TERRA E-News

TERRA E-News is a quarterly electronic newsletter of the Transportation Engineering and Road Research Alliance. *TERRA E-News* brings you the latest research on pavement, materials, and related transportation engineering challenges, including issues related to cold climates.

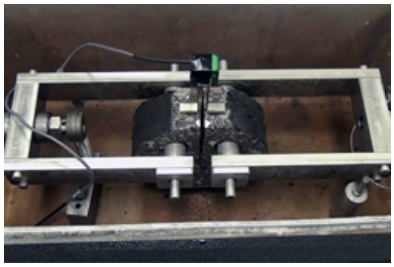
July 2014 - Vol. 8, No. 3 Current Issue | Previous Issues | Subscribe

In this issue:

Member News

Member Research Spotlight: DCT test evaluates the low-temperature performance of asphalt mixes

The Minnesota Department of Transportation provided details about this edition's featured research project.



The DCT test measures the fracture energy of asphalt mixture lab or field specimens, which can be used in performance specifications to control various forms of cracking.

Problem

Low-temperature cracking is the most prevalent form of distress found in asphalt pavements in cold climates. As the temperature drops, the pavement tries to shrink, creating cracks that allow water to seep in and eventually lead to pavement deterioration. Until now, engineers have typically evaluated the individual components (such as amount of crushed aggregate and grade of asphalt binder) and volumetric properties (such as air voids and asphalt content) of an asphalt mix, not how the final product performs in low temperature.

Solution

Developed through a decade-long multi-state pooled-fund research project, the disc-shaped compact tension (DCT) test evaluates the low-temperature performance of asphalt mixes. Created by researchers at the University of Illinois, the DCT test applies tension to an asphalt mixture sample to determine its thermal fracture resistance. The test was determined to be the best of several methods examined in the research study. As a result, engineers will be able to better judge how well a contractor's proposed asphalt mix will hold up under harsh Minnesota winters.

Implementation

The MnDOT Office of Materials and Road Research (OMRR) is conducting pilot tests to become more familiar with the DCT test and to educate road contractors, who may eventually be required to use the test in Minnesota. Last summer, OMRR asked five contractors to submit asphalt mixes for testing. If a mix didn't pass, the contractor was required to develop a new design. Suggested approaches were provided for modifying their recipe to better resist thermal cracking. This summer, OMRR plans to collect asphalt mixes from around the state to see how they measure up against a set of performance targets that were developed in the pooled-fund study. Both private and university testing labs are involved in this study to help determine the repeatability of DCT test results.

Project Partners

The DCT test stems from the TPF-5 (080) pooled-fund research study formed in 2004 by MnDOT and several state DOTs and continued through a second phase in another pooled-fund study, TPF-5(132). The University of Minnesota conducted the research with assistance from neighboring state universities. MnDOT is conducting the follow-up study, "DCT Low Temperature Fracture Testing Pilot Project," in which the DCT will be used as part of the specification during the mix design process for several pavements.

More information:

- New test could help asphalt pavements survive winter intact (blog)
- DCT Test Sample Preparation (video)
- Improving Asphalt Pavements in Cold Climates (video)
- MnROAD project, phase II
- Pooled-fund study, phase II [TPF-5(132)]
- Initial pooled-fund study [TPF-5 (080)]

Photo courtesy of MnDOT

Each TERRA member organization has an opportunity to briefly share and showcase a specific research project or initiative in the Member Research Spotlight. Those previously published here remain available through the TERRA E-News *archives.*

Member Highlights

'Why Aren't They Working On My Road?'

Ever wonder why your road isn't being repaired? A new Minnesota Local Road Research Board video explains why roads go bad and why sometimes the worst roads aren't fixed first. The seven-minute video explains what causes road pavements to deteriorate and why it may be more cost-effective to put maintenance dollars into roads that still have life left in them versus roads that are in the worst condition. In the video, city and county engineers discuss how they use a pavement management program to prioritize road repair decisions, stretching limited resources in the most effective way possible. Watch the video on YouTube.

Projects and Initiatives

Identifying new solutions for road subgrade compaction challenges

Though many think of pavement performance primarily in terms of pavement design and structure, the condition of the subgrade (compacted native soil) is actually one of the biggest factors in pavement performance.

"Unfortunately, due to the variation in soils used for subgrade and the challenges involved in measuring the characteristics of these soils, the quality of subgrade compaction is sometimes less than optimal," according to University of Minnesota bioproducts and biosystems engineering professor John Nieber.

