MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

RESEARCH SUMMARY

Standardizing Lightweight Deflectometer Modulus Measurements for Compaction Quality Assurance

WHAT WAS THE NEED?

The mechanistic-empirical pavement design method requires the elastic resilient modulus as the key input for characterization of geomaterials. Current density-based QA procedures do not measure resilient modulus. Additionally, the density-based methods do not incorporate the stiffness changes in unconventional materials over time due to moisture content changes or curing. The high costs associated with the radiation-safe operation of nuclear density gauges (NDG) also encourage the search for an alternative procedure. The Lightweight Deflectometer (LWD) is a portable device that can be used to measure the surface modulus of unbound layers directly in the field. LWDs are being employed for pavement construction QA in a few states but their broader implementation has been hampered by the lack of a widely recognized standard for interpreting the measured stiffness data obtained.

WHAT WAS THE GOAL?

The goal of this research was to establish a multi-state pooled fund study led by the Maryland Department of Transportation State Highway Administration (MDOT SHA) that would result in a straightforward procedure for using LWDs for modulus-based compaction QA and that is suitable for practical implementation by field inspection personnel.

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PRINCIPAL INVESTIGATOR:
Dr. Charles Schwartz
University of Maryland
301-405-1962
schwartz@umd.edu

The study was divided into five tasks:

1. **Evaluation of Moisture Content (MC) Measurement Devices** – The Decagon sensor is difficult to insert when the soil is compacted to a high density and impractical to use for base materials having large aggregate sizes. Therefore, only the Ohaus moisture analyzer was evaluated versus conventional NDG and oven drying during the field validation phase.

2. **Evaluation of LWD Devices –**LWDs with different configurations (drop height, deflection sensor type, plate size and type, etc.) measure different modulus values in the field and in the lab.

3. **Laboratory Testing Program** – Routine lab tests including moisture-density relations plus the LWD testing on the Proctor mold were performed on all soils. The LWD on mold test provides essential insights into the moisture, density and stress dependency of the soil that can be used to tailor the compaction criteria in the field.

4. **Field Testing Program –** A total of eight projects in six states were visited during the field validation phase. MC in the field was measured using the Ohaus MB45 analyzer and compared to the acceptable MC range from Proctor moisture-density relations testing.

5. **Specification Development** – Draft test method specifications were developed for LWD testing in the field and for target modulus determination in the lab. The specifications were written in AASHTO format and provide the additional steps required to establish the target modulus using the Proctor method of moisture-density relationship determination (AASHTO T-99 and T-180) and to adjust the target field modulus for finite layer thickness.

WHAT WAS THE OUTCOME?

The Florida, Michigan, Missouri, New York, North Carolina, South Carolina, and Virginia Departments of Transportation participated as funding partners and technical advisors on this project. The study found that LWD on mold method of target modulus determination provides a smooth transition from density-based methods to modulus-based compaction QA. It is applicable to a variety of geomaterials, including chemically stabilized and non-stabilized subgrades and bases. It is cost efficient and does not significantly increase work in the field. To effectively implement the QA plan, agencies should calibrate the specifications using test projects in conjunction with conventional density-based NDG QA.

HOW WILL MDOT SHA USE THE RESULTS?

As the next step to the initial multi-state study, MDOT SHA will rigorously validate the methodology for Maryland soils and conditions so that LWD based QA can replace current density based methods. The follow-up study will be completed by the end of 2018.

LEARN MORE

To view the final report, click here.

For additional details on the pooled fund project click here.