Tran-SET
Transportation Consortium of South-Central States

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Integrated Field Instrumentation, Full-Scale Physical Experiments, and Numerical Modeling of the Performance and Rehabilitation of Highway Embankments

Key Points

Project Number:
18GTLSU06

Start Date:
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End Date:
09/15/2019

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Louisiana State University

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$105,000

Funding Source(s):
Tran-SET
Louisiana State University
University of Texas at Arlington

Total Project Cost:
$210,000

Brief Project Description

The majority of highway embankments across the United States, specifically in Region 6, are in marginal condition because the high-plasticity clays used during construction will soften with time to significantly lower strengths. In addition to lower strengths, infiltrating rainfall will increase pore-water pressures and ultimately lead to slope instability. As such, this study will advance the understanding of time-dependent changes in hydro-mechanical properties of high plasticity fine-grained soils due to environmental conditions. Specifically, this study aims to quantify the contribution of each environmental factor (precipitation intensity and duration, temperature, humidity, etc.) on the hydro-mechanical properties of compacted highway embankments with time.

Problem Statement

Resilience of transportation infrastructure, such as highway embankments, is critical to avoiding commuter delays and costly repairs. Most earth embankments across the United States are in marginal condition. The high-plasticity clays used by state departments of transportation (DOTs) to construct highway embankments are subjected to many cycles of wetting and drying periods. These soils can weather, desiccate, and soften to significantly lower strengths. In addition, heavy rainfall increases the soil moisture and ultimately results in slope stability problems. As a result, highway maintenance crews continue to spend many hours fighting this problem annually. Accordingly, there is an important need to develop a methodology to predict locations of high failure probability areas, and determine cost-effective rehabilitation techniques for DOT districts.

Objectives

The objectives of this study are to develop a framework that predicts which locations have a high risks of slope failure and demonstrate its functionality in Region 6; and identify cost-effective rehabilitation techniques for repairing slides.

Intended Implementation of Research

Workforce Development

State DOTs spend significant effort to repair shallow slides on highway embankments. However, a comprehensive design and maintenance guideline that provides methods for estimating fully softened strength (FSS), performing stability analyses, and rehabilitating slopes is not readily available. Such a manual will be developed upon completion of the research study to assist state departments of transportation.

Education

The results from this research will be incorporated into several courses at Louisiana State University as well as several courses at the University of Texas at Arlington. In each course, a module will be developed that the professor can use to lecture on drained shear strength of fine-grained soils. For example, the undergraduate courses will obtain a basic understanding of the three types of drained shear strength (peak, fully softened, and residual), how to measure the strength of the soils, and how to apply the strengths to simple stability problems. The graduate level course will delve deeper into the fundamentals of shear strength, testing methods, and development of empirical correlations.

Outreach

The research team will develop a classroom demonstration that will allow students to envision the effect of soil type and weather (rain) on slope stability. The research team will also contribute to science fair projects that would like to test a hypothesis on different mixtures of soil, moisture, and strength.

Anticipated Impacts/Benefits of Implementation

This study will result in more resilient geotechnical infrastructure and use emerging technologies to possibly prevent and repair earth embankments. In addition, this research is highly relevant for highway embankments not only in Texas and Louisiana but also in Arkansas and Oklahoma. The outcome of this project will assist DOT agencies in Region 6 by developing a predictive tool for identifying high risk zones of instability and compiling the rehabilitation methods for highway embankments. The impact will be reduced cost of maintenance by preventing failures and developing a catalog of remedial techniques.

Weblinks:

http://transet.lsu.edu/research/research-in-progress/

https://rip.trb.org/View/1505364