

TEXAS TRANSPORTATION

# Researcher

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**PROVIDING  
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**FOR  
WORLD CLASS  
RESEARCH**



## PROVIDING SPONSORS WITH THE BEST RESEARCH FACILITIES

**T**he Texas Transportation Institute (TTI) takes great pride in providing sponsors with excellent research facilities. These facilities are key to TTI researchers' ability to help make the transportation system work, make it safe and make it last. This issue of the *Texas Transportation Researcher* highlights the Institute's research facilities.

Texas A&M University in College Station is the home and headquarters of TTI. As part of the Texas A&M University System, TTI researchers have world class research libraries, computing resources, and other services at their disposal. **The CE/TTI Building**, on the main campus of Texas A&M, houses part of the Institute. Close by are several laboratory and office buildings, including the Wisenbaker Engineering Research Center (WERC), Highway Materials Laboratory, Concrete Laboratory, Spectrum Analysis Laboratory and South Central Superpave Center.



**The Riverside Campus**, located 10 miles from the main campus, is home to the Proving Grounds Research Facility. The paved runways of the old Air Force base are perfect for conducting vehicle safety testing and a range of other experiments. The Hydraulics, Sedimentation and Erosion Control Laboratory and numerous pavement testing facilities are also located at the Riverside Campus.



**The Gibb Gilchrist Transportation Research Building**, located in the Texas A&M University Research Park, was designed and built specifically to meet the needs of leading edge transportation research. The TransLink® Research Center's Laboratory and the Driving and Pedestrian Environment Simulator are located in Gilchrist.



TTI also utilizes locations throughout Bryan/College Station and the state of Texas for its field laboratories.

# TTI Safety and Structural Systems Division uses innovative research methods

“Without the excellent work performed at the Safety and Structural Systems Division of TTI, TxDOT and other DOTs might, with all good intentions, perform new construction or repairs that may unknowingly result in negative performance in the field. It is through the unique expertise at TTI that TxDOT can be assured that we are doing state-of-the-art safety work.”

*Mark Bloschok, Special Projects Engineer, Bridge Division, TxDOT*

**T**he former Bryan Air Force base is home to some of the most innovative safety research performed in the United States. The Texas Transportation Institute (TTI) Proving Grounds Research Facility, located on what is now Texas A&M University’s Riverside Campus, enables researchers to conduct experiments and testing with the ultimate goal of improving transportation safety.

“This facility is one of only two university-based centers of its kind in the United States,” says Gene Buth, division head of the Safety and Structural Systems Division. “We perform product testing for clients from across the country, as well as test new TTI-developed roadside safety devices.”

The hub of these activities is TTI’s proving grounds, an expanse of paved runways ideally suited to perform full-scale testing of safety designs. At the proving grounds facility, roadside devices, crash cushions and barrier systems undergo the substantial testing that is required before field installation.

The size of the facility provides realistic conditions for crash testing and friction pavement testing. Researchers conduct crash tests on a wide spectrum of vehicles, from subcompacts and three-quarter ton trucks to 80,000-pound tractor-trailer rigs.

“The total crash testing effort includes expert engineering calculations, computer crash simulations and recommendations for work that TxDOT takes to the field,” says Mark Bloschok, special projects engineer with the Bridge Division of the Texas Department of Transportation (TxDOT). “These engineering recommendations assist TxDOT in understanding, mitigating and balancing risks along all the longitudinal barrier systems on our roadways and bridges.”

At the proving ground facility, construction crews install prototypes of safety devices for crash



TTI’s Proving Grounds Research Facility; (above) building, (inset) aerial of test runways.

testing and prepare the crash test site in a realistic setting. An electronics team equips the crash vehicle with appropriate measuring devices and a telemetry system for communication with the ground station, which is equipped with sophisticated computer monitoring equipment to record crash data. Finally, photographic experts set up high-speed cameras and video equipment to record the test on film. When the test is complete, TTI provides a thorough account of every aspect of the crash test. **R**

#### FOR MORE INFORMATION

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# TTI PROVING GROUNDS SAFETY FACILITIES

## The Bogie Test Vehicle

This vehicle is used to simulate a 1808-lb passenger car in collision testing. Testing with this reusable vehicle, rather than a late-model car, substantially reduces the costs of crash testing narrow objects, such as sign supports and lighting poles.



## The Parametric Measurement Facility

This facility measures a vehicle's center of gravity and mass moments of inertia to determine its stability and performance in driving maneuvers. The test vehicle is attached to a support structure that sits atop a hydraulic spherical bearing. The vehicle is then tilted around the bearing to measure center of gravity and oscillated around the bearing to measure mass moments of inertia.



## The Outdoor Pendulum Facility

This facility simulates low-speed (25 mph) vehicle impacts on roadside appurtenances. The pendulum uses a 1808-lb falling weight to induce known kinetic energy into a test article for evaluation of strength, energy absorption and failure characteristics.



## Other Proving Ground Facilities

1. A hydroplaning trough for studying the phenomenon of vehicle hydroplaning.
2. Test track of 3.5 miles that permits simulation of freeway traffic conditions at speeds up to 70 miles per hour.
3. Special pads designed for conducting tire skid tests on road surfaces of various textures.



## The Central and Western Field Test Center

One of two national reference centers for friction trailer calibrations in accordance with the American Society for Testing and Materials (ASTM). Engineers use carefully monitored reference pavements and an ASTM friction trailer to calibrate friction measurement systems for 25 state departments of transportation.



“TTI has provided excellent service regarding calibration and correlation of Florida’s Friction Test Units and associated equipment during our visits to the center,” says Larry Hewett, supervisor of the Florida Department of Transportation friction group. “The most important point is they provide continuous service, such as technical, mechanical, etc., regarding friction test systems, before and after our visits to the center.”



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# SUCCESSFUL SAFETY PRODUCT TESTING

## ET2000™ Guardrail End Terminal

Developed for TxDOT, the ET2000 is a guardrail end treatment that improves the chances of drivers surviving a run-off-the-road crash. As the ET2000's extruder terminal is pushed forward during impact, the w-beam guardrail is forced through the feeder chute and is flattened and directed away from the vehicle, absorbing the energy necessary to bring it to a safe stop. TxDOT and TTI received the Federal Highway Administration's (FHWA) 1991 Administrator's Biennial Safety Award for their development of the ET2000.



## Slotted Rail Terminal (SRT) 350™

The SRT was introduced in January 1995 as a guardrail end treatment. The SRT technology consists of cutting small slots in the ridges of the w-beam in a guardrail, thus converting the beam into four plates. The slots create weak points in the beam that cause the guardrail to buckle at predetermined locations if it is hit by a vehicle.



## WY-BET™ End Treatment

The WY-BET end treatment is constructed of box beam (tubular) rail. When hit, the end piece slides over the next section of box beam and absorbs the kinetic energy of the errant vehicle. In full-scale crash testing, vehicles were brought to a safe stop, meaning enhanced safety for car or truck occupants.



