

Research

FY 2010

Program

Research and Technology
Implementation Office

EVACUATION
ROUTE

The Texas Department of Transportation

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Institutions Active in TxDOT's 2010 Research Program

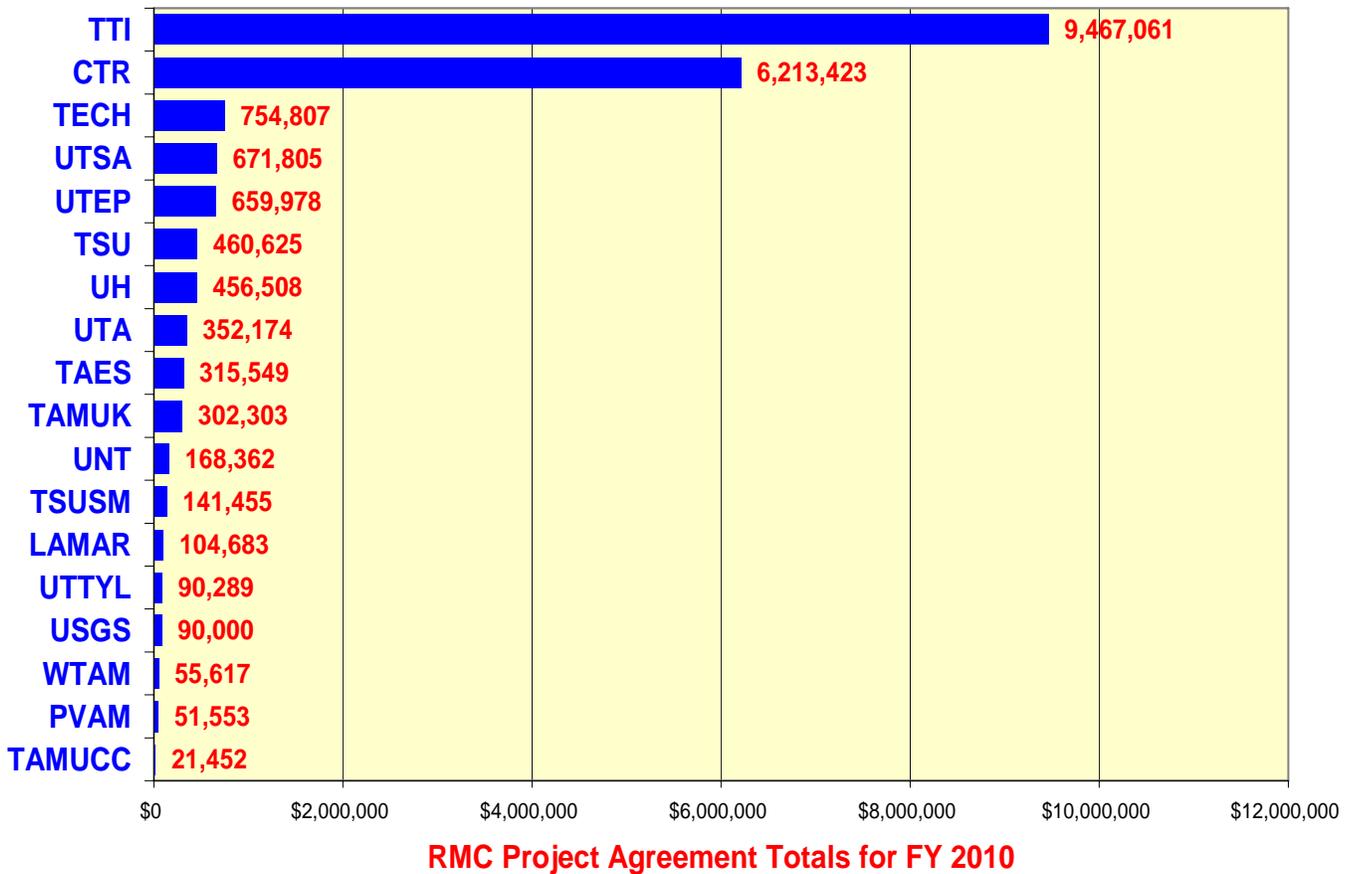
Acronym	University / Research Institution
CTR	Center for Transportation Research, University of Texas at Austin
LAMAR	Lamar University
PVAM	Prairie View A&M University
TAES	Texas AgriLife Research
TAMUCC	Texas A&M University – Corpus Christi
TAMUK	Texas A&M University – Kingsville
TECHMRT	Center for Multidisciplinary Research in Transportation, Texas Tech University
TSU	Texas Southern University
TSUSM	Texas State University – San Marcos
TTI	Texas Transportation Institute
UH	University of Houston
UNT	University of North Texas
USGS	United States Geological Survey
UTA	University of Texas at Arlington
UTEP	University of Texas at El Paso
UTSA	University of Texas at San Antonio
UTTYL	University of Texas at Tyler
WTAM	West Texas A&M University

FISCAL YEAR 2010 RESEARCH PROGRAM

University Participation

TxDOT's fiscal year 2010 research program consists of 129 projects, with budgets totaling \$20.4 million. This work is contracted to seventeen Texas state-supported universities and the United States Geological Survey (USGS). The figure below shows project agreement totals by university / research institution.

University Participation in TxDOT FY 2010 Research



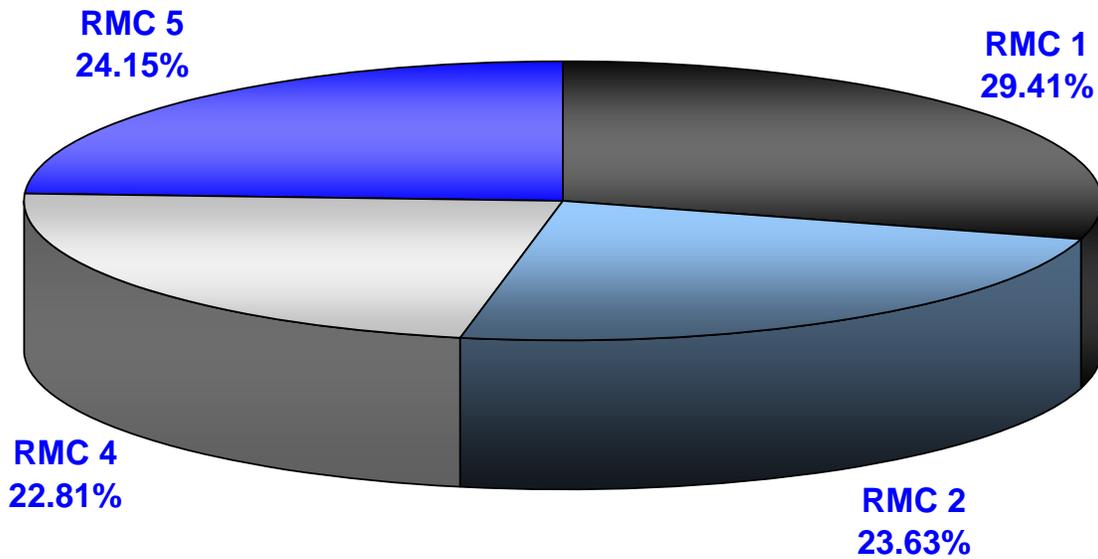
Research Management Committee (RMC) Funding

The table below shows a summary by RMC of the number of continuing and new projects, and total funding, for fiscal year 2010.

RMC	Focus Areas of RMC	Number of Continuing Projects	Number of New Projects	Total Project Funding
1	Construction and Maintenance	25	9	\$ 5,993,293
2	Planning and Environment	23	13	\$ 4,815,678
4	Safety and Operations	19	12	\$ 4,647,882
5	Structures and Hydraulics	20	8	\$ 4,920,791
Total		87	42	\$ 20,377,644

The figure below shows each RMC's proportion of the total fiscal year 2010 program.

Fiscal Year 2010 Program by RMC
Total = \$20,377,644



RMC 1 – Active Projects

Project	Title	Start Date	Page
0-5549	Horizontal Cracking in Concrete Pavements	9/1/2006	7
0-5566	Strategies to Improve and Preserve Flexible Pavement at Intersections	9/1/2008	8
0-5627	Aggregate Resistance to Polishing and its Relationship to Skid Resistance	9/1/2006	9
0-5832	Develop Mechanistic/Empirical Design for CRCP	9/1/2007	10
0-5836	Performance of Permeable Friction Course (PFC) Pavements Over Time	9/1/2008	11
0-5893	Laboratory Evaluation of Constructability Issues With Surface Treatment Binders	12/16/2008	12
0-6005	Developing a Testing Device for Total Pavements Acceptance	9/1/2008	13
0-6009	Evaluation of Binder Aging and its Influence in Aging of Hot Mix Asphalt Concrete	10/2/2007	14
0-6022	Recommendations for Design, Construction, and Maintenance of Bridge Approach Slabs	9/1/2007	15
0-6080	Performance Histories of Thermally Segregated HMA	12/11/2007	16
0-6084	Cement Treated RAP	10/16/2008	17
0-6092	Performance Evaluation and Mix Design for High RAP Mixtures	9/1/2008	18
0-6132	Development and Field Evaluation of the Next Generation of HMA Mix Design Procedures	9/1/2008	19
0-6190	Use of Dowel Bars at Longitudinal Construction Joints	10/1/2008	20
0-6255	Use of Manufactured Sands for Concrete Paving	9/1/2008	21
0-6271	FDR (Full-Depth-Reclamation) Performance-Based Design, Construction and Quality Control	10/16/2008	22
0-6274	Project Level Performance Database for Rigid Pavement in Texas, Phase II	11/14/2008	23
0-6275	Continued Development and Analysis of the Flexible Pavements Databases	3/3/2009	24
0-6326	Rational Use of Terminal Anchorages in Portland Cement Concrete Pavement	10/1/2008	25
0-6357	Monitoring of Experimental Sections Using a Pavement Database	9/1/2008	26
0-6361	Development of a New Mix Design Method and Specification Requirements for Asphalt Treated Base (Item 292)	9/1/2008	27
0-6362	Rapid Field Detection of Sulfate and Organic Content in Soils	9/1/2008	28

RMC 1 – Active Projects

Project	Title	Start Date	Page
0-6386	Evaluation and Development of Pavement Scores, Performance Models and Needs Estimates	11/7/2008	29
0-6387	Performance Based Roadside Maintenance Specifications	10/28/2008	30
0-6388	Synthesis Study on Innovative Contract Techniques for Routine and Preventive Maintenance Contracts	11/17/2008	31
0-6435	CAM Mix Design with Local Materials in Texas	9/1/2009	32
0-6444	Treatments for Clays in Aggregates Used to Produce Cement Concrete, Bituminous Materials and Chip Seals	9/1/2009	33
0-6496	Quantifying the Effects in Order to Optimize the Use of Grade 3 and Grade 4 Seal Coats	9/1/2009	34
0-6586	Review of Best Practices for the Selection of Rehab and Preventive Maintenance Projects	9/1/2009	35
0-6587	Flexible Base Acceptance Testing	9/1/2009	36
0-6589	Pavement Repair Strategies for 2R and Routine Maintenance (RMC) Projects	9/1/2009	37
0-6590	Material Selection for Concrete Overlays	9/1/2009	38
0-6591	Developing a Fundamental Understanding of the Chemistry of Warm Mix Additives	9/1/2009	39
0-6992	Develop Practical Field Guidelines for the Compaction of HMA or WMA	9/1/2009	40

0-5549 - Horizontal Cracking in Concrete Pavements

Start Date - 09/01/2006 **End Date** - 02/28/2010



Abstract

Two major distresses in continuously reinforced concrete pavement (CRCP) in Texas are punchout and spalling. Spalling is a surface distress and rarely presents a structural distress. It is also well understood that spalling has more to do with the coarse aggregate type used in concrete. Therefore, the only structural distress in CRCP is punchout. Punchout is a serious distress in CRCP which needs to be repaired as soon as possible since un-repaired punchout can cause a safety hazard to the traveling public. To address punchout issues, TxDOT made a few changes in the mid-1980's, which included the use of thicker concrete slabs, stabilized subbase (either 6-in cement stabilized base or 4-in asphalt stabilized base) and tied concrete shoulders. These changes have been effective, substantially reducing the frequency of punchout. However, during the full-depth repair of what appears to be punchout, it was observed that there was a different form of punchout, which the above three changes did not appear to alleviate. Further evaluation of this form of distress revealed that this distress is caused by horizontal cracks in concrete at the depth of close to the longitudinal steel (mid-depth of the slab). This distress type was not acknowledged in the AASHTO Road Test (CRCP was not included in the Road Test), and has not been well recognized by researchers and practitioners until recently. Neither the current 1993 AASHTO Guide nor proposed Mechanistic-Empirical (ME) Pavement Design Guide address this form of distress. A research study is needed to understand the mechanism of this type of distress, to identify the factors responsible, and to develop guidelines that will mitigate this problem.

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Research Supervisor

Moon Won, TECHMRT

Total Project Budget

\$486,023

Research Universities

Center for Multidisciplinary Research
in Transportation

Center for Transportation Research

University of North Texas

FY 2010 Budget

\$40,000

\$0

\$0

0-5566 - Strategies to Improve and Preserve Flexible Pavement at Intersections

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

Many rural intersections originally constructed with thin untreated flexible base and hot mix or a two-course surface treatment experience severe pushing, shoving and rutting. These failures cause an extremely rough surface that can cause damage to small vehicles and potentially cause motorists to lose control of their vehicle. These distresses almost always result in complete failure of the existing pavement that must be repaired several times during the life of the roadway by maintenance forces. Pavement sections constructed with the same materials adjacent to the intersection perform adequately until the approach (approximately 150 ft in advance) of the intersection and in the intersection itself when the failures become apparent. This project would seek to understand the mechanisms of intersection pavement failures and determine the best practices to minimize the failures at existing intersection pavements. The outcome of this project should help to reduce the frequency of maintenance needed at rural intersections. This project would also determine how the mechanisms causing the surface failures at intersections can be mitigated through design and construction modifications.

Project Director

Pedro (Pete) Alvarez, PHR

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Research Supervisor

Soheil Nazarian, UTEP

Total Project Budget
\$275,500

Research Universities
University of Texas at El Paso

FY 2010 Budget
\$142,500

0-5627 - Aggregate Resistance to Polishing and its Relationship to Skid Resistance

Start Date - 09/01/2006 **End Date** - 08/31/2010



Abstract

TxDOT project 5-1707 developed an effective method to measure aggregate shape, angularity and texture and the changes of these characteristics as a function of polishing time. Research project 0-5627 will relate the results of the new test method developed in 5-1707 for measuring aggregate characteristics to real-life field pavement skid resistance measured using the TxDOT standard method for measuring skid resistance (ASTM E 274, "Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire," at 50 mph using a smooth tire meeting the requirements of ASTM E 524). The work plan for this project will be in two phases.

Phase I:

1. Assist the Geotechnical, Soils and Aggregates Branch of the Construction Division in developing a new aggregate classification system using the following tests, as applicable: Micro-Deval, Aggregate Imaging System (AIMS) test (particle texture and shape), five cycle magnesium sulfate soundness, and acid insoluble residue. The aggregate classification system must render consistent and repeatable results for the same materials and quarries or similar materials.
2. Evaluate the capability of the new aggregate classification to predict skid resistance through the measurement of friction and texture in laboratory specimens.
3. Develop a surface abrasion test that can be used to measure the changes in friction and texture of the laboratory specimens for different aggregate classifications. The abraded specimens should then be measured in friction and macro-texture (as done in step 2) to evaluate if the new aggregate classification (together with gradation) provides good prediction of friction and macro-texture.

Phase II:

1. Develop and execute a factorial experiment of field test sections on in-service roads for different surface mixes and aggregate classification to complete the correlation to the skid trailer data and field texture data.
2. Revise aggregate selection criteria utilized by Wet Weather Accident Reduction Program (WWARP).

Project Director

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Research Supervisor

Eyad Masad, TTI

Total Project Budget
\$429,785

Research Universities
Texas Transportation Institute
University of Texas at El Paso

FY 2010 Budget
\$65,000
\$0

0-5832 - Develop Mechanistic/Empirical Design for CRCP

Start Date - 09/01/2007 End Date - 08/31/2010



Abstract

At the early days of CRCP usage in Texas, distresses due to structural deficiencies including improper support conditions under the concrete slab were prevalent. Over the years, TxDOT made necessary changes to address the distresses in CRCP. Those changes included the use of thicker slabs, tied concrete shoulders, and non-erodible subbases, which resulted in substantial improvements in CRCP performance. However, these improvements were made with little mechanistic analysis, and further improvements could be made to current TxDOT's CRCP designs. The benefits of mechanistic-empirical (ME) pavement design are well documented in a number of studies. They include reducing early failures of pavements and economic benefits to highway agencies and highway users by lowering facility construction and rehabilitation costs as well as reducing delay time and costs. However, these benefits can only be materialized if the results from the ME pavement design procedure are reasonably accurate. Major efforts have been made to develop ME pavement design procedures under the NCHRP 1-37(A), called MEPDG (mechanistic-empirical pavement design guide), and the procedures developed are the most advanced so far. However, there appear to be a few short-comings in MEPDG for CRCP design that could be further improved. They include prediction models for crack width, load transfer efficiency, punchout, and international roughness index and the lack of spalling prediction model. This study will evaluate the accuracy and reasonableness of those models, identify any deficiencies that need to be improved, and develop or improve the models. For crack width and load transfer efficiency, information from TxDOT's rigid pavement database will be utilized. For punchout prediction model development, field experiments will be conducted with various gages embedded, which include vibrating wire gages, temperature and moisture sensors, and multi-depth deflectometers. For IRI evaluations, TxDOT's PMIS data will be utilized to evaluate whether IRI is a good performance indicator for CRCP design, or there is other performance indicator that could be included. The spalling model developed under previous TxDOT studies will be calibrated with further field data. It is anticipated that models developed in this project will eventually be incorporated into MEPDG; in case it is not feasible to incorporate the new models in MEPDG, a standalone program for TxDOT's use will be developed. It is expected that ME design procedures to be developed in this study will improve the efficiency of TxDOT's funding usage by an optimum utilization of pavement structures.

