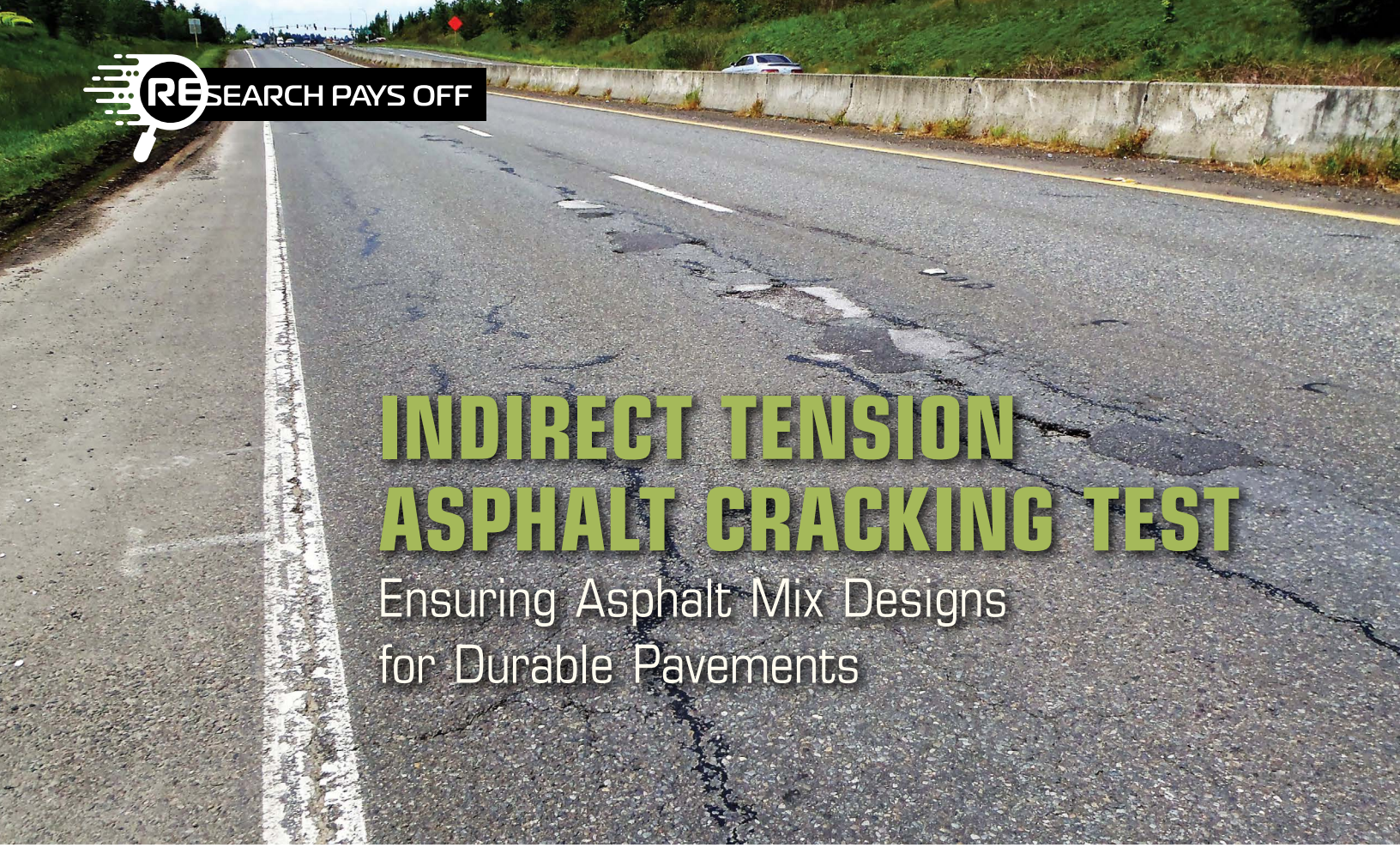

RESEARCH PAYS OFF

INDIRECT TENSION ASPHALT CRACKING TEST

Ensuring Asphalt Mix Designs for Durable Pavements

Washington State DOT

FUJIE ZHOU AND KELLY WEST

Zhou is a senior research engineer and West is senior communications specialist at Texas A&M Transportation Institute in College Station.