## Slip-Safe™ Breakaway Sign Coupling

The Slip-Safe is a breakaway sign coupling developed by engineers at TTI and is the only true 360° u-channel breakaway system available with built-in advanced safety and reusable components. In most cases, the base post, attachment hardware, castings and top post are reusable. Slip-Safe is designed to handle both small and medium size sign supports.



# Protecting homeland security

**T**he United States Department of State, Bureau of Diplomatic Security, Physical Security Division called upon the Safety and Structural Systems Division at TTI to help assess the performance of anti-terrorist protection barriers and various protective systems installed outside United States embassies.

The objective of the tests was to determine if the anti-ram wall and anti-ram bollard were capable of stopping a 15,000-pound truck traveling at 50 miles per hour. The U.S. Department of State provided initial designs for the bollard system; through a collaborative effort, based on the National Crash Analysis Center's (NCAC) analysis and simulations, the designs were improved and optimized. The wall was a new design subject to the same process.

A diesel F700 single unit-truck with a flatbed was used to perform the tests. To closely reflect an anticipated impact scenario, the vehicle was ballasted with soil-filled barrels secured to the upright frame on the front of the flatbed adjacent to the rear of the cab.

Both the anti-ram wall and bollard met the desired performance level of the State Department crash test specifications. **R**



(above) Anti-ram wall crash test.



(below and right) Sequence photos (1-4) of bollard crash test.



# Virtual crashes, real results

**D**ue to the high expenses associated with crash testing, engineers are relying more and more on sophisticated analytical models and simulation to evaluate design and analysis problems related to roadside safety. The Center for Transportation Computational Mechanics (CeTCoM) at TTI specializes in virtual crash tests using the LS-DYNA computer simulation program to model vehicle impacts.

The CeTCoM is one of five such university-based centers established by the Federal Highway Administration (FHWA). Funding for the center is provided jointly by FHWA, TxDOT, the Texas A&M University Supercomputer Center, and TTI.

Recent research sponsored by TxDOT sought to develop improved roadside barrier treatments and placement guidelines. Many TxDOT districts have adopted the practice of encasing guard fence posts in either a concrete or asphalt mow strip. The installation of mow strips can reduce hand mowing around guardrail posts for both safety and cost reasons. However, the possible vehicle safety risk associated with this practice had not

been evaluated. To accomplish this goal, TTI researchers used computer simulation models to guide the design process of the improved barriers.

“We modeled the mow strip system in a predictive manner to try and assess the nature of the problems that might exist,” says Roger Bligh, Director of CeTCoM. “We then used the simulation results to guide the development of a mow strip configuration that would be acceptable from an impact, maintenance and repair standpoint.”

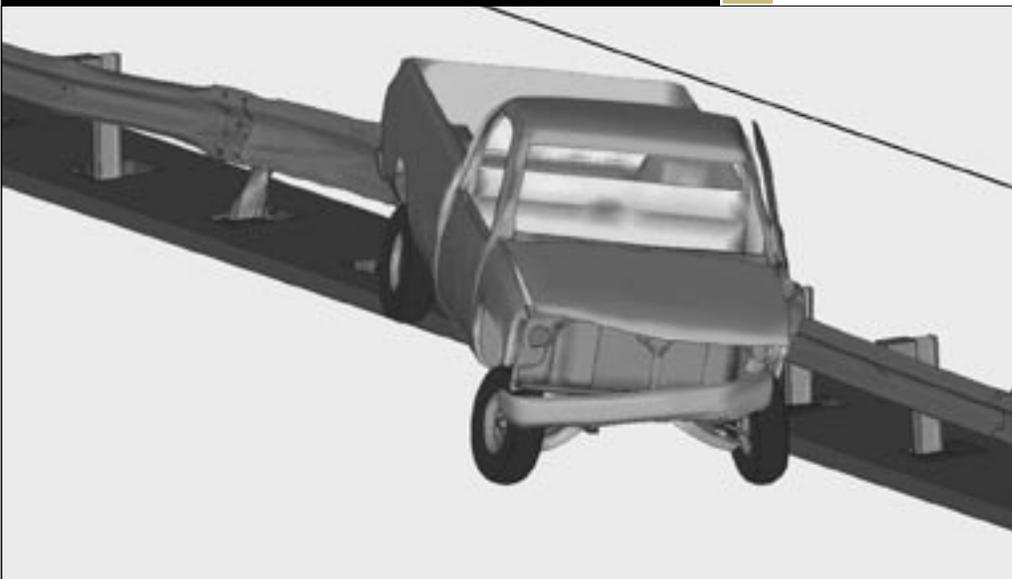
Since the mow strip configuration design is not bound by a standard, many variables, such as mow strip material and thickness, exist. Thus, conducting an investigation based solely on crash testing would not have been cost effective.

Two full-scale crash tests were performed at the TTI proving grounds based on the simulation design configuration. Both of the tests were successful and compared favorably with the simulation. “We were very pleased with the results and anticipate a standard from TxDOT as a result of this simulation and testing effort,” says Bligh.

“Using computer simulation allowed us to narrow the focus of the variables prior to running expensive full-scale tests,” says Mark Marek, the project coordinator and deputy director of design with TxDOT. “TTI was very responsive to TxDOT’s request for this research in surveying what our districts were already using out in the field and how that performed both in the field and with the modeling.” **R**



(above) Guard fence post encased in concrete mow strip; (below) virtual crash test using the LS-DYNA computer simulation program.



#### FOR MORE INFORMATION

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# Simulating driving behavior

**T**he Texas Transportation Institute's Center for Transportation Safety is home to a special resource for researchers: a fully interactive driving simulator. The driving simulator allows participants to navigate a real vehicle through realistic computer-generated driving environments while controlling acceleration, braking and steering—exactly like they would in the real world.

The Center for Transportation Safety, headed by David Willis, was established to focus on health and safety issues associated with transportation. Work performed through the center is closely coordinated with safety-related work being pursued by other agencies, such as the Texas Department of Transportation.

The driving simulator comprises four components: a vehicle, computers, projectors and screens. A 1995 Saturn SL automobile is outfitted with computers, potentiometers and torque motors connected to the accelerator, brakes and steering. The Saturn also features full stereo audio, full instrumentation and fully interactive vehicle components, all of which provide the realistic feel of driving. The Saturn is connected to a computer component that consists of one data collection computer and three image generation computers. Computer-generated driving scenes are sent to three high-resolution projectors and projected on three high-reflectance screens.

Since its installation in 1999, the simulator has been used for several projects. The largest, which tested 200 participants, examined driver's preferences for left-turn signal displays. Two additional projects assessed driver distraction due to cell phones and other in-vehicle devices, such as navigation systems.

Three research projects funded through the Southwest University Transportation Center are utilizing the simulator. The first project is an on-line, two-way integration of the driving simulator with the traffic micro-simulation program VISSIM. This integration takes advantage of the visualization capabilities of the driving simulator and the traffic modeling capabilities of the traffic micro-simulation program. Larry Rilett, associate research engineer with TTI, and Jacqueline Jenkins, graduate assistant with TTI, are leading this effort.

