

## USE OF THE CONCEPT OF CAPILLARY BARRIERS TO OPTIMIZE THE SUPPORT OF DEEP VERTICAL EXCAVATIONS IN UNSATURATED SOILS

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Deep excavation in the construction industry became vital because of the lack of availability of land in the populated urban areas to provide facilities such as parking. In a deep excavation it is necessary to ensure stability and that the deformations in the surroundings are within acceptable limits. As such, deep excavations need to be supported by properly designed earth retaining structures with adequate lateral supports. In excavations below ground water level expensive systems such as secant pile walls or diaphragm walls are needed. In unsaturated soils, simpler systems such as soldier pile walls can be used. The forces on the system are low during dry periods due to the prevailing high matric suction. But during the rainy seasons, due to the infiltration of water into the unsaturated soil matric suction will reduce leading to a reduction in shear strength. If the retaining system is designed with saturated strength parameters as a conservative measure the cost would be high.

Infiltration of rainwater can be reduced with the use of the concept of capillary barriers and the design of the earth retaining system can be optimized. A capillary barrier is an unsaturated cover system with two layers with varying hydraulic properties that functions in response to change in negative pore water pressure. It consists of a fine layer on top of a coarse layer. A capillary barrier is effective if the combined effect of evaporation, transpiration and lateral diversion exceeds the infiltration from the precipitation.

In this research study attempts were made to establish the critical parameters for the capillary barrier system like inclination and thicknesses of layers. Analyses for the applicability of the capillary barrier system on the deep vertical excavations on local Sri Lankan soils was done with rainfall experiments on a laboratory physical model. Results of the physical laboratory experiment were verified with the numerical analysis of the model using SEEPW Geoslope 2012 software.

Another analysis was done studying the effect of rainfall on the prop forces on a soldier pile wall supporting a 6m deep excavation done in an unsaturated soil with a deep groundwater table. Infiltration was studied under the natural conditions and with the capillary barrier. This study was done with MIDAS GTS NX software under 3 Dimensional conditions. From the analysis, length of 600 mm was selected for both capillary barrier and site extent of the physical laboratory model with infiltration rate of 10mm/hr. Results of numerical analysis show that the capillary barrier of this model cut the infiltration of rainwater for a 20-hour continuous rainfall. Results of the numerical analysis on actual deep excavation shows that the prop forces reduce by a significant amount in the presence of the capillary barrier. Percentage of increase in the prop forces decrease by 45% to 27% at different prop levels. These two studies show the effectiveness of the capillary barrier in economizing design of earth retaining systems in unsaturated soils.

**Keywords: capillary barrier; infiltration; porewater pressure; deep excavation**

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