Just Scratching the Surface: Electrical Resistivity Tomography Offers Nondestructive Solution to Drilling, Trenching

IDEAL-CT — Simple, Reliable, Efficient, Repeatable, Cost Effective

From Space Travel to Roadway Safety: LiDAR Helps Identify Pavement Sections Prone to Hydroplaning

TEXAS TRANSPORTATION

Researcher

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MEASURING UP

Managing Infrastructure Assets Smarter

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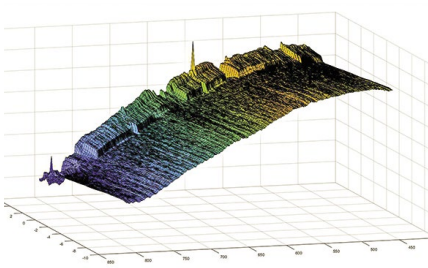
ON THE COVER: TTI researchers use advanced testing facilities, like the Asphalt Innovations Laboratory in The Texas A&M University System's Center for Infrastructure Renewal, to determine the ideal mix for materials to make roadways last longer and cost less over time.





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AMERICA'S INFRASTRUCTURE SCORE* IN 2021

C–

*Statistics taken from ASCE's 2021 Report Card for America's Infrastructure.

"It's vital — especially now, in the wake of the COVID-19 pandemic, when our economy needs all the help it can get — that Congress pass a bill aimed at rebuilding our nation's infrastructure. Doing so will create many new jobs and continue to improve every system user's quality of life. And research by my Texas A&M Transportation Institute colleagues will provide valuable solutions in meeting these challenges."

Jean-Louis Briaud
President, American Society of Civil Engineers
Manager, TTI Geotechnical and Geoenvironmental Program

$3,300/ year

per-household cost to U.S. families resulting from poor infrastructure performance.

$429B/ year

total dollars lost across all U.S. households.

$300B/ year

investment needed over 10 years to achieve an A rating for U.S. infrastructure.

6B gallons

treated water lost daily (enough to fill 9,000 swimming pools).

43%

public roadways in poor or mediocre condition.

10,000

miles of levees, the location and condition of which are unknown (one-quarter of all U.S. levees).

Just Scratching the Surface:

Electrical Resistivity Tomography Offers Nondestructive Solution to Drilling, Trenching

With roadway construction projects such as bridge construction, time and money are both at a premium. Mistakes may not only set the timeline back but stretch already strained budgets as well. Electrical resistivity tomography (ERT) is becoming a popular method to study the subsurface of a construction project area in a nondestructive way. ERT scans can help engineers determine not only where to drill but, more importantly, where *not* to drill.

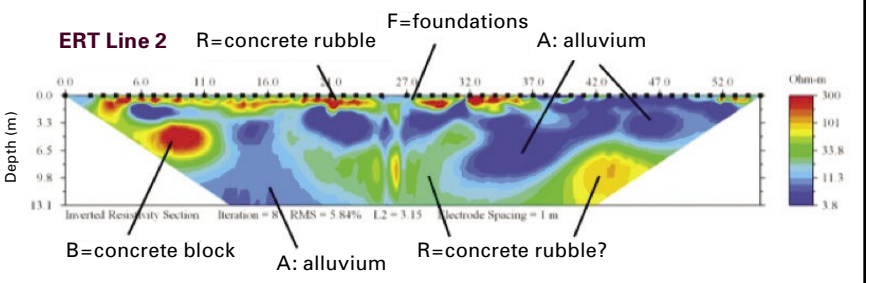
ERT is a noninvasive geophysical method that provides an image of the electrical resistivity structure in a vertical plane beneath a linear array of metal electrodes planted in the ground and connected by a multicore cable. The method provides a snapshot of the subsurface for geophysical testing that occurs at large-scale construction projects.

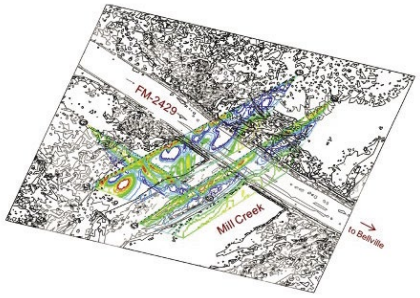
"Much like a medical imaging specialist would try to interpret an image to find a broken bone, we do the same thing in geophysical images," explains Mark Everett, Howard Karren Endowed Professor of Geophysics at Texas A&M University. "We try to make diagnoses such as what the material is, if there's any kind of moisture in the ground, and if there's any type of infrastructure down there. Then we convey that information to an engineer who can investigate further as needed. I've always said that the most import-

Above: ERT testing helped identify the best pier placements for new bridge construction near Yoakum, Texas.

ERT is a noninvasive geophysical method that provides an image of the electrical resistivity structure in a vertical plane beneath a linear array of metal electrodes planted in the ground and connected by a multicore cable. The method provides a snapshot of the subsurface for geophysical testing that occurs at large-scale construction projects.

Below: Results from ERT imaging scans.





ERT highway maintenance project at FM-696 near Elgin, Texas.

ant task of geophysics is to put an 'X' on the map."

This method was put into practice recently at a new bridge construction project for the Texas Department of Transportation (TxDOT) on FM 2429 near Bellville, Texas. In the past, during times of high-water discharge, scouring of the stream bed occurred around the existing foundations near the south bridge abutment. Concrete fragments and other large debris were placed periodically into the scoured area as a remediation effort. The new bridge was being built immediately to the east of the existing bridge. However, the concrete debris proved to be a hazard to excavation of the new foundations.

"TxDOT wanted to build a new bridge with new foundations. But the previous scour hole had been filled with concrete rubble, so they could not easily excavate to put in a new foundation," Everett says. "What they wanted ERT to do is find out how much concrete was down there. Because when they started digging it out, they just ran into more concrete, and it had the potential to be a costly nightmare. What they did in the end (after the testing) was to move their foundation by 20 feet into an area where the geophysics imaging told us there was no concrete. This guided them to redesign the bridge, actually."

"The accuracy is very good with respect to infrastructure. We've managed to successfully address the problems presented to us thus far. Looking deep with ground-coupled GPR in areas with clay soils is often hit or miss, but I've found ERT to be pretty robust."

Mark Everett
Howard Karren Endowed Professor of Geophysics at Texas A&M University

Another advantage of ERT is speed. The tests were performed in a few hours versus many more that would have been required if heavy machinery were used to move the concrete rubble.

The research team also conducted an ERT project on an interchange project on I-45 near Huntsville and measured a long section of highway in El Paso that took several days.

"ERT testing helped us identify areas with shallow water," says Texas A&M Transportation Institute Research Engineer Darlene Goehl, who worked on the I-45 project. "These conditions are not easily identified through traditional design methods and can lead to construction delays and costly change orders. Identifying these areas and designing to mitigate the potential water damage to the new pavement will save time and money."

