



# Research Digest

---

## **FORWARD ALL REQUESTS TO:**

The University of Texas at Austin  
Center for Transportation Research  
**LIBRARY**

3208 Red River • Suite 115

Austin, Texas 78705-2650

Phone: (512) 232-3126 and (512) 232-3138

Fax: (512) 232-3088

Email: [ctrlib@uts.cc.utexas.edu](mailto:ctrlib@uts.cc.utexas.edu)



# Research Digest

---

## *Item 1*

### **Field Manual for Crack Sealing in Asphalt Pavements**

*CENTER FOR TRANSPORTATION RESEARCH*

*CTR 0-4061-P3 • 2006*

This field manual was developed as a product of research project 4061 “Comparison of Hot Poured Crack Sealant to Emulsified Asphalt Crack Sealant” conducted by The University of Texas at Austin Center for Transportation Research (CTR). Organization of this field manual accompanies that of the “Crack Sealing in Asphalt Pavements” training video also developed by CTR. Pavement cracking is an inevitable phenomenon that maintenance engineers have to accustom themselves to. It is impossible to construct a pavement that does not develop cracks after a certain amount of service time. Cracking is one of the two main concerns considered in the pavement design process (the other being rutting); it is the primary mode of deterioration in asphalt cement pavement. Cracking occurs in a variety of forms: transverse, longitudinal, block, and alligator shape. Cracks need to be treated promptly because they create openings for moisture to penetrate the pavement layers. Moisture or water can cause severe damage when trapped in the crack. Neglecting pavement cracking usually leads to accelerated deterioration of the pavement, resulting in significant problems such as potholes or base failures, which cause the serviceability of the pavement to decline. Cracking, since it is such a major form of pavement deterioration, is usually the deciding factor in determining the proper time for rehabilitation and the appropriate method to be applied. When cracks develop on the surface of the pavement, it is a sign of reduction in pavement integrity and serviceability. Regular repair of pavement cracks is one of the main methods of preventive maintenance, since failure to repair cracks in a timely fashion can lead to accelerated deterioration of the pavement in the form of crack growth, spalls, secondary cracks, and potholes. The main causes of pavement cracks are thermal movements and fatigue due to excessive loading. Cracking is an inevitable problem given the network of more than two million miles of asphalt-surfaced roads in the United States. It is important to find effective solutions to minimize its effect and to extend the service life of our roads.

Full-text PDF of this report is available for free download at  
[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4061\\_P3.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4061_P3.pdf)



# Research Digest

---

## **Item 2**

### **Preventing ASR/DEF in New Concrete: Final Report**

*CENTER FOR TRANSPORTATION RESEARCH*

*CTR 4085-5 • 2006*

The state of Texas has been widely impacted by materials-related distress in various transportation structures. This distress has been mainly attributed to alkali-silica reaction (ASR) and delayed ettringite formation (DEF) and has been commonly referred to by the Texas Department of Transportation (TxDOT) as "premature concrete deterioration." In response to these problems, TxDOT has aggressively sought to prevent cases in new concrete structures by implementing new ASR specifications (initially as TxDOT Special Provision to Item 421). The specifications, and updates since, require contractors to address ASR through prescriptive options (e.g., 20-35 percent Class F fly ash) or performance testing. The research detailed in this report was performed in support of this new specification, with the intention of improving upon the initial specification efforts and increasing the service life of transportation applications. This report summarizes the overall findings of TxDOT Project 0-4085, "Preventing ASR and DEF in New Concrete." This research project was 4 1/2 years in duration, with an emphasis on both laboratory and field evaluations. The work was performed at the Concrete Durability Center (CDC) at The University of Texas at Austin (UT Austin). The main objectives and goals of this project can be summarized as follows: 1. Understand the underlying mechanisms behind ASR and/or DEF 2. Review available test methods for aggregate reactivity and for preventive measures and recommend test method(s) to prevent ASR and/or DEF in new concrete 3. Develop specification and guidelines to prevent ASR and/or DEF in new concrete 4. Identify and implement strategies for preventing ASR and/or DEF, with emphasis on prudent use of supplementary cementing materials (SCMs) 5. Develop protocol for evaluating the cause, extent, and future potential for damage owing to ASR and/or DEF in existing concrete structures 6. Transfer knowledge and experience gained from this project to TxDOT practice to increase the service life of transportation structures.