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Research Supervisor

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Total Project Budget	Research Universities	FY 2010 Budget
\$774,580	Center for Multidisciplinary Research in Transportation	\$100,630
	Center for Transportation Research	\$60,000
	Texas Transportation Institute	\$117,630

0-5836 - Performance of Permeable Friction Course (PFC) Pavements Over Time

Start Date - 09/01/2008 End Date - 08/31/2012



Abstract

Recent TxDOT Projects 0-5262, 0-5185, and 0-4834 addressed important design, construction, and maintenance issues associated with permeable friction courses (PFC) that have been increasingly utilized by TxDOT over the past several years based on safety and environmental benefits. To complete the evaluation of this relatively new hot mix asphalt concrete (HMAC) mixture type as a possible solution for pavement maintenance and rehabilitation, performance must be tracked over time to assess benefits, costs, and changes in benefits. The proposed project will address this need by developing a database of PFC performance in terms of functionality (noise, permeability), durability (resistance to raveling and possibly rutting and cracking), and safety (skid resistance and accident history). Field performance of sections from both previous TxDOT projects and new construction will be monitored non-destructively at regular intervals using ground penetrating radar (GPR), noise measurement equipment, the portable seismic pavement analyzer (PSPA), the Tex-246-F Field Water Flow Test, TxDOT skid trailers, circular texture meters (CTMeter), and i-Buttons. As performance problems are identified, cores will be taken and further laboratory evaluation will be completed. Results from analyses of multi-year performance data and previous research will be used to produce guidelines for design, construction, and maintenance of PFC.

Project Director

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Research Supervisor

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Total Project Budget
\$663,214

Research Universities

Center for Transportation Research

Texas Transportation Institute

FY 2010 Budget

\$59,541

\$103,955

0-5893 - Laboratory Evaluation of Constructability Issues With Surface Treatment Binders

Start Date - 12/16/2008 End Date - 11/30/2010



Abstract

The proposed project will mostly address constructability problems with surface treatments experienced by TxDOT field personnel. The issues of significant importance for this project are the investigation of breaking and curing characteristics and mechanisms of emulsified asphalt and cutbacks, the dilution and application rate of emulsified asphalt in fog seals and prime coat, and the evaluation of sampling processes of emulsified asphalt.

The primary sources of information will be gathered from experienced TxDOT field personnel and some recent developments in Europe, Australia and South Africa in the area of emulsions and surface treatments. Following extensive controlled laboratory and field simulation tests, a pilot program will be used in the second year of the study to confirm the predicted results from these controlled tests. At the end of the field evaluation phase, a training program will be developed for TxDOT field personnel. A surface treatment binder construction toolkit will be developed and will be added to TxDOT's Seal Coat Manual. A simple quality control test will be developed to determine the emulsified asphalt's adherence to specifications and successful field applications.

Project Director

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Project Advisors

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Total Project Budget	Research Universities	FY 2010 Budget
\$401,087	Center for Multidisciplinary Research in Transportation	\$63,085
	Center for Transportation Research	\$137,539

0-6005 - Developing a Testing Device for Total Pavements Acceptance

Start Date - 09/01/2008 End Date - 08/31/2011



Abstract

The Rolling Dynamic Deflectometer (RDD) was developed through TxDOT's research program and has provided TxDOT with valuable pavement structural condition information for over fifteen years. The pavement structural condition data collected with the RDD has been used to evaluate both highway and airport pavement conditions on numerous projects. Applications include rehabilitation treatment selection, pavement forensic investigations, evaluation of alternative, new, in-service treatment strategies on the same route, and other applications. The success of continuous deflection measurement technology is evidenced by the back-log of pavement projects waiting for RDD testing. Advancements have occurred over the past 15 years in continuous deflection measurement equipment technology and data signal processing technology. In addition, new non-destructive testing (NDT) technologies have been developed and implemented by TxDOT. Field experience has shown that RDD data is enhanced when combined with other NDT data such as pavement layer thickness and subsurface condition information from Ground Penetrating Radar (GPR); visual distress data from the V-Crack system; Right-of-Way images from a high-definition video camera; transverse profile data from rut measure devices; and accurate location measurements.

Field experience has also shown that it is sometimes difficult to collect and later compare RDD and other NDT equipment data due to variations in distance measurement accuracy on the different pieces of equipment, time lags between data collection efforts, and human error. These factors can result in excessive time delays in post processing RDD and other NDT data. Based on the extensive past history with the RDD and these other NDT technologies, TxDOT has proposed to develop a single piece of equipment that combines the capabilities of the RDD, GPR, V-Crack, rut measurement, video, and accurate distance measurements. This device will have the capability to collect all of these data types in a single pass. In addition, TxDOT has proposed that a data analysis software package be developed that can post process and display all of these data types in a customized display. The software would allow users to view various data types in a single display, which will greatly enhance analysis and interpretation capabilities. This proposed research will take advantage of extensive research knowledge and abilities, technological advancements, and extensive field experience to produce a state-of-the-art Total Pavement Acceptance Device (TPAD). The TPAD will provide TxDOT with enhanced testing capabilities for accepting new pavements and evaluating existing pavements that do not currently exist anywhere in the world.

Project Director

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Project Advisors

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Research Supervisor

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Total Project Budget

\$1,411,570

Research Universities

Center for Transportation Research

Texas Transportation Institute

FY 2010 Budget

\$757,333

\$143,210

0-6009 - Evaluation of Binder Aging and its Influence in Aging of Hot Mix Asphalt Concrete

Start Date - 10/02/2007 End Date - 08/31/2012



Abstract

While it is becoming recognized that binders oxidize in pavements over time to a significant depth in hot mix asphalt (HMA) pavements and thus reduce pavement durability, a number of important issues require a better understanding for implementation. Maintenance treatment effectiveness is not well documented, nor is the varying impact of binder oxidation on fatigue in different mixtures understood. Finally, the level of binder aging at different milestones in pavement service (placement and during pavement service) as related to laboratory aging is not well known. This proposed project will address these issues with laboratory and field studies of mixtures and pavements 1) to develop a pavement oxidation model and calibrate it with pavement binder aging data; 2) to provide information on the effectiveness of maintenance treatments; and 3) to assess the importance of different mixture parameters to the decline of fatigue resistance with aging. The expected results of the proposed project will be 1) a new test procedure and process for characterizing binder aging, and for predicting service life for different applications, 2) an HMA fatigue mix design component that incorporates aging, 3) guidelines for optimizing HMA mixture resistance to aging, and 4) guidelines for the best maintenance treatments.

Project Director

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Project Advisors

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Research Supervisor

Charles Glover, TTI

Total Project Budget

\$1,278,498

Research Universities

Texas Transportation Institute

FY 2010 Budget

\$267,500

0-6022 - Recommendations for Design, Construction, and Maintenance of Bridge Approach Slabs

Start Date - 09/01/2007 **End Date** - 08/31/2010



Abstract

Settlement and heave related movements of bridge approach slabs relative to bridge decks create a bump in the roadway. Several problems arise from these bumps, which include poor riding conditions, potential vehicle damage, loss of vehicle control potentially causing injuries or even casualties, lowered perception of the Department's road works, increased maintenance works, and constant delays to rehabilitate the distressed lanes at a cost of \$7 million dollars annually to repair them. All these make this bump problem as a major maintenance problem in Texas. Several mitigation methods have been employed and the results are not always satisfactory. Hence, there is an important research need to better understand mitigation technologies and then develop and evaluate technologies to reduce bumps for bridge approaches in Texas. Researchers from UTA and UTEP propose two phases to accomplish the research. The first phase is to compile the available documented information that covers various methods used for approach settlement mitigation technologies along with a few recommendations for new and proven technologies that need to be researched in the field environment. The second and final phase will focus on field evaluation of selected methods in producing approach slabs with no bumps. The final deliverables will include two products summarizing syntheses, available best practices, design and construction specifications of and cost-benefit studies along with a research report summarizing research findings.

Project Director

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Total Project Budget
\$502,067

Research Universities

University of Texas at Arlington
University of Texas at El Paso

FY 2010 Budget

\$104,416
\$50,000

0-6080 - Performance Histories of Thermally Segregated HMA

Start Date - 12/11/2007 End Date - 12/31/2010



Abstract

TxDOT is in the process of expanding implementation of the Pave-IR test system for thermal segregation detection on HMA construction projects. Although project 0-4126 found temperature differentials exceeding 25 °F typically indicated non-compliance with TxDOT specifications, no monitoring studies have been conducted on the consequences of these cold spots on long-term pavement performance. Additionally, recently collected thermal profile data reveal locations where the paver stops for extended periods, sometimes exceeding 30 minutes. In these areas the mat cools under the paver and in one instance, burners were left on resulting in hot spots in excess of 425 °F. The fear is that these paver stops may result in other defects such as bumps in the completed mat. The impact of paver stops on pavement properties also needs investigation. This project will document thermally segregated locations on TxDOT projects and track their performance history by identifying suitable test sites, documenting thermal segregation on the project, and monitoring the performance of the projects through time. Additionally one additional Pave-IR unit will be built.

Project Director

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Research Supervisor

Tom Scullion, TTI

Total Project Budget
\$272,100

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$68,645

0-6084 - Cement Treated RAP

Start Date - 10/16/2008 End Date - 08/31/2010



Abstract

Reclaimed asphalt pavement (RAP) has been used for several decades in hot mix asphalt (HMA) to make use of a valuable resource and reduce material costs. These RAP proportions are too small to absorb the amount of RAP being generated. Currently there is an enormous amount of RAP statewide that can be used for various other purposes such as stabilizing traffic lanes and intersections. RAP processing equipment and procedures have evolved over the years. RAP fractionating, crushing and screening of RAP into several predetermined sizes, allow for more uniform materials.

The use of cement treated RAP may ensure a stable platform that will withstand the traffic loading. With proper design, this process may be an economical and viable solution especially for the districts with little or no economical source of virgin aggregates. TxDOT currently does not provide formal recommendations and specifications for the use of stabilized RAP. Specifications and evaluation of mixes are hence needed to assure that satisfactory performance will result from the use of stabilized RAP mixes.

The purpose of this project is to develop a mix design procedure and guidelines for the construction of stabilized RAP. The procedure will provide proper processes and guidelines for using RAP with proper type and amount of additives considering the nature and source of the RAP, constructability, durability and economical factors. Appropriate processes will also be proposed for the best methods to characterize and evaluate the RAP materials. Performance evaluation methods for the final product will also be developed during the mix design process. The research team will also develop guidelines for field uses of the stabilized RAP and draft specifications for the construction of these materials.

Project Director

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Project Advisors

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Clifton Coward, CST

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Stanley Yin, HOU

Research Supervisor

Soheil Nazarian, UTEP

Total Project Budget
\$273,798

Research Universities

University of Texas at Arlington

University of Texas at El Paso

FY 2010 Budget

\$30,591

\$108,000

0-6092 - Performance Evaluation and Mix Design for High RAP Mixtures

Start Date - 09/01/2008 **End Date** - 08/31/2011



Abstract

Economical benefits of using RAP are well known, but TxDOT should only consider using it if;

- its long-term performance is judged to be the same or better than the conventional mix,
- the quality/uniformity of the RAP layer can be certified on a day to day basis, and
- for the surface layers containing RAP adequate skid resistance must be maintained as compared to conventional mix using Class A aggregates

This proposal will lay the foundation for addressing all three of these critical factors. The main focus of this proposal will be to address and develop good practices for designing and constructing mixes containing higher than normal RAP contents. Past experiences have found that high RAP contents can potentially lead to very stiff HMA mixes and in some instances virgin binders have been found to be incompatible with the existing aged binder. These issues will be described in the remainder of this background section and addressed in the proposed work plan.

As far as how TxDOT can address these issues, it is envisioned that if this research shows high RAP content mixes to be cost effective, then a potential scenario could include;

- for final mix approval the contractors will submit two sets of samples for testing; one set made using conventional materials and the other modified with RAP. These samples will be tested for rutting and cracking using the Hamburg/Overlay Tester combination. If no detrimental performance is observed then recommendations will be made for field evaluation.
- the consistency and day to day variability is a big concern especially as several of the stockpiles are owned by contractors. It is envisioned that the best day to day control will be in terms of setting tolerances on the compaction curve generated with the Superpave compactor.
- skid resistance continues to be a concern for surface mixes. TTI proposes to evaluate this characteristic property using the polishing wheel and the circular skid tester to measure the polishing potential of RAP mixes in the laboratory. Mixes which pass the tests and place in the field will then be monitored with traditional skid test equipment.

Project Director

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Project Advisors

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Research Supervisor

Fujie Zhou, TTI

Total Project Budget
\$425,975

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$138,820

0-6132 - Development and Field Evaluation of the Next Generation of HMA Mix Design Procedures

Start Date - 09/01/2008 **End Date** - 08/31/2012



Abstract

Recent changes to the Texas HMA mix design procedures have ensured that the mixes routinely used on Texas highways are not prone to rutting. The adoption of the higher PG graded binders and the Hamburg tester has virtually eliminated rutting. However concerns have been raised about mixes which are now "drier", more difficult to compact and more susceptible to both reflection and fatigue cracking. This is particularly a problem with the dense graded Type C and D mixes which are widely used throughout the state. Several studies have recently been completed either in the Universities or in the Construction Division making recommendations on how to achieve a more balanced mix design where the mix will continue to be rut resistance but also will have adequate workability and flexibility. Several new ideas are under consideration to either modify existing design criteria (target densities, VMA requirements, etc.) or to include new test procedures such as the Overlay Tester (OT).

Now it is time to critically review these findings, to extract what is practical and cost effective and to build and field test the next generation of mix design procedures. The new procedures will be run in parallel with the existing procedures and the new designs will be evaluated in a series of test sections constructed on actual construction projects. However one major concern is that with the current research cycle the construction and monitoring of test sections under actual traffic loads will take a minimum of 6 to 8 years to obtain definitive information on new mix performance. There is an urgent need to use accelerated pavement testing to validate the possible changes to TxDOT's mix design procedures.

To address this important study TTI has assembled a team of full time experienced researchers including Tom Scullion and Fujie Zhou who have been active in evaluating and field testing new concepts in mix design for the past 10 years. Dr. Amy Epps will provide support in the areas of evaluating alternative fatigue tests and D.r Samer Dessouky from UTSA will support the further development of mix workability criteria. The team will be supported by the full time certified technician's from TTI's McNew research lab and this project will have access to all of TTI

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routine and advanced laboratory and field test equipment including X-Ray CT scanner and GPR for field density testing The Accelerated Pavement Testing will be performed on Texas mixes under a cooperative agreement with the LTRC in Louisiana. This will provide the research team with the ability to test our mixes in a similar environment to Texas. The LTRC's accelerated pavement testing program has been running successfully for almost one decade and that experience will ensure that the accelerated testing of our materials will be both successfully and efficiently completed.

Total Project Budget

\$1,342,768

Research Universities

Texas Transportation Institute
University of Texas at San Antonio

FY 2010 Budget

\$450,795
\$25,000

0-6190 - Use of Dowel Bars at Longitudinal Construction Joints

Start Date - 10/01/2008 End Date - 08/31/2010



Abstract

Tie bars in longitudinal construction joints (LCJs) in Portland cement concrete (PCC) pavement are placed to primarily keep the lanes together and secondarily provide load transfer between lanes or between lanes and tied shoulders. As traffic volumes have increased, the number of lanes tied together has also increased, raising concerns that tying too many lanes might increase the potential for longitudinal cracking. These concerns led to the use of dowels in LCJs. The concern is quite valid, as subgrade drag theory (SGDT) indicates that stresses in concrete in the transverse direction increase with the pavement width. To reduce the potential for longitudinal cracking when a number of lanes are to be tied together, the Houston District of the Texas Department of Transportation (TxDOT) started using dowels at LCJs. However, the decision on when and where to place dowels is made by design engineers without clear guidelines. Normally, LCJs under traffic barriers that separate normal traffic lanes from high occupancy vehicle (HOV) lanes have been the popular choices for dowel placements in lieu of tie bars. Well-researched guidelines on the use of dowels in LCJs based on technically sound engineering principles could improve the efficiency of TxDOT's operation in this area.

The primary objective of this research project is to develop rational guidelines on the use of dowels in LCJs. To achieve the primary objective of this study in a more effective way, detailed field testing needs to be conducted to thoroughly investigate concrete slab behaviors. The results of the field testing along with companion theoretical analysis will provide answers to the following valid questions:

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Tomas Saenz, ELP

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Research Supervisor

Moon Won, TECHMRT

- 1) Are dowels needed at LCJ?
- 2) If they are, what's the maximum number of lanes that could be tied without risking longitudinal cracks?
- 3) If dowels are used at LCJ, what could be the potential problems and what could be done to address them?

Getting correct answers to the above questions is vital to the success of this research study, even though the third question above is beyond the scope of this project. The guidelines to be developed in this study will provide TxDOT design and construction engineers with an easy-to-use tool to utilize dowels in LCJs effectively. The implementation of guidelines is expected to result in better performing PCC pavement with minimum potential for longitudinal cracks.

Total Project Budget

\$220,481

Research Universities

Center for Multidisciplinary Research
in Transportation

Center for Transportation Research

FY 2010 Budget

\$71,618

\$40,000

0-6255 - Use of Manufactured Sands for Concrete Paving

Start Date - 09/01/2008 End Date - 08/31/2011



Abstract

The use of manufactured fine aggregate (MFA) is becoming much more prevalent due to the depletion of natural sand sources in parts of the state, particularly the Fort Worth and Dallas Districts. Manufactured sands are produced with amounts of minus No. 200 fractions (micro fines) ranging from 5 to 20 percent. Generally the micro fines are washed out since TxDOT limits the amount of micro fines to 6 percent, and it is not feasible to eliminate a portion of them. The elimination of the micro fines represents a wasted aggregate resource and leads to a disposal problem for producers. In addition, the elimination of the micro fines often produces a harsh mix that does not finish well, leading to the necessity of adding natural sand for workability. Research at the International Center for Aggregates Research has shown that very good concrete can be made using manufactured sand, with and without micro fines. Generally the flexural strength, abrasion resistance, and impermeability are increased; compressive strengths vary and shrinkage, while slightly higher, is still within acceptable ranges. Water reducers and mineral admixtures can be used to improve workability, since in many cases the more angular MFA results in reduced workability. Another issue using manufactured sands, particularly carbonate materials, is the low acid insoluble (AI) residue. Low values of AI are generally believed to result in polishing of the mortar matrix, which in turn leads to reduced surface friction. It is important to determine appropriate methods of using manufactured sands for paving. As natural sands are depleted in various areas of the state, MFA will result in less expensive fine aggregate if they can be used successfully. This research is directed to finding solutions for using MFA for producing good quality paving concrete that has adequate surface friction. Specifically, the research will focus on three areas:

- Development of grading guidelines. Previous research related to manufactured sands in concrete paving and paving applications will be identified using a survey of states and Texas Department of Transportation (TxDOT) Districts. Information on surface friction will be sought. The survey will seek information on MFA in Districts using significant amounts of concrete paving. A laboratory test program will be conducted to characterize sands identified in the survey. Specifications will be developed that will include grading limits, aggregate tests for characterization, and optimization of aggregates.