"The accuracy is very good with respect to infrastructure," Everett adds. "We've managed to successfully address the problems presented to us thus far. Looking deep with ground-coupled GPR [ground-penetrating radar] in areas with clay soils is often hit or miss, but I've found ERT to be pretty robust." ■

For more information, contact **Mark Everett** at (979) 862-2129 or everett@geo.tamu.edu.

Creative Strategies in Nondestructive Testing and Smart Coring Save Time, Resources

TTI's LiDAR truck collects extensive roadway geometric data, including roadway cross slopes, superelevations, front slope angle and drainage areas of a roadway. The technology can also determine the depth of a roadside ditch and its offset relative to the nearby pavement structure. All data are collected at highway speeds.

Tailoring construction and repair solutions to unique problems along a discrete part of the roadway — instead of applying a one-size-fits-all method — is gaining popularity as a pavement design/rehabilitation method for entire corridors. It's just one innovation that Texas A&M Transportation Institute (TTI) researchers are using to help the Texas Department of Transportation (TxDOT) with its roadway maintenance projects across the Lone Star State. TTI's comprehensive approach to pavement forensics is resulting in notable time and cost savings, and, in many cases, yielding environmental benefits associated with pavement reuse and recycling.

Nondestructive Testing Saves Resources for TxDOT Bryan District

Researchers recently completed testing and evaluation on a research case study for a TxDOT Bryan District pavement widening project on SH 6 from south College Station at SH 40 north to Bryan at US 190. Using a variety of pavement forensic evaluation tools, smart coring strategies, and traffic data analysis, the bulk of the work in this type of study happens before letting a project. The intention: to evaluate corridors for alternative rehabilitation methods that will accelerate construction.

"Our goal is to help the district find the most efficient use of resources," says TTI Research Engineer Darlene Goehl, who leads the TxDOT research project.

Typically, the first step is to scan the entire corridor using ground-penetrating radar (GPR) and high-definition video to identify the general problem areas that show damage. Then, explains Goehl, "Based on the type of damage seen in that analysis, we can evaluate particular areas separately with other appropriate NDT [nondestructive testing] tools that help us determine what is causing the damage and exactly where coring should occur."

In the SH 6 corridor, researchers used a falling-weight deflectometer (FWD) and a total pavement acceptance device (TPAD) to target areas to help determine that much of the main lane and frontage road pavement was in good structural condition. As a result, a complete reconstruction was not necessary. A mobile laser scanner — which uses LiDAR — was employed to evaluate the roadway geometry to determine whether to widen sections to the inside or outside. In one segment, the shoulder required an overlay with lanes widened to the outside. In another segment, the existing main lane pavement could be used as the subbase

for new concrete pavement, requiring lanes to be widened to the inside.

Typical pavement strategies are to remove and replace all existing pavement. In this case study, TTI determined that the main lane removal was unnecessary, resulting in a savings of approximately $33.4 million and a time savings related to construction impacts for the traveling public of up to 19 months.

"TTI analyzed multiple options to accelerate construction and minimize the impact to the traveling public. Its research laid the foundation that minimized the amount of rehabilitation needed and focused on the most cost-efficient plan to construct the widening," says TxDOT Bryan District Engineer James Robbins. "This research provided TxDOT the ability to sequence work to minimize the impact to daily traffic in areas of known congestion."

Finding Best Rehab Solutions for TxDOT Beaumont District

Assessing the true condition of a pavement is rarely possible with the naked eye. But knowing what exactly has caused damage — and what's in and underneath the pavement — is the key to finding the best rehabilitation solution. NDT equipment serves as the "eyes" that allow pavement engineers to literally look below the roadway's surface to find the problem.

"Variability in the pavement structure and in the support of the subgrade soil for the pavement can be a real issue with rehabilitation," says TTI Research Scientist Stephen Sebesta. "We use these NDT tools to strategically select coring and roadway sampling locations that cover the range of expected site conditions over the length of a corridor." This approach leverages time and resources to validate the interpretations of the NDT done with GPR and FWD, and minimizes risks and surprises.

TTI used GPR to examine an approximately 0.8-mile portion of FM 1746 in the TxDOT Beaumont District. The GPR scan identified this localized section as having a different structural makeup than expected, clarifying its composition and providing direction for the rehabilitation needed. According to Sebesta, "This is a good example where we would go to different locations for further sampling/testing to verify and document what that variability is, and then, as appropriate, plan the best design accordingly."

On this project, the FWD also measured a localized area of concern where a revised pavement strategy was needed. Capturing this variability up front and designing/planning for it ahead of time go a long way to ensuring a project's success.

"TTI has been instrumental in our efforts to keep our ride scores up," says John Sudela, TxDOT Beaumont District pavement engineer. "Its equipment, labs and expertise all play a role in the work we do to find the most effective and economical pavement designs and rehabilitation solutions." ■

Pavement Forensics 101 — Tools of the Trade

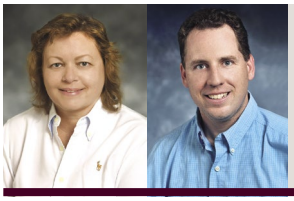
FWD is a nondestructive testing device widely used to evaluate pavement structural conditions.

TPAD can nondestructively and nonintrusively measure pavement structural conditions.

Air-coupled GPR transmits pulses of radar energy to collect data at highway speeds. Layer thicknesses and locations of air- and water-filled voids and layers with excess moisture or excess air voids can be determined using this device.

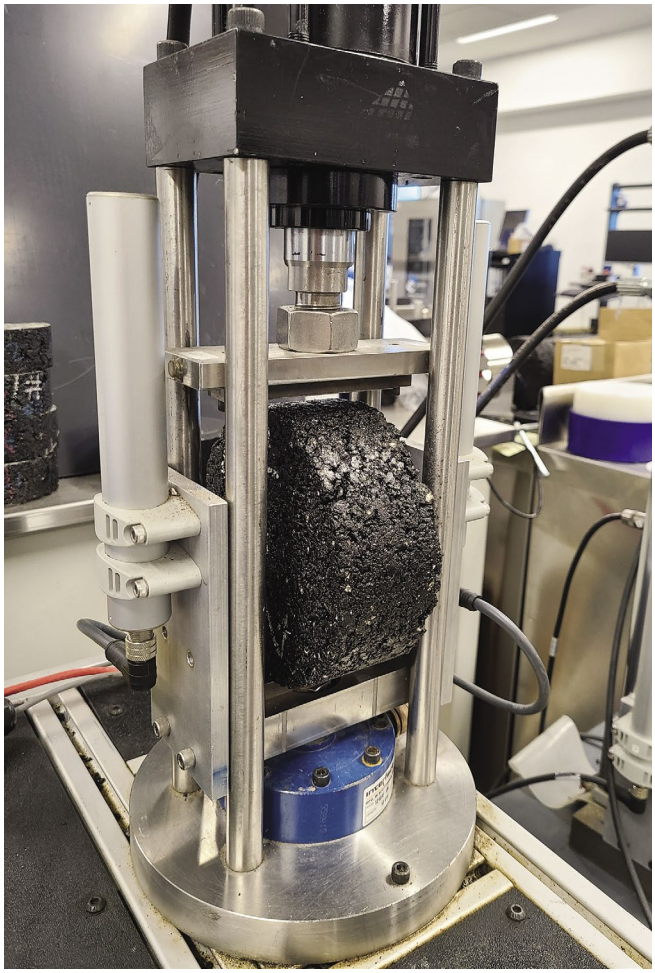
"TTI has been instrumental in our efforts to keep our ride scores up. Its equipment, labs and expertise all play a role in the work we do to find the most effective and economical pavement designs and rehabilitation solutions."