Full-text of this report is available for viewing at  
[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4085\\_5.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4085_5.pdf)

## **Item 3**

### **Defining and Measuring Rural Truck Traffic Needs in Texas**

*CENTER FOR TRANSPORTATION RESEARCH*

*CTR 4169-2 • 2006*

In 2002 the Texas Department of Transportation (TxDOT) contracted with the Center for Transportation Research (CTR) at The University of Texas at Austin and Texas Tech University to provide evidence of the truck volume and pavement damage associated with major rural truck traffic generators in Texas. It was felt that given increased funding shortfalls for the maintenance and modernization of rural infrastructure, TxDOT staff responsible for rural infrastructure will benefit from a better understanding of the rural truck trip generators in these areas that impact rural infrastructure. The objectives of the first year (2003) report were to highlight the factors that result in greater demands on rural roads, describe the condition of the existing rural road system in Texas, provide evidence of the impacts of increased demand for trucking on rural roads, and highlight the role of rail in rural areas before concluding the report. This report documents the research conducted in the second year of the study and provides information on major rural stakeholder views concerning the impacts of rural truck traffic, presents a methodology to estimate equivalent damage factors to allow for the calculation of truck pavement impacts, and finally presents a methodology to prioritize and policy options to address rural transportation concerns.

Full-text PDF of this report is available for free download at  
[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4169\\_2.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4169_2.pdf)



# Research Digest

---

## **Item 4**

### **Analysis of Hamburg Wheel Tracking Device Results in Relation to Field Performance**

*CENTER FOR TRANSPORTATION RESEARCH*

*CTR 4185-5 • 2006*

This project was conducted to determine the correlation of field performance to Hamburg Wheel Tracking Device (HWTD) testing results. The HWTD measures the combined effects of rutting and moisture damage by rolling a steel wheel across the surface of an asphalt concrete specimen that is immersed in hot water. Three designs (Superpave, CMHB-C, and Type C) and three aggregate sources (siliceous gravel, sandstone, and quartzite) were used for this study. The test sections, including nine different mixture designs, were constructed on IH-20 in Harrison County to observe the performance of the overlays under real traffic conditions. Field performance was observed through visual pavement condition surveys and nondestructive tests for 4 years. This research report summarizes the nondestructive test results and visual pavement condition surveys in the fifth year of this study. Several different measurements were used for this research, including the International Roughness Index (IRI), field rut depth, falling weight deflectometer (FWD), and portable seismic pavement analyzer (PSPA). Finally, traffic data analysis was used to compare the HWTD results and field rutting. There were no stripping problems observed in the field or lab specimens. Thus similar types of deformation patterns were assumed for both the lab specimens and field test sections. At the end of the study, it was found that the average ratio between wheel pass/ESALs can be assumed to be 37 for the specific mixes utilized for this particular research project.

Full-text PDF of this report is available for free download from

[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4185\\_5.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4185_5.pdf)

## **Item 5**

### **Landside Access Needs For Deepwater Ports**

*CENTER FOR TRANSPORTATION RESEARCH*

*CTR 4437-1 • 2006*

The following report chronicles the landside access needs at Texas deepwater seaports. It focuses on how the needs for Landside Access improvements are assessed, planned and financed. Trends in maritime trade in Texas are analyzed. The report also provides guidelines for Metropolitan Planning Organizations and ports in prioritizing their landside access needs.