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Project Advisors

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Ralph Browne, FTW
Richard Szecsy, LMC

Research Supervisor

David Fowler, CTR

- Development of proportioning guidelines. Preliminary proportioning guidelines will be developed and laboratory concrete mixtures will be prepared and subjected to a range of fresh and hardened concrete property tests. Field sections of concrete pavements will be installed as part of TxDOT paving operations to determine if the proposed grading and proportioning guidelines produce workable concrete that has suitable fresh and hardened properties suitable for concrete paving.

- Development of surface friction guidelines. Surface friction values from existing concrete pavements in other states and Texas will be sought in order to correlate the friction values with AI values and methods of surface texturing. Several concrete pavements in other states and in Texas have been identified, and the survey will likely identify others. The new concrete pavements made with MFA as part of this research will have a goal of investigating the effect of MFA and surface texture on skid resistance with time. Guidelines will be prepared that will recommend methods for insuring adequate surface friction.

Total Project Budget
\$415,000

Research Universities
Center for Transportation Research

FY 2010 Budget
\$140,000

0-6271 - FDR (Full-Depth-Reclamation) Performance-Based Design, Construction and Quality Control

Start Date - 10/16/2008 End Date - 08/31/2010



Abstract

Full-depth reclamation (FDR) is a rehabilitation process showing great potential as an economical rehabilitation alternative that provides deep structural benefit, conserves highway construction raw materials and quickly returns the section to service. The FDR process generally consists of reclaiming the existing structure by pulverizing and mixing the surface and base materials together, applying a stabilizing agent (lime, fly ash, cement, asphalt emulsion, or some combination of these are most common), cutting the stabilizing agent (and moisture) in, then compacting the mixture. Finally, a riding surface is applied. The procedure can be highly cost effective if executed properly. However, lack of comprehensive guidance in the overall design and construction process, including formulating a mixture design of the reclaimed materials, controlling the construction process, performing quality assurance of the in-place product, and bonding the surface layer to the finished base have led to construction delays and poor performance on many projects. The results of Project 0-5223 "Effects of Pulverization on Design Procedures" indicated that construction issues associated with FDR projects widely affected the outcome of FDR and stabilization projects. These issues should be included in the guidelines of this project.

The goal of this project is to develop comprehensive guidelines based on best practices, outcome of previously conducted research, or through recommending new guidelines in the form of a new or modified specification items or control procedures to be implemented through special provisions to existing standard specifications.

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Total Project Budget
\$270,050

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$132,750

0-6274 - Project Level Performance Database for Rigid Pavement in Texas, Phase II

Start Date - 11/14/2008 End Date - 08/31/2013



Abstract

The research project statement for 0-6274 "Project Level Performance Database for Rigid Pavements in Texas, Phase II" states that "The main aim of this project is to update the existing database to provide the required information to develop and calibrate TxDOT M-E Design for continuously reinforced concrete pavement (CRCP)." It also states that "The goal of this research is to develop an advanced and user-friendly database to track the performance of typical and special concrete pavements in Texas." Accordingly, this study will concentrate on the following areas:

- 1) Additional project level data collection in selected test sections: The detailed CRCP behavior and performance have been investigated in the current rigid pavement database project, 0-5445. The investigations included identifying the effect of (a) crack spacing on load transfer efficiency, (b) concrete setting temperature on transverse crack spacing, and (c) slab thickness on deflections. The investigations also resulted in developing a hypothesis on punchout mechanisms. Additional project level field testing will be conducted to gather more information on CRCP behavior and performance. The findings will be used to develop and calibrate to-be-developed TxDOT M-E design procedures for CRCP.
- 2) Expansion of the database to include more Level 2 and Level 3 sections: This will help understand the performance of jointed concrete pavement (JCP) and CRCP sections constructed with various designs and environmental conditions. Sections that encompass wide range of condition in Texas in design, materials, and environmental condition, will be included in Level 2 and Level 3 investigations. If distresses are observed and determined to be due to cumulative fatigue damage, the sections will be included in Level 1 investigations and more detailed testing and evaluations will be conducted.
- 3) Inclusion of special sections in the database: Over the years, TxDOT has built a number of special test sections to investigate the effects of various factors as well as to try new concepts. They include post-tensioned concrete pavement (PTCP) built in Waco in 1985 with additional construction in 2008, pre-cast PTCP in Georgetown, bonded and unbonded concrete overlay sections throughout the state, fast-track concrete pavement (FTCP) sections in Houston, whitetopping sections in Abilene and Odessa, and other sections described in the 0-6274 research project statement.
- 4) Further development of an advanced and user friendly database: A web-based database architecture was developed under the current database project. This database is webbased, GIS-oriented, and application-integrated, and will allow interactions with other TxDOT pavement databases. As more project level information is collected in this project, the database will be populated with the information and user friendly analysis functions will be developed.

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Total Project Budget
\$817,015

Research Universities
Center for Multidisciplinary Research
in Transportation
Center for Transportation Research

FY 2010 Budget
\$78,962
\$79,278

0-6275 - Continued Development and Analysis of the Flexible Pavements Databases

Start Date - 03/03/2009 End Date - 08/31/2013



Abstract

For the development and calibration of any pavement design and rehabilitation method, a number of databases are required. These databases should include material properties, pavement structural characteristics, traffic information, environmental conditions and observed performance data. TxDOT previously sponsored the development of a flexible pavement database under project 0-5513. This new project will continue the population of the database as necessary to calibrate and validate mechanistic and empirical pavement performance models for flexible pavement design. This calibration/validation could apply to the new AASHTO Mechanistic-Empirical Pavement Design Guide (MEPDG) or to any other flexible pavement design method used by TxDOT, such as the Flexible Pavement System (FPS) and the TxDOT MEPDG developed under project 0-5798. This requires the collection of a core data set that is sufficient for initial calibration of the pavement design models as well as the development of a comprehensive plan for further data collection and model calibration in the future.

Current pavement design procedures (such as AASHTO '93 and FPS-19) have been empirically derived and need to be updated by including new models that are mechanistically based. This project will continue the efforts that began with project 0-5513 and will use the results to update the design procedures currently used by TxDOT and others.

The project will make the necessary additions and changes required to develop a comprehensive database that will produce or calibrate models for the MEPDG in Texas. There are four main focus areas: 1) complete the experimental design so sections are representative of all Texas conditions, 2) populate the existing sections (plus the new sections) with all data elements required for pavement design, 3) collect and test site-specific material and 4) calibrate the current transfer function to Texas conditions. Finally, the current capabilities of the database will be updated from a GIS-oriented system to a fully GIS-based system.

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Total Project Budget

\$1,062,984

Research Universities

Center for Transportation Research

University of Texas at Tyler

FY 2010 Budget

\$201,748

\$13,286

0-6326 - Rational Use of Terminal Anchorages in Portland Cement Concrete Pavement

Start Date - 10/01/2008 **End Date** - 08/31/2011



Abstract

It has long been stated that Portland cement concrete (PCC) pavements can grow and push bridge structures, resulting in damages to bridge structures. To protect bridge structures from the expansion of PCC pavements, three terminal systems are currently used in Texas. They are anchor lug, wide-flange, and expansion joint systems. The anchor lug system tries to restrain concrete slab movements, while wide-flange and expansion joint systems allow the concrete slab to move rather freely. From the standpoint of how the slab movements are accommodated, there are two different philosophies. One is to control the expansion of the concrete slab by installing lugs (anchor lug system), and the other is to accommodate the slab movements by providing expansion joints (wide-flange and expansion joint systems). The Texas Department of Transportation (TxDOT) uses all three systems. However, only one statewide design standard exists and it is for anchor lug system; the standard does not provide detailed guidelines on the number of lugs that should be used. For the other two systems, there are no statewide design standards. Rather, some districts have their own design standards for the other two systems and some districts use the design standards other districts developed.

The frequency of distresses near the bridge terminal areas is relatively high compared with that of normal PCC pavements. However, what is not known is whether those distresses are due to the expansion of PCC pavement slabs, or to other distress mechanisms. Extensive field evaluations conducted under the inter-agency contract (IAC) with TxDOT revealed that most of the distresses were due to volume changes or instability in the embankment materials. The measurements made over 7 months under the same IAC indicate quite small slab movements at

the end of the pavement, regardless of terminal types used. The magnitude of slab movements is too small to cause damages to bridge structures, including bridge approach slabs. However, the work conducted under the IAC was limited in scope and duration. The objective of this research is to do a more thorough and in-depth study is needed to determine whether thermal expansion of PCC pavement slabs is really causing damages to bridge structures and if it does, which terminal type is most cost-effective. TxDOT is the leader in the use of PCC pavements in the nation, and the findings from this study, if successful, could improve the efficiency of TxDOT operations substantially.

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Total Project Budget

\$413,548

Research Universities

Center for Multidisciplinary Research
in Transportation
Center for Transportation Research
University of Texas at El Paso

FY 2010 Budget

\$60,191
\$50,000
\$27,000

0-6357 - Monitoring of Experimental Sections Using a Pavement Database

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

The recently completed TxDOT Project 0-5472 entitled, “A Data Base for Successful Pavement Sections in Texas—Including Both Experimental and Non-Experimental Pavements,” developed a database system that stores information on sections that have been deemed as “successful” according to criteria established by a panel of experts comprised of engineers from several TxDOT districts and the Texas Transportation Institute (TTI). The 1-mile minimum pavement sections were defined as “a structure that has met performance expectations over its service life with normally expected levels of maintenance for its age, materials utilized, traffic loads, and local conditions.” In terms of performance data, the database only contains PMIS scores: pavement distress score, pavement condition score, and pavement ride score. Additionally, one Ground Penetrating Radar (GPR) survey, one Falling Weight Deflectometer (FWD) test, one Dynamic Cone Penetrometer (DCP) test, and some general laboratory results are included. Regrettably, the database design has a significant limitation: the database and website are designed to allow entry and storage of up to 10 years worth of PMIS performance score information (Krugler et al., 2007). This means that if new data were to be imported, the older information would be overwritten and lost. This is a particularly serious flaw if the database is to be used to monitor the long-term performance of the sections. There should be no limit to the number of years of performance history allowed into the database because longer time series allow for more robust pavement performance analysis. In Research Report 0-5472-1, the research team actually recommended that sections from the project’s database should be uploaded onto the “Texas Flexible Pavement Database” (Krugler et al., 2007). The Texas Flexible Pavement Database (TFPD), recently developed by The University of Texas at Austin (<http://pavements.ce.utexas.edu/>), has no such limit and is actually better suited to store pavement performance data. The philosophy behind the TFPD has two distinctive characteristics: “open-to-all” and “one-stop shopping.” It is open to all because the database is available on the internet where anyone can display, query, and download the data. It is one-stop shopping because all data necessary to carry out pavement performance analysis is in the same database, available at the click of a button. However, the TFPD has an even greater advantage: it is linked to the PMIS, DCIS, and SiteManager databases, making it unique among its kind in the U.S. and worldwide. Additionally, the research team maintains a PC-based version of the database in MS Access, when web access is a limitation. We strongly believe that the TFPD is a superior

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database to meet the objectives of proposed project 0-6357. The objectives of the project are to 1) select experimental sections that have the potential for greater impact in Texas, 2) develop and agree upon a data collection plan, 3) perform data collection and data population, 4) recommend a process for analyzing the data, and 5) develop a long-term plan for maintenance and management of the database by TxDOT. This database will also be a fully GIS-based system, thus making it compatible with the latest developments currently being undertaken by the Department.

Total Project Budget

\$243,416

Research Universities

Center for Transportation Research

FY 2010 Budget

\$122,416

0-6361 - Development of a New Mix Design Method and Specification Requirements for Asphalt Treated Base (Item 292)

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

The asphalt stabilized bases in Texas are usually designed and constructed as per Item 292, “Asphalt Treatment (Plant Mixed),” of the 2004 Standard Specification book. This specification is a hybrid of base and hot mix asphalt concrete procedures and requirements, which are sometimes incompatible. Some districts have started using Tex-204-F, Part III, ‘Mix Design for Large Stone Mixtures Using the Superpave Gyratory Compactor.’ However, this procedure was originally developed to design Type A and Type B hot mix at 96% density and produce a 6 x 4 ½ in. specimen molded to either 100 gyrations or as shown on the plans. Under Item 292, the unconfined compressive strength of the mix (as per Tex-126-E) is used to assess the quality of the mix. Under Tex-204-F, the specimens are not the appropriate size for this type of testing. As such, the quality of the mix is assessed with the indirect tensile strength. A new mix design procedure is needed for this type of material that can use standard equipment such as the Superpave Gyratory Compactor (SGC) to mold the mix design specimens. In this project, we propose to evaluate Item 292 and to improve the laboratory design protocols for this type of bases. In addition, we will concentrate on the practical issues of the construction including the quality control and quality assurance and what test should be used to control the quality in the field. To that end, we will also evaluate the applicability of Tex-227-F, “Theoretical Maximum Specific Gravity of Bituminous Mixtures,” (Rice specific gravity) and Tex-207-F, “Determining Density of Bituminous Mixtures” for this type of materials.

Project Director

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Total Project Budget
\$237,000

Research Universities
University of Texas at El Paso

FY 2010 Budget
\$120,000

0-6362 - Rapid Field Detection of Sulfate and Organic Content in Soils

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

In recent years, the Texas DOT has experienced problems stabilizing subgrade soils with calcium-based additives (lime/cement). The problems often surface shortly after the road has been constructed making repairs costly. Many of these problems have been attributed to sulfate minerals in the soil or high concentrations of organic matter. These deposits can be unpredictable and are often restricted to small areas. TxDOT has test methods to measure these soil constituents, but they are taken at different intervals on the roadway. Since the deleterious deposits can be restricted to small areas, conventional tests may not sample from the problem areas and therefore not detect a problem with the soil. What is needed is a non-destructive test that can continuously gather data on a road and identify potentially problematic soils (sulfates over 3000 ppm and/or organics over one percent) on the fly. Samples can then be collected in potential problem areas for detailed laboratory analysis to determine if a problem exists and the best remediation technique in the problematic areas. By applying the work plan outlined on the following pages, the researchers hope to develop one or more NDT systems to identify potential sulfate and organic problem areas on the fly.

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Total Project Budget

\$221,911

Research Universities

Texas Transportation Institute

FY 2010 Budget

\$112,629

0-6386 - Evaluation and Development of Pavement Scores, Performance Models and Needs Estimates

Start Date - 11/07/2008 End Date - 08/31/2011



Abstract

TxDOT's current pavement management Information System (PMIS) calculates a pavement score from 0 to 100 for every roadway in Texas. The overall Pavement score is computed using both a Condition score which is based on surface distress and a Ride score based on pavement roughness. These scores are weighted for pavement traffic, posted speed and environment. Over the past decade the final pavement score has become an increasingly important factor for both performance monitoring and fund allocation. Most Districts are using the pavement scores and associated color coded maps to plan their future rehabilitation and maintenance programs. There is a need to evaluate how road condition scores are calculated. With the growing importance of the PMIS pavement score there is an urgent need to review and update the current system.

The objective of this ambitious project is to develop improvements to the Texas Pavement Management Information System (PMIS) to meet the evolving needs of TxDOT. These improvements include reviews of current practices and pavement maintenance and repair assignments, prioritization, new pavement performance models and condition prediction procedures, decision trees, and improvements to budgeting and impact analysis scenarios.

Project Director

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Gary Charlton, DAL

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Total Project Budget

\$768,716

Research Universities

Texas Transportation Institute

University of Texas at El Paso

University of Texas at San Antonio

FY 2010 Budget

\$119,779

\$66,533

\$67,528

0-6387 - Performance Based Roadside Maintenance Specifications

Start Date - 10/28/2008 End Date - 08/31/2010



Abstract

To better serve its customers, preserve and improve the value of its roadside assets, and optimize the use of its resources, the Texas Department of Transportation (TxDOT) is investigating the use of performance-based specifications and contracts in roadside maintenance. Under performance-based specifications, the highway agency does not specify any method or material requirements. Instead, it specifies measurable performance targets and outcomes that the maintenance contractor is required to meet or exceed within a certain timeframe. The objectives of this study are to 1) summarize best practices in performance-based contracting for roadside maintenance, 2) determine the optimum scope for this type of contract (asset types, maintenance activities, etc.), 3) develop methods for assessing the initial qualifications and continuing performance of contractors, 4) develop feasible and reasonable oversight methods for potential use by TxDOT, and 5) prepare performance-based roadside maintenance specifications for potential use by TxDOT. These objectives will be accomplished through a practical work plan that consists of five tasks: 1) identify and summarize best practices, 2) define feasible scope and performance requirements for the specifications, 3) develop draft performance-based specifications for roadside maintenance, 4) conduct field trials to test and revise the draft specifications, and 5) close out the research project.

Project Director

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Total Project Budget
\$285,784

Research Universities
Texas Transportation Institute
University of Texas at Tyler

FY 2010 Budget
\$152,546
\$11,190

0-6388 - Synthesis Study on Innovative Contract Techniques for Routine and Preventive Maintenance Contracts

Start Date - 11/17/2008 End Date - 12/31/2009



Abstract

In the past decade, the Federal Highway Administration challenged state highway agencies to focus on preserving and maintaining our existing highway system to prevent deterioration of a critical national asset. To achieve this goal, many states have shifted to greater outsourcing to augment their in-house personnel, bringing together in-house and contract staff to maximize cost, quality, expertise, and efficiency. However, while many reports suggest that contracting out maintenance services has generally been successful and cost-beneficial, there are some indications that not all efforts have been successful because outsourcing goals and agency needs have not been aligned with the appropriate contracting strategy.

Several districts within TxDOT have contracted out a significant portion of their maintenance activities because they do not have sufficient personnel to complete the work in-house. This lack of personnel has created voids in expertise that make outsourcing especially important so that maintenance tasks can be completed efficiently. Consequently, TxDOT may be faced with a need to expand their maintenance contracted services, and, as a result, they have a need to investigate efficient contracting strategies - beyond their current method - that might be implemented to help them achieve their maintenance goals. Previous studies have presented conflicting results about the effectiveness of innovative contracting strategies, creating confusion about the factors that contribute to success or how to align maintenance outsourcing goals with

an appropriate contracting strategy. Therefore, this research will: (1) objectively evaluate innovative contracting strategies used by other states; (2) objectively evaluate the effectiveness of TxDOT's maintenance contracting strategies; (3) compare the innovative strategies used in other states to TxDOT's current methods, needs, and goals; and, (4) provide a decision method for selecting and implementing those innovative contracting strategies that may be appropriate for implementation by TxDOT to help them achieve their maintenance goals.