John Sudela
TxDOT Beaumont District Pavement Engineer



For more information, contact **Darlene Goehl** at (979) 317-2329 or d-goehl@tti.tamu.edu, or **Stephen Sebesta** at (979) 317-2297 or s-sebesta@tti.tamu.edu.

RECIPE IN THE MAKING: The TxDOT Balanced Mix Design Project Is Developing a New System Design of Asphalt Mixtures



The mixtures placed in the field projects are tested via the ideal cracking test in the CIR Asphalt Innovation Laboratory.

Using recycled materials on roadways has been standard procedure in construction for several decades. The challenge lies in having a practical mix design process — think of it like a recipe, selecting the right ingredients and proportions — that agencies responsible for highway infrastructure can rely on for guidance.

The Texas Department of Transportation's (TxDOT's) Balanced Mix Design (BMD) Project is like a test kitchen where researchers experiment with tools that can help produce mixture recipes to build better roadways. The project is a collaborative effort by TxDOT, the Texas A&M Transportation Institute (TTI), The University of Texas at Austin's Center for Transportation Research, The University of Texas at El Paso's Center for Transportation Infrastructure Systems, and contractors and material suppliers from the Texas Asphalt Pavement Association.

"We're currently developing a new mix design process that will provide more economical, high-quality and longer-lasting asphalt mixtures," explains TTI Executive Associate Director Jon Epps, a principal investigator on the project. Epps leads TTI's Pavement, Materials and Constructed Facilities Group. "And we're prioritizing using more recycled materials — like reclaimed asphalt pavement [RAP] — whenever possible. That's better for the environment because it reduces the overall carbon footprint of roadway construction, rehabilitation and maintenance operations."

In the project currently underway, researchers are testing potential mixtures under real-world conditions (e.g., severe weather, traffic loads, aging over time, etc.) using a variety of recycled materials, including RAP. Testing is occurring in the laboratory and at 12 field projects across Texas. Each field project is its own experiment — involving one-lane strips of road (test sections) paved with a standard mixture (the control) and mixtures created via tools developed for the new BMD method. To date, the team has constructed six field projects, including two each in TxDOT's Atlanta and San Antonio Districts and one each in the Yoakum and Paris Districts.

TTI is conducting associated mixture testing at the Asphalt Innovation Laboratory in The Texas A&M University System's Center for Infrastructure Renewal (CIR), focusing on the new indirect tension asphalt cracking test and ideal shear rutting test to assess each mixture's resistance to cracking and rutting, respectively. Successful field projects to demonstrate these tests and their ties to performance are the first step in revising asphalt mixtures using the BMD method.

"Building on the current TxDOT BMD specification makes it possible to engineer improved asphalt mixes. I'm very excited to be a part of the team and very confident that the outcomes will make a difference in producing longer-lasting roadways."

Haydar Al-Khayat
TTI Assistant Transportation Researcher

"Building on the current TxDOT BMD specification makes it possible to engineer improved asphalt mixes," says TTI Assistant Transportation Researcher Haydar Al-Khayat. "I'm very excited to be a part of the team and very confident that the outcomes will make a difference in producing longer-lasting roadways."

TxDOT spent nearly $1.5 billion on roughly 20 million tons of asphalt mixtures during this past construction season. Ensuring a thorough approach to improving asphalt mixtures can reduce the construction and maintenance costs associated with road building by creating longer-lasting, more environmentally friendly roads. And better roads can encourage economic growth. For example, if agencies can extend pavement life by one year, the savings could potentially reach $160 million per year.

"The TxDOT BMD initiative will provide mix designers with the tools to design asphalt mixtures that are more durable," TxDOT Flexible Pavements Section Director Enad Mahmoud says. "The BMD framework is an excellent tool to responsibly use recycled materials and adjust aggregate and asphalt grade/content to optimize mix performance." ■

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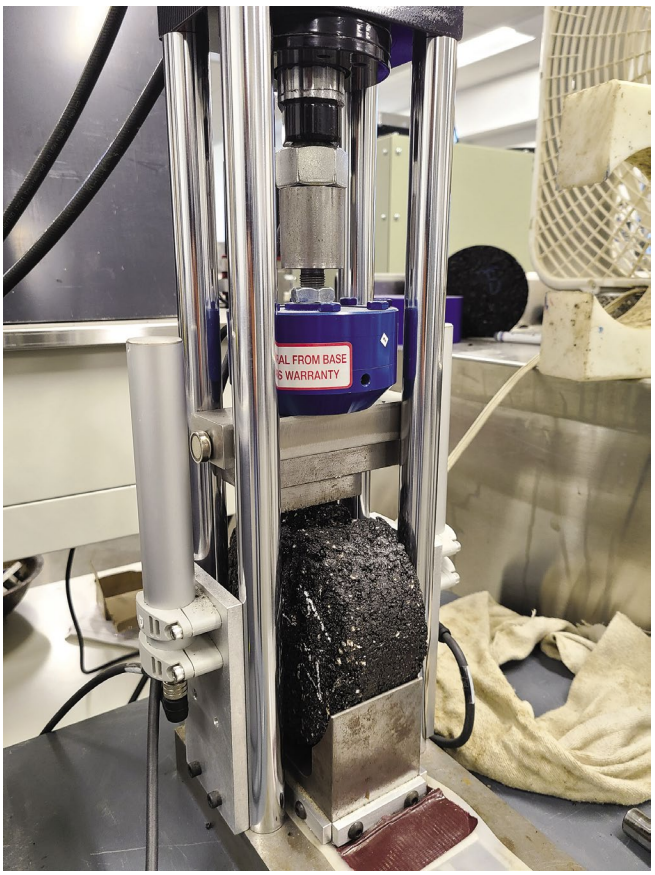
Jon Epps
TTI Executive Associate Director



In the CIR Asphalt Innovation Laboratory, TTI researchers test asphalt mixtures using the ideal shear rutting test.

