Tran-SET
Transportation Consortium of South-Central States

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Development of Geopolymers Based Cement and Soil Stabilizers for Transportation Infrastructure

Key Points

Project Number:
18CTAM03

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Texas A&M University

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$124,000

Funding Source(s):
Tran-SET
Texas A&M University
University of Texas at Arlington

Total Project Cost:
$248,000

Brief Project Description

The overall objective of this study is to develop an innovative, sustainable, eco-friendly and durable geopolymer cement (GPC) for transportation infrastructure in Region 6, more specifically for GPC concrete structures (pavements, bridges, etc.) and stabilization base and subgrade foundation support for pavements, using natural and waste materials that are abounded in the region.

Problem Statement

Ordinary Portland Cement (OPC) is a key material for transportation infrastructure as it has been widely used for concrete structures and stabilization of base and subgrade materials. However, production of OPC involves large energy consumption to achieve the very high temperatures that are required for reaction between clay and calcium-carbonate. This process also results in the release of carbon dioxide. Geopolymer cement (GPC) has been substituted for OPC in many engineering applications due to their high strength. They have received much attention as an ecofriendly and sustainable alternative to OPC because they can be processed at room temperature inexpensively from waste materials (e.g. fly ash) or natural sources (e.g. clay). Most recently, GPC has been investigated as an alternative to OPC for soil stabilization to prevent frequent failures of the pavement and other transportation infrastructure as a result of reaction between OPC with the clay and sulfate minerals in the soil causing it significant swelling. Significant research still needs to be undertaken on GPC before it can reach the level of acceptance achieved by OPC. This study addresses some of those issues by focusing on durability studies of GPC concrete and stabilized base and subgrade materials under extreme service conditions typical for Region 6, including large water uptake during flooding and rainfalls.

Objectives

The overall objective of project is to develop an innovative, sustainable, eco-friendly and durable GPC for transportation infrastructure in Region 6, more specific study objectives are to:

- Select composition of GPC with optimum workability and mechanical properties;
- Characterize degradation of their structure and properties in condition simulating real severe weather conditions typical for Region 6, such as flooding, heavy rainfall or drought using extensive durability testing;
- Conduct leachability studies, to study the volume of leachate generated and its chemical composition.
- Provide guidance for the optimum composition of GPCs for extended durability of concrete structures and stabilized soil;
- Implement research results and develop the workforce with the expertise in using novel technologies for soil stabilization.

Intended Implementation of Research

Workforce Development

The outcome of this research will lead to a comprehensive report that will provide design methods and guidance for Geopolymer treatments of bases and subgrade materials, capable of long-term performance. The information will also be disseminated in various venues including technical publications, and conference presentations. Results will be also presented in at least two papers published in the peer review journals.

Education and Outreach

Two doctoral graduate students and one postdoctoral fellow will be recruited to work on the study. We will develop a simple visual module to demonstrate soil stabilization technologies and durability testing to high school and middle school students from Texas during their summer recruitment programs. This will contribute to the awareness and education of general public on issues related to soil stabilization and its importance for durability of transportation infrastructure. Also, results from this research will be incorporated into several courses at the University of Texas at Austin and Texas A&M University.

Anticipated Impacts/Benefits of Implementation

The proposed research will result in more resilient and sustainable transportation infrastructure by using novel materials. The increase in durability and decrease in leachate formations of GPC products would enhance the performance of pavements and other transportation infrastructure and minimize the environmental impact, which would be beneficial to all areas of Region 6. Both life cycle assessments and low carbon footprints in using Geopolymer cements are anticipated, which eventually lead to green transportation infrastructure.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1505455)