Project Director

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Total Project Budget

\$81,388

Research Universities

Center for Transportation Research

FY 2010 Budget

\$12,296

0-6435 - CAM Mix Design with Local Materials in Texas

Start Date - 09/01/2009 End Date - 08/31/2011



Abstract

FY

The focus of this study will be on the use of Crack Attenuating Mixes (CAM) designed using local aggregates with different binders. By characterizing the critical properties of the aggregates influencing the response of CAM to traffic loads (rutting, fatigue, and polishing) and environmental degradation, it will be possible to predict or anticipate the relative performance of CAM designed using local or new aggregate sources. This proposal outlines a laboratory program to characterize the frictional, strength, and durability properties of aggregates for CAM mixtures from local sources. Based on the outcome of laboratory testing of these aggregates, the existing CAM mix design procedure will be evaluated and improved, if necessary, to cater to the use of local aggregates with different binders. The emphasis on the mix design of CAM is on preventing rutting, cracking, and flushing of these mixtures. For successful application, the performance of these CAM mixtures must satisfy both rutting and fatigue requirements. It is proposed that current performance criteria in terms of Hamburg Wheel Tracker (HWT) and Overlay Tester (OT) be applied to develop minimum aggregate quality criteria for CAM mixes. Additional performance tests are proposed to supplement HWT and OT testing to more rapidly assess the rutting and cracking properties of CAM using a wide range of local aggregates. Finally, it is recommended that the procedures as proposed be validated in the field by constructing and monitoring the in-situ performance of a number of selected CAM mixtures designed using local aggregates with different binders.

Project Director

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Richard Izzo, CST

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Research Supervisor

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Total Project Budget

\$299,819

Research Universities

Center for Transportation Research

FY 2010 Budget

\$145,354

0-6444 - Treatments for Clays in Aggregates Used to Produce Cement Concrete, Bituminous Materials and Chip Seals

Start Date - 09/01/2009 **End Date** - 08/31/2012



Abstract

The Texas Department of Transportation has recently expressed concern about clay contamination of coarse and fine aggregates used in Portland cement concrete, bituminous mixes and chip seals. We propose to determine what clay minerals (i.e. smectite, illite, kaolinite, etc.) are responsible for deterioration of these pavement structures. We will also identify a quick test method to measure the deleterious clay minerals in the stockpile. Our testing plan is designed to identify the lowest concentration of clay mineral one can have in an aggregate and still obtain an acceptable pavement structure. We intend to start with clay mineral standards and good aggregates to determine what clays are detrimental and how they affect the engineering properties. We will then move on to natural aggregates from Texas that have traditionally had problems with clay contamination and do the same testing on these aggregates. We will fully characterize the mineralogy of each aggregate and use this information to develop a remediation plan. Knowing clay mineralogy, you can determine what kind of chemical pretreatments will benefit the aggregate. At the end of the project we should be able to quickly identify clay mineralogy in a stockpile, determine what type and concentration of clay mineral will result in poor pavement performance and suggest ways to lower the clay contamination and make the aggregate acceptable for use.

Project Director

Marvin Garcia, LBB

Project Advisors

Kimberly Frost, ATL
Michael Dawidczik, CST
Miguel Arellano, AUS
Ryan Barborak, CST

Research Supervisor

John (Pat) Harris, TTI

Total Project Budget
\$390,755

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$126,171

0-6496 - Quantifying the Effects in Order to Optimize the Use of Grade 3 and Grade 4 Seal Coats

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

The Texas Department of Transportation (TxDOT) has the challenging responsibility of maintaining serviceability of almost 80,000 centerline miles of roadway. The agency is pursuing numerous methods of accomplishing this responsibility with diminishing resources. The objective of this study is to develop guidelines for optimal selection of aggregates gradation for seal coat type selection based on conditions of the pavement and the roadway location. Initial results will be provided to TxDOT after the first year of the project based on interviews with district personnel and an analysis of Pavement Management Information System (PMIS) data. Side-by-side test sections using different aggregate gradations will be planned and constructed to provide information unattainable from the interview and PMIS data analysis tasks. This project also includes a thorough evaluation of noise considerations when selecting seal coat materials and different aggregate gradations.

Project Director

Elias Rmeili, BWD

Project Advisors

Brett Haggerty, CST
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Darrel Welch, BRY
James Combes, LBB
Jarod Withrow, LBB
Jimmy (Neal) Munn, MNT

Research Supervisor

Paul Krugler, TTI

Total Project Budget
\$241,332

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$117,072

0-6586 - Review of Best Practices for the Selection of Rehab and Preventive Maintenance Projects

Start Date - 09/01/2009 **End Date** - 08/31/2010



Abstract

With finite resources and an extensive road network to maintain, Texas Department of Transportation (TxDOT) personnel must select the roadways to receive rehabilitation and preventative maintenance treatments as well as select rehabilitation and preventive maintenance (PM) methods that are structurally sound, capable of being opened to traffic quickly. Straightforward construction methods will be used and most importantly minimize the associated costs. This research project focuses on developing guidelines to aid TxDOT personnel in making optimal selections of rehabilitation and PM projects. TxDOT district personnel have implemented various selection procedures, but there is a tremendous need to have a comprehensive, logical approach developed.

The University of Texas at San Antonio (UTSA) has assembled a strong research team in conjunction with the Texas Transportation Institute (TTI). The team consists of faculty, full-time researchers, and includes former Texas Department of Transportation pavement engineering expertise. Members of this team have a proven and recent track record in efficiently and effectively gathering knowledge information from TxDOT personnel in a manner which minimizes time involvement and impact on those from whom information is being obtained. Implementable, useful, and practical tools have resulted from recently completed projects performed by team members.

Project Director

Lowell Choate, AUS

Project Advisors

Dan Perry, PAR

Dar Hao Chen, CST

Jack Moser, BMT

Jesse Fleming, WFS

Michael Beaver, WFS

Mike Craig, LBB

Randy Hochstein, AMA

Tina Massey, DAL

Research Supervisor

Samer Dessouky, UTSA

Total Project Budget	Research Universities	FY 2010 Budget
\$125,000	Texas Transportation Institute	\$60,000
	University of Texas at San Antonio	\$65,000

0-6587 - Flexible Base Acceptance Testing

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

Current TxDOT Item 247 requires flexible bases to meet a dry density target determined from laboratory Test Method Tex-113-E. However, the field requirement does not include moisture criteria, and problems have been reported from bases being worked too dry or too wet from optimum. Additionally, current acceptance methods do not evaluate the modulus or stiffness of the layer. This project will recommend modifications to base acceptance methods by performing a thorough review of existing protocols, investigating new mechanistic-based testing devices (including the impact of varying moisture content and density on device outputs), and shadowtesting the new devices on several TxDOT construction projects. In addition, the year 1 budget includes \$50,000 to build controlled test sites at Texas A&M Riverside Campus where alternate test procedures can be investigated in a controlled environment. This project will also produce a video detailing current methods, potential new methods, and problems that can occur when best practices are not followed.

Project Director

Miguel Arellano, AUS

Project Advisors

Andrew Wanees, AUS

Caroline Herrera, CST

Daniel Taylor, PAR

Darlene Goehl, BRY

Mike Wittie, LBB

Stevan Perez, LBB

Research Supervisor

Tom Scullion, TTI

Total Project Budget
\$235,150

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$140,175

0-6589 - Pavement Repair Strategies for 2R and Routine Maintenance (RMC) Projects

Start Date - 09/01/2009 **End Date** - 08/31/2010



Abstract

Edge failures are one of the major distresses in FM roadway networks in Texas. They appear in the form of longitudinal cracking, alligator cracking, or rutting. A quick, preliminary review of the PMIS database yielded that districts with the most sections in this analysis are Fort Worth, Austin, Paris, Corpus Christi, San Antonio, and Houston. The Texas Department of Transportation (TxDOT) has implemented several treatments procedures however distresses have shown to reappear in short time. With finite resources and an extensive road network to maintain, TxDOT maintenance forces must select repair and treatment strategy that is based on the main cause of the failure and also be cost effective. This research project focuses on developing guidelines for repair strategy and tools to inspect edge failure in the FM network for the maintenance forces. The research team made efforts to specifically focus on distresses common in expansive soil environments.

Project Director

Clark Slacum, BMT

Project Advisors

Cody McKenney, HOU

Julie Rodgers, PAR

Kylan Francis, LBB

Larry Buttler, MNT

Lowell Choate, AUS

Kyle Novicke, YKM

Research Supervisor

Samer Dessouky, UTSA

Total Project Budget	Research Universities	FY 2010 Budget
\$135,000	Lamar University	\$30,000
	Texas Transportation Institute	\$50,000
	University of Texas at San Antonio	\$55,000

0-6590 - Material Selection for Concrete Overlays

Start Date - 09/01/2009 End Date - 08/31/2011



Abstract

Concrete overlays have been a rehabilitation method for many years. TxDOT has used a number of them, mostly in the Houston District, and with the extensive system of concrete pavements they offer great potential for more extensive future use as bonded overlays for pavements that are not severely distressed and as unbonded overlays for pavements that are too distressed to use bonded overlays. Whitetopping has been shown to be a viable option for rehabilitating asphalt concrete pavements using concrete overlays.

Concrete overlays have many advantages: (1) utilizing the existing pavement, either as part of a thicker, stiffer pavement in the case of bonded overlays, or as the base for a new, structural pavement; (2) improve the durability and/or surface characteristics of the existing pavement; (3) expedite construction since it takes less time to construct an overlay that results in a reduction in lane closures and inconvenience to the public; and (4) minimizing clearance problems. These benefits make overlays a cost-competitive option for pavement rehabilitation.

One of the main keys to successful performance is proper preparation of the substrate: a pavement in relatively good condition for constructing bonded overlays, and an adequate separation layer beneath unbonded overlays. The research will build on the experience that has been developed in Texas and other states. The research team is very experienced in concrete overlays and was involved in nearly all of the TxDOT overlays built previously. A survey of the overlays in Texas will be conducted to learn from their success and problems. Condition surveys, deflection testing, and coring will be performed to determine the condition and the types of materials used in the overlays. A laboratory investigation is proposed to evaluate materials, particularly innovative materials for overlays, including high volume fly ash and fibers. The laboratory tests will include small slabs overlaid with candidate overlay materials that are exposed to outdoor conditions. The tests will help determine which materials bond well under realistic conditions and if these materials are beneficial for bonded concrete overlays.

Project Director

Clifford Halvorsen, HOU

Project Advisors

Hua Chen, CST

Jeffrey Harmon, TYL

Mike Alford, HOU

Research Supervisor

David Fowler, CTR

Total Project Budget
\$300,000

Research Universities
Center for Transportation Research

FY 2010 Budget
\$150,000

0-6591 - Developing a Fundamental Understanding of the Chemistry of Warm Mix Additives

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

Several technologies have been introduced in the last half-decade in the United States to produce asphalt mixtures at temperatures that are 86° to 112°F lower than conventional mixing and compaction temperatures. These mixtures are referred to as Warm Mix Asphalt or WMA mixtures. There are several different technologies that may be used to produce WMA mixtures. These include additives such as chemicals, organic compounds, water-bearing zeolite particles, or introduction of water during mixing to cause foaming. Several field demonstration projections based on one or more of these technologies have been executed in Texas and other states over the past two to three years. The National Cooperative Highway Research Program (NCHRP) is sponsoring two projects on the development and validation of a mix design procedure for WMA mixtures. Several independent research studies have made broad comparisons between the engineering properties and performance of WMA mixtures to conventional HMA mixtures. However, there is very little evidence in the literature that indicates the mechanisms by which the WMA additives or processes affect the physio-chemical and rheological properties of the asphalt binder and consequently their long-term performance as a pavement material. This proposal provides a brief background on the challenges and several important un-answered questions that are crucial to ensure that the WMA mixtures perform better or on par with HMA mixtures. For example, the detailed mechanisms and implications of WMA additives on aging, resistance to rutting, fracture and fatigue, and moisture damage are not well established. There is a need to identify strategies to improve durability or limit the use of WMA mixtures that do not meet existing specifications established for HMA mixtures. In the case of WMA mixtures that satisfy specification requirements for tests originally intended for HMA mixtures, it is important to verify that these tests and requirements capture the long-term durability related problems that may be unique to WMA mixtures. The work plan included in the proposal addresses the above questions using a multi-faceted approach. The physical and chemical changes in the asphalt

binders due to the presence of WMA additives or processes are investigated using a comprehensive set of fundamental material characterization tests. Examples of tests include spectroscopic analysis, changes in molecular size distribution, changes in surface characteristics, and adhesion. The impact of these changes on the rheological properties of not aged and long-term aged binders with and without WMA additives is investigated. Finally, a series of standard and specialized mechanical performance tests are conducted on sand-asphalt mixtures and full asphalt mixtures to evaluate the long-term performance characteristics of WMA mixtures.

Project Director

Dale Rand, CST

Project Advisors

Bryan Wilson, LBB

Jeremy Dearing, LBB

Martin (Marty) Stewart, FTW

Research Supervisor

Amit Bhasin, CTR

Total Project Budget
\$304,900

Research Universities
Center for Transportation Research

FY 2010 Budget
\$149,814

0-6992 - Develop Practical Field Guidelines for the Compaction of HMA or WMA

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

This project aims at developing practical procedures for monitoring field compaction of hot and warm asphalt mixes in order to improve the performance of Texas pavements and extend their service life. These procedures will be based on the "Compaction Index" (CI) method developed by members of our research team in the TxDOT project 0-5261. This index is the summation of the multiplication of each roller pass with an effectiveness factor. The effectiveness factor at a point on the mat is a function of the location of the point with respect to the roller width. A point on the mat closer to the center of the roller is subjected to more effective compaction than a point closer to the edge of the roller. It has been shown that the CI is useful to set up the compaction pattern in order to achieve uniform percent air voids; a more uniform CI corresponds to more uniform air voids.

In addition, the laboratory compaction data will be correlated with the CI needed in the field to achieve a certain density. This project will build upon the developments in project 0-5261 by using the following tasks:

- (1) Investigate and monitor the field compaction of diverse hot and warm asphalt mixtures. The results will be used to develop a robust method to calculate the "Compaction Index" for different types of mixtures used in Texas.
- (2) Expand the relationships developed in TxDOT project 0-5261 for predicting the field compactability of asphalt mixtures based on laboratory experiments for a wide range of hot and warm asphalt mixtures.
- (3) Implement the methods developed in steps (1) and (2) above in a simple and practical

Project Director

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Project Advisors

Alan Albus, LBB
Bryan Esmaili-Doki, PAR
Eric Weaver, FHWA
Grady Mapes, HOU
Robert Lee, CST
Tom Thomson, FTW

Research Supervisor

Tom Scullion, TTI

Compaction Monitoring System (CMS) that will allow TxDOT and contractors to use the developed methods in predicting field compactability, monitoring uniformity of field compaction in real time during construction, and ensuring achieving the target density. This system will utilize the temperature measurements from an infrared temperature bar attached to the paver in order to account for the effect of temperature segregation on the mixture compactability. The successful implementation of the methods developed in this study will significantly reduce the variation in asphalt pavement density, and it will assist in the selection of mixtures during the mix design process that can be compacted in the field to achieve the target density.

Total Project Budget
\$379,004

Research Universities
Texas Transportation Institute
University of Texas at San Antonio

FY 2010 Budget
\$170,767
\$20,000

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RMC 2 – Active Projects

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0-6544	Appraisal of Available Analytical Tools to Assess Environmental Justice Impacts of Toll Road Projects	9/1/2009	75
0-6581-CT	TxDOT Administration Research	10/23/2008	76
0-6581-TI	TxDOT Administration Research	10/10/2008	77
0-6583	Methods for Developing External Travel Survey Data	2/27/2009	78

0-4570 - The South Texas Native Plant Restoration Project

Start Date - 05/15/2002 End Date - 08/31/2011



Abstract

The goal of the project is the development of adaptable and successful native seed mixes viable to South Texas that will be made available for commercial growers to supply the growing demand for native seed by public and private land managers and the development of effective planting strategies and revegetation techniques for this area of the state.

Project Director

Dennis Markwardt, MNT

Project Advisors

Barrie Cogburn, DES

Marvin Hatter, SAT

Steve Prather, MNT

Research Supervisor

Forrest Smith, TAMUK

Total Project Budget
\$1,288,819

Research Universities
Texas A&M University – Kingsville

FY 2010 Budget
\$150,000

0-5220 - Investigation of Stormwater Quality Improvements Utilizing Permeable Pavement and/or the Porous Friction Course (PFC)

Start Date - 09/01/2006 **End Date** - 08/31/2010



Abstract

Preliminary monitoring of runoff from a section of a highway in the Austin area with a Permeable Friction Course (PFC) overlay indicates that, in addition to recognized safety benefits, PFC substantially reduces the concentration of many pollutants in stormwater runoff. The observed reduction in pollutants may allow TxDOT to incorporate stormwater treatment into the pavement itself, rather than constructing and maintaining the expensive structural treatment controls now used. To promote the use of PFC for this purpose, two parallel and complementary research tracks are underway. The objective of the first track is to document the water quality benefits associated with the use of PFC. Continued monitoring of the initial site and addition of a second site to provide confirmation will provide additional documentation of the water quality benefits. Data from a second site that could be outfitted with a flow meter and automatic sampler would also provide information on the effect of this highway surface type on the quantity and rate of stormwater runoff. The second research track involves characterization of the hydraulic properties of PFC. This track includes permeability and porosity testing of samples from existing installations. These tests will document the hydraulic properties and help determine the rate at which the pavement becomes clogged. Knowledge of these hydraulic properties in both the horizontal and vertical directions will allow the development of a model similar to those used for groundwater flow to predict the movement of runoff within the pavement itself. This information is useful in that the effect of cross slope, highway width, curves, and superelevation on flow within the pavement can be evaluated. This information will be useful for supporting the development of guidelines for the appropriate use of PFC. A final consideration in this research

is the relative cost of PFC versus other paving options. The cost of PFC is normally considered to be somewhat higher than that of conventional hot mix asphalt. This comparison might be misleading if the PFC surfaced roadway would not have to include the structural Best Management Practices (BMP)s now constructed for conventional highways in the Edwards Aquifer recharge zone and other areas of the state. Consequently, an additional objective is a valid cost comparison that includes all elements of the highway project including design life, structural controls (and their maintenance), right-of-way requirements, and alternate paving materials.