Part of the challenge in subgrade compaction is making lab findings more relevant during construction. For each project, soil samples are taken to the lab to determine the proper moisture content and density for the subgrade. However, determining whether these values are achieved in the field is often difficult because of the limitations of the technologies available for measuring bulk density and moisture content in situ.

"The key to ensuring the field compaction values come as close as possible to the lab values is having an accurate way to measure density and moisture content in the field," Nieber explained. Traditionally, one of the instruments used to conduct these measurements has been a radioactive nuclear density gauge. However, transportation agencies are currently trying to find alternatives to this instrument because of safety, regulation, and financial concerns, he said.

To help address these challenges, a study involving two TERRA members evaluated four potential instruments—alternatives to the nuclear density gauge—that might be used to accurately measure the in situ moisture status of subgrade soils (loam, silt, silty/clay) commonly used in Minnesota roadway construction projects. The study, conducted by University of Minnesota researchers and sponsored by the Minnesota Department of Transportation (MnDOT), identified the soil types and situations in which each of these four instruments is most useful, and alerts transportation practitioners to possible sources of data error for each of the instruments.

The instruments evaluated for potential to accurately measure water content or matric suction in subgrade soils were the DOT600 (a portable device to measure moisture content and density), the WP4C dewpoint potentiometer (a bench-top instrument used to estimate matric suction), the button heat-pulse sensor (a soil probe to measure moisture content related to temperature rise), and the exudation pressure device (a lab test to measure moisture content related to compressive force required to exude water from the sample).

The DOT600 showed a strong correlation between the output period (measured in micro-seconds) and volumetric water content. The WP4C did not accurately measure matric suction for any of the loam, silt, or silt/clay soils at suctions below 250 kilopascals (kPa). (Published data shows matric suction of soils compacted at optimum moisture content usually is in the range of 200–300 kPa.) The BHPS showed a strong correlation between measured temperature rise and water content but, in its current configuration, is not rigorous enough to withstand field conditions. The exudation pressure device was applied to soils compacted in an AASHTO T99 mold at various moisture contents. Water was exuded from the packed samples at pressures between 100 and 500 pound per square inch (psi) corresponding to AASHTO-T99 moisture contents of 10 to 25 percent. However, accurate moisture content readings from any of these instruments may not be as important as a more precise and simple calibration between the measurement units of the instrument and the optimum moisture content determined from the AASHTO T99 test.

"We know that even small differences in moisture content can lead the strength of some soils to drop very quickly, resulting in under-performance of the pavement foundation," Nieber said. "With this research, transportation practitioners are one step closer to identifying better ways to get accurate, real-time in situ measurements of moisture content in the field and allow them to make the proper adjustments during construction in order to improve the pavement's long-term performance."

Adapted from CTS Catalyst*, June 2014. Photos courtesy of MnDOT.*

Related resources:

- Research report
- Research project page

New technology will improve diagnosis of pavement problems

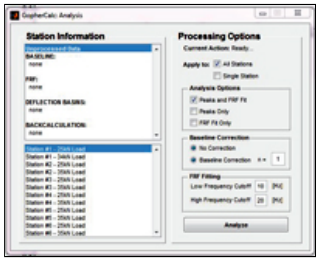
When diagnosing a patient, doctors often rely on advanced imaging technologies such as X-rays and MRIs. In recent years, civil engineers have also used technologies such as the falling weight deflectometer (FWD) and ground penetrating radar (GPR) to pinpoint what's going on beneath a pavement's surface and diagnose pavement problems. GPR generates a cross-sectional image of the pavement's subsurface, while FWD measures stiffness of the pavement layer.

GPR can be used on vans traveling at highway speeds.

"These tests offer significant benefits over the traditional, labor-intensive method of taking core samples," said University of Minnesota civil engineering professor Joe Labuz. "They are non-invasive and can be performed quickly with minimal traffic disruption, which improves highway safety."

Though FWD and GPR are now widely used by civil engineers in the United States, both have room for improvement. The data interpretation needed for these tests can be overly simplistic, and inherent assumptions can reduce each test's accuracy when they are used in standalone fashion, Labuz said.

To improve the effectiveness and accuracy of these tests, a team of University of Minnesota researchers—Labuz (the principal investigator), graduate student Shuling Tang, and Professor Bojan Guzina—created a new software tool for field engineers called GopherCalc. This new software package combines the analysis of both FWD and GPR data into a single tool. By integrating the two tests, calculations and results from one test can be used to inform the other. This reduces the number of assumptions needed to analyze the data, thereby increasing their accuracy. Their work was funded by the Minnesota Department of Transportation (MnDOT).



GopherCalc's graphical user interface provides a user-friendly way to conduct analyses of GPR and FWD data.