The second project utilizes the visualization capabilities of the simulator to investigate how pedestrians interact with the roadway environment (see "Simulating Pedestrian Behavior," p. 9).

The final project, led by Susan Chrysler, associate research scientist with TTI, assesses meth-



(top) Computer-generated driving scenes are sent to three high-resolution projectors and projected on three high-reflectance screens; (above left) data collection computer; (above right) inside view from the driving simulator.

odological differences for traffic sign comprehension when tested in the simulator compared to conventional paper-and-pencil based tests.

A recent upgrade to the simulator allows more traffic to be present in the simulated environments. The addition of pedestrian capabilities is also underway (see p. 9). These expansions of the simulator's capabilities are already appearing in research proposals for projects with the National Cooperative Highway Research Program, National Institutes of Health, National Highway Traffic Safety Administration, and Federal Highway Administration.

"The driving simulator provides a valuable facility to research driver behavior and a powerful visualization tool to evaluate the traditional traffic engineering areas such as geometrics and operations," says Chrysler, who coordinates the driving simulator. 



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# Simulating pedestrian behavior

**T**he driving simulator at TTI has been modified to provide the capability to model pedestrian situations. The pedestrian simulator (PedSim) is used to investigate a variety of issues related to pedestrian interaction in the roadway environment and other situations.

To use the PedSim, the driving simulator test vehicle is moved to the back of the room, and the human subject replaces the car. Using a joystick, subjects can navigate a virtual world as seen from a pedestrian viewpoint. The speed and eye level are adjusted to coincide with those of a pedestrian.

A current study funded by the the Southwest University Transportation Center is examining pedestrian behavior using the PedSim. The goal of the study is to help researchers and practitioners in both health and transportation fields deliver and design roadway and sidewalk environments that facilitate and encourage walking and cycling.

“We’re looking particularly at pedestrian behavior at intersections—what their decisions are, learning more about their gap acceptance and how to signalize for visually impaired. We want to find out how safe they actually are in those situations,” says Harlow Landphair, TTI research scientist.

In addition to the simulator experiment, the research team is also conducting focus groups with parents of children that attend elementary schools. Topics discussed in the focus groups include children’s health, walking and the perception of safety in the pedestrian environment of the neighborhood. Based on the information gathered from the focus groups, a procedure and scale will be developed for measuring the presence or absence of features that encourage or discourage walking.

“What makes this research unique is the idea of a pedestrian laboratory—one part of which is the simulator environment,” says Landphair. “We hope to eventually develop an outdoor facility at full scale to parallel the pedestrian simulator.” **R**



(above and below) using a joystick, a test subject navigates a virtual world as seen from a pedestrian viewpoint



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# Testing structural systems

**L**ocated behind the Wisenbaker Engineering Research Center on the Texas A&M University campus is a laboratory specializing in finding solutions to unique materials problems. This laboratory complex, managed by the Texas Engineering Experiment Station (TEES), consists of a full-service machine shop, a high-bay structural testing facility and a materials testing area.

The two-story high-bay Testing, Machining and Repair Facility (TMRF) facility has a 40-foot by 75-foot strong floor and is used to build full- and partial-scale bridge structures for testing. Reaction frames and test specimens are positioned with a 20-ton overhead crane and can be bolted to the 24-inch thick floor through tie-down holes located on three-foot centers. Hydraulic actuators are used to apply forces to the test piece.

“The structural bay gives researchers the capability to perform full scale experimental tests on structural systems and their assemblages and components using different types of loading that simulates real conditions,” says Joe Bracci, associate research engineer with the Texas Transportation Institute (TTI).

Bracci used the TMRF when conducting research, sponsored by the Texas Department of Transportation, to determine the cause of unexpected cracking in reinforced concrete bent caps on bridge columns. Besides being visible eyesores, these cracks allow the propagation of corrosive materials through the concrete cover to the steel reinforcement. Over time, this can potentially compromise the strength and long-term durability of these highway bridge structures.

Researchers designed and constructed 16 full-scale bent cap specimens at the structural bay. The research team then conducted tests that were designed to isolate several parameters within the specimens to determine their role in cracking.

Being able to use the facilities of the structural bay helped the research team to achieve success in the study. “TMRF had the facilities, loading equipment, measurement instrumentation and staff support that enabled the testing of full-scale bent cap specimens,” says Bracci. **R**



(above and below) Testing, Machining and Repair Facility.



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# Scour testing device now available to the public

Of the 1,000 bridge failures in the United States over the last 30 years, 60 percent were due to scour. Currently, 25,000 bridges in the U.S. are scour critical, meaning their foundations could fail due to erosion.

In 1991, Jean-Louis Briaud, program manager for the Materials and Pavements Division at TTI and professor of civil engineering at Texas A&M University, began work on the design of a new device. He hoped to measure the erodibility of soils and rocks, a phenomenon referred to as *scour*, which occurs due to the erosion of soil around bridge foundations by the action of flowing water. Shortly thereafter, Briaud was joined by Hamn-Ching Chen, a professor of civil engineering at Texas A&M. The purpose of the research, originally sponsored by the Texas Department of Transportation (TxDOT), was to help prevent bridge failures due to the effects of scour.

Predicting the effects of scour is important because out of the 1,000 bridge failures in the United States over the last 30 years, 60 percent were due to scour. Currently,

25,000 bridges in the U.S. are scour critical, meaning their foundations could fail due to erosion.

After a decade of developmental research by the Scour Research Team at TTI, the HM-4000 Erosion Function Apparatus (EFA) is now being manufactured by the Humboldt Manufacturing Company and patented through TTI and the Texas A&M Technology Licensing Office. The EFA is designed to be used in conjunction with the scour rate in cohesive soils (SRICOS) method of scour prediction. The SRICOS method, also developed at TTI by Briaud and Chen, is a site-specific method that involves collecting soil samples and testing them in the EFA.

Besides measuring the erodibility of soil and soft rocks, other applications of the EFA include piping of dams, beach erosion and surface erosion problems.

TTI researchers have been conducting erodibility investigations across the country using the EFA device for several years. One of these studies involved an Amtrak train derailment near Kingman, Arizona, in 1997. Traveling about 89 miles per hour, the passenger train derailed on a bridge that collapsed in a flash flood. The bridge collapsed as the result of scour undermining one of its piers. Burlington Northern Santa Fe Railroad sponsored a National Transportation Safety Board investigation into the bridge failure, conducted by Ayres Associates, Inc.

"An important part of the investigation into the cause of the failure was to determine the erodibility of the caliche layers that were in the foundation soil material," says Everett Richardson, who led the investigation for Ayres Associates. "The EFA, developed by TTI researchers, helped in determining the erodibility of the caliche layers and materially aided the investigation." **R**

(below) HM-400 Erosion Function Apparatus (EFA); (right) bridge washout due to erosion.