Project Director

Gary Lantrip, AUS

Project Advisors

Amy Foster, ENV

James Williams, AUS

Richard De La Cruz, SAT

Richard Izzo, CST

Research Supervisor

Michael Barrett, CTR

Total Project Budget

\$687,443

Research Universities

Center for Transportation Research

FY 2010 Budget

\$107,926

0-5731 - Synthesis and Study of the Establishment and Management of Roadside Vegetation

Start Date - 09/01/2006 **End Date** - 08/31/2010



Abstract

The Texas Pollutant Discharge Elimination System (TPDES), which is administered and enforced by the Texas Commission on Environmental Quality (TCEQ), requires that re-vegetation be completed in a timely manner when the project is completed and before a Notice of Intent can be issued to release the contractor. Failure to establish the vegetation can result in monetary penalties or closing a job site down. TxDOT roadway projects often terminate at times of the year when establishment of permanent vegetation is very difficult. Even when the construction calendar and the ideal growing season line up, it is still a constant challenge for TxDOT. If optimal seeding windows are not met, sites may become eroded, causing significant impacts on storm water runoff and receiving waters. The objective of this study is to provide a more diverse set of tools and options for TxDOT personnel that will help insure rapid vegetation establishment after construction. These will help prevent project delays and reduce long-term costs in vegetation development and management.

Project Director

Chris Chambers, SAT

Project Advisors

Ann Finley, LBB

Barrie Cogburn, DES

Ethan Beeson, HOU

Laurie Williams, ODA

Marvin Hatter, SAT

Mike Alford, HOU

Nancy Fisher, SJT

Stephen Ligon, ENV

Steve Prather, MNT

Research Supervisor

Beverly Storey, TTI

Total Project Budget

\$510,047

Research Universities

Texas A&M University – Kingsville

Texas Transportation Institute

West Texas A&M University

FY 2010 Budget

\$20,000

\$72,430

\$19,971

0-5949 - Bioretention for Stormwater Quality Improvement in Texas

Start Date - 09/01/2007 End Date - 08/31/2011



Abstract

The purpose of this project is to investigate the applicability and identify benefits and drawbacks of bioretention best management practices (BMPs) in Texas, specifically for highway related applications. Bioretention was developed in the late 1980's in Prince George's County, Maryland. This technique utilizes soil, sand, organic matter, and vegetation-based storage and infiltration facilities for treating runoff from paved surfaces such as parking lots, streets, and highways. Currently, most bioretention results have been created by experiments conducted in different regions where climates and plants are very different from Texas. This project will begin with a literature review and case study and identify applicable situations for The Texas Department of Transportation, followed by pilot testing and in-situ demonstrations. The pilot testing will focus on analyzing the bioretention cell's water quality performance and hydrologic responses. The full scale, in-situ demonstrations will closely monitor performance over a 2-3 year period to address not only the water quality issues, but maintenance of the facility. The findings will be used to develop design and implementation guidelines for adoption by TxDOT. The significance of this project is that TxDOT will have an opportunity to adopt the bioretention technology and include the design guidelines in TxDOT's design manuals. This will enable TxDOT designers to familiarize and apply the latest design tool promoted by the US Environmental Protection Agency. Potential applicable situations include rights-of-way at interchanges and along roadsides.

Project Director

Stephen Ligon, ENV

Project Advisors

Amy Foster, ENV

Barrie Cogburn, DES

Craig Dunning, DES

David Zwernemann, AUS

John Moravec, BRY

Jon Geiselbrecht, AUS

Research Supervisor

Ming-Han Li, TTI

Total Project Budget
\$462,967

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$110,894

0-5974 - Estimating Texas Motor Vehicle Operating Costs

Start Date - 09/01/2007 **End Date** - 08/31/2011



Abstract

Vehicle operating costs (Vcost) play an important role in several TxDOT policy making areas ranging from the economic evaluation of highway construction, maintenance, and rehabilitation strategies to lane rental, liquidated damages and construction bonus calculations. Vcost relationships have not been studied in Texas for over two decades and these now risk obsolescence in the face of new design technologies, engine changes - both hybrid and improved gasoline/diesel - better tire performance (including super single tire adoption) and sharper forensic driven maintenance strategies. This study will develop a Vcost data base and use it to develop a fuel consumption model and an aggregate Vcost model for selected Texas representative vehicles. Also, while not addressing the measurement of external costs associated with vehicle use, the results should form a platform for the future development of full transportation impacts, comprising both direct owner (as studied in this proposal) and social costs.

Project Director

Don Lewis, GSD

Project Advisors

Jackie Ploch, ENV
Janie Temple, TPP
Jo Woten, GSD
Mark Johnson, TRF
Paul Campbell, FIN
Peggy Thurin, TPP
Robert Stuard, AUS
Woody Raine, GSD

Research Supervisor

Robert Harrison, CTR

Total Project Budget
\$697,626

Research Universities
Center for Transportation Research

FY 2010 Budget
\$145,871

0-6095 - Longer Combination Vehicles & Road Trains for Texas?

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

Transportation and logistics have been major contributors to U.S. economic growth, driven in part by productive modal systems. In the last two decades, planes have become larger and more fuel efficient, trains longer and heavier, container vessels substantially larger and more productive, but trucks have only benefited from marginal changes in trailer length and width on the federal highway system. The U.S. has the least productive trucks in the developed economies that form its competitive global market. This is now a drag on cost, made more severe by increases in fuel costs, and is prejudicing the U.S. competitive position.

This study will consider the impact that larger, productive trucks would have if permitted on Texas highways. The trucks evaluated in this proposal range from a heavier tridem semitrailer to a variety of combination trucks, including road trains, collectively termed long combination vehicles (LCVs). The research team in the first year will to evaluate the extensive body of research undertaken on LCV operations and develop calibrated approaches to the determination of LCV productivity, bridge and pavement impacts, safety, operational considerations, and policy review determined from a series of Texas highway case studies. Furthermore, the team has the support of specialists familiar with Canadian, Australian, and Texas trucking who would

complement the TxDOT technical advisors already selected for this study. The external Expert Panel would be informed of progress and meet in Austin at the end of the first year with their TxDOT advisory counterparts. Together they will review both the proposed methods and suggested case studies and act in a peer review capacity. The second year will consist of applying different LCV types to (a) a major interstate freight corridor, (b) an intrastate trade corridor, (c) TTC-35, and finally (d) a truck-only toll road. A broad-based evaluation method is envisioned, comprising traditional cost-benefit approaches strengthened by estimates of productivity, emissions, and safety.

Project Director

Duncan Stewart, RTI

Project Advisors

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Don Lewis, GSD
Emad Shahin, EPA
Jack Heiss, TTA
Jefferey Tomkins, BRG
Jianming Ma, TRF
Maria Burke, DES
Melisa Montemayor, LRD
Randy Anderson, ROW
Raymond (Ray) Hutchinson, MCD
Robert Stuard, AUS
Susan Geist, FHWA

Research Supervisor

C Walton, CTR

Total Project Budget
\$423,000

Research Universities
Center for Transportation Research
University of Texas at San Antonio

FY 2010 Budget
\$151,925
\$73,075

0-6142 - Feasibility and Applications of RFID Technologies to Support Right of Way Functions

Start Date - 10/20/2008 **End Date** - 12/31/2009



Abstract

Radio frequency identification device (RFID) technology provides the capability to store a unique ID number and some basic attribute information, which can be retrieved wirelessly when the markers detect a radio signal from a remote reader. RFID technology is currently used in many applications including inventory management and highway toll tags. The use of RFID technology offers the potential for TxDOT to improve its right-of-way (ROW) functions and the manner in which it manages the assets located within the ROW. This research project is a feasibility study of how RFID technology can be used to support various TxDOT ROW functions. This one-year project will identify RFID technologies and the potential of those technologies to support ROW activities such as identifying utilities, outdoor advertising, infrastructure, and ROW markers. Activities include gathering information from a range of sources, assessing potential applications, conducting limited evaluations of RFID technologies to assess applicability for ROW functions, conducting a webinar to identify possibilities and obtain input, assessing institutional issues associated with RFID implementation, assessing economic factors related to implementation, and the developing recommendations. The research team includes researchers from the Texas Transportation Institute and Prairie View A&M University.

Project Director

Randy Anderson, ROW

Project Advisors

Dean Wilkerson, TSD

Don Hill, ENV

John Ewald, OGC

Ryan Bonner, WAC

Research Supervisor

Harvey (Gene) Hawkins, TTI

Total Project Budget	Research Universities	FY 2010 Budget
\$180,537	Prairie View A&M University	\$8,009
	Texas Transportation Institute	\$17,000

0-6147 - Bacteria Levels in Discharges from Road Right-of-Ways

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

Excessive bacteria concentrations are the most common cause of water quality impairments in Texas with almost 300 waterbodies identified by the Texas Commission on Environment Quality (TCEQ) as not meeting state standards. Total Maximum Daily Loads (TMDLs), which are designed to bring the waterbodies into compliance by reducing the bacteria discharge, must be adopted for each of these systems. TxDOT is often identified as being a contributor to these problems even though runoff from roads and bridges is only a very small fraction of the contributing watershed and has little in the way of natural bacteria sources. This research project is designed to provide TxDOT with the information to respond to regulatory requirements by evaluating the contribution of bacteria from TxDOT facilities to two systems in Central Texas: The Upper San Antonio River and its tributaries, and Gilleland Creek. These rivers were chosen for several reasons. Each of them already has a TMDL adopted by TCEQ that requires substantial reductions in bacteria discharge from all sources in their watersheds. In addition, these rivers have numerous highway crossings in a variety of settings from densely developed urban to rural, agricultural dominated land uses. This provides the opportunity to document bacteria discharges and the degree of impact on the receiving water quality in a way that the results can be extrapolated statewide and applied to other problem areas in the state such as Harris County. The project will begin with a literature review to compile information on the bacteria content of highway runoff. The review will also include an evaluation of the Best Management Practices (BMP) that are commonly used for treating stormwater runoff as well as those currently being marketed specifically to provide disinfection. The proposed site monitoring has three main components: an evaluation of the quality of runoff from TxDOT facilities, an assessment of receiving water quality upstream and downstream of the highway crossing, and a qualitative survey for birds and other sources of bacteria under and around bridges.

Project Director

Stephen Ligon, ENV

Project Advisors

Mario Mata, ENV

Research Supervisor

Michael Barrett, CTR

The project will provide TxDOT with relevant and timely information that can be used to respond to TMDL requirements statewide. Without this study, TxDOT may be forced to spend substantial amounts of money to address a perceived, rather than real problem. Consequently, TxDOT will be able to implement the results of this research immediately and realize potentially large cost savings.

Total Project Budget
\$377,698

Research Universities
Center for Transportation Research
University of Texas at San Antonio

FY 2010 Budget
\$117,913
\$70,506

0-6199 - Estimated Impact of the 2010 Census on the PTN Funding Formula

Start Date - 09/01/2008 **End Date** - 02/28/2010



Abstract

Changes in the population and land area of urbanized areas in Texas will play a significant role in determining the allocation of public transportation funds to service providers in Texas after Census 2010. The purpose of this research project is to review demographic trends in order to anticipate changes in urbanized and non-urbanized areas in Texas and the resulting implications for transit funding. This collaborative effort between the Texas Transportation Institute (TTI), and the Institute for Demographic and Socioeconomic Research at the University of Texas at San Antonio will draw upon the complementary expertise of public transportation planners, demographers, and geographic information systems (GIS) professionals of the two research organizations. The research project will identify areas with potential to become over 200,000 in population and those nonurbanized areas that have potential to become urbanized (over 50,000 people) in 2010. The implications of these changes will be examined relative to the current Federal and State funding allocations. The research staff will provide a comprehensive assessment of these changes for the State as a whole and for individual transit service providers as well as recommendations for changes in current funding allocation formulas and suggestions for legislative action.

Project Director

Karen Dunlap, PTN

Project Advisors

Carole Mayo, WFS

Gary Williams, PTN

Kelly Kirkland, PTN

Linda Gonzalez, PTN

Maureen McCoy, CAMPO

Research Supervisor

Karl Eschbach, UTSA

Total Project Budget

\$134,623

Research Universities

Texas Transportation Institute

University of Texas at San Antonio

FY 2010 Budget

\$33,318

\$16,966

0-6205 - Benchmarking and Improving Texas Rural Public Transportation Systems

Start Date - 09/01/2008 **End Date** - 10/31/2009



Abstract

In recognition of growing unmet needs for transportation services in rural America, SAFETEALU increased federal funding for rural transit. Texas demographic projections indicate that the state can expect rural transit needs continuing to increase into the future. It will become increasingly important to maximize service for every funding dollar. The research objective is to develop peer groupings of the 39 Texas rural transit districts and establish performance benchmarks for each. Analyses will focus on the efficiency and effectiveness indicators contained in the TxDOT funding allocation formula. Researcher will then conduct case studies of highly-performing agencies, highlighting transferable best practices. A special case study will specifically examine how Medical Transportation Services impact rural operators. This information will be documented in a guidance document that will help rural operators understand and improve their performance, increasing the return on federal and state rural transit investments.

Project Director

David Merritt, PAR

Project Advisors

Alfredo Gonzales, ODA
Karen Dunlap, PTN
Kelly Kirkland, PTN
Matt Penney, LNGVIEWTRA
Tamara Cope, BWD

Research Supervisor

Jeffrey Arndt, TTI

Total Project Budget	Research Universities	FY 2010 Budget
\$119,872	Prairie View A&M University	\$3,150
	Texas Transportation Institute	\$12,700

0-6208 - Preserving Functionality / Asset Value of the State Highway System

Start Date - 09/01/2008 **End Date** - 02/28/2010



Abstract

This project will examine what losses to state highway functionality occur over time and what actions can be taken to preserve, recover, and enhance functionality over time. The key characteristic of functionality to be addressed will be operational capacity and efficiency. However, a state highway's function also derives from its right of way (including boundary conditions like access), infrastructure conditions, and safety, so those will also be considered. This project will examine experiences and results for highways within and outside Texas, both from existing information and through case studies of selected Texas highways. The research will seek to establish cause and effect relationships between various policies, actions, and practices and the resulting functionality over the life cycle of highways. The project will produce a research report, a guidebook of recommended practices, and workshops delivered to TxDOT districts.

Project Director

Blair Haynie, ABL

Project Advisors

Bob Appleton, BRY
Doug Woodall, TTA
Henry Wickes, TRF
Kenneth Petr, AMA
Maria Burke, DES
Melisa Montemayor, LRD
Peggy Thurin, TPP

Research Supervisor

Edwin Hard, TTI

Total Project Budget
\$194,323

Research Universities
Texas Southern University
Texas Transportation Institute

FY 2010 Budget
\$0
\$32,788

0-6235 - Sketch Planning Techniques to Assess Regional Air Quality Impacts of Congestion Mitigation Strategies

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

Mobile sources present air quality issues in a variety of congested regions around the state, where travel delays are rising and transportation systems are in need of improvement. Within this context, it is important to anticipate, quantify, and communicate the benefits and costs of new, congestion-abating transportation projects and policies. While additions to existing systems may facilitate new and longer trips, thereby increasing regional vehicle-miles traveled (VMT), such VMT tends to occur at preferred times of day, to more attractive destinations and/or at lower costs. The travel time and cost savings, as well as added choice benefits for personal and commercial travelers, can be sizable, along with crash reductions and other benefits. Procedures are needed to permit early and comprehensive evaluation of project proposals, facilitate project prioritization, and enhance communication with all stakeholders, as transportation planners pursue and promote new and beneficial transportation improvement plans.

The proposed project will develop such a procedure by synthesizing, expanding, upgrading, and refining existing and emerging tools within a user-friendly, highly accessible Microsoft Access software platform. The resulting toolkit will accommodate both basic and more detailed inputs, pivoting off of existing datasets while facilitating, where present, the travel demand modeling

capabilities that already exist in Texas' most congested nonattainment regions. Toolkit outputs will display all impacts of interest to the Project Monitoring Committee in both tabular and graphical formats (across the region of study), while highlighting any emission reductions from existing travelers and distinguishing these from emissions increases that emerge from latent demand. Within the existing vacuum of defensible sketch-level emissions impact procedures for largescale projects, the current project will produce a methodologically sound product for others to emulate. All forecasting tools and recommendations will be clearly defined in a User Guidebook, for distribution at case study workshops and for immediate use by Texas MPO and TxDOT modeling staff.

Project Director

Bernard Kadlubar, ENV

Project Advisors

Dan Lamers, NCTCOG
Godfrey Sendawula, TPP
Janie Temple, TPP
Laura Norton, TPP
Madhu Venugopal, NCTCOG
Mary McGarry-Barber, TCEQ

Research Supervisor

Kara Kockelman, CTR

Total Project Budget
\$310,000

Research Universities
Center for Transportation Research

FY 2010 Budget
\$160,000

0-6237 - Characterization of Exhaust Emissions from Heavy Duty Diesel Vehicles in the HGB Area

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

The relative contribution of heavy-duty diesel vehicles to mobile source emissions has grown significantly over the past decade. It is critical to address this component of the fleet, especially in nonattainment areas such as the Houston-Galveston-Brazoria (HGB) eight-county ozone nonattainment area. However, most emissions studies have not incorporated random sampling in their study designs, are mostly based on laboratory settings using chassis dynamometer testing, and are focused on gaseous pollutants, such as hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x), and do not include particulate matter (PM) and mobile source air toxics (MSATs). No study has been found that incorporates random sampling, real world testing, and also addresses PM and MSATs. This proposed project will address all these aspects and add one additional component that is often overlooked – the impact of high-emitting vehicles. This project will be directly beneficial to all districts of TxDOT, especially those that have responsibilities in nonattainment, near nonattainment and early action compact areas. The project will also be of great benefit to TxDOT divisions, such as Environmental (ENV) and Transportation Planning and Programming (TPP), which handle air quality issues such as mobile source emission reductions, policy formulation, plan implementation, National Environmental Policy Act (NEPA) reviews, and conformity determination. The findings of the study will also be of direct use to other agencies such as Metropolitan Planning Organizations (MPOs), the Texas Commission on Environmental Quality (TCEQ), and the U.S. Environmental Protection Agency (EPA).