Full-text PDF of this report is available for free download from

[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4437\\_1.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4437_1.pdf)



# Research Digest

---

## **Item 6**

### **Guidebook for Cost-Effective Strategies for Communication with Remote Surveillance Stations**

*CENTER FOR TRANSPORTATION RESEARCH  
CTR 4449-P1 • 2006*

The advances of modern communication technologies have changed the way the roadway information is collected. Innovative surveillance systems powered by various communication technologies have been installed to support various transportation operations. The abundance of available communication technologies and multiple available communication system configurations presents overwhelming challenges for traffic engineers in selecting proper communication technologies for users of various traffic operation and ITS applications. The objective of this research is to propose an effective approach to characterize available communication technology choices, and analyze how they can be applied to various traffic operations. Of particular interest is the development of a guidebook to facilitate the decision-making in choosing appropriate communication technology given the operational requirements and decision objectives. Because of the fast-paced developments in communication technologies, a web-based Knowledge Management System that enables on-line learning of applications vs. communication technology choices, as well as continual updates of the technology choice set, has been developed to ensure the continual usability of this research product.

Full-text PDF of this report is available for free download from  
[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4449\\_P1.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4449_P1.pdf)

## **Item 7**

### **Durations for Acquiring Roadway Right of Way and Assorted Expediting Strategies**

*CENTER FOR TRANSPORTATION RESEARCH  
CTR 4617-1 • 2006*

The Right-of-Way (R/W) acquisition process involves the coordination of various entities including multiple Texas Department of Transportation (TxDOT) districts, divisions, local, state, federal agencies, and private companies. Delays in the acquisition process necessary for the successful delivery of R/W for construction have historically caused project delays and cost overruns. In order to overcome the negative effects and to identify the problems and causes of delay, this study includes a comprehensive process review and evaluation, a development of duration prediction data, an identification of various process durations and key drivers of durations, along with recommendations for strategic management. The goal is to provide efficient delivery of transportation systems for the traveling public through increased knowledge and better management efforts of the R/W procurement process.

Full-text PDF of this report is available for free download from  
[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4617\\_1.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4617_1.pdf)



# Research Digest

---

## *Item 8*

### **Duration Quantification and Opportunities For Improvement in the Texas Department of Transportation's Utility Adjustment Process**

*CENTER FOR TRANSPORTATION RESEARCH*

*CTR 4617-2 • 2006*

Reducing the duration from planning to delivery of major highway projects is a major goal of the Texas Department of Transportation. A key component of this is the quantification of duration of the Utility Adjustment process. This study quantified durations of historical utility adjustment projects to provide guidelines in estimating future utility adjustment project durations, modeled the TxDOT utility adjustment process, and compiled key lessons learned for transportation project planners to better understand and improve efficiency in utility adjustments.

Full-text PDF of this report is available for free download at  
[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4617\\_2.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4617_2.pdf)

## *Item 9*

### **Texas Truck Collection Data Guidebook**

*CENTER FOR TRANSPORTATION RESEARCH*

*CTR 4713-P4 • 2006*

In August 2003, the Texas Department of Transportation (TxDOT) contracted with the Center for Transportation Research at the University of Texas at Austin to recommend a robust methodology to TxDOT planners for collecting and maintaining inter-county and interstate truck travel data in a format required for the Statewide Analysis Model (SAM). This guidebook discusses two data collection approaches - roadside intercept surveys and truck carrier participation - that showed the most promise of providing TxDOT with statistically reliable and verifiable truck travel data over the next three to five years.

Full-text PDF of this report is available for free download at  
[http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_4713\\_P4.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_4713_P4.pdf)



