LABORATORY MODELLING OF INFILTRATION INTO UNSATURATED RESIDUAL SOILS

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Rain induced failures in slopes made of residual soils are a major concern in Sri Lanka. Sri Lankan sloping grounds are made of colluvial soils, residual soils, and rocks at different levels of weathering. Soils at upper levels in most slopes are in an unsaturated state during dry season. The high matric suction near to the surface enhances the shear strength. Infiltration rainwater during the rainy season reduces the matric suction and could create perched water table conditions. Ground water table could also rise. A detailed understanding of the infiltration process is necessary to get an insight into rain induced slope failures. Infiltration process can be modelled with GEOSLOPE software, but it needs to be verified with data acquired from field instrumentation. A field study would be quite complex due to the prevailing nonhomogeneous conditions. As such, initial studies are done under simplified laboratory conditions.

In this research infiltration process is studied with a laboratory model of a uniform soil mass prepared in a barrel. The matric suction changes predicted by numerical model are verified by laboratory measurements. Initial study was done by filling the barrel with a lateritic fill of low permeability (K_{sat} = 1.0 x 10^{-7} m/s). In the current study a sandy soil with high permeability of 1.0 x 10^{-4} m/s was used. Sand was placed in layers with proper compaction.

Rainfalls of different intensities were simulated. To simulate the rainfall the required quantity of water for 15 minutes was calculated and applied uniformly over the model at 15-minute intervals by a perforated cup. A constant head was achieved by having an overflow from the cup. The matric suctions and moisture contents during the rainfall events were measured using tensiometers and moisture sensors. Measurements were done after the event also to model the process of evaporation. The experimental results were compared with results from numerical modelling with GEOSLOPE SLOPE/W 2012 software. SWCC was modelled using the Fredlund and Xing model.

Results of this study showed that, in first few hours after applying the rainfall the matric suction was reduced rapidly at the top of the sand column and with time it propagated to the bottom of the sand column. Thereafter, matric suction reduced gradually. When it was subjected to a continuous heavy rainfall positive pore water pressures were developed. Matric suctions increased after the cessation of the rainfall. Experimental observations and numerical predictions were in close agreement.

In the tests done with lateritic soils high matric suctions prevailed after the compaction and rainfall caused a reduction in matric suction but positive pore water pressures were not developed.

Keywords: matric suction; unsaturated soil; infiltration; rainfall; tensiometer, pore water pressure

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