Evaluation of Sustainable and Environmentally Friendly Stabilization of Cohesionless Sandy Soil for Transportation Infrastructure

Creating a stabilization method for sandy soil in transportation infrastructure

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$65,000

Using native materials to establish transportation infrastructure is often the most desirable solution. However, the presence of cohesionless geomaterials, especially in the coastal areas often hinder the use of native soils in its original form. Mechanical or chemical stabilization of these soils with fibers and cementitious materials, respectively, usually result in enhanced mechanical properties which may satisfy the design requirements. However, there are significant environmental effects of using traditional stabilizers. Also, during natural disasters, such pavements may undergo significant damages. Recently, a new group of alumino-silicate-polymers, commonly known as Geopolymers, have received attention for its green, sustainable nature and its cementitious properties. An ongoing study is being performed to synthesize and evaluate the performance in terms of strength, stiffness, volumetric changes, and durability of Geopolymer-stabilized sulfate-rich soils. In the proposed study, we aim to synthesize similar Geopolymers and explore their suitability as sustainable stabilizers as the sole additive and as a co-additive in enhancing the of cohesionless soil performance in Region 6.

Problem Statement

Many subgrades in the southeastern US are cohesionless sandy materials and these materials also experience issues like low relative density, high erosion potential and can have low strength and stiffness properties. Examples of such sites include pavement infrastructure built along gulf coast and in western USA states including Texas and other Region 6 states. Transportation infrastructure built using cohesionless or cohesive soils in these regions often report distress like pavement collapse, embankment failures and others, especially due to floods and hurricanes. Hence, there is a need to stabilize sandy soils in in-situ conditions. Stabilizers such as Ordinary Portland Cement (OPC) and other chemical additives are often considered as having high carbon footprint and thus researchers are exploring other chemical additives that will be effective in stabilization with low carbon footprints with sustainable benefits.

Objectives

The research project aims to synthesize an innovative, sustainable, and ecofriendly Geopolymer suitable for stabilizing cohesionless soils for transportation infrastructure in Region 6, using natural and waste materials that are deposited in the region. This research will bring benefits in the design of distress-free pavement infrastructure in severe problematic conditions that plague in Region 6. Specific objectives of the proposed projects include:

- Select composition of Geopolymer with best workability and mechanical properties.
- Select the best cohesionless soil suitable for the study.
- Explore the effectiveness of Geopolymers for stabilization of cohesionless soil.
- Provide guidance for the optimum composition of Geopolymers for stabilizing cohesionless soil.
- Implement research results and teach the workforce with the expertise in using novel technologies for soil stabilization.

Intended Implementation of Research

Workforce Development: This research will lead to a comprehensive report that will provide design methods and guidance for Geopolymer and Cement-Geopolymer treatments of cohesionless soils. The information will also be shared in various venues including technical publications, and conference presentations.

Outreach and Education: Two Ph.D graduate students will work on the present research tasks, and they will work with PIs at TAMU. A simple visual module to demonstrate soil stabilization

technologies and testing will be developed for high school and middle school students from Texas to see in their summer recruitment programs at TAMU. This will contribute to the awareness and education of the public on issues on stabilization of cohesionless soils. The results from this project will be integrated into courses at Zachry Department of Civil Engineering in CEVN-689 Ground Improvement and Geosynthetics, and at Department of Material Science and Engineering including MSEN410 Materials processing and MSEN625 Mechanical Behavior of Materials in Texas A & M University.

Anticipated Impacts/Benefits of Implementation

The main deliverables of this study is: (1) a comprehensive report summarizing the all task results from both participating institutions; (2) at least two journal publications to disseminate the findings of this study to a broad audience as well as presentations at national conferences.

Figure 1: Extreme damages to pavement built using cohesionless soils near the coastal region of southern United States

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.