

Measuring Modulus for Better-Performing Pavements



Image from contractor's final report

During field tests, researchers compared several devices for measuring compacted geomaterials, including lightweight deflectometers, portable seismic property analyzers, and the GeoGauge.

REAL-WORLD NEED

Proper compaction of roadway base and subbase is vital to ensuring good performance of a pavement throughout its life span. While density measurement has traditionally been used to indicate geomaterial compaction, this practice has limitations. Modulus, a measure of stiffness, is a better predictor of performance and provides inputs necessary for mechanistic-empirical design. Measuring modulus is particularly important for predicting the performance of recycled materials since there is little data relating the density of these materials to their strength.

RESEARCH SOLUTION

As highway agencies face increasing pressure to deploy limited resources effectively, measuring the base and subbase modulus can help to optimize the performance and life span of a highway pavement. In NCHRP Project 10-84, researchers developed a proposed AASHTO specification for measuring the modulus of compacted geomaterials in pavement foundations. The specification also provides guidance for setting a target modulus for compacted geomaterials and reviews the devices, such as the lightweight deflectometer, that can be used to measure modulus.

NEXT STEPS Put It into Practice

DEMONSTRATE

Introduce the new specification gradually in pilot projects with your staff and contractors who are open to the new approach.

COLLABORATE

Work closely with your staff and contractors to ease the culture shock that may result from the new approach.

EVALUATE

As projects are built using the new specification, collect feedback and adjust protocols as needed.

ADAPT

Take advantage of the specification's flexibility to incorporate your state's expertise and address your state's unique needs.

PARTNER

Apply for NCHRP implementation funding. See trb.org/nchrp.

About the Research

RESEARCH STRATEGY

In the first phase of NCHRP Project 10-84, researchers collected information about several complex and interrelated issues necessary to developing a sound specification for modulus, such as how site variability and moisture content affect modulus. Then they conducted laboratory, small-scale, and field tests to measure and validate how modulus is affected by site characteristics and measurement methods. Finally, they validated the proposed specification through five field projects located in different regions of the country. These regions included as many geomaterial types, environmental conditions, and construction and quality control procedures as possible.

WHAT WE LEARNED

The proposed Standard Specification for Modulus-Based Quality Management of Earthwork and Unbound Aggregates provides a flexible method for measuring the modulus of compacted geomaterials that can be adapted to local requirements and materials. The proposed specification also includes a process for selecting a target modulus for specific compacted geomaterials. Several devices successfully measured modulus, although lightweight deflectometers are recommended due to their ease of use and widespread availability. Different kinds of deflectometers provided different measurements, however, so construction specifications should specify which model of deflectometer should be used.

WHY IT MATTERS



Several technologies for measuring the modulus of compacted geomaterials performed reasonably well, but lightweight deflectometers are recommended due to their ease of use and widespread availability.

Modulus is one material property that directly relates to the long-term performance of pavement. As a result, it can be used in mechanistic-empirical design, which can help agencies maximize the value they get from their construction investments by designing roads to meet performance needs without using more construction materials than necessary. A specification for measuring modulus will also be valuable as agencies use more recycled geomaterials in construction.

RESOURCES



NCHRP PROJECT 10-84

FINAL PRODUCTS

NCHRP Research Results Digest 391: Modulus-Based Construction Specification for Compaction of Earthwork and Unbound Aggregate
trb.org/Main/Blurbs/172045.aspx

Contractor's report and appendices
apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2908

NCHRP SENIOR PROGRAM OFFICER

Edward Harrigan | eharrigan@nas.edu

PRINCIPAL INVESTIGATOR

Soheil Nazarian | nazarian@utep.edu

ADDITIONAL RESOURCES

Modulus-Based Construction webinar
trb.org/ElectronicSessions/Blurbs/173279.aspx

MnPAVE pavement design tool
mndot.gov/app/mnpave/index.html

Pooled Fund Study TPF-5(285)
pooledfund.org/Details/Study/527

The National Academies of
 SCIENCES • ENGINEERING • MEDICINE


 TRANSPORTATION RESEARCH BOARD