Drivers endured a bumpy ride along a stretch of Padden Parkway in Washington State's Clark County, coming up to its 2017 repair. Before then, the asphalt roadway had been prematurely affected by fatigue cracking and rutting. Researchers have now developed an economic and reliable cracking test that helps state departments of transportation determine how well pavement will hold up under the ravages of time—and heavy traffic.

Over the past five years, researchers at the Texas A&M Transportation Institute developed and implemented a simple and practical indirect tension asphalt cracking test (IDEAL-CT) for use during asphalt balanced mix design and quality control/quality assurance (QC/QA) testing. The test was developed for National Cooperative Highway Research Program (NCHRP) Project 20-30/Innovations Deserving Exploratory Analysis (IDEA) 195, "Development of an IDEAL Cracking Test for Asphalt Mix Design, Quality Control and Quality Assurance"[1] and demonstrated to several state departments of transportation (DOTs) through NCHRP Project 20-44(16), "Implementation of the IDEAL Cracking Test for Asphalt Mix Design QC/QA."[2] The test is now an ASTM standard test method—D8225-19: *Standard Test Method for Determination of Cracking Tolerance Index of Asphalt Mixture Using the Indirect Tensile Cracking Test at Intermediate Temperature*.

Problem

State DOTs have long faced the problem of premature asphalt pavement cracking (Figure 1). The current—and increasing—use of recycled materials and binder modifications can potentially make these asphalt mixes even more susceptible to this type of damage. A number of asphalt cracking tests have been developed over the years, but none offers the desired ease-of-use, reliability, efficiency, repeatability, and cost effectiveness. So, transportation agencies

[1] Review the full report at https://onlinepubs.trb.org/onlinepubs/IDEA/FinalReports/Highway/NCHRP195.pdf.

[2] See the full report at https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-44(16)_Final_Report.pdf.

FIGURE 1 Typical fatigue cracking in asphalt pavement.

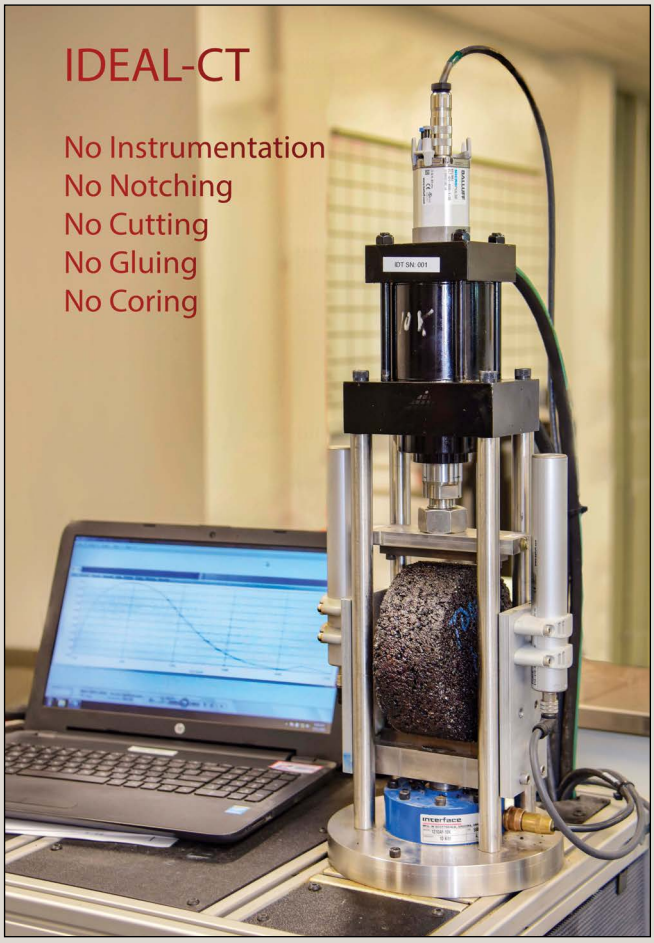

FIGURE 2 IDEAL cracking test.

have long felt a need for an economical, reliable, practical asphalt cracking test that state DOTs could routinely use in their balanced mix design process, as well as during QA testing.

Solution

The IDEAL-CT, shown in Figure 2, fills this need and has proven to be a reliable cracking test for fatigue cracking, top-down cracking, low-temperature cracking, and reflective cracking, which is caused by breaks in underlying layers from movement at the original crack. The test was validated using performance data from FHWA's Accelerated Loading Facility, Long Term Pavement Performance Special Pavement Study 10 (*1*), the National Center for Asphalt Technology (NCAT) test track, the Minnesota Road Research Facility, and a number of Texas test sections.

