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# Geotextile- and Geogrid-Reinforced Soil Slopes with Various Backfills and Sand Cushion Thickness Subject to Rainfalls

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# Geotextile- and Geogrid-Reinforced of Soil Slopes with Various Backfills and Sand Cushion Thickness Subject to Rainfall

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## ABSTRACT

This study presents a numerical study to investigate the hydraulic response and stability of GRS slopes subject to rainfalls, considering the combined effect of backfill (i.e., sand silt, and clay), reinforcement types (i.e., geogrid or nonwoven geotextile) and rainfall intensity (350 and 800 mm/day). The backfills were modeled using three soil-water characteristic curves (SWCCs) representing the general suction range associated with sand, silt and clay. The numerical models were first validated for their accuracy and suitability for stability analyses considering the effect of matric suction on soil shear strength using the experimental results of an unsaturated reinforced embankment. Thereafter, a series of numerical simulations of unsaturated slopes with various backfill–reinforcement systems subject to rainfall infiltration were performed. The effect of sand cushion thickness (0 - 35 cm) on improving the stability of reinforced slopes with marginal backfills was also assessed. The numerical results reveal the loss of matric suction and development of capillary barrier effect within clay backfills could have negative impacts on both the global and local stabilities of reinforced-clay slopes. The contribution of matric suction in enhancing slope stability is high initially for reinforced clay slopes; however, the global stability of the reinforced clay slope decreases substantially due to the loss of matric suction as the rainfall infiltration proceeds. The local instability of geotextile-reinforced slope with clay backfill occurred due to the capillary barrier effect at the geotextile-clay interface. Both the global and local factors of safety (FS) of reinforced sand slope shows little influence by the loss of matric suction induced by the rainfall infiltration and by the geosynthetic type (with and without drainage function). The required reinforcement tensile strengths for silt-geogrid and clay geogrid system to maintain $FS$ = 1.3 are approximately 3 and 4 times respectively larger than that for sand-geogrid system. Numerical results also indicated that the inclusion of sand cushions can effectively enhance the slope stability and the increase in the thickness of the sand layer leads to less decrease in both the global and local factors of safety. Even with a thin layer of sand cushion inclusion (5 cm), the stabilities of reinforced clay slopes are significantly improved. The contribution of sand cushions to the stability improvement resulted from their strength and drainage functions; in particular, the strength function is more effective in the global stability improvement, whereas the drainage function become more dominant in the local stability improvement. Findings of this study provide improved methodologies for the analysis and design of reinforced soil structures constructed with marginal soils and provide a suitable guidance of selecting an appropriate backfill-reinforcement-drainage system.

**Keywords:** Geosynthetics, Unsaturated backfill, Sand cushion, Slope stability, Suction, Infiltration

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