Project Director

Bernard Kadlubar, ENV

Project Advisors

Charles Airiohuodion, HOU
Don Lewis, GSD
Graciela Lubertino, HGAC
Madhu Venugopal, NCTCOG
Morris Brown, TCEQ
Paul Tiley, TPP
Ruben Casso, EPA
Shelley Whitworth, HGAC

Research Supervisor

Josias Zietsman, TTI

Total Project Budget
\$424,401

Research Universities
Texas Southern University
Texas Transportation Institute

FY 2010 Budget
\$35,000
\$199,834

0-6263 - Study of the Potential Impacts of Highway Construction on Selected Birds with an Emphasis on Golden-Cheeked Warblers

Start Date - 09/01/2008 **End Date** - 08/31/2012



Abstract

A major challenge for the Texas Department of Transportation (TxDOT) is to be able to conclusively state the potential impact of road construction work on both flora and fauna, with particular emphasis on those species granted special protection by law or regulation. The Texas Hill Country, comprising much of the Austin, San Angelo and San Antonio Districts, is home to a variety of species that are either threatened or endangered. This study will determine if road construction activity alters the spatial distribution, breeding success, and behavior of Hill Country birds, with an emphasis on the Golden-Cheeked Warbler. Other focal bird species that will be included, depending on abundance a study site, include the Black-and-white Warbler and White-Eyed Vireo. Data will be gathered over three field seasons coinciding with the breeding period each year for the Golden-Cheeked Warbler. The information gathered will be used to meet the following objectives: (a) determine the influence of the impacts on the abundance of birds in relation to distance from the edge of right of way (ROW); (b) determine the spatial and temporal influence of the impacts on breeding success and behavior in relation to distance from the ROW; (c) determine the extent to which vocal adjustment or other behaviors is being utilized by birds in response to unnatural noise; and (d) determine the spatial and temporal extent of impacts to study species caused by the impacts; and make recommendations designed to alleviate negative impacts.

Project Director

Nancy Fisher, SJT

Project Advisors

Allison Arnold, USFW
Ann Maxwell, SJT
Brandy Huston, ENV
Cal Newnam, AUS
Julia (Julie) Brown, SAT
Mike Shearer, ENV
Stirling Robertson, ENV

Research Supervisor

Michael Morrison, TAES

Total Project Budget
\$1,150,496

Research Universities
Texas AgriLife Research

FY 2010 Budget
\$315,549

0-6265 - Landside Freight Access to Airports - Challenges & Solutions

Start Date - 10/27/2008 **End Date** - 02/28/2010



Abstract

Texas' airports play a large role in the national and regional movement of goods by air. This includes goods moved within the state, across the country, and internationally to several continents. Most of this is accomplished at the largest of airports in Texas. However, as freight demand grows, a time will come when other airports will need to be utilized to accommodate additional demand.

Properly planned transportation infrastructure is critical in ensuring the vitality of an airport's freight operations. Time sensitive air freight requires high levels of operational efficiency which is generally optimized by taking steps to ensure both freight and passenger roadway access within the airport boundaries. Connections and design features of regional highways near the airports is no less important as it allows access to these important economic generators.

The objectives of this research are to identify the issues, barriers, physical bottlenecks (e.g., infrastructure needs), and solutions (including funding mechanisms) concerning landside access to airports in Texas and to propose a methodology for identifying and evaluating existing access performance from a freight perspective.

Project Director

Mark Young, FTW

Project Advisors

Josephine Jarrell, AVN
Michelle Hannah, AVN
Paul Douglas, TPP

Research Supervisor

William Frawley, TTI

Total Project Budget
\$179,155

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$73,037

0-6268 - Acquisition, Uses, & Funding Options for Abandoned Rail Corridors

Start Date - 09/01/2008 **End Date** - 02/28/2010



Abstract

The use of existing and abandoned railroad rights of way has been a proven method of acquiring linear corridors for the construction of roadways since the formation of the Texas Highway Department. Either paralleling existing rail lines or re-using corridors first used by railroad companies exhibited tremendous wisdom since the railroads had dictated development patterns throughout the state in the half-century prior to the road building era. The long period of railroad system consolidation since the end of World War II has resulted in the loss of many abandoned rail corridors which could now be extremely valuable if put to use either as new transportation corridors (roadway, transit, etc.) or multiuse recreational trails (hiking, biking, skating, etc.). This project will evaluate the current Texas Administrative Code statutes governing TxDOT acquisition and use of abandoned rail corridors and look at potential funding options for purchase and preservation of these corridors by TxDOT or other public agencies. Public-private partnerships to achieve the goal of preserving the corridors for future transportation purposes and their interim or permanent use as recreational trails will also be explored. Identification of potential uses of existing abandonment corridors and suggested changes to existing statutes will also be completed.

Project Director

Mark Werner, TPP

Project Advisors

Angie Parker, OGC

Gilbert Wilson, TPP

Maria Burke, DES

Research Supervisor

Curtis Morgan, TTI

Total Project Budget
\$196,339

Research Universities

Center for Transportation Research

Texas Transportation Institute

FY 2010 Budget

\$27,911

\$38,415

0-6297 - Freight Planning Factors Impacting Texas Commodity Flows

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

Efficient, reliable, and safe freight transportation is critical to the economic prosperity of any region. An efficient multimodal and intermodal transportation system reduces transportation and supply chain transaction costs and increases connectivity, reliability, and accessibility to local and global markets. An efficient freight transportation system, therefore, supports economic development, the expansion of international trade, increases national employment, growth in personal income and the Gross Domestic Product of a region, and improves the quality of life of its citizens. Intermodal and freight concerns have thus received increasing attention in the wake of globalization, increasing congestion, and changes in the logistics structure of shippers to facilitate just-in-time production. Both the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and the subsequent reauthorization of the Transportation Equity Act for the 21st century (TEA-21) have identified an understanding of the needs of the freight transportation sector as a critical component of transportation planning.

The objectives of this proposed research are to (a) improve the understanding of the size, scope, and type of commodities that are produced, consumed, and moved through different regions in Texas, (b) gain an insight into the business and transportation system factors that shippers and

Project Director

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Paul Tiley, TPP

Peggy Thurin, TPP

Timothy Juarez, TTA

Research Supervisor

C Walton, CTR

receivers consider when making shipping decisions, (c) identify and describe factors that impact the competitiveness of multimodal freight modes operating in Texas, (d) provide commodity data regarding origin and destination flows that will facilitate updates to various Texas freight models and studies, (e) identify and document significant multimodal freight system trends, needs, and issues in Texas, (f) recommend freight policies, strategies, performance measures, and infrastructure improvements that TxDOT can consider for implementation and funding, and (g) explore the interest, feasibility, and requirements for forming a Freight Advisory Committee in Texas.

Total Project Budget
\$325,000

Research Universities
Center for Transportation Research

FY 2010 Budget
\$158,000

0-6394 - Evaluation of Overweight Load Routing on Buried Utility Plan

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

Overweight traffic movements can negatively affect pavement integrity and quality. However, it is less known to what degree buried utility plant along and across the right of way is affected by these overweight loads, especially if the utility facility is aged, placed under an exception to the Utility Accommodation Rules, and/or subjected to repetitive loads. Routing decisions for repetitive overweight loads may be determined without consideration of cumulative impacts to utility infrastructure, particularly municipally owned lines that could be aged, accommodated under an exception, or of substandard materials. Given the growth in volume in overweight load permits (particularly mid-heavy and superload), the adequacy of the Utility Accommodation Rules is unknown.

The purpose of the research is (a) to evaluate the adequacy of the Utility Accommodation Rules with respect to recent increases in overweight permitting activity, and (b) develop guidelines for better coordination among TxDOT divisions, regional centers, and districts, to minimize impact on buried utility infrastructure.

Project Director

Randy Anderson, ROW

Project Advisors

Dean Wilkerson, TSD
Guy Sledge, LBB
Justin Obinna, MNT
Raymond (Ray) Hutchinson,
MCD
Stephen Stakemiller, HOU

Research Supervisor

Edgar Kraus, TTI

Total Project Budget
\$302,792

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$144,860

0-6395-CT - Modeling Revenue for Use in Developing Reasonable Expectations of Revenue for Long Range Plan Development

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

This project will assess issues associated with transportation funding mechanisms beyond classic fuel tax based revenue streams

Project Director

Jessica Castiglione, SAT

Project Advisors

Jenny Peterman, TPP
Robert (Bob) Brown, DAL
Stuart Hanzlik, FIN
Teresa Lemons, ADM

Research Supervisor

Robert Harrison, CTR

Total Project Budget
\$219,000

Research Universities
Center for Transportation Research

FY 2010 Budget
\$100,000

0-6395-TI - Modeling Revenue for Use in Developing Reasonable Expectations of Revenue for Long Range Plan Development

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

This project will assess issues associated with transportation funding mechanisms beyond classic fuel tax based revenue streams

Project Director

Jessica Castiglione, SAT

Project Advisors

Jenny Peterman, TPP

Robert (Bob) Brown, DAL

Stuart Hanzlik, FIN

Teresa Lemons, ADM

Research Supervisor

David Ellis, TTI

Total Project Budget
\$212,340

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$100,000

0-6396 - Pre-Determining Performance Based Operational and Toll Rate Setting Measures

Start Date - 09/01/2009 **End Date** - 08/31/2010



Abstract

The Texas Department of Transportation (TxDOT) and its mobility partners are planning, constructing and operating numerous projects with pricing components to meet growing mobility needs throughout the state. These projects differ in facility type and operating strategies: they may be greenfield projects operating as a traditional toll road; they may be toll lanes on an existing facility; or they may be new lanes on an existing facility that are managed using price and/or occupancy. As these projects are being planned and constructed, questions arise as to the most effective way to operate them to maintain mobility and desired performance over time. This research project will provide TxDOT and its mobility partners with a multi-faceted framework to aid in operational decision-making over the life of a facility. The research will support development of a framework that is predicated on broad guiding principles, which in turn will assist local entities in establishing performance measures and thresholds for optimum operating conditions. The thresholds will capture the appropriate operational performance measures at the project level while maintaining consistency with regional toll policy. The advantage of an established framework in place is that the process for changing price or other operational parameters becomes more efficient and transparent, both to policy-makers and the traveling public. Part of this research will include communicating, in layman's terms, performance measures and the efficacy of using them to make operational changes, resulting in a "performance promise ."

Project Director

Matt MacGregor, DAL

Project Advisors

Brandy Huston, ENV

Flor Tamez, TRF

Heath Bozeman, LBB

Kori Herrera, AUS

Terron Evertson, AUS

Research Supervisor

Ginger Goodin, TTI

Total Project Budget

\$141,410

Research Universities

Texas Transportation Institute

FY 2010 Budget

141,410

0-6404 - Accommodating Oversize & Overweight Loads

Start Date - 09/03/2009 End Date - 02/28/2011



Abstract

Adequate management of oversize/overweight (OS/OW) permit loads throughout the state of Texas is critical to maintaining a vibrant state economy. The growth in the number and size of permit loads in recent years is clear evidence that new tools and new techniques are needed to match this growth without causing undue delays to permit applicants. Problems such as increasing prevalence of reroutes due to maintenance and other district activities, along with potential damage to the highway infrastructure from permit loads led to this research project. One other significant commitment to help resolve these issues, which is already underway, is development of a new automated routing program-Texas Permit Routing Optimization System (TxPROS). Its completion coincides with the beginning of this research project, so this project can achieve its objectives even more effectively. Research objectives are to:

- identify the most common OS/OW dimension and weight groups,
- identify criteria for assigning these OS/OW groups to existing road networks, and
- identify criteria for assigning current and projected OS/OW groups to the future road network upgraded to meet future demand.

Recommended actions will include use of technologies to improve verification that the permit requirements were met during the move and that establish near real time communication between the Motor Carrier Division (MCD), the carrier, and perhaps the district(s). The research project will result in a statewide map recommending primary and alternate OS/OW route networks for the most common origins and destinations based on historical MCD data.

Project Director

Connie Flickinger, BRY

Project Advisors

Andrew Wanees, AUS

Brian Merrill, BRG

Darlene Goehl, BRY

Dean Wilkerson, TSD

Janet Manley, BMT

John Holt, BRG

Justin Obinna, MNT

Raymond (Ray) Hutchinson, MCD

Vincent Lewis, DAL

Research Supervisor

Dan Middleton, TTI

Total Project Budget

\$196,685

Research Universities

Texas Transportation Institute

FY 2010 Budget

\$131,192

0-6412 - Equipment Replacement Optimization

Start Date - 09/01/2009 End Date - 08/31/2011



Abstract

TxDOT has a fleet value of approximately \$500,000,000 with an annual turnover of about \$50,000,000. Substantial cost savings with fleet management has been documented in the management science literature. For example, a 1983 Interfaces article discussed how Phillips Petroleum saved \$90,000 annually by implementing an improved system for a fleet of 5300 vehicles. Scaling up to the TxDOT fleet, the corresponding savings would be around \$350,000 in 2008 dollars. Similar savings were reported in a 2008 presentation by Mercury Associates.

TxDOT Research Project 7-4941 (1997), Equipment Replacement Criteria Based on LCCBA, created a SAS decision analysis tool to be used by the department in its equipment replacement process. While the 7-4941 analysis tool met project scope within the data limitations existing at the time of its delivery, an improved vehicle cost data base will now allow a more normative decision support tool for fleet replacement optimization. In this sense, optimization means minimizing the life-cycle sum of maintenance cost and replacement cost (new equipment price minus resale value). The Department needs a system which recommends whether to retain or replace a unit of equipment, given that class of equipment's age, mileage, resale value, and the cost of replacement equipment. TxDOT categorizes, accounts for, and replaces equipment based on classes of equipment; the new automated fleet optimization system must use these class codes.

The objective of this project is to (1) determine the best optimization methodology; (2) evaluate commercial fleet management systems; (3) develop the model if this is cost-effective relative to

Project Director

Don Lewis, GSD

Project Advisors

David Bennett, MNT
David Fernandez, TSD
James (Cory) Jackson, LBB
Karen Dennis, GSD
Mark Bradshaw, BWD
Ron Hagquist, ADM
Scott Hamilton, SAT

Research Supervisor

Wei Fan, UTTYL

purchasing a commercial model; and (4) validate the new model as needed using data available on TxDOT's current fleet. To accomplish this project, the research team will formulate the equipment replacement optimization problem as a Mixed-Integer Linear Programming (MILP) model, and propose both Deterministic Dynamic Programming (DDP) and Stochastic Dynamic Programming (SDP) approaches to solving the Equipment Replacement Optimization (ERO) problem. Certainly, this system will be user-friendly and designed so that it can be easily used by non-technical district personnel (to evaluate individual district units against a class) and by technical division personnel (Fleet Manager) to develop optimal aggregate classcode replacement cycles.

Total Project Budget
\$256,636

Research Universities
Center for Transportation Research
University of Texas at Tyler

FY 2010 Budget
\$61,108
\$65,813

0-6467 - Identification of Priority Rail Projects

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

This project will develop a system of evaluative tools which will allow the Texas Department of Transportation (TxDOT) to prioritize its investments in rail-related projects on a statewide basis. The purpose is to ensure that the limited available funding for rail projects is applied in the most beneficial and efficient manner and is focused upon addressing TxDOT's strategic goals. The research will:

- examine rail funding sources at all levels of government in terms of both the amount of funding and the restrictions on types of projects allowable by each funding source;
- recommend a transparent methodology for evaluating proposed rail projects, especially ones that might differ in scope and receive a negative bias under current evaluation criteria and procedures; and
- establish a process through which rail-related investments can periodically be reevaluated.

Existing project ranking tools will be examined and assessed in order to determine opportunities for direct application or adaptation towards TxDOT uses and objectives. A set of performancebased criteria for TxDOT-funded rail projects will be included in the detailed plan for implementing the recommended prioritization process within TxDOT. A guidebook to assist local and regional planners in routinely executing the methodology will also be produced.

Project Director

Tom Beeman, DES

Project Advisors

Darin Kosmak, TRF

Gilbert Wilson, TPP

Sarah Stroman, ENV

Steve Calles, HOU

Research Supervisor

Curtis Morgan, TTI

Total Project Budget
\$273,815

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$141,000

0-6473 - Filling the Transit Gaps: Unserved Urbanized Area Populations

Start Date - 09/01/2009 **End Date** - 08/31/2010



Abstract

Public transportation in Texas relies upon federal and state funding to support operating and capital costs. Federal and state urban funding programs allocate funds largely based upon population within urbanized areas. Urban service providers, which are often part of municipal government, operate transit within their service area. Service areas usually cover only a portion of the urbanized area for which funding is allocated. The areas within the urbanized area boundaries but outside the service area boundaries, is termed the urban "gap". With the coming national census in 2010, these gap areas are likely to enlarge. New urbanized areas will likewise need to identify ways to fund services currently provided by rural transit operators.

The purpose of this research is to identify and characterize the existing gaps in Texas. Researchers will inventory services that are being provided in gap areas, both inside and outside Texas, and identify salient financial, operational and administrative features of those services. Research findings will identify best practices for funding and operating transit service in the urban gaps.

Project Director

Wanda Carter-Dyer, YKM

Project Advisors

Joe Holland, PTN

Marty Allen, TYL

Sarah Stroman, ENV

Research Supervisor

Jeffrey Arndt, TTI

Total Project Budget
\$148,011

Research Universities

Texas Transportation Institute

University of Texas at San Antonio

FY 2010 Budget

\$95,764

\$52,247

0-6483 - Rural Planning Organizations - Their Role in Transportation Planning and Project Development in Texas

Start Date - 03/20/2009 End Date - 08/31/2010



Abstract

While a formal planning and programming process is established for urbanized areas through Metropolitan Planning Organizations (MPO), no similar requirement has been established for rural areas. Currently, under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), states are required to consult with non-metropolitan local officials in transportation planning and programming. The consultation process between state DOTs and non-metropolitan local officials is not prescribed in the planning rules and consultation practices vary widely among each state's Department of Transportation (DOT).

Historically, the Texas Department of Transportation has worked in cooperation with each individual rural county to plan and program projects. This has often resulted in a county-by-county project list that the TxDOT Districts must try to fashion into a regional strategy or plan. A need exists to examine the concept of rural planning organizations and research their use in Texas to determine if a formal rural planning organization may offer a means to improve transportation planning and project development. The objective of this research is to identify and examine rural planning organizations, their organization and operation, and their role in transportation planning and programming. The project will include a review of current processes used by TxDOT and other agencies to plan and program transportation projects in rural areas.