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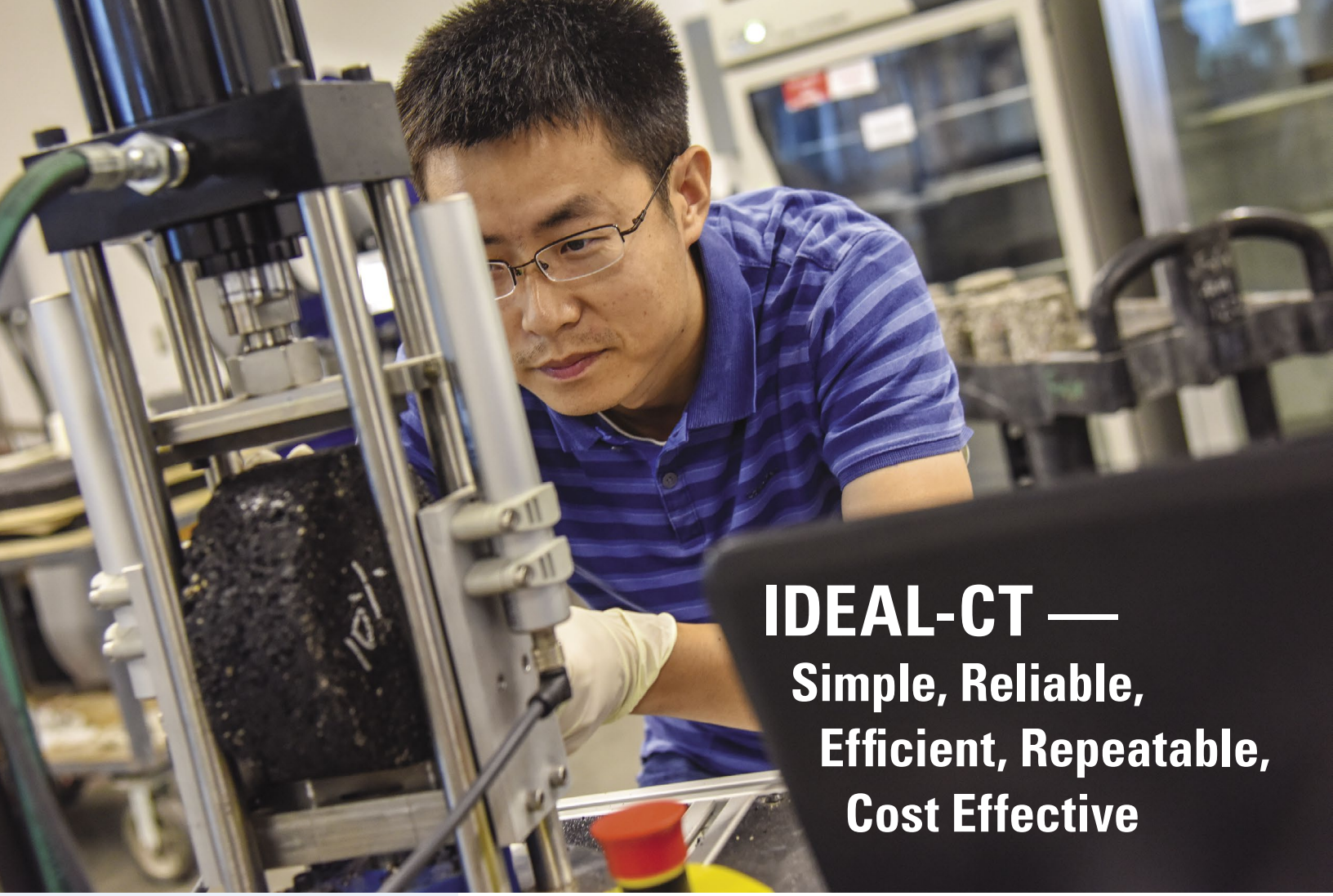


IDEAL-CT — Simple, Reliable, Efficient, Repeatable, Cost Effective

"Every department of transportation is looking for a simple, practical cracking test for use during mix design, quality control and quality assurance."

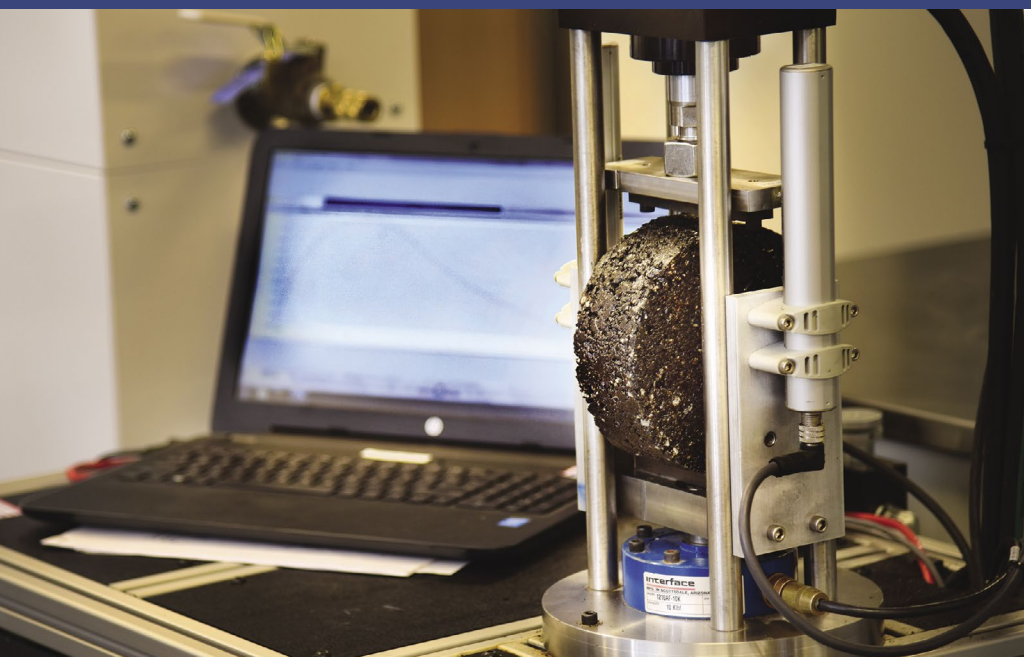
Fujie Zhou
TTI Senior Research Engineer

State departments of transportation (DOTs) nationwide have long dealt with the problem of asphalt pavement cracking — the primary type of distress that creates the need for pavement rehabilitation. Many cracking tests have been developed, but no single test has been simple, reliable, efficient, repeatable and cost effective — until now.

Over the past four years, researchers at the Texas A&M Transportation Institute (TTI) have developed and validated a single test that does it all: the indirect tension asphalt cracking test (IDEAL-CT).

"Every department of transportation is looking for a simple, practical cracking test for use during mix design, quality control and quality assurance," says TTI Senior Research Engineer Fujie Zhou, the expert who led development of the IDEAL-CT.

The test was created under projects in the Transportation Research Board's Innovations Deserving Exploratory Analysis programs. The research was funded by the American Association of State Highway and Transportation Officials as part of the National Cooperative Highway Research Program (NCHRP).



What Makes This Test Special?

The most commonly used traditional cracking tests in the United States require significant specimen preparation before testing; that prep work involves cutting, notching or gluing when using the flexural beam fatigue test, semi-circular bend test, overlay test or other cracking tests.

"This new test has fewer steps in sample preparation, so there's less potential for human error," says Zhou, who has worked on cracking-related issues for two decades.