#### FOR MORE INFORMATION

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# FACILITIES THAT BIND RESEARCH TO ROADWAYS

**The bottom line for the driving public is safer, smoother rides on better roads at a lower cost. The facilities at the Texas Transportation Institute (TTI) allow sponsors to access some of the most advanced, state-of-the-art equipment for both laboratory and non-destructive field testing.**

## THE SOUTH CENTRAL SUPERPAVE CENTER

The South Central Superpave Center (SCSC) assists state departments of transportation and other asphalt paving industry members in the central U.S. to continue improving the quality of our nation's highways through implementation of Superpave (Superior PERforming Asphalt PAVements)—the asphalt mixture design and analysis system of the 21<sup>st</sup> century. SCSC, a partnership between TTI and the Texas Department of Transportation (TxDOT), with additional funding support from the Federal Highway Administration (FHWA), is headquartered at TTI.

Superpave is a performance-based system for designing asphalt pavements to meet demanding roadway needs. This approach holds the promise of more durable pavements that can withstand temperature extremes and heavy traffic. Superpave implementation allows highway agencies to spend scarce public funds more efficiently by extending pavement life and lowering maintenance costs. Joe Button, head of TTI's Materials and Pavements Division, manages the center.

Particular regional challenges across the country will continue to evolve as Superpave implementation

proceeds. Dale Rand, TxDOT Flexible Pavements branch director, says "TTI's expertise and equipment, used on many different research projects, have facilitated TxDOT's conversion of conventional mixes to the improved Superpave mix design methodology."



### Shear testers

The SCSC at TTI is fully equipped with Superpave binder and mixture analysis equipment. It is the only laboratory in the country with two Superpave shear testers (SSTs), one of which is provided by FHWA.

## CENTER FOR ASPHALT AND MATERIALS CHEMISTRY

The Materials and Pavements Division also has four well-equipped laboratories devoted exclusively to asphalt chemistry research. Charles Glover heads the Center for Asphalt and Materials Chemistry, as the four labs are known, which is housed in Texas A&M University's Department of Chemical Engineering. Researchers at the center test properties of asphalt binders, evaluate the change in oxygen content of asphalt after aging and compute surface tension and contact angle data for fluid-fluid and fluid-solid systems, among other analytical tests. The center is well known for its lab-scale asphalt refinery. Called ROSE (Residual Oil Supercritical Extractor), the refinery is unique



Charles Glover and Jung Sung seen with the rotovap, a device used to remove volatile solvents from asphalt.

in that it enables researchers to make custom research batches of asphalt and test their properties.

“TTI’s expertise and equipment, used on many different research projects, have facilitated TxDOT’s conversion of conventional mixes to the improved Superpave mix design methodology.”

*Dale Rand,  
TxDOT Flexible Pavements Branch Director*

**STATE-OF-THE-ART EQUIPMENT FOR THE ROADS OF THE FUTURE**

Standing amidst the whirring fans and stainless steel walls in an environmental chamber can confuse the senses. Regardless of the weather outdoors, twelve walk-in research rooms can bake anything inside—usually pavement samples—to temperatures as high as 140°F, or drop the chamber’s core temperature to a bone chilling minus 20°F. Researchers can adjust the ambient humidity from a dry 25 percent to a misty, rainy 100 percent humidity.

Part of TTI’s Materials and Pavements Division, the environmental chambers are one element of the extensive indoor laboratory research facilities housed on the campus of Texas A&M University. In addition

to the SCSC and the sophisticated chemical analysis labs described earlier, these facilities include a binder lab, concrete laboratory and spectrum analysis laboratory.

According to Button, what separates TTI’s materials research facilities from similar facilities around the world is twofold—the people and the equipment.

“We have 25 engineers working in materials research,” Button says. “We have specialists in asphalt materials testing, flexible pavement testing, concrete, chemistry of paving materials and modeling of laboratory findings to predict field performance. Several of these people are internationally known experts.”

In total, the Materials and Pavements Division owns about 150 laboratory and field testing devices with a value of \$4 million.



**AASHTO 2002—simple performance testing machine**

Researchers are looking beyond Superpave and other current testing models to the next generation of research, testing and training—AASHTO 2002 Pavement Design Guide. TTI recently installed a device dedicated to performing dynamic modulus and other simple performance tests associated with the guide.



**Environmental chambers**

The environmental chambers are a source of great interest to visiting researchers. “We have numerous visitors touring the environmental rooms, and they leave very impressed,” Button says. “They tell me they have an environmental room to conduct research in; we have twelve, which gives us a lot of capabilities and flexibility.”



**Spectrum analysis lab**

The spectrum analysis laboratory offers the ability to measure atomic changes in asphalt that occur due to aging.



**Concrete lab**

The concrete laboratory is fully equipped to evaluate aggregates and cements as well as fresh and hardened concrete.

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# INSTRUMENTS OF ADVANCED MATERIALS RESEARCH

## Overlay Tester

Unique to TTI, the overlay tester is used in measuring stress and strain for fracture mechanics research and to test new asphalt mixes at very controlled temperatures.



## Pressure Aging Vessel

This instrument forces oxygen into asphalt samples at pressures of 300 PSI and high heat to simulate the asphalt aging that would occur in the field over a number of years.



## FISONS Elemental Analyzer

FISONS measures the percentage of carbon, hydrogen, nitrogen, sulphur and oxygen in asphalt test samples.



## Asphalt Pavement Analyzer

The asphalt pavement analyzer evaluates fatigue cracking and rutting susceptibility of asphalt concrete specimens or pavement samples.



## Dynamic Shear Rheometer and Bending Beam Tester

In testing asphalt binders, the dynamic shear rheometer (1) and bending beam tester (2) give researchers a master curve of the complete rheological behavior of the binder from plant to pavement.



## Falling Weight Deflectometer

The falling weight deflectometer (FWD) is a test system for performing non destructive testing of pavements. The system develops force from acceleration caused by the arrest of a falling weight. These forces are transmitted onto the surface of a structure causing it to deflect much as it would due to the weight of a passing wheel load.

Because the FWD is a complex system that contains electrical, hydraulic and mechanical systems, proper calibration is needed to ensure accurate data are obtained. FHWA supports a TxDOT managed calibration center that serves the southern region. John Ragsdale, TTI research associate, operates the calibration facility. The center calibrates all the sensors on the FWD, ensuring proper data collection in the field.



## NON-INTRUSIVE GEOPHYSICAL TESTING

Ground penetrating radar (GPR) is a nondestructive geophysical method that “sees” underground and produces a record of subsurface features—without drilling, probing, digging or coring. Since 1988, researchers at TTI have been developing, testing, and implementing GPR technology for TxDOT to use in its road repair and maintenance activities.

GPR operates by transmitting pulses of high-frequency radio waves (electromagnetic energy) into the ground through a transducer or antenna. The transmitted energy is reflected from various buried objects or distinct contrasts between different earth materials. The antenna captures the reflected waves and stores them for subsequent analysis. TTI-developed software (COLORMAP) then converts these signals into information

under the freeway. Testing indicated the presence of a major washout beneath the asphalt surface layer. Traffic was routed around the problem area and repairs were scheduled for the following day. However, the roadway collapsed by itself overnight. In this case, the timely use of GPR prevented a possible major accident on this interstate.