Project Director

Bob Appleton, BRY

Project Advisors

Alfredo Marquez, TPP
Brandy Huston, ENV
Caraly Foreman, GPA
Daniel Brown, WFS
Edward Kabobel, WAC
Elias Rmeili, BWD

Research Supervisor

John Overman, TTI

Total Project Budget
\$205,476

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$142,034

0-6487 - Development of a Performance Measurement Based Methodology to Objectively Compare Operational Improvements with Capacity Additions

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

This project will produce a performance-based methodology and user-friendly spreadsheet-based tool for straightforward and equitable comparison of benefits (and costs) across any set of operational improvements and capacity expansion projects that district offices may be considering. Recognizing that congestion, safety, economic opportunity, asset valuation and emissions levels are key measures of project success, the tool will emphasize multi-criteria evaluation for project scores and ranks. Performance scores, based on time savings, travel time, reliability, safety improvement, emissions reductions, land appreciation, pavement quality, and other features of the enhanced network-vis-a-vis project costs, over the project's lifetime-will highlight opportunities for optimal investment decisions, as well as project limitations that may require remedy.

Project Director

Ron Hagquist, ADM

Project Advisors

Brandy Huston, ENV
Dean Wilkerson, TSD
Diane Venable, DES
Keith Taylor, AUS
Mark Johnson, TRF

Research Supervisor

Kara Kockelman, CTR

Total Project Budget
\$304,889

Research Universities

Center for Transportation Research
Texas A&M University – Kingsville

FY 2010 Budget
\$130,000
\$19,936

0-6495 - TxDOT and Electric Power Transmission Lines

Start Date - 09/01/2009 **End Date** - 08/31/2010



Abstract

Texas has substantial untapped clean renewable energy generation sources that can only reach their potential to complement existing power generation plants if they are linked into an efficient transmission network. TxDOT will have an important role to play in accommodating or facilitating many of these connections, particularly given the authorizations contained in House Bill 3588 that allow the department to build, own or operate transmission. At present the department has a significant degree of uncertainty as to its future role in coordinating power transmission. The following proposal identifies TxDOT's current role in electric power transmission and provides baseline information necessary to identify TxDOT's future needs that will be associated with infrastructure expansion and partnering with public utilities.

Project Director

Terron Evertson, AUS

Project Advisors

Dean Wilkerson, TSD

Jianming Ma, TRF

Jim Heacock, HOU

Randy Anderson, ROW

Tommy Jones, ABL

Research Supervisor

Phillip Nash, TECHMRT

Total Project Budget
\$156,683

Research Universities

Center for Multidisciplinary Research
in Transportation

Center for Transportation Research

FY 2010 Budget

\$96,683

\$60,000

0-6498 - Texas Energy Developments and TxDOT Right of Way

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

In recent years, there has been a boom of energy-related activities in the state. While these efforts contribute to enhance the state's ability to produce energy reliably, many short-term and long-term impacts on the state's right of way and infrastructure are not properly documented. Examples include the impact of frequent, heavy loads on TxDOT infrastructure (e.g., pavement, shoulders, traffic safety, and operations); impact on underground infrastructure and the corresponding impact on TxDOT's ability to manage the right of way effectively; and impact on TxDOT regarding the use of mineral rights within the state right of way. TxDOT has begun to document some of the impacts. The purpose of the research is to measure the impact of increased level of energy-related activities on the TxDOT right of way and infrastructure, develop recommendations to reduce and manage TxDOT's exposure and risk resulting from these activities, and develop recommendations for potential changes to relevant Texas Administrative Code rules.

Project Director

Dale Booth, TYL

Project Advisors

Brian Crawford, ABL
Dean Wilkerson, TSD
Justin Obinna, MNT
Randy Anderson, ROW
Richard Schiller, FTW
Scott Stephenson, GSD
Ted Moore, LBB

Research Supervisor

Cesar Quiroga, TTI

Total Project Budget
\$303,000

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$155,000

0-6511 - Evaluating the Impact of Transit Oriented Development

Start Date - 09/01/2009 **End Date** - 08/31/2010



Abstract

Transit-oriented development (TOD) is seen as an increasingly desirable choice for many residents and businesses. Typically characterized by higher development density, TOD offers planning agencies, cities, and counties opportunities for sustainable development options to counteract some of the deleterious effects of urban sprawl, declining urban cores, and possibly congestion sparked by rising populations. However, questions remain regarding how TOD impacts the use of road transportation facilities. It has been surmised that TOD can not only alter transportation mode choices, trip lengths (and ultimately vehicle-miles traveled) and frequency of roadway use, but it can also impact route selection. Using a variety of analytic techniques, this proposed research will investigate the degree to which TOD affects travel behavior among residents of TOD properties, the nature and extent of the impacts of these behavior changes on facility demand and TxDOT revenues, and potential roles that TxDOT could play in encouraging future transit-oriented development projects to enhance overall transportation network efficiency.

Project Director

Ed Collins, AUS

Project Advisors

Brandy Huston, ENV
Joseph Carrizales, AUS
Paul Douglas, TPP
Stephen Endres, DAL

Research Supervisor

Terry Clower, UNT

Total Project Budget	Research Universities	FY 2010 Budget
\$175,878	Texas Transportation Institute	\$32,250
	University of North Texas	\$97,857
	University of Texas at Arlington	\$45,771

0-6513 - Impacts of Energy Developments on the Texas Transportation System

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

Texas's energy sector has a critical impact - historically and currently - on both the state economy and the Texas transportation system. The objectives of this research study are to (a) illustrate and quantify the current and anticipated future demand for and impacts imposed by the energy sector on Texas's transportation system (by energy source, mode, and region) and (b) identify key energy demand indicators by energy source that TxDOT can track in an effort to anticipate the associated future transportation impacts on Texas's transportation system. The outcome of this research can be used to inform the development of strategies to expand, rehabilitate, and maintain those portions of Texas's transportation system that serve and are impacted by the energy sector.

Project Director

Duncan Stewart, RTI

Project Advisors

Ann Zeeck, GPA

Connie Flickinger, BRY

Dean Wilkerson, TSD

Mark Johnson, TRF

Mary Anne Griss, ADM

Randy Anderson, ROW

Research Supervisor

Jolanda Prozzi, CTR

Total Project Budget
\$265,000

Research Universities

Center for Transportation Research

University of Texas at San Antonio

FY 2010 Budget

\$124,235

\$15,765

0-6538 - Planning Tools to Assess the Real Estate Leveraging Potential for Roadways and Transit

Start Date - 09/01/2009 **End Date** - 08/31/2010



Abstract

A funding crisis exists for financing much needed transportation infrastructure projects across the nation and Texas is no exception. The State of Texas has responded to the crisis by passing several bills allowing innovative financing and alternative options for project financing. Among these is the 80th Legislature Senate Bill 1266 (SB1266) which provides the legal backdrop for the creation of an institutional arrangement called the "Transportation Reinvestment Zone" (TRZ). A TRZ facilitates value capture of the potential benefit or tax increment from a future transportation project. There are only two implementation projects to date using this funding mechanism. This research aims to provide various mechanisms to augment the implementation of SB1266 provisions across the state of Texas. More specifically, the research proposes to address knowledge gaps and provide guidance with respect to the Bill, examine issues in the Bill text as it stands, make recommendations for needed amendments, and provide cost effective, simple and standardized procedures for ascertaining the feasibility of TRZ implementation for various types of projects.

Project Director

Gerardo Leos, ELP

Project Advisors

Armida Sagaribay, ELP
Charles Gurganus, TYL
Eduardo Calvo, ELP
Jim Patterson, TSD
Lucio Vasquez, TTA
Melisa Montemayor, LRD
Wayne Wells, FIN

Research Supervisor

Sharada Vadali, TTI

Total Project Budget	Research Universities	FY 2010 Budget
\$148,266	Center for Transportation Research	\$26,884
	Texas A&M University - Corpus Christi	\$21,452
	Texas Transportation Institute	\$99,930

0-6544 - Appraisal of Available Analytical Tools to Assess Environmental Justice Impacts of Toll Road Projects

Start Date - 09/01/2009 **End Date** - 08/31/2010



Abstract

Given the fiscal constraints of traditional roadway funding sources, the financing of new roads and the modernization of existing roads through investments that will be recovered through toll charges have been promoted at both the national and state level. The objectives of this project are to extend the work that has been done under TxDOT Research Project 0-5208 by (a) critically reviewing the robustness of available data collection and processing measures, (b) critically reviewing the robustness of available tools and analysis techniques through an evaluation of state-of-the-practice applications of these tools and analysis techniques in quantifying and qualitatively describing the EJ impacts associated with toll road projects and toll road systems/networks, and (c) recommending suitable tools and analysis techniques to effectively evaluate the impacts of toll roads and toll road systems/networks on EJ communities.

Project Director

Sarah Stroman, ENV

Project Advisors

Brandy Huston, ENV

Dean Wilkerson, TSD

Jianming Ma, TRF

Mark Arrington, FHWA

Mary-Telles Goins, ELP

Matt MacGregor, DAL

Michael Batuzich, FHWA

Research Supervisor

Jolanda Prozzi, CTR

Total Project Budget

\$145,000

Research Universities

Center for Transportation Research

FY 2010 Budget

\$145,000

0-6581-CT - TxDOT Administration Research

Start Date - 10/23/2008 End Date - 08/31/2010



Abstract

This research project will evaluate numerous individual transportation issues and develop findings and/or recommendations based on results. This project has been structured to: 1) respond to transportation research needs that are identified in a manner that necessitates a quick response that does not fit into the normal research program planning cycle, and 2) individual transportation research needs that are not large enough to justify funding as a stand-alone research project, despite the fact that the issue may be an important one.

Project Director

Rick Collins, RTI

Project Advisors

Research Supervisor

Khali Persad, CTR

Total Project Budget
\$300,000

Research Universities
Center for Transportation Research

FY 2010 Budget
\$150,000

0-6581-TI - TxDOT Administration Research

Start Date - 10/10/2008 End Date - 08/31/2010



Abstract

This research project will evaluate numerous individual transportation issues and develop findings and/or recommendations based on results. This project has been structured to: 1) respond to transportation research needs that are identified in a manner that necessitates a quick response that does not fit into the normal research program planning cycle, and 2) individual transportation research needs that are not large enough to justify funding as a stand-alone research project, despite the fact that the issue may be an important one.

Project Director

Rick Collins, RTI

Project Advisors

Research Supervisor

Josias Zietsman, TTI

Total Project Budget
\$300,000

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$150,000

0-6583 - Methods for Developing External Travel Survey Data

Start Date - 02/27/2009 End Date - 02/28/2010



Abstract

The Texas Department of Transportation (TxDOT) has a comprehensive on-going travel survey program that supports the travel demand models being developed for transportation planning efforts in urban areas throughout Texas. One component of the survey program is the external travel survey. External travel surveys provide data on travel movements into, out of, and through urban areas. In recent years, there has been a heightened sensitivity to the methods used to collect external survey data as well as the type of data that is collected. This research examines alternative methods for collecting data on external travel movements and evaluates the potential for synthesizing/modeling external travel in lieu of conducting external surveys. The research will provide recommendations to TxDOT on the most viable methods to estimate external travel movements for use in travel demand models in urban areas in Texas.

Project Director

Bill Knowles, TPP

Project Advisors

Charlie Hall, TPP

Eduardo Calvo, ELP

Greg Lancaster, TPP

Paul Tiley, TPP

Research Supervisor

Stephen Farnsworth, TTI

Total Project Budget

\$141,021

Research Universities

Texas Transportation Institute

FY 2010 Budget

\$84,629

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RMC 4 – Active Projects

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0-5548 - Development of Field Performance Evaluation Tools and Program for Pavement Marking Materials

Start Date - 09/01/2007 **End Date** - 08/31/2010



Abstract

Historically the prequalification or selection of pavement marking materials (PMMs) is mainly based on product specifications and lab testing, which do not correlate well with the field performance of the products. This project will develop field performance-based evaluation procedures for PMMs. Field decks are expected to be designed incorporating regular long lines together with transverse stripes for accelerated testing. Field decks will be installed at selected locations in the state considering area climate, roadway surface type, and traffic condition. Carefully selected PMM products will be installed and monitored for their field performance over time. Field test results will be used to correlate with initial specifications to develop new performance based specifications. At the end of the project, a field performance database that can record and query all relevant data, track individual jobs and products, graphically display performance changes over time, and predict future performance of PMMs will be developed for the use of the Texas Department of transportation (TxDOT).

Project Director

Larry Colclasure, WAC

Project Advisors

Frank Phillips, LBB

George Villarreal, LBB

Janet Manley, BMT

Johnnie Miller, CST

Michael Chacon, TRF

Research Supervisor

Yunlong Zhang, TTI

Total Project Budget
\$316,742

Research Universities

Center for Multidisciplinary Research
in Transportation
Texas Transportation Institute

FY 2010 Budget

\$5,586
\$88,406

0-5856 - Safety and Economic Impacts of Converting Two-Way Frontage Roads to One-Way

Start Date - 09/01/2007 **End Date** - 08/31/2010



Abstract

When the opportunity arises, TxDOT is converting existing two-way frontage roads to one-way operation. Frequently the conversion projects occur at the urban fringe areas of rapidly growing communities. The motoring public is typically concerned about safety and mobility related to frontage road conversion, while business and property owners are concerned with economic impacts associated with access, business activity, and property values. This research will fill the need for updated and statistically valid information on the safety and economic impacts of frontage road conversion. To satisfy these needs, this research effort will satisfy three objectives: 1) develop accurate information that can be used to communicate the types of safety impacts that have been experienced and can be expected, 2) develop accurate information that can be used to communicate the types of economic impacts that have been experienced and can be expected, and 3) develop accident modification factors (AMFs) that roadway designers and decision-makers can use to guide frontage road conversion project planning. The research will produce technical documentation to address these objectives.

Project Director

Jonathan Bean, SAT

Project Advisors

Bob Appleton, BRY

Cathy Kratz, AUS

Chris Hehr, DES

Heath Bozeman, LBB

Julia (Julie) Brown, SAT

Stephen Gbur, BMT

Research Supervisor

William Eisele, TTI

Total Project Budget

\$389,244

Research Universities

Texas Transportation Institute

FY 2010 Budget

\$64,524

0-6031 - Analysis of Roadway Departure Crashes on Two-Lane Rural Roads in Texas

Start Date - 09/01/2007 End Date - 08/31/2010



Abstract

Nearly 80% of the roadways that are operated and maintained by the Texas Department of Transportation (TxDOT) are two-lane highways located in rural areas. In 2004, more than 1,300 fatal collisions occurred on Texas highways, with about 60% of those happening on rural two-lane roads. The crash statistics have shown that about 40% of these crashes are attributed to single-vehicle crashes, which includes roadway departure crashes. The high crash rates and fatality rates occurring on rural two-lane highways results in a high cost to all Texas motorists in terms of both lives and dollars and have prompted TxDOT to begin a statewide review of roadway departure crashes. This study will provide TxDOT valuable information about contributing factors associated with roadway departure crashes on rural two-lane highways on a district by district basis. The study will include identifiable crash patterns and high risk locations as well as site and operational variables influencing roadway departure crashes. The study will also provide engineering countermeasures to reduce the number and injury related to this category of crashes. The countermeasures will be tailored by district or region, as governed by the contributing factors identified in the first part of this study.

Project Director

Debra Vermillion, TRF

Project Advisors

Angie Ortegon, SJT
Herbert Bickley, LFK
Kelli Williams, ODA
Lance Simmons, ATL

Research Supervisor

Dominique Lord, TTI

Total Project Budget
\$489,509

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$173,744

0-6103 - Evaluation of Longitudinal Channelizing Barricade Effectiveness

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

Work zones create unexpected conditions for motorists. In some cases, the complexity of the work zone can make it difficult for motorists to identify the correct travel path, which can result in motorist confusion and possibly intrusion into the work zone. Longitudinal channelizing barricades (more recently referred to as longitudinal channelizing devices (LCDs)) are crashworthy, lightweight, deformable devices that can be connected together to create a continuous line (i.e., no spacing between devices). Currently, LCDs may be used instead of a line of cones, drums, or barricades (whose spacing is dependent upon the posted speed). However, research has not been conducted to assess whether LCDs used in continuous line applications improve traffic safety and operations of work zones. Therefore, currently no guidance is provided regarding the work zone configurations and conditions where LCDs should be considered in lieu of these other devices.

The objectives of the proposed research are to:

- determine whether LCDs used in continuous line applications improve traffic safety and operations of work zones relative to the use of other types of channelizing devices (cones, drums, etc.). and
- develop guidance regarding the application of LCDs in work zones.

Project Director

Doug Skowronek, TRF

Project Advisors

Cynthia Landez, DES

Gary Tarter, TRF

Michael Jedlicka, BRY

Paul Clutts, FHWA

Terry McCoy, AUS

Tom Beeman, DES

Research Supervisor

Melisa Finley, TTI

Total Project Budget
\$304,540

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$155,420

0-6106 - Lane Assignment Traffic Control Devices on Frontage Roads and Conventional Roads at Interchanges

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

The “Intersection and Mandatory Movement Lane Control Signs” placed on diamond intersection approaches are critical to safe and efficient intersection operations. Ramp, frontage road, and cross street approaches to diamond interchanges often widen at the intersection to accommodate additional through or turn lanes. Currently there is inconsistency in conveying to drivers how they should align themselves upstream of a diamond intersection to maneuver for their desired turning movement as the intersection widens. These inconsistencies can result in drivers making incorrect lane selection which may result in late lane changes or illegal turns. The proper placement of signs and markings may be some distance back from the intersection, prior to where the roadway widens. Conveying lane assignments at sufficient distance so the motorist understands to make necessary lane changes is challenging using existing TMUTCD guidance. TxDOT project 0-4170 produced the Freeway Signing Handbook. This handbook contained a section on frontage road signing largely based on the application of MUTCD principals; but no research on the recommended practices was conducted. The draft Freeway Signing Handbook has not been adopted by TxDOT. Neither the TMUTCD nor Federal MUTCD provide authoritative guidance on design and placement of lane assignment signs (or the use of signs in conjunction with lane assignment pavement markings).