The IDEAL-CT simply requires that a disc-shaped specimen be molded to a commonly used size — with no cutting, notching or gluing required. The specimen can then be tested in a standard indirect tensile strength testing machine.

Because the test doesn't require traditional prep work or sophisticated user training to achieve accurate results, the IDEAL-CT automatically has two very desirable features — simplicity and practicality. With the loading rate at 50 mm per minute and the testing time taking a minute or less, the test is far more efficient than its predecessors.

Most contractors and DOTs already own the testing equipment needed for performing the IDEAL-CT. And even if a new test machine is purchased, the cost is often less than $10,000, making equipment costs economical over the long term.

"We use exactly the same indirect tensile strength testing machine, the same test, even the same loading speed," Zhou explains. "The only thing we do differently is to look at the data in a new way."

The calculation of the cracking tolerance index (CTIndex) requires the whole load versus displacement curve rather than just the maximum load alone that's normal for that machine. Fortunately, those load-displacement curve readings can be recorded manually, or laboratories can opt to buy an accessory for less than $3,500. The larger the CTIndex, the better the cracking resistance.

The IDEAL-CT has proven a reliable cracking test for fatigue cracking, reflective cracking, top-down cracking and low-temperature cracking. Researchers have validated the test using performance data from the Federal Highway Administration's accelerated loading facility, Long Term Pavement Performance Special Pavement Study 10, the National Center for Asphalt Technology (NCAT) test track, the Minnesota Department of Transportation's Road Research facility, and numerous Texas test sections.

How Is the Test Being Implemented?

The IDEAL-CT became ASTM Standard D8225 in 2019 and is being used to evaluate the cracking resistance of asphalt mixes around the world. In the United States, Zhou is leading a national effort sponsored by NCHRP to implement the IDEAL-CT for balanced mix design (BMD) in addition to quality control/quality assurance testing for six states: Texas, Oklahoma, Virginia, Kentucky, Minnesota and Maine.

"The IDEAL-CT is such a simple, practical and reliable cracking test. We have been using it for our balanced mix design implementation initiative, testing pilot BMD sections placed in Virginia over the past three years," says Virginia Department of Transportation Assistant State Materials Engineer Rob Crandol. "The simplicity and timeliness of the IDEAL-CT sample preparation will be key to our efforts for performing cracking testing during actual plant mix production."

A recent survey conducted by NCAT showed that at least 14 DOTs around the nation are using the IDEAL-CT as the cracking test for their BMD efforts to improve mix quality and durability.

"The IDEAL-CT is intended for ensuring high-quality mix production at plants in Texas, which is a critical step in the overall process of building and maintaining strong and long-lasting roadways," says Flexible Pavements Section Director Enad Mahmoud of the Texas Department of Transportation's Materials and Tests Division. ■

For more information, contact **Fujie Zhou** at (979) 317-2325 or f-zhou@tti.tamu.edu.

Making Space for Big Rigs

TTI Helps TxDOT Evaluate Technologies to Facilitate Truck Parking

Finding safe parking is a constant concern for the nation's hundreds of thousands of truck drivers. There are typically not enough parking spaces along their routes, and there is no real way for truckers to know in advance about parking availability.

How big is the issue in Texas? According to the Texas Department of Transportation's (TxDOT's) Statewide Truck Parking Study completed last year, 140,000 trucks need to park each day in the state. Without more designated parking areas — or ways of letting truckers know where and how many parking spaces are available — the problem will likely get worse as freight needs grow along with Texas's population.

"The lack of truck parking availability — where drivers need it — results in unauthorized parking on highway shoulders, ramps and frontage roads," says Sherry Pifer, freight systems branch manager in TxDOT's Freight Trade and Connectivity Section of the Transportation Planning and Programming Division. "Truck parking shortages impact the safety of drivers and the traveling public throughout Texas, and TxDOT is committed to making Texas highways the safest in the country."

Texas A&M Transportation Institute (TTI) researchers have been working with TxDOT on various aspects of this problem since 2015. Truck parking information systems activity is part of

An oversized truck entering a northbound I-45 safety rest area. Notice the TTI-developed entry detection system located on the utility pole.

TxDOT Project 0-6837, Assessment of Innovative and Automated Freight Systems and Development of Evaluation Tools. After identifying many potential freight-related strategies and technologies that could improve freight mobility in the state, in Phase III of the ongoing project, researchers will test numerous intelligent-transportation-system-based technologies that could facilitate the timely flow of commercial freight through Texas. (See the sidebar to this story for more project activities.)

"We are evaluating two types of sensor technologies to help count and communicate available truck parking spaces," says Curtis Morgan, lead on the project and manager of TTI's Multimodal Freight Program. "Because it's such a pervasive problem, the ultimate goal is to give truckers advanced and accurate notice of available parking spaces."

The TTI research team is evaluating a scanning LED sensor from LeddarTech, which is a LiDAR-based detection system. The entry/exit system was placed at the entrance and exit of the parking lots to count and keep track of both arriving and departing vehicles.

"These two technologies can help determine the reliable number of available spaces in a particular lot," says TTI's Dan Middleton, a leader in vehicle detection research and commercial vehicles issues. His work is taking place in the truck parking lots of the twin TxDOT safety rest areas (SRAs) on I-45 in Walker County, located north of Huntsville.

The team has also contracted with the parking management company IPsens to install in-pavement infrared/magnetic sensors in all the marked truck parking spots in the SRAs. The system detects when a truck covers a sensor and counts that spot as occupied.

"In our preliminary evaluation, both systems seem to be working well, keeping accurate tallies of the number of trucks versus the number of spaces," Middleton says. As part of the project, changeable message signs were placed before each SRA entrance, letting truckers know real-time parking space availability.

"The lack of truck parking availability — where drivers need it — results in unauthorized parking on highway shoulders, ramps and frontage roads. Truck parking shortages impact the safety of drivers and the traveling public throughout Texas, and TxDOT is committed to making Texas highways the safest in the country."

Sherry Pifer
Freight Systems Branch Manager in TxDOT's Freight Trade and Connectivity Section of the Transportation Planning and Programming Division

"This was a good first step in determining that counting truck spaces is achievable," Middleton says. The next step could be the development of a high-tech information system that notifies truckers about space availability, perhaps through TxDOT's LoneStar system or even through the truck's onboard electronic logging device system.

