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Evaluation of the Performance of Reinforced Red Coffee Soils Embankments Subject to Rainfall Event

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Abstract

Infrastructure development in Kenya has led to the need for alternative material in slopes and embankments construction. Sourcing of recommended cohesionless material often leads to the destruction of the environmental features such as rivers and involves high extraction and transportation costs. The need for alternative material is the motivation behind this study. The study aims to evaluate the potential of Red coffee soils of Kenya as a backfill material in the construction of slopes and embankments. Provision of sand cushion layers to sandwich non-woven geotextile material has been suggested to overcome the water drainage and stability problems that have been associated with these soils. The study first involved identifying the properties of both the Red coffee soils (RCS) and the river sand that is to aid in drainage. Numerical model SEEP/W was used in evaluating the effect of geotextile inclination on the performance of RCS embankments before the effect of introducing sand cushions of different thickness evaluated. The numerical results revealed that the stability of reinforced RCS decreased with increase in pore water pressure in the embankments due to rainfall infiltration. Provision of sand cushion layers helped improve both the local and global stabilities of the RCS subjected to rainfall infiltration. The results showed that 150mm sand cushion layer was adequate to improve the performance of RCS embankments and reduced the sand consumption in the construction of embankments to 15%.

Keywords: Drainage; Embankments; Non-Woven Geotextile; Red Coffee Soils; Sand Cushion; Slope Stability.

1. Introduction

The design guidelines, AASHTO [1] have recommend the use of coarse grained cohesionless soils as backfill material in reinforced walls and slopes. This is majorly attributed to their low plasticity levels, high frictional values which are helpful in pullout resistance especially when geotextile materials are used to reinforce these structures. Despite the advantages presented by the cohesionless soils, their extraction has proved detrimental to the environment as most of these soils are extracted from river banks or near water bodies as deposits. Patricia [2] reported that sand harvesting along rivers has contributed to the destruction of river banks and drained water points leading to drying of rivers. Backfill material in geosynthetic reinforced structures account for 30-40% of the total cost of the structure [3]. This demonstrates the importance of a cheaper alternative in the construction of earth structures.

In Kenya the availability of RCS which in most construction sites comprises of the largest percentage of waste material can be put into use. However, studies [4, 5] reveal that red coffee soils fall under soils with medium to high plasticity also referred to as marginal soils. In a study that involved 171 failed reinforced soil structures, Koerner [6]

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