RESEARCH
PROJECT CAPSULE [11-1GT]
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TECHNOLOGY TRANSFER PROGRAM

In-situ Evaluation of Design Parameters and Procedures for Cementitiously Treated Weak Subgrades using Cyclic Plate Load Tests

JUST THE FACTS:

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POINTS OF INTEREST:

Problem Addressed / Objective of Research / Methodology Used Implementation Potential

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PROBLEM

Due to the soft nature of subsurface soils in southern Louisiana, roads often have to be constructed on very weak subgrade soils with high in-situ moisture contents that do not have the sufficient strength/stiffness to support the construction/traffic loads, which pose a significant challenge for construction of highway projects. To solve such a challenge, cementitious additives such as cement, lime, fly ash, cement kiln dust (CKD), and slag, alone or in combination can be used to treat/stabilize these soils to improve their engineering properties such as strength and stiffness, thus providing the needed support for pavement construction. The long-term performance of treated/stabilized soils is usually influenced by the type and characteristics of the parent subgrade soil, the type and quantity of stabilization additive, the construction practices, the frequency and magnitude of loading, and the environmental conditions.

The common practice in Louisiana is to treat/stabilize in-situ weak subgrade soils or hauled soils with cement, lime, or a combination, depending on the soil's plasticity index (PI), thus enhancing their engineering strength/stiffness properties. While LADOTD engineers provide recommendations on the selection of stabilizer type and content for treating hauled soils (controlled layer), the selection of stabilizer type and content for treating in-situ weak subgrade layer (under in-situ moisture/density conditions) is based on achieving a specific compressive strength (50 psi for working platform and 100 psi for subgrade stabilization). It is evident that cementitiously treated subgrade soils can provide strong, stiff, and durable composite subgrade support layer to pavement structures, thus enhancing the short- and long-term performance of pavements. However, no credit is given to the treated subgrade soils in the pavement design process. To give a reliable credit to the treated hauled soils and the uncontrolled treated in-situ weak subgrades is challenging. This study is aimed at evaluating the range of benefits to incorporate a composite resilient modulus model to represent the treated/stablized and untreated subgrade soil layers as a composite layer in the pavement design process, and to evaluate the resilient modulus for treated hauled soils.

OBJECTIVE

The objectives of this study are to: (a) provide appropriate stabilization schemes (using lime + fly ash) for treating/stabilizing in-situ weak subgrade soils of low-plasticity clay, medium-plasticity clay, high-plasticity clay, and heavy clay; (b) evaluate the resilient modulus and permanent deformation properties of the cement/lime treated hauled soils and the lime/fly ash treated in-situ weak subgrade soils; and (c) evaluate a representative composite resilient modulus [$M_{r(composite)}$] and damage models for the in-situ treated and untreated subgrade soil layers using in-box cyclic plate load tests for inclusion in pavement design. The research findings are expected to eventually facilitate the design of cementitiously treated soils in pavement structures in Louisiana.

METHODOLOGY

The main objective of this research study will be achieved in four phases.

Phase 1: conduct repeated loading triaxial tests (RLTs) to evaluate the resilient modulus and permanent deformation characteristics of the cement/lime treated hauled soils compacted at maximum dry density and ± 2% of optimum moisture content for incorporating the benefits into the pavement design. The RLTs will include resilient modulus tests, single-stage permanent deformation tests, and multi-stage permanent deformation tests.

Phase 2: conduct unconfined compressive strength (UCS) on in-situ weak subgrade soils of high moisture contents to determine the appropriate stabilizer content (lime + fly ash) to achieve a minimum strength of 50 psi for working platform and 100 psi for subgrade stabilization.

Phase 3: conduct RLTs to evaluate the resilient modulus and deformation characteristics of the lime/fly ash treated/stabilized subgrade soil specimens prepared at different moisture contents.

Phase 4: selected lime/fly ash treated in-situ weak subgrade sections will be constructed inside a test box for cyclic plate load test (PLT) to evaluate a representative composite resilient modulus [$M_{r(composite)}$] of subgrade soil (treated subgrade soil layer over untreated subgrade soil) that can provide a more suitable input pavement design value. A statistical regression analysis will be also carried out on the laboratory test results to develop generalized models for estimating the resilient modulus for cementitiously treated/stabilized soils, such as the model adopted by the new AASHTOWare Pavement ME Design using the k_1, k_2 and k_3 parameters.

IMPLEMENTATION POTENTIAL

By the end of the proposed research, the research team is expected to provide LADOTD with typical design parameters of cementitiously treated subgrades [e.g., $M_{r(composite)}$ and damage model]. The researchers are also expected to provide LADOTD pavement engineers with supplemental guidance on how to include the cementitiously treated work platform in the design of flexible pavements using both the AASHTOWare Pavement ME Design and the 1993 AASHTO Pavement Design Guide.