"Truck parking information systems will help truck drivers and dispatchers make informed decisions about where to safely and efficiently park along the Texas Highway Freight Network," Pifer confirms. ■

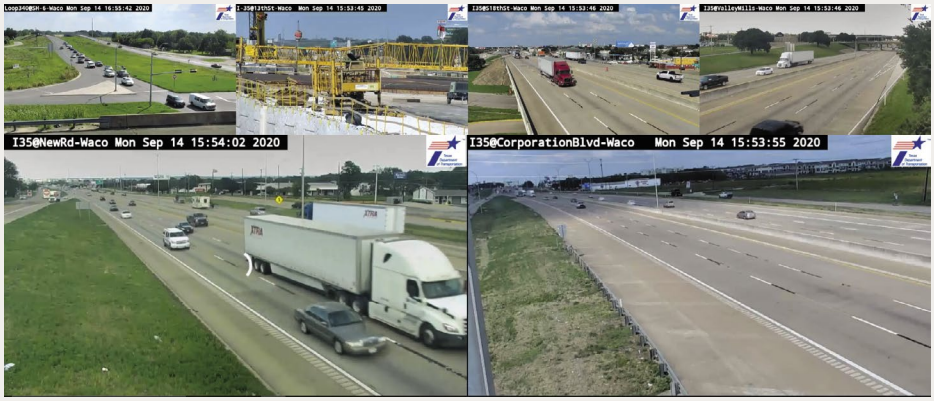
For more information, contact **Dan Middleton** at (979) 317-2826 or d-middleton@tti.tamu.edu.

Just like the sensor technologies that are being evaluated to calculate accurate parking space availability for the trucking industry, other technologies and advanced modeling techniques will likely play an important role in creating a more efficient freight system in Texas. As part of TxDOT Project 0-6837 Phase III, TTI researchers are applying freight strategies to address issues that adversely impact Texas freight movement. Other project goals include:

- **Improving truck mobility near Texas ports:** evaluating advanced traffic signal controllers and video detection equipment designed to detect trucks and synchronize corridor traffic signals.
- **Assessing benefits of dedicated passing or truck-only lanes:** using mesoscopic and microsimulation modeling to determine if truck separation strategies can improve safety and mobility on a 32-mile section of the I-20 corridor in the Dallas–Fort Worth region.
- **Easing congestion with train-monitoring systems:** deploying a system that alerts trucks to often-blocked railroad crossings so drivers can avoid these areas, eliminating truck backups and congestion/safety issues.

I-35 Traveler Information System Helps Waco Fire Department Navigate Routes, Improve Response Times

In 2008, the Texas Department of Transportation (TxDOT) began its massive My35 Reconstruction Project to improve mobility and safety along 100 miles of I-35 in Central Texas. While most of the project is complete, Project 4B in Waco is currently underway, providing travelers improved traffic control, updated access roads and better interstate access locally.



"The cameras are particularly helpful since they show what's actually happening on the roadway in real time."

Leonard Ruback
TTI Senior Research Scientist

Since the project's inception, the Texas A&M Transportation Institute (TTI) has provided TxDOT with work zone and traveler information innovations. A significant contribution is TTI's development of a first-of-its-kind traveler information system to keep motorists informed about I-35 traffic. Travel times, construction delay, lane closures, and the impacts of pedestrian and bicycle closures are communicated via a website, dynamic message signs, email, social media and real-time video feeds.

"The cameras are particularly helpful since they show what's actually happening on the roadway in real time," TTI Senior Research Scientist Leonard Ruback says. "All you have to do is look at the 4B traffic map or YouTube streams before you begin your trip."

While the cameras were initially intended to help motorists navigate the corridor, it turns out other groups also find them useful. Besides being a major route for local and through travel on I-35, the Project 4B area is also vital for emergency service providers. And if anyone needs real-time information about travel conditions in this busy corridor, it's first responders. That's why the TxDOT Waco District's I-35 Waco Project 4B team is working with McLennan County Emergency Services to help emergency responders.

"The cameras have been tremendously helpful in getting our emergency responders to incidents as quickly as possible."

Robert Beechner
WFD Deputy Chief

The 22 streaming video cameras in the 4B project have proven particularly helpful to the Waco Fire Department (WFD) in planning its response routes when emergency calls come in. By viewing roadway conditions before they roll, WFD personnel can identify and avoid potential choke points. To help make the cameras more useful to WFD, TTI designed a portal for the department to streamline its access to video feeds throughout the project area.

"In emergency situations, even a few minutes can be crucial to delivering lifesaving care," says WFD Deputy Chief Robert Beechner. "The cameras have been tremendously helpful in getting our emergency responders to incidents as quickly as possible." ■

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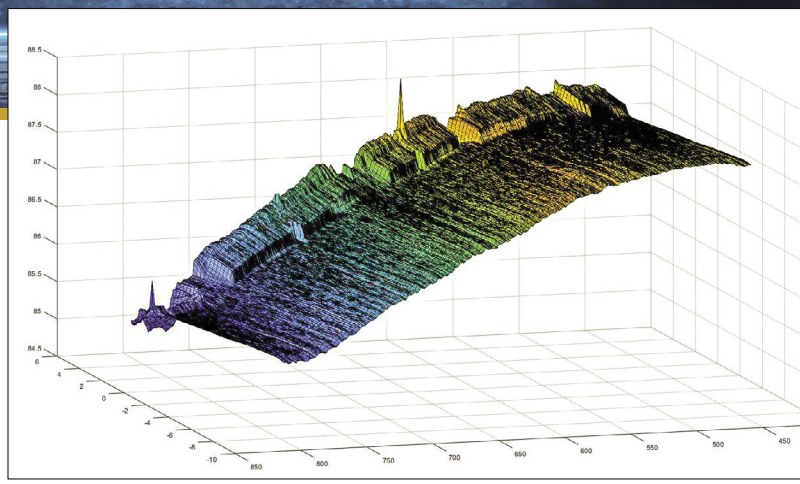
From Space Travel to Roadway Safety

LiDAR HELPS IDENTIFY PAVEMENT SECTIONS PRONE TO HYDROPLANING



Using digital renderings of the roadway and roadside surface to model how water flows along the surface, researchers can determine how big a pavement drainage really is. And with that as a baseline, cost-effective solutions that also improve safety are easier to find.

A technology once focused on aerospace applications half a century ago is finding new utility to improve the safety of driving surfaces in Texas thanks to evolving research at the Texas A&M Transportation Institute (TTI). The effort employs LiDAR — or light detection and ranging — which calculates distances by transmitting a laser beam to an object and gauging the time the light takes to return to its source.

Led by TTI Associate Research Engineer Charles Gurganus, this new effort funded by the Texas Department of Transportation (TxDOT) builds upon earlier work originally designed to improve roadway resilience and add to TxDOT's Asset Management Plan. Gurganus and his team first used LiDAR in 2017 to measure roadside drainage channel dimensions to ensure those ditches served their intended purpose — to draw stormwaters away from the roadway and guard against premature wear and tear on and beneath the driving surface.

What started out as a method to relate roadside drainage to pavement durability and maintenance needs, however, has now become a way to determine hydroplaning potential. The research team is mapping pavement surfaces to detect spots where thin layers of rainwater collect and fail to drain quickly enough from the pavement surface.

"Water can be an amazing force," Gurganus says. "And hydroplaning results from a series of events; a lot of bad things happen all at once."

For example, analyzing data from Texas's Crash Records and Information System can reveal that a certain 20-mile stretch of roadway has a higher-than-average number of wet-weather crashes, Gurganus notes, but the new LiDAR application can isolate much shorter segments where the pavement geometry might be a contributing factor. And that means maintenance and prevention measures can be more effectively targeted.

