MarTREC
Maritime Transportation Research & Education Center

MarTREC UTC Project Information Form
USDOT Tier 1 University Transportation Center
Agency ID or Contract Number DTRT13-G-UTC50

Project Title: DEVELOPMENT OF A DESIGN PROTOCOL: SUSTAINABLE STABILIZATION OF SLOPE USING RECYCLED PLASTIC PIN IN MISSISSIPPI

Project Abstract (Brief Description): The maritime and multimodal system is an integral part to the efficient movement of the nation's freight, which includes around 25,000 miles of commercially navigable harbors, channels, and waterways, 4 million miles of public highways and roads, and over 140,000 miles of national, regional, and local railroad networks. Slopes and embankments are one of the major components of the maritime and multimodal transportation infrastructure, which often subjected to shallow landslides due to the existence of expansive clay soil. In Mississippi, the shallow slope failure is induced by the climatic (temperature and rainfall) variation that cause shrink-swell behavior of expansive Yazoo clay soil, and require significant budget to repair. As a cost effective alternative, Recycled Plastic Pins (RPP) can be utilized to stabilize shallow slope failures, to offer a sustainable option and increase the economic competitiveness to maintain multimodal transportation infrastructure. The current study intent to investigate the effectiveness of RPP to stabilize shallow slope failure on Yazoo clay in Mississippi, and develop a next generation design protocol based on the climatic variation of Mississippi, to maintain an efficient, resilient, and sustainable multimodal transportation system. Highly plastic Yazoo clay soil samples from will be collected and investigated in the laboratory to determine the physical and mechanical soil properties. The laboratory test result will be utilized to conduct safety analysis of unreinforced and RPP reinforced slope using Finite Element Method (FEM) in Plaxis, to evaluate the effectiveness of RPP in Mississippi. The historical rainfall data of coastal Mississippi from NOAA will be evaluated and the rainfall pattern will be determined. The rainfall data (with different intensity and duration) will be applied over the RPP reinforced slopes (with different spacing) in coupled flow mode, and associated deformation and safety analysis will be conducted to evaluate slope performance under different rainfall condition. Based on the extended FEM analysis results, the optimum spacing of RPP will be determined and a design protocol for Mississippi will be developed.

Describe Implementation of Research Outcomes: Based on the flow analysis results, it was observed that there is a high suction at the initial moment before rainfall. With short duration of rainfall, a decrease in the suction takes place. This decrease in suction is immediate at the shallow surface faster compared to the deeper surface. It was also noticed that with an increase of rainfall intensity does not affect much infiltration, due to the low permeability of the highly plastic clay soil. The total volume of the rainfall plays a major role in the infiltration behavior for highly plastic clay soil. In addition, the successive rainfall can have a significant influence on slope failure in shallow depth in Mississippi due to several rainfall events.

Impacts/Benefits of Implementation: Based on the numerical analysis, it was observed that the Recycled Plastic Pin (RPP) increase the failure of safety of the slopes on Yazoo clay. The uniform spacing of RPP result in a high factor of safety and significantly less deformation near the crest of the 2H: 1V slope. On the other hand, the varied spacing of RPP result in a high factor of safety. However, it has significant deformation near the crest of the slope.

Web Links: https://martrec.uark.edu/

Budget (Funding) Amounts & Source(s) (US DOT +Match(s) =Total Costs): 57.5k USDOT + 28.75k matching = 86.25k total
Project Start and End Dates: 05/01/2016 – 04/30/2017. No cost extension granted to 10/30/17. Project complete.
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