials under suction and water content control

Chao-Fa Zhao[*,‡], **Hien N. G. Nguyen**[†], **Niels P. Kruyt**[*] **and Olivier Millet**[†]

[*] Department of Mechanical Engineering, University of Twente,
P.O. Box 217, Enschede 7500 AE, the Netherlands

[†] LaSIE-UMR CNRS, Université de La Rochelle,
23 Avenue Albert Einstein, La Rochelle 17000, France

[‡] Corresponding author, e-mail: chaofa.zhao@gmail.com

ABSTRACT

It has been widely recognized that the behaviour of granular materials is dependent upon the loading path. For unsaturated granular materials in the pendular regime, recent studies of the behaviour at the micro scale demonstrate that the properties of capillary bridges between two spherical particles under suction and water content control are significantly different. In particular, the rupture distances of capillary bridges under these two loading conditions are very different. Consequently, the failure behaviour of wet granular assemblies is expected to be highly dependent on the hydraulic loading paths.

This study investigates the influence of hydraulic loading path on the hydromechanical behaviour of wet granular materials in the pendular regime. For this purpose, Discrete Element Method (DEM) simulations have been conducted. In these simulations, the properties of capillary bridges between spherical particles are represented by the newly developed analytical theories that are consistent with the governing Young-Laplace equation and that are suitable for capillary bridges under volume as well as suction control.

Using DEM simulations, wet granular assemblies in the pendular regime were consolidated under different confining pressures. The prepared samples were then sheared to large deformations under suction and water content control respectively. The simulation results reveal the extent of macro-scale difference of wet granular materials originating from the inter-particle capillary bridges at the micro scale under suction and water content control.