



Project Summary

Texas Department of Transportation

0-5569: Accelerated Stabilization Design

Background

Chemical stabilizers, such as lime, cement, and fly ash, are commonly used to improve the performance of problematic soils. To achieve effective stabilization, special attention needs to be given to proper type and concentration of the additives. If the selected type or concentration of additives is not adequate to ensure short- and long-term durability, the stabilization will be ineffective, and costly pavement rehabilitations may be necessary. In the state of practice, the optimum stabilizer content is obtained by following time-consuming (up to three weeks) protocols. Given the length of time required, many districts assign the type and concentration of stabilizers based on their previous experiences. Since the mineralogy of fines significantly impacts the effectiveness of the stabilization, there is a need for a rapid protocol to ensure the suitability of a given stabilizer and the adequacy of the additive concentration. Other important issues that need to be addressed are adequate mixing and curing, adequate density and moisture, adequate short-term and long-term strength and stiffness, and proper construction.

What the Researchers Did

To develop an accelerated mix design protocol, several soils with different characteristics and different additives were investigated. The type and concentration of the additives were first determined based on the existing protocols. Every step of the process was evaluated for possible ways of improving it and reducing the time necessary to conduct it. Based on this activity, alternative methods for compaction of fine-grained soils, curing and moisture conditioning of the specimens, and assessing the long-term durability of the stabilized mixes were proposed. In addition, simple new mineralogical tests were also introduced in the protocol.

To select the recommended alternatives, simplicity and costs of acquiring the equipment were considered along with their correlations with the current specifications. Parameters such as strength, stiffness, moisture susceptibility and long-term durability of mixes, and potential for leaching of the stabilizers from the mix were considered. Based on our observations and testing, alternative guidelines and test protocols were developed to achieve a faster (normally in three days) and more reliable mix design.

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What They Found

Based on the outcome of this research, the following recommendations were made:

- Moisture conditioning with the traditional backpressure saturation was recommended to supplant the ten-day capillary saturation method currently used. In almost all cases, more uniform moisture conditioning throughout the length of the specimen was achieved within one day.
- These alternative methods of sample preparation, curing, and moisture conditioning generally resulted in lower strengths than those achieved under current specifications. The lower strength was attributed to the higher and uniform moisture absorption by the specimens during the proposed procedure. The current ten-day capillary moisture conditioning and the proposed processes yielded similar results only when the moisture penetrated throughout the length of the specimens under moisture capillary saturation.
- Leach rate of stabilizers was small (typically about 0.5%) which is not problematic for high concentrations of additives (5% or higher). This could affect the permanency of the stabilized soil, if the original dosage is less than 4%.
- To evaluate the durability, the ASTM D559 21-cycle wetting/drying tests were carried out. Soils with Montmorillonite as a dominant mineral in the fine fraction were much less durable.
- In the selection of the type and concentration of stabilizers, one should not only consider the plasticity and gradation of the material, but also the clay mineralogy. Simple tests, such as Cation Exchange Capacity, Specific Surface Area, and Total Potassium, can provide clay mineralogy of the fine fractions of the soil. If Montmorillonite is the dominating mineral in the fine fraction, higher stabilizer contents should be considered.
- Even though pH tests are appropriate to obtain an estimate of the lime content, further strength, stiffness, and moisture susceptibility tests are needed to complete a reliable mix design.

What This Means

A more refined characterization of the soil that includes mineralogy is proposed to conduct a more reliable mix design. A complete mix design could be completed in 3 days using accelerated methods proposed. The new protocols addressed some of the shortcomings that exist in the current practice. Tests presented are simple and could be readily adopted by TxDOT personnel.

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