

JOINT TRANSPORTATION RESEARCH PROGRAM

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Chemical Modification of Uniform Soils and Soils with High/Low Plasticity Index

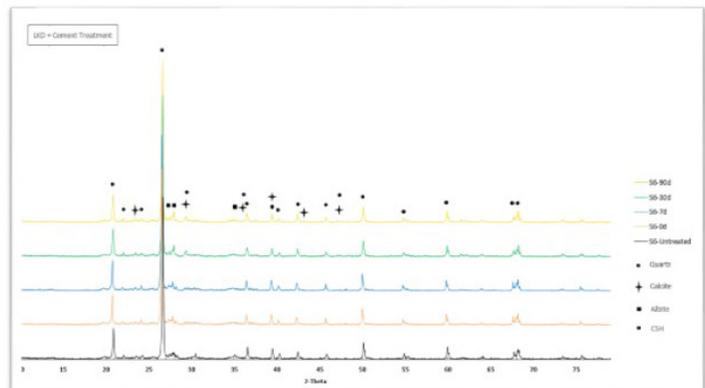
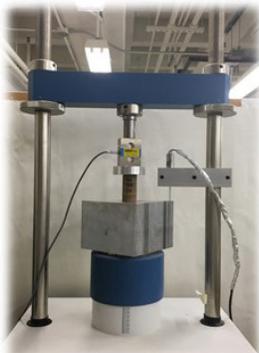
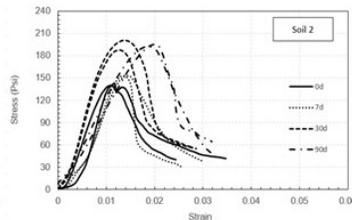
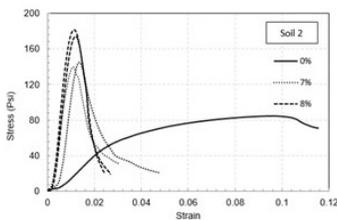
Introduction

The addition of chemicals, often lime kiln dust (LKD) and portland cement, into the subgrade during construction to improve soil workability, compactability, and engineering properties is a common practice. Many departments of transportation have been using chemical modification for more than 20 years and, in fact, 90% of current subgrade is treated. Nevertheless, problems persist.

The Indiana Department of Transportation (INDOT) Design Manual states that subgrade clays with low plasticity ($PI < 10$) must be treated with cement and that high plasticity clays (density < 95 pcf, or $PI \geq 25$)

in the subgrade must be replaced with suitable soils. However, uniform granular soils do not stabilize with lime products or with a low dosage of cement, and current knowledge does not provide information about stabilization of these soils.

This research explores LKD, including combinations of LKD and portland cement to treat high and low plasticity clayey soils, and treatment with portland cement of uniform granular soils. (Problem soils, e.g., expansive and organic soils, are not considered in the research.) A comprehensive laboratory testing program was undertaken to investigate the potential for treatment and to report changes in mineralogy and engineering properties of the treated soils over time.



Findings

The objective of this study was to evaluate the treatment of uniform granular soils, and clay soils that have high or low plasticity, with lime, cement, or a combination of lime and cement. Two uniform granular soils, three fat clays, and three lean clays were selected for the study. For each soil, a comprehensive set of laboratory tests was completed. The results from the tests led to the following conclusions:

- The high plasticity clays required an LKD percentage between 7% and 8%, while for the low plasticity clays the requirement ranged between 6% and 7%.
- With treatment of equal amounts of LKD and cement, the high plasticity clays required 4% to 6% of the combination of LKD and cement, while the low plasticity clays required only 4%.
- Results of the cement treatment of the uniform soils showed that 5% cement with 10% water provided acceptable results.
- Unconfined compressive strength tests revealed that the uniform sand with higher calcium/magnesium content and more angular particles achieved the highest strength with the cement treatment.
- Results from unconfined compression tests and x-ray diffraction (XRD) tests conducted at different times after treatment of the soil showed that the strength of the soil increased with time and that the improvement obtained did not degrade with time.

Implementation

- Granular uniform soils and clayey soils with low and high plasticity index can be successfully treated with adequate amounts of LKD, cement, or LKD and cement.
- The actual percentages and type(s) of chemical(s) (or their combination) needed, strength improvement achieved, and construction procedures to reach the target performance in the field are site specific and will depend on the actual soil conditions and properties.
- It is recommended that proper laboratory testing be performed in each case on representative soil samples to evaluate potential soil treatment, improved properties of the treated soil, and the most cost-effective treatment for the site.

Recommended Citation for Report

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