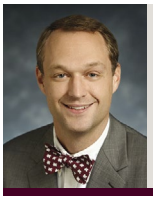
This new application of LiDAR is a major advancement, but it brings along with it a hefty challenge, namely processing the sheer volume of data collected for analysis. "It's the world we live in," Gurganus points out. "We're data rich and information poor."

Overcoming that circumstance is an ongoing task for the research team, which is making the analysis of pavement data more digestible with visualization tools and readily available to TxDOT engineers at the network level.

What started out as a method to relate roadside drainage to pavement durability and maintenance needs, however, has now become a way to determine hydroplaning potential.

By applying a technology used by NASA in the 1970s to aid spacecraft development and travel, TxDOT can now make conditions safer for roadway travel.

"TxDOT already does a lot to prevent wet-weather crashes, from warning signs to pavement texturing to aggregate selection," Gurganus says. "This gives TxDOT another tool to identify and prioritize the most vulnerable spots. It makes it possible to perform surgery with a scalpel instead of a hatchet." ■



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TTI Participates in TRB's 100th Annual Meeting

VIRTUAL FOR THE FIRST TIME

The Texas A&M Transportation Institute (TTI) was well represented at the 100th Annual Meeting of the Transportation Research Board (TRB) Jan. 5–29. This was the first time in its history TRB has held the event virtually.

The meeting program included more than 3,000 presentations addressing 350 sessions and workshops on topics aimed at policy makers, administrators, practitioners, researchers and government representatives in the public and private sectors. More than 130 TTI employees participated in the meeting, 80 of whom were presenters on various transportation topics. The meeting spotlighted the theme Launching a New Century of Mobility and Quality of Life and featured dozens of sessions on COVID-19's impact on transportation, as well as how transportation professionals and researchers are responding to the pandemic.

"A virtual annual meeting certainly wasn't what TRB had in mind for its 100th anniversary, but TRB leadership and staff did an outstanding job in this new space to offer the quality sessions that TRB participants are accustomed to," says TTI Executive Associate Director Katie Turnbull, a member of the TRB Executive Committee. "Participation in committee meetings, lectern sessions and poster sessions was vibrant, with a record number of close to 20,000 people attending."

Although this year's conference did not allow TTI's participants to physically network with one another, the Institute's virtual exhibit hall was a perfect spot to leave behind a business card or stop and greet transportation professionals around the world. Designed to inform visitors about the Institute, TTI's booth was complimented by multiple visitors for its interactive features. Visitors could navigate to the main TTI website, search for job opportunities, read the latest *Texas Transportation Researcher* magazine, and subscribe to TTI's new podcast.

TTI Researchers Srinivas Geedipally, Dominique Lord, Michael Pratt, Kay Fitzpatrick and Eun Sug Park were awarded the Safety Performance and Analysis Committee's 2021 Best Paper Award for their paper "Safety Performance of One-Way Arterials."

"This paper is based on a project sponsored by the National Cooperative Highway Research Program," said Geedipally. "Prior to this study, safety prediction procedures for assessing the performance of one-way arterials were not available. Safety data collected in California, Illinois, Michigan, Oregon and Texas were used to calibrate predictive models, each of which included a safety performance function and several crash modification factors. The study results can be used to estimate the expected crash frequency of one-way arterials and to understand the differences in the safety performance when a two-way street is converted to a one-way operation or vice versa. The models developed in this study will be included in the second edition of the *Highway Safety Manual*." ■

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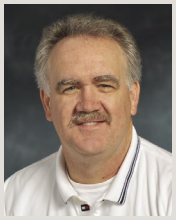
Transportation Planning Fellowship Named for TTI's Andy Mullins



Mullins

The Texas A&M University System Board of Regents approved the Andy Mullins Transportation Planning Fellowship, established by colleagues at TTI. A TTI research scientist and the manager of TTI's Travel Forecasting Program, Mullins passed away unexpectedly Oct. 22, 2020.

His research explored travel demand modeling and transportation planning. Mullins was an outstanding mentor to other researchers as well as students, and this $1,000 fellowship recognizes full- or part-time graduate-student TTI employees pursuing degrees that focus on transportation planning.

TTI Executive Associate Director Katie Turnbull, who organized establishing the fellowship, says, "The Andy Mullins Transportation Planning Fellowship honors Andy and his commitment to educating the next generation of transportation professionals. It is made possible by the generous support of his colleagues throughout the Institute." ■

TTI Launches Podcast: Thinking Transportation

TTI recently launched its new podcast, *Thinking Transportation: Engaging Conversations about Transportation Innovations*. Hosted by TTI Editor-at-Large Bernie Fette, the biweekly podcast examines all aspects of transportation, from the promise of smart cars to new approaches for improving traffic safety to the continuing challenges of traffic congestion.

But beyond the technical topics, Fette notes, the podcast also examines the human context — and sometimes cost — of how we use our transportation system. *Thinking Transportation* delves into how we get from home to school (and work and play), as well as how the products we purchase travel from the factory to the front porch.

"Transportation is tied to almost everything we do in our lives," Fette says. "It has a profound impact on our daily existence, so the conversations you'll hear are about more than technology and trends. Often, by extension, they're also about how we live."

"TTI's researchers are respected worldwide as thought leaders in transportation research through organizations like the Transportation Research Board and the Institute of Transportation Engineers," TTI Agency Director Greg Winfree says. "*Thinking Transportation* will give TTI experts a chance to reach a whole new audience and discuss the solutions they're developing to address the challenges we all face every day — from repairing potholes to shaping policy. If you depend on our transportation network, listen in — you're bound to learn something new." ■

TTI, Neology Inc. Extend Research Partnership to Support Mobility Innovation

TTI and Neology Inc. recently completed the Neology Transportation Research Center, located at the TTI Proving Ground on The Texas A&M University System's RELLIS Campus, extending their long-term master research agreement for an additional five years. The center will help accelerate the vision for smart cities and safer communities by advancing next-generation technologies in the mobility industry.

The facility is an open, scalable, flexible site for designing, developing and testing new tolling and intelligent transportation system solutions for driverless and connected vehicles. It features a 1-mile test track that supports vehicle speeds up to 100 mph and includes two test gantries to accommodate the deployment of future technologies, as well as a state-of-the-art observation center for demonstrations and test viewing.

"Neology Inc. is a valued private-industry partner for TTI, and we're pleased to extend our research agreement and collaborative activities in the development and testing of intelligent transportation system technologies," says TTI Agency Director Greg Winfree. ■

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Zmud Helps Author Policy Brief on Infrastructures and Robomobility


Zmud

TTI Senior Research Scientist Johanna Zmud helped author the recently published policy brief "Defining the Role of Automated Transportation Infrastructure in Shaping Sociotechnical Systems" in the Think20 (T20) Task Force publication *Infrastructure Investment and Financing*. T20 is part of an international forum called the Group of Twenty, comprised of regional and international think tanks, that coordinates international cooperation on issues related to finance and economics.