# Research Digest

---

## **Item 10**

### **Evaluation of On-Street Bicycle Facilities Added to Existing Roadways**

*CENTER FOR TRANSPORTATION RESEARCH*

*CTR 5157-1 • 2006*

Many local and regional transportation authorities in Texas are proposing retrofitted bicycle facilities—those added to existing roadways without changing the curb-to-curb width—under the Congestion Mitigation and Air Quality (CMAQ) Program and the Selective Traffic Enforcement Program (STEP). As custodian of the federal money for these programs, the Texas Department of Transportation (TxDOT) must approve or reject these proposals according to TxDOT design standards, which are based on the American Association of State Highway and Transportation Officials (1999) Guide to the Development of Bicycle Facilities. This research was undertaken to provide additional tools to evaluate the suitability of an on-street bicycle facility for both motorists and cyclists, especially as the tools apply to the approval or rejection of bicycle facility retrofits. The additional tools for evaluation of this study developed primarily from approximately 3,500 observations of motorists passing cyclists and over 4,000 observations of motorists unaffected by cyclists at 24 sites across Texas. These observations led to multivariate regression models of the lateral position of motorists and cyclists based on geometric and traffic characteristics such as motor vehicle lane width, percentage of truck traffic, presence and width of bicycle lane, and presence of a center turn lane. The research also included a review of roadway design literature relevant to bicycle facility retrofits and an analysis of bicycle-car crash data from the Houston-Galveston Area Council for the years 1999-2001. The results of this research and that of another bicycle facility evaluation tool, the Bicycle Compatibility Index developed by the Highway Safety Research Center at University of North Carolina at Chapel Hill, were used to create the Written Guide to Selecting Among Limited Right-of-Way Streets and Designing Geometric Solutions for the Provision of Bicycle Lanes, later renamed the Texas Guide for Retrofit and Planned Bicycle Facilities.

Full-text PDF of this report is available for free download at [http://www.utexas.edu/research/ctr/pdf\\_reports/0\\_5157\\_1.pdf](http://www.utexas.edu/research/ctr/pdf_reports/0_5157_1.pdf)

## **Item 11**

### **Recommended Access Management Guidelines for Texas**

*TEXAS TRANSPORTATION INSTITUTE*

*TTI 0-4141-2 • 2006*

This report documents the research performed during this two-year research project to provide recommendations for the use of access management techniques on state roadways in Texas. In the first year of the project, the research team focused on developing a matrix of guidelines for the application of different access management techniques for various roadway access classifications. The access management treatments for which recommended guidelines are presented include access spacing, corner clearance, median treatments, auxiliary lanes, alternate left-turn treatments, access separation at interchanges, frontage roads, and the use of traffic impact analyses for site development. The matrix allows the user to identify critical threshold criteria for the application of each access management technique for each roadway access classification. In the second year of the project, the matrix has been revised. The revised matrix and supporting information is presented in this document.

Full-text PDF of this report is available for free download at <http://tti.tamu.edu/documents/0-4141-2.pdf>



# Research Digest

---

## **Item 12**

### **Design Procedure for Pavements on Expansive Soils: Volume 3**

TEXAS TRANSPORTATION INSTITUTE

TTI 0-4518-1 Vol. 3 • 2006

Swelling and shrinkage of sub-grade soils are critical factors contributing to increases in roughness and degradation of serviceability of highway pavements. Existing procedures for predicting swell are largely based on the potential vertical rise (PVR) procedure developed by McDowell in 1956. While the PVR procedure represents a major development in the design of pavements on expansive soils, instances of apparently over-conservative PVR predictions have led some designers to suggest revision or replacement of the existing procedure. This project reviews the basic assumptions of the existing PVR procedure and identifies the likely sources of the questionable predictions that have arisen in the past. An alternative procedure is presented that features rigorous modeling of both the moisture diffusion process that induces changes in suction within a soil mass and the deformations that occur in response to changes in suction. This alternative procedure includes provisions for measuring and/or estimating soil and environmental input parameters necessary for the predictions. A procedure for predicting the impact of soil deformations on pavement performance is also presented. The proposed procedure is applied to three study sections involving Texas roadways on expansive soils, and parametric studies are presented evaluating the effectiveness of various design measures including moisture barriers, lime treatment, and replacement of in situ sub-grade soils with "inert" soils.