On a national level, the American Association of State Highway and Transportation Officials is beginning efforts to implement use of GPR across the country. Currently, TTI is continuing research and development of GPR use on the state’s highways. Researchers have delivered training courses in numerous TxDOT districts, as well as created analysis software and interactive CD-ROM and web-based training tools for TxDOT personnel. TTI is working with Texas A&M University’s Department of Electrical Engineering to develop and implement more specialized antennas that can provide detail at varying depths. With three GPR systems operating and active, TxDOT and TTI plan to continue supporting the research and working to add more units to the current stock.

## RIDE/RUT FACILITY TO ELIMINATE BUMPY RIDES

TTI’s Ride/Rut Facility consists of test sections for evaluating surface profile measurements. The facility supports efforts of departments of transportation around the nation that are implementing end-result smoothness specifications. Constructed jointly by TTI and TxDOT, the facility was developed to aid in the evaluation, support and implementation of profiling products, technology and initiatives.

“It’s the only one of its kind in the nation,” says TTI research engineer Emmanuel Fernando. Over the last year, the facility has been used as part of the implementation of TxDOT’s new ride specification. This effort requires that inertial profilers be certified for use in quality assurance of pavement smoothness. TTI has certified six profilers to date for TxDOT.

“The development and implementation of this certification program at TTI has allowed TxDOT to transfer this data collection effort from an in-house operation to the contracting industry while maintaining a high level of data integrity,” says Ken Fults, director of the TxDOT Materials and Pavements Section Construction Division. “This was a vital step forward that allowed TxDOT to draft specifications with a bonus/penalty provision based on third party data collection.”

In addition, FHWA asked TTI to evaluate three portable profilers at the Ride/Rut Facility. Due to TTI testing, FHWA was able to improve the equipment so that its measurements are now accurate and repeatable, making the units suitable for implementation across the country. **R**

meaningful to engineers. GPR can monitor changes in layer thickness of pavements and detect areas of either trapped moisture or air voids beneath the roadways.

A single use of GPR in the Ft. Worth area illustrates the value of GPR technology. On a 14.2 mile, two-lane strip of FM 917, the submitted repair estimate was \$3.1 million—before GPR was brought in to test the section. “The GPR analysis showed us air voids under the pavement,” says TxDOT Ft. Worth engineer Andrew Wimsatt. “Knowing that allowed us to change our rehabilitation strategy.” The new repair solution came to only \$2.55 million, saving the state around 15 percent—\$550,000 in this single instance.

Recently GPR was used to test a section of I-35 in downtown Austin following a major water main break



(above right) Van equipped with ground penetrating radar (GPR); (inset) monitoring devices inside the van; (below) Ride/Rut Facility.



# Erosion control lab makes rain

“The erosion control laboratory has been very beneficial to TxDOT. We have evaluated erosion control products in the outdoor lab for 11 years.”

*John Mason, TxDOT*

**R**ainfall and runoff are some of nature’s most destructive forces. Their erosive powers cost taxpayers millions of dollars each year in roadway repair. Because of its destructive capabilities, researchers have long sought methods to control storm runoff and to limit the damage to channels and roadsides.

According to Harlow Landphair, head of the Texas Transportation Institute’s (TTI) Environmental Management Program, the soil picked up by stormwater runoff is a major pollutant. As water flows across land, such as during and after a heavy rainfall, it picks up soil in the form of sediment to increase its load of total suspended solids, the measure of sediment in storm water. Researching the process of soil erosion and how to prevent it is at the core of work conducted at the Texas Department of Transportation (TxDOT)/TTI Hydraulics, Sedimentation and Erosion Control Laboratory (HSECL).

The laboratory, funded by TxDOT and TTI, tests the field performance of rolled temporary erosion control products, sprayed-on materials, and flexible channel liners or turf reinforcing mats. These products, tested for use on transportation projects, are designed to allow grass to grow while minimizing soil loss during rainfall runoff. The HSECL at Texas A&M University’s Riverside Campus occupies approximately 19 acres. A large earthen embankment surrounds a 6-acre pond that is used as a water source for various channel and flume flow tests. The embankment replicates sloped earthen structures used in transportation systems and is currently the testing grounds for a Federal Highway Administration (FHWA) research project on native plant materials.

Since its inception, the laboratory has grown and now houses an indoor rainfall simulator, as well as greenhouses, 30-foot channel testing flume, 60-foot soil flume and 5100-gallon potable water tank. The HSECL is able to receive and test soil from anywhere in the world, and any soil profile can be recreated in the all-weather facility. Before this indoor facility came online, researchers were not able to account for soil lost because naturally occurring wind and rainfall interfered with experimental conditions. This new facility allows researchers to test year-round.

In order to maximize the lab’s capabilities, TxDOT worked with FHWA to create a multi-state, pooled-fund project. This approach allows other states to participate in erosion and sediment control research. Texas is participating in the pooled-fund project along with New York, New Jersey, Nevada, Nebraska, Missouri and Louisiana.



(above) Aerial view of TTI’s 19-acre erosion control laboratory: (1) compost berm test facility, (2) testing flume, (3) slope protection facility (indoor rainfall simulator), (4) vegetation greenhouse; (above left) indoor rainfall simulator close-up; (above right) compost berm test facility.

Working with TxDOT, the lab will continue to seek economical environmental solutions for erosion and sedimentation control and find increasingly affordable ways to test products. Research conducted at the lab will continue to provide TxDOT with performance-based specifications needed to meet Environmental Protection Agency regulations on stormwater management.

“What we’re really doing is trying to improve water quality,” says Landphair. “We’re looking at how we can use materials to help keep the water clean. We are also pioneering technology to improve measurement precision.” According to Landphair, data gathered at HSECL contribute to an understanding of surface erosion and how to mitigate its impact, which helps preserve the environment and protect roadways from the destructive power of water. **R**

## Rainfall Simulator

The indoor rainfall simulator has two soil beds that can be adjusted to match any desired slope up to 1:2 (or 50%). It provides water drop size, distribution and impact velocity typical of storms common to Texas and the gulf coastal regions of the country. The rainfall simulator is designed to subject test beds of selected soils to the largest, most destructive rainfall characteristics. Almost all of the water droplets reach terminal velocity before they hit the soil. Rain is dropped from a height of 14 feet, which causes the speed and erosive force of the water to approximate some of the most severe rainfall properties. This state-of-the-art facility has dramatically expanded the research capabilities of the lab.



## Channel and Soil Flumes

The 30-foot channel flume is used for testing channel-lining materials at high stress flows. The 60-foot soil flume is used to replicate shallow, low-velocity roadside channels. Current research using the soil channel is analyzing compost filter berm characteristics, looking at the chemical composition of the leachate from compost filter berm placement in sheet flow, low-velocity stormwater situations. This study is also conducting trials of the berm's structural stability, looking for failure thresholds.