New methods of transportation are needed to address the global challenge of reducing greenhouse gas emissions, including issues related to the development of automated vehicles (a form of robomobility). The deployment of robomobility services requires a substantial investment in three main areas of mobility infrastructure: physical, digital and energy. Understanding how these new mobility practices may impact society will help governments and policy makers come to informed decisions on future infrastructure investments.

"The societal effects of robomobility are quite complex," says Zmud. "Leaders around the world should take robomobility seriously to better understand how a rise in autonomous vehicles can impact everyday factors such as climate change and traffic congestion." ■

Briaud Named President of American Society of Civil Engineers


Briaud

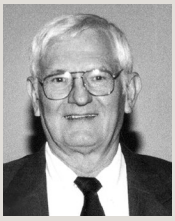
Distinguished Professor Jean-Louis Briaud assumed the role of 2021 president of the American Society of Civil Engineers (ASCE) Oct. 29, 2020. Founded in 1852, ASCE is the nation's oldest engineering society and represents more than 150,000 civil engineers worldwide. Briaud manages TTI's Geotechnical and Geoenvironmental Program and holds the Spencer J. Buchanan Chair in Texas A&M's Zachry Department of Civil and Environmental Engineering.

Briaud has performed research for the National Cooperative Highway Research Program and various state departments of transportation for more than 30 years. Briaud has also been an advisor to the U.S. Congress on several large bridge scour and erosion projects, such as the Woodrow Wilson Bridge, the Katrina Hurricane–New Orleans levee erosion, and the cliffs of Normandy, France, scaled by the Allies on D-Day during World War II.

Briaud's focus as president of ASCE is on improving communication with members, encouraging collaboration between institutes and their local regions, and enhancing the student transition rate.

"The role of ASCE president is a fantastic honor and responsibility," says Briaud. "I look forward to working with everybody to build upon the good work that's been done before me." ■

TTI's Neilon Rowan Passes Away


Rowan

Dr. Neilon Rowan, traffic operations pioneer, passed away Jan. 8, 2021. A retired TTI research engineer and a professor emeritus with Texas A&M University's Zachry Department of Civil and Environmental Engineering, Rowan was also a beloved and respected mentor to many students and researchers.

Rowan led TTI's Traffic Operations Program in the 1970s and 1980s and was a recognized national expert in the subject. He published many papers and reports on highway design and traffic operations, highway grade-crossing design and operations, roadway lighting design, and highway safety. He was pivotal in the development of breakaway sign supports, now used internationally, and served in several senior-level TTI management positions.

Rowan was also the first TTI research engineer to become the international president of the Institute of Transportation Engineers. His achievements in the transportation field inspired many young transportation professionals who now mentor others and instill that same passion he is best remembered for.

"Dr. Rowan treated us as colleagues from the day we walked in the door as grad students," says TTI Deputy Director Bill Stockton. "His manner was to lean on the doorframe of the office and just talk, with that unforgettable grin on his face. It is impossible to count how much wisdom he imparted from the doorway." ■

Harsher Weather? Build Better.

RESILIENCY SHOULD BE A PRIORITY FOR INFRASTRUCTURE FUNDING

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In February, Texas suffered a brutal storm that made international news — an arctic blast knocked most of the state's power grid offline and plunged millions of residents into darkness. The luckier folks only suffered rolling blackouts and had plenty of water. Others slept in their cars with the motor — and heater — running.

It was the power grid's lack of preparedness for the harsh weather, not the blast that vaulted Texas to the top of the news feed. And we seem to be having more extreme weather events like that lately — hurricanes, wildfires, tornadoes, bomb cyclones — all of which batter our national transportation infrastructure (and escalate costs to taxpayers to repair it).

When I was assistant secretary of transportation at the U.S. Department of Transportation, we still thought of infrastructure as mostly "roads and bridges." But as we Texans learned, it's also the power grid and the fuel lines feeding it from natural gas plants, wind turbines and nuclear power plants. It's likewise reflected in the accompanying water storage and transmission failures and other impacts on critical infrastructure. The American Society of Civil Engineers (ASCE) just released its 2021 report card on America's infrastructure, and the country's grade went from a D+ in 2017 to a C- in 2021. While that might seem like progress, I'm of the opinion that this year's grade was on a soft curve and the state of repair of our national infrastructure as a whole remains poor.

ASCE's 2021 report card looks at 18 categories — from aviation to public parks, from wastewater to inland waterways — rating each for its ability to meet 21st century needs. We should acknowledge the interdependencies of those assets to help us manage them efficiently, but we have to be cautious in trying to solve all of America's infrastructure problems at one time. While "roads and bridges" is a limited — and incomplete — way of looking at our national infrastructure, targeting different infrastructure areas when it comes to funding has some virtues.

The unpredictability of the future makes the imperative for proactive research all the more necessary, with a focus on building resilient assets that require less post-event repair.

ASCE estimates we'll need $300 billion over the next decade to raise America's infrastructure grade to an A. I'd argue that part of that funding should prioritize proactively building resilient transportation assets that better withstand extreme weather events. Typically, research funding focuses on fixing problems that already exist. But as deadly weather becomes more frequent and intense (and shows no sign of abating), the traditional approach to asset management — reactively, as a pothole to fill, rather than using technology that prevents potholes — opens a money pit for taxpayer dollars.

The unpredictability of the future makes the imperative for proactive research all the more necessary, with a focus on building resilient assets that require less post-event repair. Recent experience suggests Mother Nature's capacity for damaging our transportation infrastructure is limitless. Taxpayer dollars? Not so much. ■

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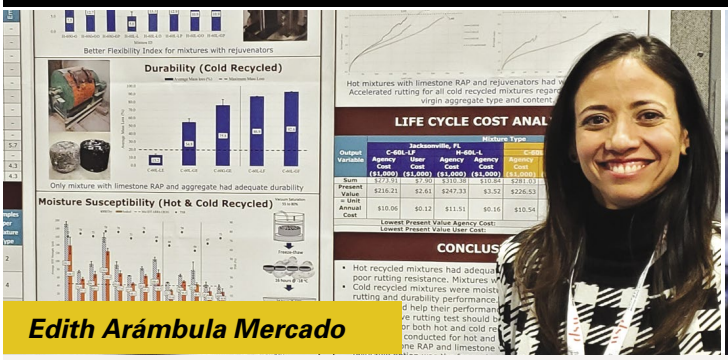
THINKing TRANSPORTATION

GOOD NEWS, BAD NEWS.

A better grade for America's infrastructure, *but still no bragging rights.*



Edith Arámbula Mercado

Charles Gurganus

TTI researchers Edith Arámbula Mercado and Charles Gurganus reflect on the American Society of Civil Engineer's 2021 Infrastructure Report Card. They explain how taking care of America's infrastructure is a lot like taking care of our homes — the longer you wait to make repairs, the more costly they can be.

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