Focus on Research

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*"**Focus on Research** updates engineers and technicians on items of interest upcoming in active TxDOT research projects."*

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Texas Department of Transportation

Research and Technology Transfer Office, in cooperation with the FHWA

CTR Study Seeks To Improve TxDOT's Traffic Data Acquisition Capabilities

Given that competent roadway management depends on careful analyses of traffic data, the Texas Department of Transportation (TxDOT) requires effective traffic data acquisition tools. Too often, however, the equipment used for such data acquisition is expensive, unreliable, difficult to install, and not adaptable to TxDOT requirements. Because recent research indicates that photo-electric sensing technology — that is, modulated, infrared-frequency, light-beam technology — can effectively sense the presence of a vehicle (or vehicle component, such as a tire), TxDOT is determining whether equipment based on this technology can be adapted to the department's specific requirements.

Assisting TxDOT in this determination is Research Project 0-2043, *Traffic Data Acquisition with Infrared Sensors.* The overall objective of this Center for Transportation Research study is to develop improved traffic data acquisition capabilities using infrared light-beam sensors and microprocessor technology for data processing and storage. Specific tasks include:

- developing a portable traffic volume survey system suitable for counting, over specified time periods, vehicles on interchange ramps (traffic volume);
- developing an infrared light-beam axle sensor device that can be combined with two inductance loop detectors in a traffic lane to count, classify (by axle arrangement), and measure the speed of vehicles operating in the lane; and
- developing a data acquisition system to count, classify (again, by axle arrangement), and measure the speed of vehicles operating in a traffic lane; such a system would employ only a pair of surface-level infrared light-beam sensors and a microprocessor unit.

Expected benefits include more effective, consistent, and timely processing of traffic data. Most importantly, the new infrared-sensor-based traffic data acquisition systems will allow TxDOT to obtain critical traffic volume data from interchange ramps, where application of currently available sensing technology is not feasible. The project will also yield collateral savings in hardware and installation costs.

Thus far, the researchers have tested a system using reflex-type infrared sensors. They have also conducted experiments to determine the optimum size of the reflector, and have tested the ability of micro-corner-cube reflective sheeting to substitute for round retroreflectors.

Once the project is completed, the findings will be immediately implemented within TxDOT and other government agencies. This project started in December of 1993 and is scheduled to end in December of 1995.

Area 1 — PD: Dean Barrett, TPP
Researcher: Dr. Clyde E. Lee, P.E., CTR

Concrete Study Will Yield Longer Bridges, Lower Costs

Over the last 10 years, conventional materials and production techniques have successfully produced concrete having compressive strengths well in excess of 69 MPa (10,000 psi). Much of this success is due to research aimed at specific aspects of materials selection, mix proportioning, concrete production, and reinforcing steel detailing. However, little or no documentation is available regarding the complete construction process — from design to service — of a high performance concrete bridge structure.

Study 9-589, *High Performance Concrete for Bridges,* will assist TxDOT in designing and constructing an eight-span bridge structure over the North Concho River in Tom Green County, San Angelo District. During the course of this long-term study, the researchers will document the benefits of using high performance concrete (i.e., 69 to 104 MPa, or 10,000 to 15,000 psi) and, more broadly, will advance the state of the art in high performance concrete bridge design and construction.

The study findings will promote the construction of longer spans and greater beam spacings — both of which are possible using high performance concrete. Other benefits associated with high performance concrete include reduced maintenance costs and decreased permeability. Overall, the research findings will lead to greater design flexibility and less expensive construction. The reduced permeability and increased durability of high performance concrete should also reduce maintenance costs.

For TxDOT, this project will provide the structural design and construction practice information necessary for implementing high performance concrete in bridge construction. Agency benefits include improved bridge design efficiency, enhanced transportation system performance, and reduced construction and maintenance costs.

The Texas Department of Transportation will immediately implement the research findings in the construction of the US 87 bridge over the North Concho River. Beyond that application, the researchers expect that engineers throughout Texas and in other states will use the project findings to design and construct other successful high performance concrete bridges. Project 9-589 runs from January 1995 through September 1999.

Area 4 — PD: Mary Lou Ralls, P.E., DES
Researchers: Drs. Ramón Carrasquillo, P.E., Ned H. Burns, P.E., and David W. Fowler, P.E., CTR

Project To Develop Real-Time Traffic Monitoring System

In recent years, the Texas Department of Transportation (TxDOT) has developed comprehensive traffic control plans to manage congestion-prone urban traffic. The agency has especially focused on minimizing the adverse impacts of traffic incidents, construction projects, and, to a lesser extent, sporting events, since studies have shown that such contingencies contribute most significantly to urban traffic congestion. These efforts have led to the implementation, in various locations, of freeway courtesy patrols, roadside emergency phones, changeable message signs, and advisory radio broadcasts.