## Greenhouses

The greenhouses provide a controlled environment for growing approved seed mixes free from outside contaminants such as weeds. The erosion and sedimentation control materials are tested to determine their ability to establish perennial vegetation cover. The purpose is to understand how materials foster establishment of vegetative cover and how vegetation contributes to the control of surface erosion on slopes and in channels.



# Over a decade of benefits

The HSECL was originally constructed in 1989 to provide TxDOT with quantitative data from the testing of erosion and sediment control materials for placement on its Approved Products List (APL). "The erosion control laboratory has been very beneficial to TxDOT," said John Mason, a vegetation management specialist for TxDOT and project director for the laboratory. "We evaluated erosion control products outdoors for 11 years."

Mason said the ability to test erosion control products at the lab has allowed TxDOT to maintain an APL that contains the names of products that have met minimum sediment loss and vegetation standards. Based on research conditions at HSECL, the APL allows design, construction, and maintenance engineers to recommend a class and type of erosion control product to site contractors, rather than promoting specific products. Contractors can then choose a specific, commercially available product from the TxDOT Approved Product List.

"The net result of research in the lab is matching the right product to the right job, which results in a saving to taxpayers," says Landphair.

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# TransLink lab offers real-time results

“The facilities provide TxDOT with a real-world laboratory that is closely coordinated with our installed ITS systems.”

*Al Kosik, Traffic Management Engineer, TxDOT*

**S**tanding in the middle of the Texas Transportation Institute’s (TTI) TransLink® Gilchrist Laboratory is like being at the heart of mission control. Traffic images wink across screens. A video wall at the front of the room shows real-time images from traffic and train intersections. Cameras feed images to video monitors across some of the world’s most sophisticated fiber optic and cable networks. Visitors can watch the impressive, interactive display from behind glass panels in a 35-seat viewing gallery that offers a glimpse of the next generation of traffic management and research technologies.

At more than 2,400 square feet, the TransLink® lab contains transportation research equipment including video and data workstations, a mock-up of a freeway management center, and traffic cabinets that house control electronics. A car shell allows researchers to explore the interfaces between traffic management centers and vehicles. This complex array of equipment is fed by more than six miles of cable underfoot.

TransLink’s® lab is an innovative example of a public/private partnership. The lab was designed to establish the important links between the various elements of the transportation system.

This approach generated interest and support from public agencies and private industry. Public support came from the Federal Highway Administration, Texas Department of Transportation (TxDOT), Metropolitan Transit Authority of Harris County and TTI. Rockwell International and Southwestern Bell also provided funding.

Much of the lab’s success can be attributed to the flexible ways it can be utilized. The viewing gallery and video capabilities are ideal for training and professional development, as well as showcasing the importance of research and education in the field of transportation.

Among the lab’s features is the ability to display real-time data and images, via more than 30 desk monitors and a video wall. The video wall comprises eight screens that create a viewing surface more than five feet in height and thirteen feet in length. The real-time pairing of traffic data



TxDOT employees attend a training session in TTI’s TransLink® Gilchrist laboratory.

and images allows researchers to verify the data they gather with the images provided to them on monitors in the laboratory. These images stream into the center in real-time via networks from test beds and video cameras along Wellborn Road in College Station, SH-6 in College Station, and IH-35 in Austin, Texas.

Equipment housed in the lab simulates intelligent transportation system (ITS) technologies such as traffic signal controllers, communication technologies, control electronics and train detection technologies prior to field trials.

Al Kosik, TxDOT traffic management engineer, was the TxDOT project director for a multi-agency, multi-modal ITS project that studied important ways to link elements of the transportation system through management centers.

“The facilities provide TxDOT with a real-world laboratory that is closely coordinated with our installed ITS systems,” Kosik says. “The TransLink® laboratory provides a unique environment for researchers and TxDOT employees in the support of research projects.”

At the center of the work being done in the lab is the effort to improve the overall operation and efficiency of the entire transportation system.

“We’re on the cutting edge of technology in terms of traffic management,” says Kevin Balke, director of the TransLink® Research Center. “One of our most important ongoing efforts is to consider transportation facilities as a system, as opposed to isolated units. TransLink’s most important benefit is its holistic approach to looking at transportation.” **R**



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# Eye in the sky

## TTI's video imaging test beds allow safe evaluation of traffic monitoring and detection devices

**T**ravel southbound on SH-6 through Bryan/College Station and you may get the feeling you're being watched. Motorists who travel this corridor regularly have had several years to get used to the idea, but they may not know that they're participating in research that could save lives.

Mounted some 40 feet above the roadway, several cameras monitor vehicles passing below. The cameras, part of the Texas Transportation Institute's (TTI) System Monitoring Program, are capable of measuring a vehicle's lane occupancy, volume, classification and speed.

Much of this same data can also be generated using inductive loops and various other detectors that are em-

The Texas Department of Transportation (TxDOT) has provided funding for this research at two test bed facilities—one in College Station and one in Austin—to determine if non-intrusive systems can take the place of embedded sensors. In addition to providing data similar to that generated by embedded sensors, video imaging systems can provide real-time images of the traffic passing along the corridor. These images and traffic data can be viewed in facilities like the TransLink® lab in TTI's Gibb Gilchrist Building. Sponsors and researchers can access the images and data via the Internet.

According to Dan Middleton, program manager of TTI's System Monitoring Program, TTI's test bed facilities allow researchers to test traffic monitoring and detection devices for as long as several months or even a few years.

"We're doing long-term performance monitoring on some of these technologies which hasn't been done anywhere else," Middleton says.

Brian Burk, transportation operations engineer for TxDOT's Austin District, recently worked with Middleton on a research project titled "Evaluation of Vehicle Detection Systems." According to Burk, the data gathered at the test bed facilities are useful to those seeking ways to use cost-saving methods of traffic detection.

"We learned a lot about the technologies investigated," Burk says. "We know a lot more useful questions to ask before making a large purchase or accepting a large proposal from a contractor." Finding more accurate and dependable data from detection devices is an ongoing objective for Middleton's group at the test bed sites.

"Over a long time period these devices are more efficient than humans," Middleton says. "Human counters are fairly accurate, but humans get tired. Machines don't." **R**

(left) Cameras monitor traffic on SH-6; (right) detector field instrumentation cabinets.



bedded under the roadway surface. Like the cameras, these embedded detectors are being evaluated at the SH-6 test bed.

While embedded detectors have proven a popular method of obtaining traffic data, they aren't without challenges. Safety is among the top concerns driving the exploration of non-intrusive methods of traffic detection. Placing and repairing embedded detectors means closing lanes to traffic, which causes motorist delay and endangers the lives of the crew members who install and repair embedded detectors.

Implementing embedded devices involves sawing into the pavement, placing the sensor, and then sealing the pavement once again with a special sealant. Sawing into the pavement weakens the roadway surface, possibly causing both the pavement and the embedded sensor to fail prematurely. Investigating alternatives to embedded sensors, like using video image detection cameras, is an important research avenue being pursued within TTI's Transportation Operations Group.