Full-text PDF of this report is available for free download at

<http://tti.tamu.edu/documents/0-4518-1-V3.pdf>

## **Item 13**

### **Median Barrier Guidelines for Texas**

TEXAS TRANSPORTATION INSTITUTE

TTI 4254-1 • 2006

Cross-median crashes are typically violent collisions with a high probability of multiple serious injuries and deaths. Previous research has shown that while cross-median crashes are not as common as other types of median-related crashes, they have a fatality rate that is disproportionately high. Many of these severe cross-median crashes can be prevented with adequate barrier protection. However, the decision of whether or not to use a median barrier should take into account the overall changes in the characteristics of median-related crashes that will result, including the frequency and severity of barrier impacts. There is a need for an analysis of the characteristics of median-related crashes and an investigation into the use of median barriers to identify changes to current standards, specifications, and procedures for median barrier need, selection, and placement that will result in the highest practical level of safety. Under this project, new guidelines were developed to assist highway engineers with the evaluation of median barrier need such that the highest practical level of median safety can be achieved. The recommended guidelines are based on analysis of median-related crashes in Texas. The crash data were used to develop crash statistical models for the various types of median-related crashes. Based on the estimates derived from the frequency and severity models and crash costs used by the Texas Department of Transportation (TxDOT), an economic analysis of median barrier need was performed. Guidelines for installing median barriers on divided, access-controlled freeways were developed as a function of average annual daily traffic (AADT) and median width. Guidance based on mean cross-median crash rate was also developed to assist engineers with evaluation of median barrier need on existing highway facilities.

Full-text PDF of this report is available for free download at <http://tti.tamu.edu/documents/0-4254-1.pdf>



# Research Digest

---

## **Item 14**

### **Application of Calibrated Mechanistic Fatigue Analysis with Aging Effects**

TEXAS TRANSPORTATION INSTITUTE

TTI 4468-3 • 2006

The work contained in this report constitutes Phase II of TxDOT Project 0-4468. Phase I is documented in Reports 0-4468-1 and 0-4468-2. The primary objective of Phase II was to provide additional laboratory validation and sensitivity analysis of the calibrated mechanistic with (CMSE) and without (CM) surface energy measurements fatigue analysis approaches recommended in Report 0-4468-2. The second objective was to provide a better understanding of the binder-mixture relationships and effects of binder oxidative aging on both mixture fracture properties and fatigue life (Nf). The third objective was to explore the possibility of establishing a surrogate fatigue test protocol based on the CMSE approach. These objectives were achieved through fatigue characterization of additional hot-mix asphalt concrete (HMAC) mixtures with different mix-design parameters and materials under varying laboratory aging exposure conditions. Analysis of the results indicated that the CMSE approach provides a promising and rational methodology for fundamentally characterizing the fatigue resistance of HMAC mixtures. The results obtained were reasonable and exhibited low statistical variability. Compared to the CMSE, the simplified CM approach has a reduced laboratory test program and analysis time, but it is less versatile. For the materials and test conditions considered in the project, Nf was observed to be dependent on both mix-design parameters and material properties. Generally, an increase in binder content improved the mixture fracture properties and Nf. The results further indicated that binders and mixtures do stiffen due to oxidative aging and that the Nf decline is characteristic of each mixture type. The application of Miners' cumulative damage concept also provided a fundamentally promising basis for quantifying Nf decline as a function of both aging and traffic loading effects and should be explored further. With respect to CMSE laboratory testing, although the repeated direct-tension test provided the best correlation with CMSE Nf predictions, the tensile strength test was preliminarily proposed as the surrogate fatigue test protocol based on practicality and simplicity. However, additional validation of the CMSE and CM approaches together with the surrogate fatigue test Protocols and software development are recommended.

Full-text PDF of this report is available for free download at <http://tti.tamu.edu/documents/0-4468-3.pdf>