Researchers also established cracking criteria for different types of asphalt mixes and worked with several equipment manufacturers to make low-cost, stand-alone IDEAL-CT equipment or test fixtures to allow the use of existing load frames (such as the Marshall stability load frame).

The IDEAL-CT is, essentially, an indirect tensile strength test and is run at intermediate temperature using cylindrical specimens at 50 millimeters per minute loading rate. The intermediate temperature depends on the asphalt binder used; most state DOTs are currently using 25°C (77°F). Lab-molded cylindrical specimens are tested directly without the need for being instrumented, glued, cut, notched, cored, or using any other preparation. The procedure for sample preparation and testing is detailed in the ASTM Standard Test D8225-19.

The software provided with the IDEAL-CT system continuously records the load and vertical deformation and then automatically calculates the parameter: the cracking tolerance index. The larger the cracking tolerance index value, the better the cracking resistance.

Application

According to an NCAT survey conducted in 2020, at least 14 state DOTs were using the IDEAL-CT as the cracking test in their balanced mix design work to improve mix quality and durability at that time (*2*). The 14 states noted in the NCAT survey were Alabama, Arizona, Arkansas, Georgia, Idaho, Kentucky, Maryland, Missouri, Oklahoma, Tennessee, Utah, Virginia, West Virginia, and Wisconsin. Researchers worked with the states of Kentucky, Maine, Minnesota, Oklahoma, Texas, and Virginia to implement the IDEAL-CT for balanced mix design and QC/QA testing through NCHRP Project 20-44(16). The implementation activities included a demonstration workshop, webinars, training videos, and flyers for technicians,

engineers, and managers. Texas DOT intends to use the test for ensuring high-quality mix production at asphalt plants. Virginia DOT has been using it for its balanced mix design implementation initiative, with pilot balanced mix design sections placed in Virginia over the past three years.

Benefits

Commonly used traditional asphalt cracking tests in the United States—such as the flexural beam fatigue test, semicircular bend test, and overlay test—require significant specimen preparation before testing, such as cutting, notching, or gluing. The IDEAL-CT offers users the following benefits:

- **Simplicity**—Needs no specimen cutting, gluing, coring, or notching;
- **Practicality**—Requires minimum training for routine operation;
- **Efficiency**—Completed test within one minute;
- **Affordability**—Uses existing or low-cost equipment;
- **Repeatability**—Coefficient of variation less than 20 percent; and
- **Sensitivity**—Sensitive to mix compositions (e.g., recycled materials, aggregates, binder, and aging).

IDEAL-CT requires fewer sample preparation steps, which helps minimize the potential for human error. The test simply requires molding the specimen to a commonly used size disc—with no cutting, notching, or gluing. The specimen is tested in a standard, indirect tensile-strength testing machine, which most contractors and state DOTs already own and know how to use. Even if a new test machine needs to be purchased, the cost is generally less than $10,000—at least seven times cheaper than the flexural beam fatigue test, making the equipment cost-economical over the long term. For data analyses, the calculation of the cracking tolerance index requires the whole load versus displacement curve, rather than just the maximum load. Those load-displacement curve readings can be recorded manually, or laboratories can automate them with an accessory for less than $3,500.

In addition to its simplicity and practicality, the IDEAL-CT is much more efficient and rapid than its predecessors, with a loading rate of 50 millimeters per minute and a testing time of one minute or less, compared with days for the flexural beam fatigue test. The simplicity, practicality, and rapidity of the IDEAL-CT make it highly desirable for cracking testing during asphalt plant mix production to ensure high quality of the produced mix.

REFERENCES

1. FHWA. Specific Pavement Study Experiments. https://highways.dot.gov/research/ltpp/datal-collection/specific-pavement-studies. Accessed March 27, 2023.
2. West, R. A Roadmap to Implementation of Performance Tests in Asphalt Specifications. Presented at 1st FHWA Technical Feedback Group, 2020.

View a three-minute video about the IDEAL-CT at https://www.youtube.com/watch?v=6D327J5lXMo.

TRANSPORTATION

Factoid

Based on data gathered from FHWA and other government agencies, New Hampshire ranks first as having the best roads in the United States, followed by Minnesota and Vermont.

—Source: Consumer Affairs