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Measurement of unsaturated hydraulic conductivity with the instantaneous profile method

Amin Askarinejad, Alexander Beck, Francesca Casini, and Sarah M. Springman
Institute for Geotechnical Engineering, ETH Zurich

Hydraulic conductivity is one of the most important hydraulic properties, which affects infiltration rate and pore pressure distribution in saturated and unsaturated soils. The hydraulic conductivity of unsaturated soil is a function of material variables describing the pore structure (e.g., void ratio and porosity), the pore fluid properties (e.g. density and viscosity), and the relative amount of pore fluid in the porous system (e.g. water content and degree of saturation).

The unsaturated hydraulic conductivity of a silty sand is determined in this study. The soil is from Ruedlingen (Canton Schaffhausen, Switzerland), where landslide triggering experiments were carried out in Autumn 2008 and Spring 2009. The hydraulic conductivity measurements are conducted based on the instantaneous profile method. This method consists of measuring the variation of the suction and volumetric water content profile within an infiltration column as a function of time during the infiltration process. Accordingly, an infiltration column was developed with a height of 600 mm and inner diameter of 170 mm. The suction and volumetric water content were measured simultaneously every 100 mm in depth by small tensiometers and TDRs, respectively. These measurements will provide enough data to correlate the hydraulic conductivity with the negative pore water pressure and/or degree of saturation. Hydraulic conductivity k is calculated by dividing the water flow velocity by the hydraulic gradient. The water flow velocity v is defined as the volume of water flow passing through the whole cross-sectional area over a given time increment.

The change in the height of the soil sample during the flow of water inside is monitored using a set of LVDTs on the upper part of the soil column, enabling the volumetric changes to be tracked during the cycles of wetting and drying. The tests are performed on statically compacted soils with different initial void ratios. Several cycles of wetting and drying are applied for each test and the changes in the hydraulic conductivity function are determined. The saturated conductivity is about 10-6m/s. These values are low compared to the insitu measurements of hydraulic conductivity carried out in the course of the landslide triggering experiments. The insitu saturated conductivity is approximately 10-4 m/s. The differences can be explained by the influence of preferential paths in natural soil. The water passes through macro-pores and along dead roots. The results will be compared with empirical equations based on water retention curves and grain size distribution.