# Research Digest

---

## **Item 15**

### **Evaluation of the Clearview Font for Negative Contrast Traffic Signs**

TEXAS TRANSPORTATION INSTITUTE

TTI 4984-1 • 2006

Texas Department of Transportation (TxDOT) sponsored research has shown that the Clearview font provides longer legibility distances than the Highway Gothic font Series E (Modified) when used on freeway guide signs with positive contrast of white letters on a dark background. Additional studies have shown that Clearview outperforms other versions of Highway Gothic fonts on other, smaller types of guide signs. These results have helped support the adoption of the Clearview font into the Federal Highway Administration's (FHWA) Standard Highway Signs book. The Clearview font has been developed with two sets of fonts-- one for positive contrast signs and another for negative contrast signs. Prior to this research project, there were no studies documenting the performance of the Clearview font for negative contrast signs such as those found in the regulatory and warning sign series. This research project evaluated the negative contrast Clearview font in black letters on fluorescent yellow, fluorescent orange, and white backgrounds. The researchers performed a laptop-based presentation survey and a closed-course field study. The laptop survey used static, in-context sign images to compare sign fonts. The field study was a dynamic recognition and legibility test using full-sized retroreflective signs during the day and at night. The field study compared the standard font to three treatments of the Clearview font. The results of this research project show that the Clearview font provides the same performance as the current FHWA font series for negative contrast traffic signs with the exception of the nighttime recognition. In this instance, the straight replacement of Clearview did not achieve similar recognition distances as the FHWA font series until the stroke width was increased to the next weight. The recognition distance provided by traffic signs can be considered one of the most critical measures of effectiveness when assessing sign performance. Therefore, because there were no statistically significant increases in recognition or legibility distances for any of the Clearview fonts tested, and because the results of the nighttime recognition analysis showed a decrease in recognition distance when the FHWA font was replaced with the Clearview font, the researchers recommend that TxDOT continue using the FHWA font series for negative contrast signs.

Full-text PDF of this report is available for free download at <http://tti.tamu.edu/documents/0-4984-1.pdf>

## **Item 16**

### **PAVE-IR Operator's Manual - Version 1.2**

TEXAS TRANSPORTATION INSTITUTE

TTI 5-4577-01-P3 • 2006

This manual provides Pave-IR operators with instructions for installing the Pave-IR Version 1.2 hardware and using the Pave-IR software package to collect and view thermal imaging data with the Pave-IR system. Pave-IR version 1.2 mounts to the footplate of the paver and therefore does not require operators to propel the device.

Full-text PDF of this report is available for free download at

<http://tti.tamu.edu/documents/5-4577-01-P3.pdf>



# Research Digest

---

## *Item 17*

### **Impacts of Toll Roads on the Regional Economy: Suggested Measures**

UNIVERSITY OF NORTH TEXAS

TTI/UNT 5437-1 • 2006

It is widely believed that toll roads will increasingly be used to meet the transportation needs of Texas citizens and businesses. For planning purposes and the edification of affected communities, the Texas Department of Transportation (TxDOT) requires the ability to disseminate information regarding the potential economic, developmental, and fiscal impacts of toll roads including new facility construction and the addition/adaptation of tolled managed and express lanes to existing facilities. In this report, we examine the type of metrics that can be employed in evaluating the economic, developmental, and fiscal impacts of toll roads. We have drawn these metrics from the literature of analyses and case studies of toll and non-toll facilities. Where the literature does not address a specific metric for a relevant impact, we suggest one. These metrics will be used in later components of this research project to assess impacts realized or projected for selected case studies of local and regional economies from the construction and operation of toll facilities in Texas in urban, suburban, and rural settings. The information gathered from these case studies will support the development of project deliverables.

Full-text PDF of this report is available for free download at <http://www.unt.edu/cedr/tollroadimpacts.pdf>

## *Item 18*

### **Crack Width Prediction for Interior Portion of Inverted 'T' Bent Caps**

UNIVERSITY OF HOUSTON

UH 1854-3 • 2006

Inverted "T" bent caps are used extensively in highway bridges to support elevated roadways on beams. Such bent caps have appeal because they are esthetically pleasing as well as economically sound. The cross-section of an inverted "T" bent cap consists of a "web" (or "stem") with short cantilever "ledges" at the bottom to support the beams, thus minimizing the structural depth of bridges. At service load unacceptable diagonal cracking frequently occurs between the cantilever ledges and the web. An important factor contributing to the observed cracking is the lack of a rational behavioral theory that supports serviceability design of such bent caps. Current design guidelines are based on the ultimate load stage and do not address cracking at service load (AASHTO, 1996; ACI, 95; Mirza and Furlong, 1985). Thus, it is necessary to develop a serviceability design method that takes into account the deformation compatibility condition because any method that attempts to determine crack width must consider strains in both the concrete and the steel. To this end, we have taken the following approach: First, develop a compatibility-aided struts-and-ties model that leads to a simple design method capable of controlling crack widths at service load; and second, conduct experimental tests on full-sized specimen and use the test results to calibrate the theoretical model.

