Tran-SET
Transportation Consortium of South-Central States

Transportation Consortium of South Central States

Key Points

Project Number:
17GTTAM02

Start Date:
05/08/2017

End Date:
11/08/2018

Principal Investigator(s):
Dr. Miladin Radovic
Texas A&M University
Email: mradovic@tamu.edu

Dr. Anand Puppala
University of Texas, Arlington
Email: anand@uta.edu

Lead Institution:
Texas A&M University

Funds Requested to UTC:
$85,000

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

Total Project Cost:
$170,000

Development of Environmentally Friendly Stabilization Methods for Transport Infrastructure Based on Geopolymers

Brief Project Description

In recent years, the use of geopolymers has received much attention as an eco-friendly and sustainable alternative to conventional chemical additives since they can be processed at room temperatures from aqueous solutions of waste materials (e.g. fly ash) or abounded natural sources (e.g. clay). The objective of the proposed research is to develop an environmental and eco-friendly solution using Geopolymers for stabilizing bases and subgrades. Research tasks include the material aspects and pavement engineering performance aspects of the treated soils and bases. The effects of Geopolymer composition, dosage rates, curing time and temperature on overall properties of Geopolymer stabilized base and subgrade materials will be studied to optimize the use of Geopolymers derived from local waste and natural materials. Both material characterization studies related to micro to macro behavioral changes should be evaluated as a part of this research.

Problem Statement

At present, cementitious stabilizers such as ordinary Portland cement (OPC) and lime are commonly used as soil stabilizers, and their stabilizing mechanisms and properties have been relatively well understood. One of the major issues with conventional cementitious soil stabilizers that are calcium based is that they react with the clay and sulfate minerals (usually gypsum) in the soil causing the frequent failures of the pavement and other transportation infrastructure. In addition, production of cementitious soil stabilizers is energy intensive and emit a large quantity of CO2. For example, one metric ton of CO2 is produced during production of one metric ton of OPC. In the recent years, polymers with different chemical additives have been also used as stabilization solutions to address problems including soil property enhancements and provide durable solutions. However, their durability and especially long-term effects on environment are still of enormous concern and subject of discussion. Finally, the raw materials readily available for production of cementitious and polymer based soil stabilizers are being over-consumed.

Geopolymers have become increasingly popular in recent years as an environmentally friendly and sustainable alternative to OPC. Geopolymers

constitute a long range of covalently bonded alumino-silicates, non-crystalline networks and are generally substituted for many civil engineering applications due to their high strength and durability. They have received much attention as an eco-friendly and sustainable alternative building materials because they can be processed inexpensively from waste materials (e.g. fly ash) or natural sources (e.g. clay), thus providing the plentiful worldwide raw material supply. Most recently, Geopolymer has been investigated as a candidate material for soil stabilization, because they provide less expensive, environmentally friendly and sustainable alternative to conventional soils stabilizations.

Objective

The overall objective of this research study is to develop an innovative, sustainable and eco-friendly solution to provide resilient stabilized base and subgrade foundation support for pavements in Region 6, using natural and waste materials that are abounded in the region. This research should bring major benefits in the design of durable and distress free pavement infrastructure in problematic soil conditions that prevail Region 6. More specific objectives of the proposed projects are:

- Select composition of Geopolymers with optimum workability and properties for soil stabilization;
- Select appropriate Base and Subgrades in Region 6 suitable for Geopolymer treatment;
- Validation of the selection through comprehensive characterization of Geopolymers treated based and subgrades;
- Optimize composition of Geopolymers and solid stabilization parameters;
- Implement research results and develop the workforce with the expertise in using novel technologies for soil stabilization.

Intended Implementation of Research

Technology Transfer

The final deliverable will be a comprehensive technical report summarizing all results from both institutions. We also anticipate several publications from this research. This project would lead to immediate implementation as this Geopolymer treatment is considered to be environment friendly resilient solution. Both life cycle assessments and low carbon footprints in using these treatments are anticipated, which eventually lead to green transportation infrastructure.

Education, Workforce Development, and Outreach

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. The information will also be disseminated in various venues including technical publications, and conference presentations. Research team will also disseminate research findings at Transportation Research Board annual meetings. Result of this project will be also presented in at least three papers published in the peer review journals.

Two doctoral graduate students and one postdoctoral fellow will be recruited to work on the present research tasks and they will work with PIs at TAMU and UTA. We will develop a simple visual module to demonstrate soil stabilization technologies to high school and middle school students from Texas during their summer recruitment programs At TAMU

and UTA. 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.

The results from this research will be incorporated into several courses at UTA including CE3343 Soil Mechanics and CE5374 Ground Improvement, and at Texas A&M University including MSEN410 Materials processing and MSEN625 Mechanical Behavior of Materials. We develop the course modules that cover pavement subgrade stabilization designs using Geopolymers as well as sustainability assessments.

Anticipated Impacts/Benefits of Implementation

The proposed research with Geopolymer treatments is anticipated to enhance durability with low pavement distress problems. Both life cycle assessments and low carbon footprints in using these treatments are anticipated, which eventually lead to green transportation infrastructure. Hence this research will have major impact on the Region 6 transportation infrastructure.

Weblinks:

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

https://rip.trb.org/view/1467369