

Centrifuge Permeameter for Unsaturated Soils. I: Theoretical Basis and Experimental Developments

Jorge G. Zornberg, M.ASCE¹; and John S. McCartney, A.M.ASCE²

Abstract: A new centrifuge permeameter was developed with the specific objective of expediting the measurement of the hydraulic characteristics of unsaturated soils. The development, theoretical basis, and typical results associated with using the centrifuge permeameter for concurrent determination of the soil-water retention curve (SWRC) and hydraulic conductivity function (K function) of unsaturated soils are presented in this paper. Components developed for the centrifuge permeameter are described, including the centrifuge, permeameter, water flow control system, and instrumentation used to concurrently and nondestructively measure the infiltration rate (flow pump and outflow transducer), volumetric water content (time domain reflectometry), and matric suction tensiometers in flight during steady-state infiltration. A companion paper focuses on definition of the SWRC and K function for a clay soil using the procedures described in this paper. While conventional geotechnical centrifuges are used to reproduce the response of earth structure prototypes, the centrifuge developed in this study is used to accelerate flow processes. Accordingly, it required a comparatively small radius (0.7 m) but high angular velocity (up to 875 rpm or 600 g's) to impart a wide range of hydraulic gradients to an unsaturated soil specimen. Analytical solutions to Richards' equation in the centrifuge indicate that steady-state infiltration allows direct determination of the relationships between suction, volumetric water content, and hydraulic conductivity from the instrumentation results. Typical instrumentation results during a drying stage are presented to illustrate determination of data points on the SWRC and K function at steady state. These results were found to be consistent with analytical flow solutions.

Full reference:

Zornberg, J.G., and McCartney, J.S. (2010). "Centrifuge Permeameter for Unsaturated Soils I: Theoretical Basis and Experimental Developments." *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, Vol. 136, No. 8, August, pp. 1051-1063.

Link to file*:

[http://dx.doi.org/10.1061/\(ASCE\)GT.1943-5606.0000319](http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000319)

*File may be downloaded for a fee from ASCE Library