Project Summary

Texas Department of Transportation

0-5135: Improving Correlation Between Field Construction of Soils and Bases and Laboratory Sample Construction Techniques

Background

Test Method Tex-113-E has been used for decades to prepare laboratory-molded flexible base specimens in order to determine compaction characteristics and mechanical properties of the base material. However, concerns over poor precision of results, and questions about whether the compaction mechanism employed in Tex-113-E best correlates with the field, led to a critical review of the Tex-113-E compaction procedure. Additionally, some concerns existed that the compaction effort in Tex-113-E was too low, allowing contractors to reach density too easily while not optimizing field performance of the base material.

What the Researchers Did

Texas Transportation Institute (TTI) researchers focused on addressing the concerns with Tex-113-E by evaluating the following topics:

- Should TxDOT specify Modified Proctor for all Texas base materials?
- Should TxDOT consider alternatives to impact hammer lab compaction as employed in Tex-113-E?
- How can the existing Tex-113-E procedure be improved?

Research Performed by:

Texas Transportation Institute (TTI), The Texas A&M University System

Research Supervisor:
Stephen Sebesta TTI

Researchers:
Pat Harris, TTI
Wenting Liu, TTI

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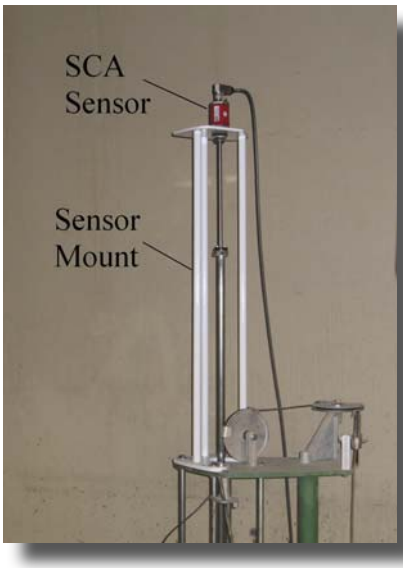

To address these topics, TTI researchers selected Grade 1 and Grade 2 flexible bases and systematically studied the impact of changing laboratory compaction techniques on the base materials' mechanical properties and on the precision of molded densities. Researchers evaluated the impact of specific changes to the Tex-113-E procedure, then focused on developing a system to measure and document the compaction energy produced by the automatic tamper. This system, called the Soil Compactor Analyzer (SCA), attaches to the automatic tamper used for Tex-113-E as Figure 1 shows. The SCA uses rapid sampling of hammer displacement to measure impact velocity. Using the known mass of the hammer and the determined velocity, the SCA determines the energy of each hammer drop applied to the sample.

Figure 1. Soil Compactor Analyzer Configuration.

What They Found

Laboratory test results showed that Modified Proctor compaction resulted in improved mechanical properties of the Grade 2 flexible base, but not the Grade 1. A field experiment revealed that compaction of a 6-inch lift of the flexible base placed on top of a cement-treated subbase did not produce densities that exceeded the Tex-113-E maximum. This field experiment utilized medium pneumatic and 12-ton vibratory steel wheel rollers. When evaluating alternatives to impact hammer lab compaction, researchers concluded that lab vibratory compaction provided the most promise to better mimic field construction. Although vibratory compaction did not yield improved precision of sample dry density as compared to impact hammer compaction, vibratory compaction did result in improved triaxial, modulus, moisture susceptibility, and particularly permanent deformation characteristics. A computed axial tomography analysis suggested that vibratory compaction produced fewer interconnected voids, which could help explain the observed improvement in performance.

To improve the existing Tex-113-E procedure, research showed that implementation of a slide-hammer finishing tool instead of the rawhide hammer improved the precision of the molded densities, particularly within commercial laboratories. Altering the number of lifts and methods of placing the aggregate into the mold revealed that the current methods should be retained. When evaluating multiple automatic tampers with the SCA, results showed none of the machines produced compaction efforts meeting the Tex-113-E specification. Measured energies ranged from 81 to 95 percent of the specified value.

What This Means

The results from this project support the following:

- Modified Proctor should not be mandated statewide.
- The vibratory lab compaction concept should be examined further if TxDOT considers adopting the use of rutting parameters.
- The slide-hammer finishing tool should be incorporated into Tex-113-E.
- The procedure of compacting lab specimens in 4 lifts while hand-placing aggregates greater than 7/8-inch should be retained in Tex-113-E.
- The SCA should be considered for implementation to calibrate and document the compaction energies produced by laboratory automatic tampers.

For More Information:

0-5135-1 Investigation of Methods for Improved Precision of Test Method Tex-113-E
0-5135-2 Improving Lab Compaction Methods for Roadway Base Materials
0-5135-3 Improving Lab Compaction Specifications for Flexible Bases Within The Texas Dot

Research Engineer - German Claros, TxDOT, 512-465-7403
Project Director - Caroline Herrera, TxDOT, 512-506-5907
Research Supervisor - Stephen Sebesta, TTI, 979-458-0194

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keyword: research

Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, Texas 78763-5080
512-465-7403