"The project provides a good tool for MnDOT to use for pavement evaluation," said Shongtao Dai, a research operations engineer with MnDOT's Office of Materials and Road Research. "Traditionally, only peak value from FWD sensor response is used for pavement backcalculation. GopherCalc uses dynamic history data from GPR and FWD for the backcalculation and pavement thickness calculation, which should provide more reasonable results. So, GopherCalc has potential to improve pavement structure evaluation in the future."

The GopherCalc software is designed to be user-friendly for the field engineer. It uses simple menu-driven navigation and makes it easy for users to switch back and forth between the two programs, one for FWD and one for GPR, simplifying the analysis process.

"With this software, field engineers will be able to easily gain more accurate test results that can be used to make better judgments about a pavement's condition," Tang said. "This will help highway departments determine how to best invest limited pavement rehabilitation dollars to achieve the greatest impact."

Reprinted from CTS Catalyst*, March 2014. Images courtesy of MnDOT.*

Related resources:

- Technical Summary (1.0 MB PDF)
- Research report
- Research project page

Announcements

TERRA Innovation Series to feature University–DOT collaborations, Aug. 20

A half-day TERRA Innovation Series event on August 20 will highlight some of the current pavement-related research topics in the Wisconsin transportation community and showcase the collaboration between the University of Wisconsin–Madison and the Wisconsin Department of Transportation. The event, held in conjunction with the Mid-Continent Transportation Research Symposium on August 21–22 in Madison, Wisconsin, is hosted by TERRA, in cooperation with UW–Madison and the WisDOT. The event will feature a presentation on the large-scale pavement and railroad test models as well as presentations by the Asphalt Research Center, Recycled Material Research Center, and Construction and Material Support Center. The event will include tours of the Traffic Operations and Safety Laboratory and Driving Simulator Laboratory. There is no cost to attend, but registration is requested by Wednesday, August 13. More information.

MnROAD to celebrate 20th anniversary with open house, Aug. 6

MnROAD celebrates its 20th anniversary this summer and is welcoming research partners, supporters, and friends from 10 a.m. until 2 p.m. on August 6, 2014, to an open house. MnROAD staff will be conducting tours of the mainline and low-volume road (LVR) during the day along with equipment demos in the parking lot. Staff also will be available to discuss current and completed research and gather suggestions for research in 2016. Details and registration.

SHRP2 workshop for the preservation of high-traffic roads, Sept. 2–5

The SHRP2 R26 Workshop for the Preservation of High-Traffic-Volume Roadways with on-site inspection of preservation test cells at MnROAD will be held September 2–5, 2014, in conjunction with the AASHTO Midwestern Pavement Preservation Partnership (MPPP) meeting at The Depot Renaissance in Minneapolis.

International in-place recycling conference, Aug. 5–8

The 2014 International & Western States In-Place Recycling Conference will be held August 5–7, 2014, at the Crowne Plaza Denver International Airport, in Denver, Colorado. The conference is an international forum of pavement professionals to share information and identify common issues for further investigation. The conference will provide a platform for national and international pavement professionals to present the state-of-the-art in-place recycling. Breakout sessions will identify issues, barriers, and gaps in knowledge that are preventing increased use of these sustainable pavement preservation/maintenance techniques and develop a roadmap to address these issues.

More upcoming events

- Mid-Continent Transportation Research Symposium, August 21–22
  Concourse Hotel & Governor's Club, Madison, Wisconsin
- 2014 International Conference on Perpetual Pavement (ICPP), October 30-31
  Hilton Columbus/Polaris, Columbus, Ohio

TERRA E-News is produced quarterly by the Center for Transportation Studies at the University of Minnesota.

Comments?
We would like to hear what you think of *TERRA E-News*. Please e-mail us at mpmccarthy@umn.edu.

Contacts for more information about TERRA

- Chris Kufner, Manager, Road Research Section, MnDOT Office of Materials, 651-366-5507, chris.kufner@state.mn.us
- Stephanie Malinoff, Director, Outreach Services, Center for Transportation Studies, University of Minnesota, 612-624-8398, malinoff@umn.edu

TERRA publications staff

- Editor: Michael McCarthy, mpmccarthy@umn.edu, 612-624-3645
- Contributing Editors: Christine Anderson, Pam Snopl

Subscribe/Unsubscribe
Those who receive this newsletter have expressed interest in TERRA.

To receive this newsletter by e-mail, please use the online subscription form. If you know of others who may be interested in this newsletter, please forward this page to them.

If you wish to be removed from our e-mail distribution list for this newsletter, please use the online unsubscribe form.