Full-text PDF of this report is available for free download at <http://library.ctr.utexas.edu/pdf/0-1854-3.pdf>



# Research Digest

---

## **Item 19**

### **Investigation of a New Generation of FCC Compliant NDT Devices for Pavement Layer Information Collection -- Test Procedure and Facility**

*UNIVERSITY OF HOUSTON*

*UH 4820-2 • 2006*

To comply with FCC rules on GPR devices, it is necessary to fully understand the test procedures and facilities for EM radiation measuring. This report introduces the procedures and facilities for radiation spectrum measurements. The developed GPR system is measured under the similar conditions. The test results demonstrate that the developed GPRs are able to comply with FCC rules. The impacts of FCC rule on the FMCW GPR are more serious, because FMCW GPR transmits continuous sinusoidal waves, and the limitation on emission level would definitely decrease its penetration depth.

Full-text PDF of this report is available for free download at <http://tti.tamu.edu/documents/0-4820-2.pdf>

## **Item 20**

### **Investigation of a New Generation of FCC Compliant NDT Devices for Pavement Layer Information Collection: Technical Report**

*UNIVERSITY OF HOUSTON*

*UH 4820-3 • 2006*

To comply with the Federal Communications Commission (FCC) rules on the ground-penetrating radar (GPR) devices, the first stage of the project has investigated methodologies to avoid FCC banned frequency bands, and developed a hybrid GPR system that utilizes two separate frequency bands, DC-960MHz and 3.1GHz-8.5GHz. The detailed information of this system can be found in the reports 0-4820-1 and 0-4820-2 of this project. This report will concentrate on the air launching version of the pulse GPR, including new air launching antenna design, signal processing, and subsurface layer information extraction from GPR raw data. A lot of lab tests have been performed. Field tests have been conducted on TTI Annex, FM2818, Texas Avenue, and SH21 in College Station and Bryan, respectively. The measured results agree with the real cases very well. The developed GPR system is able to collect pavement layer information accurately and in real time. The system is completely ready for implementation.

Full-text PDF of this report is available for free download at <http://tti.tamu.edu/documents/0-4820-3.pdf>



# Research Digest

---

## ***Item 21***

### **Feasibility Study of Non-Contact, High-Speed Elastic Property Measurement of Pavements: Theoretical and Experimental Results**

*UNIVERSITY OF HOUSTON*

*UH 4827-1 • 2006*

Currently, the elastic properties of pavements are measured using FWD and RDDs. These devices use geosensors that need contact with pavement surface when measurements are made. In this project, a laser system has been developed to replace the geosensors in pavement deflection measurement. A Ground Penetrating Radar (GPR) system was also developed for the measurement of elastic properties of asphalt pavement. Several experiments and field tests have been conducted using the developed laser system and the GPR system. Lab tests performed using the Frequency Modulated Continuous Wave (FMCW) GPR and the Pulse GPR indicated a close correlation between the dielectric constant of asphalt and its density. The Pulse GPR was then used to estimate pavement deflection for a 0.3 mile pavement section, and the results were compared with the FWD results. The pavement deflections estimated using the GPR, and those measured using the FWD were found to be within an acceptable range of error.