However, to reroute traffic more effectively (while minimizing delays to emergency vehicles and motorists), TxDOT also requires real-time, accurate, and detailed information that can provide early detection, exact location, and extent of damage of urban freeway incidents. Research Study 7-2900, *Interim Traffic Monitoring System on US 59 (Eastex) Freeway Using Alternative Sensor Technologies,* is assisting the department to provide the traveling public with such incident information.

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On a 10-mile section of US 59 (Eastex Freeway) in Houston, the study researchers will develop and install an interim real-time traffic monitoring system using alternative sensor technologies that will provide 24-hour traffic information over a period of 3 years. Once installed, the system will provide up-to-date, real-time information on traffic volume, lane occupancies, and vehicle speeds at several locations in each direction. If successful in Houston — one of the state's most congested urban areas — the researchers are confident that the system will provide effective congestion relief on other Texas urban freeway networks. This project began in June of 1994 and will end in August 1997.

Area 3 — PD: Mark Conway, P.E., HOU
Researcher: Dr. William R. McCasland, P.E., TTI

Project 0-1328

Toll Road Procedures Subject of TTI Study

At present, Texas has no established criteria for assessing whether a proposed private toll road project can pay for itself. Even data from functioning public and private toll roads, which TxDOT and the Transportation Commission could use (in lieu of other guidelines) to evaluate the accuracy of the revenue and cost projections presented in feasibility studies for private toll roads, remain insufficient. At risk is the possibility that TxDOT will recommend that the Commission reject a sound proposal or, worse, approve a toll road destined to default on the revenue bonds issued to finance the project.

Project 0-1328, *Feasibility of Private Toll Roads: An Evaluation Procedure for TxDOT,* is developing comprehensive and systematic guidelines for TxDOT's use in evaluating private toll roads. Releasing the study results to the public (through the media and through printed manuals) will help TxDOT maintain favorable relations with those directly and indirectly involved with (or affected by) the construction of private toll roads. This enhanced relationship will come about through a widespread understanding, in advance, of what is expected in feasibility studies and how the proposal will be evaluated.

Both TxDOT and the Commission can use the study results to direct the preparation of more comprehensive, systematic, and reliable feasibility studies for private toll road projects by their sponsors. In addition, the Texas Turnpike Authority can use the results regarding the long-term accuracy of various toll revenue and cost projection methods as it prepares feasibility studies for its public toll road projects. This project began in September 1989 and ended in August 1994.

Area 1 — PD: Peggy Thurin, P.E., TPP
Researcher: Thomas Green, TTI

Researchers Assessing Benefits of Paving Mixture

Asphalt, even when modified, cannot support its own weight, so people should not expect it to support the weight of trucks. Aggregates are the key to solving rutting problems. Unfortunately, some efforts to stop rutting by changing aggregate components have caused other pavement distresses, compounding the problem. With these facts in mind, TxDOT's Materials and Tests Division developed a novel asphalt paving mixture called coarse-matrix high-binder (CMHB) and an associated mix design procedure. This procedure supplements the Strategic Highway Research Program (SHRP) mix design procedures which gave little consideration to aggregate gradation or quality. The CMHB design strives for stone-on-stone contact of the largest stones in the mixture that gives it a tough stone "skeleton" covered by a thick film of asphalt. TxDOT expects CMHB will replace dense-graded asphalt mixtures for thin surfaces.

The nine field trials of CMHB mixtures have been very promising. It is easier to place and compact than conventional mixes (particularly in thin lifts). It also provides excellent rut and skid resistance. However, some engineers worry that CMHB mixtures may be more permeable than a conventional dense-graded mixture at similar or slightly higher air void contents. More permeable mixes generally age (oxidize) faster and are usually less durable. Project 0-1238, *Permeability of Coarse-Matrix High-Binder Mixtures and Its Effects on Performance,* will:

- develop or identify permeability test protocols suitable for measuring CMHB and dense-graded mixtures in the laboratory and in the field;
- measure the permeability of CMHB and dense-graded mixtures;
- compare oxidative aging of CMHB and dense-graded mixtures;
- compare moisture susceptibility of CMHB and dense-graded mixtures;
- monitor field performance of CMHB field test pavements and compare performance with control sections of conventional dense-graded mixtures; and
- suggest methods to optimize performance of CMHB mixtures.