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# Digital media facility offers limitless creative capabilities

“We’ve shot videos and produced events all over the north Texas area with TTI’s help. Their in-house staff and technical capabilities are fast, flexible and cost effective.”

*Mark Ball, Public Information Officer, TxDOT*

Imagine having some of the world’s most advanced media equipment at your disposal. With this technology there are few creative undertakings you can’t pursue. At your fingertips is the ability to share your research with the world.

All digital, fully integrated and staffed by a team with more than 120 years of experience, the Texas Transportation Institute’s (TTI) Digital Media Group offers all of this, and more, through its state-of-the-art facility located in TTI’s Gibb Gilchrist Building. The facility has the full capabilities found in advanced video production facilities including cameras, lights, sound equipment and digital software editing tools.

Headed by David Dennis, coordinator of electronic media, TTI’s Digital Media Group offers a platform of ideas and technology for creating one-of-a-kind, customized audio/video products such as video news releases, informational videos, public service announcements, training CD-ROMs, DVDs and media-rich websites.

According to Dennis, sponsors are becoming more sophisticated in what they need and expect for deliverables. “That’s why our capabilities have grown,” he says.

Considering the costs and inconveniences associated with transportation improvements, public involvement has never been more important in the field of transportation. The Digital Media Group offers the ability to **show** rather than **tell** the public how transportation research projects will look and work. A new fiber-channel network provides a four-fold increase in storage space, which means faster production and higher quality for sponsors. Using the improved network capabilities, the power of video can show the public exactly the location, impact and possibilities a project can bring to their neighborhoods and businesses.

“They are an asset to us because they can design, write, produce, shoot and edit a variety of video and film productions that win awards, entertain viewers, educate and influence,” says Jay Nelson, district engineer, Dallas District, Texas Department of Transportation (TxDOT).



Clyde Hance shoots footage for a TransGuide® presentation; (inset) Mark Coppock prepares an interactive DVD presentation.

Not all of the Digital Media Group’s efforts are targeted to the general public. Professional development and training is another important area where the group’s services are often used.

“We can create everything from videos, to interactive CD-ROMS, to web-based training in order to get the most effective information to those who need it—no matter where they are,” says Dennis. TxDOT has explored using interactive CD-ROMS as training and research implementation tools.

In addition to finding innovative ways to reach the public and creating class-leading training modules, the Digital Media Group offers help on how to interact with the media, how and where to place a story and which tools might most effectively communicate the story. “There’s no limit to how we can help people communicate,” Dennis says. “Our job is to create the best, most effective way to share research results, to help train staff and to present information to the public and other groups.” 



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# Digital publishing facility produces high-quality research deliverables

**E**nsuring that research reports and other documents get to sponsors quickly and in high quality form is the goal of the Texas Transportation Institute (TTI) Publishing and Distribution Services (PDS) group. This group has provided full-service quick copy and distribution services to TTI researchers for 10 years. From research report reproduction to online publishing to order distribution, the group applies its 40 years of collective experience to ensure that quality technical publications are delivered to research sponsors and the transportation research community.

“Our years of experience ensure quality documents are printed and distributed in a timely fashion,” says Chris Pourteau, coordinator of publishing and distribution services.

Patrick McConal, publications coordinator, is the key point of contact in the reproduction facility. He works with researchers and their staffs to ensure the quality of print jobs prior to publication.

“By the time a report gets to me, most authors are already working on their next project,” says McConal. “I do what I can to make sure their reports get pub-

lished as quickly as possible, without compromising quality.”

Recently, PDS purchased a new IKON Imagerunner 110 publishing system, which uses digital imaging to approximate 3-dimensional images in a 2-dimensional environment. The Imagerunner processes incoming print files directly from the customer’s work station, so documents are produced in a fraction of the time. Color copies are produced on the IKON CLC 1150. Following collation, the publications are bound and turned over to distribution.

Though primarily responsible for distributing Texas Department of Transportation (TxDOT) research reports to libraries, other departments of transportation and individuals, Nancy Pippin, distribution coordinator, also maintains mailing lists and handles specialty publications, including the *Texas Transportation Researcher*. Pippin coordinates the labeling, packaging, metering and delivery of mailings directly to the U.S. Post Office.

“TTI’s PDS team produces quality printed documents under a tight deadline,” agrees Kay Lee, former TxDOT project director for ITEC. “They keep me in the loop when I need to be, and I know that, from printing to distribution, the entire process will be handled professionally. Their publications look great!” 

(below) Pat McConal and Nancy Pippin inspect stacks of printouts from the new IKON Imagerunner 110 printer to ensure a consistent high-quality product.



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**TxDOT Short Course continues record of success**

In October 2002, more than 2,000 Texas Department of Transportation (TxDOT) employees and other transportation professionals from across the state and nation attended the 76th Short Course in College Station, Texas.

TxDOT Executive Director Mike Behrens spoke to the audience on the importance of transportation research,

keeping lines of communication open with the citizens of Texas and TxDOT's continued commitment to high quality work and ethical behavior. "Be a good communicator. You can tell the TxDOT story," said Behrens. "Tell it in a simple way that means something to the average citizen."

Behrens went on to highlight six important areas in need of communication: preserving and rehabilitating the current system; improving safety; increasing mobility in major cities; re-authorizing the federal transpor-

tation bill; funding the Texas Mobility Fund; and planning the future of transportation in Texas and the benefits of regional mobility authorities, toll equity, and the Trans Texas Corridors.

Sponsored cooperatively by TxDOT and the Texas Transportation Institute (TTI), the annual Short Course offers opportunities for interaction and professional development concerning the latest in transportation tools, techniques and technology. ■

**Arnold Oliver honored as 'Friend of TTI' at annual luncheon**

The annual Short Course luncheon is traditionally held to honor Texas Department of Transportation (TxDOT) award winners.



This year, TTI Deputy Director Dennis Christiansen presented Arnold Oliver, former executive director of TxDOT and current chairman of TTI's Advisory Council, with the annual 'Friend of TTI' award at the luncheon.

Over the years, a large number of people have provided significant support for TTI. Beginning in 1999, the Institute decided to formally recognize

on an annual basis one individual who has been remarkably supportive for many years.

"Arnold Oliver is a true transportation leader in Texas and the nation," said Christiansen. "His continued support of transportation education and research is well known and has been a great benefit to Texas and TTI over the years."

In his acceptance remarks, Oliver said he was pleased to be associated "with a truly great organization—one of the best transportation research organizations anywhere."

