

Raid Repair of Cracks on the Embankment Slopes Using Bio-Cement

Exploring the feasibility of using bio-cement to rapidly seal, waterproof, and cement the cracks on the embankment slopes.

Slope repair approaches like soil nails, retaining structures, plastic pins, surface water management, and lime, etc have been used to restore the embankment slopes. In Louisiana, most highway embankments with slope failures were repaired using Nonwoven geotextiles placed at a 12-inch vertical spacing to provide reinforcement. However, most of these methods involve large earth work, special installation equipment, and special construction processes, which may delay the construction timeline, cause road closure, and increase the project cost. The proposed research investigates an innovative slope repair method using bio-cement. This bio-cement can seal, waterproof, and cement slope cracks in a relatively short time (12 hours) due to its fast reaction rate. Thus, no special installation equipment or processes are required, which saves time and costs.

earth work, special installation machinery, and/or unique construction processes, which may require long construction time, disturb the traffic, and be costly.

To achieve the goal of the research, the following tasks will be performed: (1) conduct literature review regarding bio-cement and assess the repair methods for embankment slopes; (2) measure the improvement of shear strength of soils after bio-cement treatment using direct shear tests; (3) perform lab-scale embankment slope stability tests treated by bio-cement; (4) assess the effects of bio-cement treatment on the improvement of embankment slope stability using commercial software; and (5) work with Louisiana DOTD to perform a pilot test in the field.

Intended Implementation of Research

Workforce Development: The PI and graduate students will develop a design manual by incorporating the outcome of this research for the state DOTs within the Tran-SET membership. Furthermore, several videos that cover the overview, preparation, and treatment procedure of bio-cement will be developed for the Page | 7 state DOTs and consultants to understand the bio-cementation process. This video will be incorporated into the online course, CE 7335 Soil Improvement and Stabilization developed by the PI, for the LSU online Master of Science program in Civil Engineering which attracts many state DOT engineers and consultants. The test results will also be disseminated using social media (Twitter and Facebook), web-based science news, webinars organized by Tran-SET, conference presentations, and technical publications.

Education and Outreach: The PI will develop a module for undergraduate and graduate students which will be incorporated into the courses taught by the PI, including CE 4300 Geotechnical Engineering II, and CE 4330 Geotechnical Design, CE 7335 Soil Improvement and Stabilization, and

Problem Statement

Highway embankment slope failures cause road closures, damage public and private property, and cause safety hazards. Restoring highway embankment slope failures is a serious challenge with major impacts on State and Federal maintenance budgets. Highway slope failures are common throughout Region 6. Most of these slope failures happen due to desiccation cracks induced by wetting and drying weather cycles. The formation of the desiccation cracks allows water infiltration into the embankment, increasing the moisture content and reducing the soils' shear strength, and eventually causing embankment slope failures.

Objectives

The goal of this project is to investigate the use of bio-cement for rapid repair of cracks on the embankment slopes. Slope failures are often caused by surface cracks which are usually present on the embankment slopes. To date, most rapid slope failure repair methods (e.g., geosynthetics, soil nails, plastic pins, and lime, etc.) involve major

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\$90,001



CE 7700 Advanced Foundation Engineering. A lecture on bio-cementation will be provided in class. Hands-on experiments will be provided in which a simple soil slope model will be built in the lab and subjected to the compression loading at the crest of the slope. Bio-cement will be used to treat the slope when the cracks are formed during loading. A comparison of the force-displacement relationships before and after bio-cement treatment will be compared. The PI and research graduate students will also develop a classroom demonstration for K-12 students.

Anticipated Impacts/Benefits of Implementation

This research will provide an efficient, non-traffic disturbed, economical method (bio-cement) for sealing, waterproofing, and cementing slope cracks on highway embankments. This slope repair method will reduce the life-cycle costs for maintaining highway embankment slopes for state DOTs. Furthermore, bio-cementation has been extensively studied in the lab and currently focusing on its applications, such as ground improvement, liquefaction mitigation, seepage, and erosion control. If successful, this research can potentially expand the applications of this innovative technique.

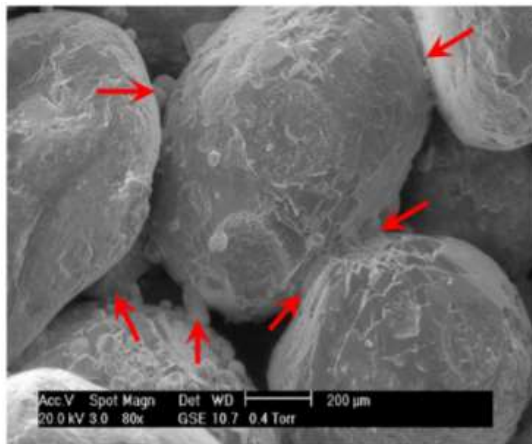


Figure 1: SEM images of MICP-treated sands (arrows show calcite crystals cementing sand particles).

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

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.