The researchers expect the findings to offer a more practical method for measuring the permeability of CMHB and other asphalt paving mixtures. In addition, the findings should improve thin overlay performance by reducing rutting, water damage, oxidative aging, cracking (fatigue and thermal), and skidding accidents. Overall, the research will provide a better understanding of the engineering properties of CMHB mixtures, and will reduce the long-term costs of highway rehabilitation programs.

Because TxDOT routinely uses asphalt pavement overlays in maintenance and rehabilitation operations, the findings will have widespread application. Highway specifications, paving materials acceptance criteria, test methods, mix design procedures, and pavement construction practices may all change as a result of these findings. Finally, the researchers will recommend test protocols and will include the results of permeability and creep tests on CMHB and dense-graded mixtures in the final report. This study started in September 1993 and will end in August 1995.

Area 2 — PD: Maghsoud Tahmoressi, P.E., MAT
Researchers: Joe Button, P.E., Drs. William Crockford, P.E., and Cindy Estakhri, P.E., TTI

Use of Recycled Glass in Roadway Construction Analyzed

Many Texas communities collect postconsumer glass containers as part of their recycling efforts. Recycling glass into new containers, however, poses several problems. These problems include: a limited number of Texas reprocessing plants, mixed-glass breakage causing color contamination, low glass value, and high transportation costs.

The Texas Department of Transportation (TxDOT) views the use of glass cullet in roadway construction and maintenance projects as a possibility that needs further study. If TxDOT develops specifications for glass cullet usage, Texas city and county transportation entities could also take advantage of these specs.

Project 0-1331, *Use of Glass Cullet in Roadway Construction*, will identify sound engineering and environmental uses of cullet in construction and maintenance projects and develop specifications for each sound use. Specification development is the main goal of the research.

This project will yield several products useful to the department, including:

- assessments of cullet sources and suppliers in Texas,
- draft specifications for the use of cullet in construction projects,
- an overview of cullet in transportation projects, and
- procedures for enhancing the performance of cullet in construction.

The use of recycled glass as a construction aggregate will benefit the department by increasing sources of aggregate and (maybe) by affecting aggregate costs through increased competition. There are other advantages: Cullet is a waste product; using it as a construction aggregate recycles waste materials and, therefore, conserves natural resources. Furthermore, using waste glass will allow the department to satisfy mandates on recycled materials usage.

The researchers will prepare an interim report that summarizes the literature review, provides cullet sources and suppliers in Texas, offers a life-cycle cost-benefit analysis, and makes recommendations regarding continuance of the research. TxDOT will either continue or terminate the project based on the conclusions of this interim report. Study 0-1331 started in December of 1994 and is scheduled to end in August of 1995.

Area 2 — PD: Tom Roy, P.E., ABL
Researchers: Phillip Nash, P.E., Dr. Priyantha Jayawickrama, and Richard Tock, P.E., Texas Tech

Research Assisting with Transit/IVHS

Intelligent vehicle highway systems (IVHS) encompass a wide range of computer, communication, control, and information technologies. Used effectively, such systems can greatly improve the management and operation of surface transportation, whether represented by individual vehicles or by an integrated multimodal system.

Project 0-1439, *TxDOT Support of the Texas A&M IVHS Research Center of Excellence,* will help TxDOT integrate transit into advanced traffic management systems. Among other objectives, the researchers will develop real-time, multimodal, traffic-adaptive diamond interchange control; improve transportation efficiency in the international border area through the use of IVHS technology; improve specialized transportation delivery; integrate railroad information into advanced traffic management systems; expedite incident response and management by improving police vehicle technologies; and develop detailed designs for a real-time, traffic-adaptive, multimodal traffic management system training facility.

When completed, this study will provide the conceptual guidelines necessary for integrating transit into advanced traffic management systems. This project runs from May 1994 through August 1995.

Area 3 — PD: Gary Trietsch, P.E., TRF
Researchers: Drs. Raymond Krammes, P.E., Dennis Christiansen, P.E., Tim Lomax, P.E., Katy Turnbull, and Tom Urbanik, P.E., TTI

Focus on Research

The purpose of ***Focus on Research*** *is to update engineers and technicians on items of interest in active or upcoming projects. The contents of the various articles do not necessarily reflect the official views of the FHWA or TxDOT.*

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