Evaluation of the Mechanical and Environmental Performance of Biofuel Co-Product Stabilized Unpaved Roads

tech transfer summary

Constructing unpaved roads with materials that can sustain their performance for a considerable amount of time with less maintenance can be addressed economically in locations that are close to sources of considerable amounts of biofuel co-products (BCPs).

Problem Statement

Large, unbound particles on unpaved roads form an unstable road surface that becomes rough—developing potholes and corrugations as the "floating" material is scattered by vehicles or washed away by rain. As a result, these roads require frequent maintenance and reconstruction, which becomes very expensive for Iowa counties.

Background

Total public road length in the US is about 4.1 million miles—including 1.4 million miles of unpaved roads (FHWA 2011). Billions of dollars are spent keeping these roads in good and serviceable condition. Thus, having an effective and long-lasting maintenance plan is a priority for the transportation agencies that maintain them.

More than 50% of roadways in Iowa are classified as unpaved. The performance and long-term sustainability of these roads are dependent on the quality of the surfacing material, which varies considerably by location.

August 2018

RESEARCH PROJECT TITLE
Evaluation of the Mechanical and Environmental Performance of Biofuel Co-Product Stabilized Unpaved Roads

SPONSORS
Midwest Transportation Center
U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology (USDOT/OST-R)

PRINCIPAL INVESTIGATOR
Bora Cetin, Assistant Professor
Civil, Construction, and Environmental Engineering, Iowa State University
515-294-8158 / bcetin@iastate.edu

CO-PRINCIPAL INVESTIGATORS
Halil Ceylan, Professor and Director
Program for Sustainable Pavement Engineering and Research (PROSPER)
Institute for Transportation
Iowa State University

Jeramy C. Ashlock, Associate Professor
Civil, Construction, and Environmental Engineering, Iowa State University

MORE INFORMATION
intrans.iastate.edu

MTC, Iowa State University
2711 S. Loop Drive, Suite 4700
Ames, IA 50010-8664
515-294-8103

The Midwest Transportation Center (MTC) is a regional University Transportation Center (UTC). Iowa State University, through its Institute for Transportation (InTrans), is the MTC lead institution.

MTC's research focus area is State of Good Repair, a key program under the 2012 federal transportation bill, the Moving Ahead for Progress in the 21st Century Act (MAP-21). MTC research focuses on data-driven performance measures of transportation infrastructure, traffic safety, and project construction.

IOWA STATE UNIVERSITY
Institute for Transportation

Goal and Objectives

The goal of this project was to evaluate an alternative to traditional practices to determine the efficacy of using biofuel co-products (BCPs) to as a stabilization material for unpaved roads. The research objectives were as follows:

- Investigate the effects of three types of glycerin (glycerin bottoms, crude glycerin, and glycerin 95) and lignosulfonate on the strength of loess soil
- Investigate the effects of corn oil on the strength of loess soil

Research Description

The research approach considered the combination of lignosulfonate and three glycerin BCPs, as they have been used as dust suppressants in the past and because dust suppressants should not affect the engineering properties of soil in a negative way.

Loess soil from Iowa was mixed with 4, 8, 12, and 16% of the BCP by weight, thus allowing for variety in observation. Specimens underwent a series of leaching tests focused on pH levels and metals such as chromium, aluminum, iron, arsenic, and zinc. Additionally, specimens were also made containing similar amounts of corn oil, an ethanol co-product, and tested.

Key Findings

- The lignosulfonate improved the unconfined compressive strength (UCS) of the loess soil to some extent because of the natural binding property of lignin present in the lignosulfonate and dispersion of the clay fraction due to the presence of lignin.
- Although glycerin has been used as a dust suppressant to minimize the dust problem of unpaved roads, it was observed that using glycerin bottoms, crude glycerin, or glycerin 95 decreased the UCS of the loess soil regardless of glycerin content.
- Similar to the trend observed with the glycerin, using corn oil decreased the UCS of the loess soil.
- Due to a reduction in the bonding between loess soil particles, crack formations were observed in specimens containing a relatively higher amount of each material. Additionally, all specimens turned into a mud if excessive amounts of the materials were used.
- The researchers also found through water leach tests (WLTs) and toxicity characteristic leaching procedure (TCLP) tests that the addition of the BCPs did not influence the leaching of metals from the loess soil. These results show that BCPs do not cause any environmental concerns from a metal leaching perspective.

Implementation Readiness and Benefits

It is important to construct unpaved roads using materials that provide long-term performance with less maintenance. This problem can be addressed economically in locations that are close to sources of considerable amounts of BCPs.

Through the evaluation and comparison of multiple BCPs, the researchers found that lignosulfonate improved the UCS of loess soil during testing and could be used as a cost-saving alternative to conventional road construction techniques, if storage areas were created to reuse these waste materials.

It was found that the use of lignosulfonate as a dust suppressant may be more effective for granular soil types. So, not only lignosulfonate but also the glycerin and corn oil materials should be mixed with granular soils for proper dust management. In addition, several durability tests such as freeze-thaw (F-T) or wet-dry (W-D) tests should be performed to observe whether the materials used in this study improve the durability rather than the strength of loess soil and other soil types.

References

FHWA. 2011. *Highway Statistics*. U.S. Department of Transportation, Federal Highway Administration, Washington, DC.