Full-text PDF of this report is available for free download at <http://tti.tamu.edu/documents/0-4827-1.pdf>

## ***Item 22***

### **Development of Vehicle-mounted Measuring Devices for Non-Contact Thickness and Uniformity Measurement of Thermoplastic Pavement Marking Material**

*UNIVERSITY OF HOUSTON*

*UH 5882-1 • 2006*

In this project, the researcher successfully developed a highway speed vehicle-mounted thermoplastic pavement marking material (TPMM) thickness measurement device based on the research results in Project 0-4882, Refinement of a Non-Contact Method to Determine the Thickness and Uniformity of Application for Thermoplastic Pavement Marking Material. The device can be used in routine TxDOT project monitoring practice. In Project 0-4882, a compact, lightweight pushcart laser device was successfully developed for measuring TPMM thickness. In comparison with the laser device developed in Project 0-4882, two new versions of vehicle mount laser thickness measurement devices have been developed in this project. The first new version, a point laser device, uses three synchronized point laser units to solve the inaccuracy problem caused by the slope of the road. The second new version, a scanning laser device, was developed based on the auto-synchronized laser scanning principle. This new scanning device can scan in the transverse direction and measure the average cross-section TPMM thickness. Since the scanning laser covers an area wider than the TPMM, the driver doesn't need to strictly follow the stripe, and the measurement accuracy will be increased on a bumpy or sloping road. In this report, the laser triangulation and auto-synchronized scanning laser method is briefly reviewed. Then, the specifications of the laser devices and field test results are presented.

Full-text PDF of this report is available for free download at <http://tti.tamu.edu/documents/0-5882-1.pdf>

*Please fold along dotted line.*

*From:*

Name: \_\_\_\_\_

District: \_\_\_\_\_

Division: \_\_\_\_\_

Building: \_\_\_\_\_ Floor: \_\_\_\_ Room: \_\_\_\_

Other agency: \_\_\_\_\_

Agency address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Please report address corrections to:  
ctrlib@uts.cc.utexas.edu



*To:*  
**Research Digest**

THE UNIVERSITY OF TEXAS AT AUSTIN  
CENTER FOR TRANSPORTATION RESEARCH  
ATTN: LIBRARY  
3208 RED RIVER, SUITE 115  
AUSTIN, TX 78705-2650



# Research Digest

The University of Texas at Austin  
Center for Transportation Research  
LIBRARY

3208 Red River • Suite 115 • Austin • Texas • 78705-2650  
Phones: (512) 232-3126 and (512) 232-3138 • Fax: (512) 232-3088  
Email: ctrlib@uts.cc.utexas.edu

## September Issue 06-09

Please check the box for the item(s) you want to borrow.

- |                             |               |                             |                     |
|-----------------------------|---------------|-----------------------------|---------------------|
| <input type="checkbox"/> 1  | CTR 0-4061-P3 | <input type="checkbox"/> 12 | TTI 0-4518-1 Vol. 3 |
| <input type="checkbox"/> 2  | CTR 4085-5    | <input type="checkbox"/> 13 | TTI 4254-1          |
| <input type="checkbox"/> 3  | CTR 4169-2    | <input type="checkbox"/> 14 | TTI 4468-3          |
| <input type="checkbox"/> 4  | CTR 4185-5    | <input type="checkbox"/> 15 | TTI 4984-1          |
| <input type="checkbox"/> 5  | CTR 4437-1    | <input type="checkbox"/> 16 | TTI 5-4577-01-P3    |
| <input type="checkbox"/> 6  | CTR 4449-P1   | <input type="checkbox"/> 17 | TTI/UNT 5437-1      |
| <input type="checkbox"/> 7  | CTR 4617-1    | <input type="checkbox"/> 18 | UH 1854-3           |
| <input type="checkbox"/> 8  | CTR 4617-2    | <input type="checkbox"/> 19 | UH 4820-2           |
| <input type="checkbox"/> 9  | CTR 4713-P4   | <input type="checkbox"/> 20 | UH 4820-3           |
| <input type="checkbox"/> 10 | CTR 5157-1    | <input type="checkbox"/> 21 | UH 4827-1           |
| <input type="checkbox"/> 11 | TTI 0-4141-2  | <input type="checkbox"/> 22 | UH 5882-1           |

These items are available on a **two-week** loan basis.

Please fill out form completely and use other side of this page to mail in order. Thank you.

NAME \_\_\_\_\_

D/D/O \_\_\_\_\_

MAILING  
ADDRESS \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

EMAIL \_\_\_\_\_