OPTIMISATION OF THE DESIGN OF DEEP EXCAVATION IN UNSATURATED SOILS THROUGH CAPILLARY BARRIERS

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Deep excavations to accommodate basements have become widely attractive in densely populated cities in recent years. Excavations that extend below groundwater table need to be watertight and expensive structures in the form of diaphragm walls and secant pile walls are needed. Above the ground water level, much simpler structures in the form of soldier pile walls can be used. However, with the infiltration of rainwater the matric suction will be lost and saturated cohesion values are used in the designs normally.

Using a capillary barrier, infiltration of water into the soil underneath could be reduced and a much higher apparent cohesive value accounting for the presence of a matric suction can be used and the design of the soldier pile wall can be optimised. This feasibility of this proposal was studied with an instrumented laboratory model and experimental results were verified by a numerical simulation done with SEEP/W software, modelling the process of infiltration.

Results of the laboratory model instrumented with tensiometers and moisture sensors revealed that matric suctions of the soil below the capillary barrier remained high over 8 days withstanding a rainfall of 10 mm/h. A failure occurred after 9 days. Subsequently, the study was extended to a 6 m deep field excavation laterally supported at three levels by a soldier pile system. Effectiveness of capillary barriers of width 1 m, 2 m and 4 m with 300 inclination was studied numerically. With the capillary barrier of 2 m width, high matric suctions were maintained underneath of CB over 4 days of continuous rainfall. The force on the struts were only 60 kPa during this rainfall. In the absence of a capillary barrier the strut forces would have increased by 250 %.

The results of the study revealed that in the presence of a capillary barrier the infiltration would be minimised and design of the soldier pile wall system could be significantly economised. A capillary barrier of a limited width of 2 m would be sufficient making it feasible in the limited space available in sites.

Keywords: Capillary barrier, Deep excavation, Infiltration, Horizontal total stress

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