Oliver joins three other "Friend of TTI" award winners: Chancellor Emeritus of The Texas A&M University System Barry Thompson (2001), Former Mayor of Houston Bob Lanier (2000) and Former General Manager of the Metropolitan Transit Authority of Harris County Bob MacLennan (1999). ■

**TxDOT selects six TTI projects as top research innovations**

Each fall, the Texas Department of Transportation (TxDOT) selects Top Research Innovations and Findings for the past year. These research and implementation projects are selected based on anticipated or realized dividends to the department and the state. This year, the following Texas Transportation Institute projects were chosen:

- *Detection-Control System for Rural Signalized Intersections (Project 0-4022);* Jim Bonneson
- *Development of a GIS Platform of Inventory of Utilities Located within TxDOT Right-of-Way (Project 0-2110);* Cesar Quiroga
- *Impacts of Inland Ports of Trade Flows and Transportation in Texas (Project 0-4083);* Russell Henk
- *Techniques for Managing Access on Arterials (Project 0-4141);* Bill Frawley and Bill Eisele
- *Develop Guidelines and Procedures for Stabilization of Sulfate Soils (Project 0-4240);* Pat Harris

More details and highlights will appear in the next issue of the *Texas Transportation Researcher*. ■

**TTI hosts scour conference**

The First International Conference on Scour of Foundations was held in November 2002 in College Station. The event featured the EFA apparatus manufactured by



Humboldt Manufacturing Company and a lecture by Jean-Louis Briaud on the SRICOS method. Briaud expects that the exposure of the EFA will result in an increase in sales.

"If a consulting firm purchases the EFA, we can relay all of our phone calls that we would normally get from DOTs to them," explains Briaud. "In this sense, we're creating business and getting consultants involved by giving them a better solution to existing problems." ■

### The Intelligent Transportation Society of Texas honors Seymour

Each year, the Intelligent Transportation Society of Texas gives awards to outstanding individuals, groups or projects that make



a significant contribution to the development and use of intelligent transportation systems (ITS) in the state of Texas. At the annual ITS-Texas meet-

ing in November 2002, TTI Senior Research Engineer Edward J. Seymour was honored with this award.

Seymour was recognized for his efforts in linking the statewide ITS software developments with the national ITS standards. For several years, he has played a vital role in providing input into the development of the National ITS Standards, keeping Texas as one of the key states in driving the direction of the standards. The award directly cited his expertise, encyclopedic knowledge and depth of experience in managing traffic and working with sometimes difficult people as "qualities that place this man in a league of his own." ■

### Houston TranStar website wins top FHWA award

In October, the Federal Highway Administration announced the winners of its 2002 national awards for traveler information websites that provide vital information about safety and mobility to users nationwide. Winners included the Houston, Texas, TranStar website, along with three other websites. This is the second year in a row that Houston TranStar's team was selected as a winner.

"The internet is an important means of providing traveler information," FHWA Administrator Mary E. Peters says. "These outstanding sites were chosen because of their 'user friendliness,' comprehensiveness of information and real-time reporting. Reliable, accessible traveler information helps

relieve congestion and improve safety by giving travelers and shippers the information they need to choose the best time, route and even mode of transportation."

Houston TranStar (<http://traffic.tamu.edu/>) is a consortium of agencies in the greater Houston area. The Texas Department of Transportation, working with the Texas Transportation Institute (TTI), sponsors the website. Houston TranStar provides information and links related to most modes of transportation, emergency preparedness and environmental issues. Houston TranStar also has added cameras and links to roadway weather stations. TTI's Systems Analyst Mike Vickich and Programmer Kathy Tran are the TTI Houston office staff responsible for all of the developmental work on the website. ■

### Buth receives Regents Fellow Service Award

The Texas A&M University System Board of Regents recently bestowed its Regents Fellow Service Award on TTI Senior



Research Engineer C. Eugene "Gene" Butth. In 1998, the Board established the Regents Fellow Service Award Program to honor service, extension and research professionals who have provided exemplary professional service to society that has created large and lasting benefits to Texas and beyond. The award recognizes Butth's contributions to roadside safety in Texas and the world.

Butth has been with Texas Transportation Institute for almost forty years and has been a faculty member at Texas A&M University for three decades. He has thirty years of experience in design, testing and evaluation of bridge railing, guardrails, transitions, impact attenuators, sign supports and other highway safety features. In his service to the driving safety of Texans, Butth has been a principal investigator of many research studies for Federal Highway Administration, National Cooperative Highway Research Program, Texas Department of Transportation, other state transportation agencies and private industries. He is also co-holder of three U.S. Patents: Guardrail Extruder Terminal, Metal Beam Rail Terminal and Frame Catcher Adaptation for Guardrail Extruder Terminal.

"Gene's hard work, dedication and leadership have enabled TTI to maintain its worldwide reputation as a leader in roadside safety," says TTI Director Herb Richardson. "His impact has been enormous in terms of saving lives and reducing the costs of roadside accidents." ■

#### CORRECTIONS TO THE LAST ISSUE OF RESEARCHER

The editorial staff would like to apologize for and correct the following errors in the last issue of the *Texas Transportation Researcher*: (1) The top photo shown on page 8 should identify "**Robert (Bob) Yielding**" and Luther DeBerry, rather than "De Witt C. Greer" and Luther DeBerry. (2) In the second photo shown on page 8, the first name in the identification line should read "**Herbert C. Petry, Jr.**" rather than "Herbert C. Petny, Jr." These errors have been corrected on the web and PDF versions of the issue posted on the TTI website, <http://tti.tamu.edu>.

## THE BACK ROAD



The heart of any research agency is its people—researchers, as well as technical and support staff—who are dedicated to providing sponsors with solutions to transportation problems. However, even the best researchers also need a range of state-of-the-art laboratories and testing facilities if they are to meet the rapidly changing technological needs of the transportation industry.

Since our goal is to provide our sponsors with research results they can put into practice, we often conduct testing in our labs as part of the project.

In its over 50 years of existence, Texas Transportation Institute (TTI) has developed some of the best of transportation research facilities in the nation. We are very fortunate to be associated with a university system that appreciates and supports transportation research by helping the Institute develop and maintain the many labs and other facilities essential for leading edge transportation research. The state support provided by the legislature has also been a key in our ability to maintain these resources for the benefit of all Texans. This issue of the *Researcher* will give you an overview of our facilities, some of which are unique to Texas and the nation. All are essential to our efforts to make the transportation system work, make it safe and make it last.

TTI's research facilities are housed primarily in three locations: the Civil Engineering/TTI Building located in the engineering complex on the main campus; the newer Gibb Gilchrist Transportation Research Building on the west campus; and the Proving Grounds Research Facility at the Riverside Campus, some 10 miles from the main campus. Each of these locations provides state-of-the-art equipment and research facilities that help ensure TTI researchers have the latest and best tools at their disposal. They range from former runways used for full-scale testing of roadside safety devices and an erosion lab that makes its own rain, to high tech computer labs that can simulate driver and pedestrian environments. TTI is also home to the Center for Transportation Computational Mechanics, one of five FHWA centers around the nation using the latest computer simulation program to model the effects of vehicle crashes. Other labs focus on materials and pavements, bridge and other structural issues, and the latest real-time traffic management systems.

I hope you'll learn something new about TTI in this issue, and that it will help you understand the importance of maintaining these essential facilities and laboratories. We would be delighted to have you visit us and see some of this equipment in operation. Thanks for your interest in TTI.

## Researcher

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## Researcher

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