Project Director

Mark Wooldridge, YKM

Project Advisors

David Valdez, TRF

Gregg Granato, SAT

Jim Heacock, HOU

John Nguyen, DAL

Larry Colclasure, WAC

Mark Olson, FHWA

Research Supervisor

Anthony Voight, TTI

Total Project Budget
\$284,455

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$149,255

0-6112 - Development of Guidelines for Triple Left and Dual Right-Turn Lanes

Start Date - 11/26/2008 End Date - 08/31/2010



Abstract

Triple left turn lanes and dual right-turn lanes are still considered as relatively new design alternatives that have been implemented in a very limited number of intersections in Texas. This project is intended to achieve two goals: (1) develop geometric design and installation guidelines for triple left-turn and dual right-turn lanes, and (2) evaluate the safety and operational performances of existing triple left-turn and dual right-turn lane sites in Texas. To this end, the research will (1) review existing design guidelines and practices regarding triple left-turn lanes and dual right-turn lanes around the country, (2) perform studies of existing triple left-turn and dual right-turn locations to document existing design issues and concerns, operational performance, and safety performance, (3) identify the important factors that affect the design, operation and safety of triple left-turn and dual right-turns, (4) develop geometric design criteria for triple left-turn and dual right-turn lanes, (5) develop installation criteria for determining when triple left-turn or dual right-turn lanes should be installed, and (6) develop guidance on the signal design for installation of triple left-turn or dual right-turn lanes.

Project Director

Roy Parikh, FTW

Project Advisors

Jane Lundquist, DES

John Black, CITY

John Gianotti, SAT

Mark Mathis, CITY

Stuart Corder, HOU

Research Supervisor

Scott Cooner, TTI

Total Project Budget
\$289,998

Research Universities
Texas Southern University
Texas Transportation Institute

FY 2010 Budget
\$85,250
\$69,749

0-6120 - An Evaluation of the Performance of High Impact Signs

Start Date - 10/30/2008 End Date - 08/31/2010



Abstract

There are approximately 15,000 Exit Gore signs installed on Texas highways. Because of their frequency and exposure to high-speed traffic, they remain one of the most commonly struck signs by errant vehicles. Thus, Exit Gore signs present a significant maintenance challenge for TxDOT; namely, the safety of personnel working in gore areas to replace these signs, and the resources (staff, equipment, and stock) that are necessary for continual maintenance. In addition, other roadside signs that are located near the travel lanes due to lack of available clear zone are also prime "high impact" candidates. The proposed research project will identify sites with safety problems related to high impact signs, diagnose the problems and recommend countermeasures using the Positive Guidance procedure. The countermeasures include alternative installation techniques and sign locations, and alternative signs/markings. The most promising countermeasures will be evaluated in the field.

Project Director

Ismael Soto, CRP

Project Advisors

Andrew Oberlander, DAL

Doug Skowronek, TRF

Edgar Fino, ELP

Michael Jedlicka, BRY

Research Supervisor

Geza Pesti, TTI

Total Project Budget
\$253,227

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$128,919

0-6121 - Prototype Design for a Predictive Model to Improve Evacuation Operations

Start Date - 02/17/2009 **End Date** - 01/31/2011



Abstract

As was demonstrated during the 2005 hurricane season, mass evacuations of the Texas Gulf Coast remain a difficult challenge. These events are massive in scale, highly complex, and entail an intricate, ever-changing conglomeration of technical and jurisdictional issues. While this project will focus primarily on the specific issue of developing a new technical tool to help TxDOT better predict when major elements of evacuation operations should be implemented, special attention will also be given to the important and delicate nature of the jurisdictional issues involved in making such decisions. In particular, technical analyses will be employed to develop a new decision support system that will enable TxDOT to more effectively decide when evacuation shoulder operations versus full contraflow operations are needed to manage evacuation demand. This new tool will have a predictive mechanism to provide TxDOT with adequate lead time to properly implement these two operational scenarios, so as to minimize excessive delays on primary evacuation routes or total system gridlock from which recovery may be extremely problematic or impossible.

Project Director

Ismael Soto, CRP

Project Advisors

Brian Stanford, TRF

Carla Baze, MNT

David Fink, HOU

Frank Bushong, TSD

Marla Jasek, YKM

Seth Jones, USACE

Stacey Worsham, MNT

Research Supervisor

Russell Henk, TTI

Total Project Budget
\$346,187

Research Universities
Texas Transportation Institute
University of Houston

FY 2010 Budget
\$143,658
\$45,741

0-6127 - Bicycle and Pedestrian Friendly Crossings at Freeway Interchanges

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

Bicycle and pedestrian travels have played historic roles in transportation. Bicycling is widely accepted as with the energy efficiency, cost effectiveness, health benefits and environmental advantages. The reduction in motor vehicle trips creates additional capacity and reduces physical wear on roadways which both contribute to longer life and increased value of those assets. Given their relatively small size, maneuvering, and the vulnerability of their riders, bicycles and pedestrians often have difficulty mixing with modern modes of transportation. Traveling behaviors of bicyclists and pedestrians are quite different with motorists. The goal of this research is to identify a design guideline on how to provide safe and efficient movement of bicycles and pedestrians crossing freeway interchanges. To this end, the research entails the following specific objectives: (1) Identify behaviors of bicyclists and pedestrians when crossing freeway interchanges; (2) Identify facilities that are suitable for bicycle and pedestrian crossing at freeway interchanges; (3) Develop systematic guidelines for bicycle and pedestrian crossing at interchanges. By this proposal, travel behaviors of bicyclists and pedestrians crossing freeway interchanges will be carefully studied through field surveillances and synthesis of successful practices. The TSU Mobile Van with Autoscope, an effective tool for monitoring and collecting on-site, real time traffic data at any locations, will be possibly employed in field surveillance. Guidance on bicycle and pedestrian friendly crossing at interchange will be finally synthesized.

Project Director

Chad Bohne, BRY

Project Advisors

Bob Appleton, BRY

Maria Burke, DES

Teri Kaplan, HOU

Research Supervisor

Fengxiang (George) Qiao, TSU

Total Project Budget
\$260,000

Research Universities
Texas Southern University
University of Texas at Arlington

FY 2010 Budget
\$100,000
\$30,000

0-6135 - Super 2 Design for Higher Traffic Volumes

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

As traffic volumes increase statewide, the demand on the state's network of two-lane highways also increases. The increased volumes have an effect on congestion, air quality, and safety as traffic density increases, often approaching the limits of capacity for two-lane highways. High proportions of heavy vehicles compound the problem, contributing to a decrease in safety as impatient drivers attempt to pass slower vehicles in no-passing zones or pass trucks despite having diminished sight distance beyond such vehicles. Previous research (TxDOT Project 0-4064, "Design Criteria for Improved Two Lane Section (Super 2)") demonstrated that periodic passing lanes can improve operations on two-lane highways with low to moderate volumes; these "Super 2" highways can provide many of the benefits of a four-lane alignment at lower cost. The current Texas Roadway Design Manual contains these guidelines for highways with Average Daily Traffic (ADT) lower than 5000. This proposed project will expand on that research to develop design guidelines for length and spacing of passing lanes on two-lane highways with higher volumes. As in Project 0-4064, this project will consider the effects of volume and terrain on traffic flow; in addition, the effects of varying proportions of heavy vehicles will also be considered.

Project Director

Mark Wooldridge, YKM

Project Advisors

A. Rory Meza, DES

Chris Reed, CHS

David Harper, LBB

Roy Wright, ABL

Research Supervisor

Marcus Brewer, TTI

Total Project Budget
\$270,155

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$136,300

0-6143 - Standards for Mounting Traffic Control Signs and Devices on Concrete Traffic Barrier (CTB) in Construction Work Zones

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

Portable concrete traffic barriers (CTBs) have many uses on construction projects. A common use is to provide positive separation between opposing traffic streams on construction projects. One of the challenges in work zones is to provide signs that are visible to the traffic driving in the left lanes of a multi-lane construction work zone. Often, there is not enough room on the shoulder, or high speed traffic makes the support unstable. One solution would be to mount the signs on the center CTB. This would require a detachable system to attach such signs. The purpose of this project is to develop a crashworthy sign that is attached to the top of a portable concrete traffic barrier. The goal of this research will be to develop a sign mount connection that could be incorporated into the TxDOT standard specifications for signs used in construction work zones.

Project Director

Tracey Friggle, DAL

Project Advisors

Doug Skowronek, TRF
James (Kelly) Selman, DAL
Stuart Corder, HOU

Research Supervisor

William Williams, TTI

Total Project Budget
\$219,878

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$103,896

0-6163 - Improved Positive Protection Guidance for Work Zones

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

FHWA regulations (23 CFR 630.1102-1110) require states to establish explicit policies and procedures to guide when and where positive protection is to be used in work zones, as well as the type of protection that will be provided. Currently, TxDOT guidance regarding portable concrete barrier (the most common type of positive protection) use in work zones is rather limited. In addition, technologies such as steel barriers and low-profile concrete barriers which are more portable and thus less costly to install, move, and remove are now more readily available but guidance on their application is not available. In some work zones, alternatives to physical barriers that could reduce vehicle intrusion risk into the work zone (law enforcement, speed trailers, enhanced Portable Changeable Message Signs (PCMS) usage, etc.) may actually be more practical and cost effective for TxDOT to implement, but guidance on when and where to do this is also not available. In this project, researchers are conducting a variety of different analyses to assess the safety, cost, and other qualitative trade-offs of each of the above technologies and strategies for providing positive protection in work zones. These analyses will be used to develop improved guidance on when and where positive protection should be used as well as the type of positive protection technology that should be used for the specific roadway and work zone conditions that exist for a particular project.

Project Director

Ismael Soto, CRP

Project Advisors

Bobby Dye, DES

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Research Supervisor

Gerald Ullman, TTI

Total Project Budget
\$298,576

Research Universities

Texas A&M University – Kingsville

Texas Transportation Institute

FY 2010 Budget

\$32,898

\$117,000

0-6167 - Assessment of Need and Feasibility of Truck-Mounted Changeable Message Signs (CMS) for Scheduled and Unscheduled Operations

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

Unscheduled operations are typically characterized by work that is present at any one location for a very short duration (such as debris removal, snow/ice removal, incident management, hurricane evacuation, etc.) and is therefore not recognized as a common condition for drivers. This project will focus on the use of truck-mounted changeable message signs (TMCMSs) as a possible means of providing increased information to motorists regarding conditions downstream of their current location. More specifically, researchers will evaluate the types of hazards and/or issues that could be addressed through the use of TMCMS and the symbol or text displays that would be appropriate for different scenarios. A thorough review of the state-of-the-practice will help to identify scenarios that could be considered in this evaluation. Additionally, the research project will employ both human factors motorist comprehension and field evaluation studies to evaluate the effects of the TMCMS information on the identified scenarios. At the end of the project, researchers will develop guidelines regarding the implementation of TMCMS during unscheduled operations.

Project Director

Christopher Freeman, AMA

Project Advisors

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Research Supervisor

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Total Project Budget
\$209,090

Research Universities

Texas A&M University – Kingsville
Texas Transportation Institute

FY 2010 Budget
\$49,461
\$60,105

0-6173 - Driver Understanding of Congestion-Based Pricing Messages

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

Changeable message signs (CMS), also called variable message signs (VMS) or dynamic message signs (DMS), are programmable traffic control devices that display messages composed of letters, symbols, or both. It is important to design and display CMS which are employed to convey pertinent, real-time, and remotely updated traffic information, including the dynamic pricing messages. Several toll roads/managed lanes in Texas will use dynamic pricing displays. In order to display the congestion-based pricing messages, several key research issues should be addressed, including: (1) what is the maximum number of lines of text per sign; (2) what is the drivers' comprehension to dynamic pricing messages; (3) how many destinations should be listed on each sign board; (4) is it necessary to list other dynamic information such as travel time simultaneously; and (5) will the dynamic pricing message add unsuitable workloads to motorists. Therefore, there is a strong need to synthesize the current relevant practices and research on pricing message design, and prepare guidelines for the use of CMS in dynamic congestion-based pricing messages. The goal of this study is to ascertain driver's understanding of congestion-based pricing messages. To this end, the research entails the following specific objectives: (1) evaluate drivers' psychological behaviors and workload in designing congestion-based pricing messages; (2) simulate and examine the driver's understanding of pricing messages using a driving simulator; and (3) develop guidelines for changeable message signs with regards to static and dynamic components of the sign, and to the number of signs and placement of signs.

Project Director

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Project Advisors

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Edgar Fino, ELP

Jianming Ma, TRF

Mark Olson, FHWA

Michael Chacon, TRF

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Total Project Budget

\$328,641

Research Universities

Texas Southern University

Texas Transportation Institute

FY 2010 Budget

\$129,595

\$28,909

0-6177 - Portable Traffic Signal Monitoring and Evaluation Toolbox to Improve Signal Operations and Safety

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

Traffic signal operators are faced with the challenge of documenting signal operations. Typically operators program signal timings and do not have the resources to conduct a long-term monitoring of the new signal timing changes. Some of the settings may or may not be appropriate. Similarly operators frequently get complaints from motorists about detection operations especially video detection. However, the signal engineers and technicians are often unable to replicate the described problem. Signal operators need a tool to document traffic signal controller and detection operations in order to diagnose problems reported and develop appropriate solutions. This tool can be used as a maintenance device due to the scarcity of man power in most districts. This project will deliver a toolbox consisting of hardware and software that will interface with the TS-2 signal controller cabinets which TxDOT uses to operate traffic signals. The toolbox's hardware will be built from off-the-shelf components in a cost-effective manner. The toolbox comprises of a miniature field hardened computer, a simple and easy interface to connect to a TS-2 traffic cabinet, and software that will interface, log, and analyze the signal operation in the field and provide a report to the operators.

Project Director

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Herbert Bickley, LFK

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Total Project Budget
\$260,000

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$134,000

0-6262 - Signing Guidelines for Flooding Conditions and Warrants for Flooded Conditions Detection Systems

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

In Texas, approximately eight flood-related fatalities occur each year – the majority of these (78.6 percent) involve motorists that are trapped in their vehicles or washed away. In many cases, victims, not wanting to take a lengthy detour, ignored barricades and tried to drive across a flooded street or low-water crossing – literally driving themselves into harms way. It takes as little as two feet of water to float most cars. Several districts in Texas have developed different signing strategies for warning motorists of low water crossings. As part of this research, Texas Transportation Institute (TTI) will be developing guidelines and recommendations for creating signing uniformity for low water and flood-prone section of roadways. Signing guidelines will be created for following situations: 1) the beginning of a roadway section that has several low water crossings where water flows over the roadway in wet conditions, 2) at the actual low water crossing, and 3) for temporary road closures due to high water. TTI will also develop criteria for when to implement active water level detection and advance warning systems at low water crossings and flood-prone roadway sections.

Project Director

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Project Advisors

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Mitch Murrell, TRF

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Research Supervisor

Kevin Balke, TTI

Total Project Budget
\$253,010

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$128,480

0-6267 - Benefits of Public Roadside Safety Rest Areas in Texas

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

Despite their popularity with the public, increased competition for public funding and concurrent increases in safety rest area costs, have brought into question the cost-effectiveness of publicly funded safety rest areas in Texas. To adequately respond to this question, a reliable and acceptable method for comparing safety rest area benefits with costs is required. While the costs associated with safety rest areas are typically well-defined, many of the benefits and disbenefits of rest areas may be difficult to quantify. The objective of this project is to develop such a benefit-cost analysis methodology for safety rest areas in Texas and to demonstrate its application in select corridors throughout the state. In addition, this project will consider novel safety rest area development approaches that could reduce the public cost burden borne by individual public agencies. The proposed research will characterize available data to support safety rest area benefit-cost analysis in Texas, assess existing benefit-cost methods identified through literature and state of the practice review, develop and apply a unique safety rest area benefit-cost analysis methodology for Texas, and explore alternate safety rest area development opportunities.

Project Director

Andy Keith, MNT

Project Advisors

Jim Hollis, TRF

Paul Campbell, MNT

Brenda Harper, TRV

Martha Martin, TRV

Research Supervisor

Jodi Carson, TTI

Total Project Budget
\$213,770

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$102,750

0-6363 - Improvements to Large and Small Roadside Sign Hardware and Design

Start Date - 09/01/2008 **End Date** - 08/31/2010



Abstract

Many of the design practices that TxDOT uses for large and small sign mountings were established many years ago. These mounting details may no longer be appropriate given changes in sign materials, fabrication methods, and installation practices. Further, the vehicle fleet and operating conditions on our highways have changed considerably, and there is a need to assess the compliance of some existing sign support systems with current vehicle testing criteria, and to evaluate new technologies that offer to enhance performance and maintenance. This two-year research project is designed to provide the Texas Department of Transportation (TxDOT) with a comprehensive review and update of mounting details and standards for large and small sign supports, and to provide a mechanism for TxDOT to quickly and effectively evaluate and address high priority needs related to sign support systems. The information provided through the project will be used to update standard Sign Mounting Detail (SMD) sheets, revise or set policies and standards, and evaluate new products and technologies. The issues to be researched under this project will be formulated on an annual basis, with the ability to modify priorities as needed.

Project Director

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Research Supervisor

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Total Project Budget
\$249,976

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$126,474

0-6390 - Asset Management for Safety and Operations

Start Date - 06/02/2009 **End Date** - 04/30/2011



Abstract

TxDOT is challenged with managing a wide range of transportation safety and operations assets in order to respond to public and other outside interests. These assets include, but are not limited to pavements, pavement markings, raised pavement markers, structures, roadside signs, traffic signals, roadway illumination, traffic barriers, guard fences, attenuators, maintenance equipment, vehicles, ITS equipment, traffic detection equipment, real estate, corporate data, and materials. Asset management is a comprehensive strategic approach to documenting and managing these assets, as well as using information gathered during the process to assist TxDOT in making cost-effective investment decisions. This project will provide TxDOT with guidance on developing a well-designed asset management system as a critical component of the agency's approach to providing for the mobility of its customers, preserving the infrastructure already in place, planning for future improvements of that infrastructure, and being responsive and accountable to the public regarding the investment of their tax dollars. Such a system will be an integral part of TxDOT's ability to meet its goals of reducing congestion, enhancing safety, expanding economic opportunity, improving air quality, and increasing the value of transportation assets.

Project Director

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Justin Obinna, MNT
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Mike Alford, HOU
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Total Project Budget
\$297,252

Research Universities
Prairie View A&M University
Texas Transportation Institute

FY 2010 Budget
\$40,394
\$130,042

0-6401 - Night Time Speed Limit and Truck Speed Limits

Start Date - 09/01/2009 **End Date** - 08/31/2012



Abstract

Legal maximum speeds establish the upper boundary of speed limits. In Texas, speed limits vary by vehicle type and light condition. While there are a few states that have nighttime speed limits for certain functional classes of roadway, Texas is the only state with a universal night speed limit. Texas also maintains provisions for separate truck speed limits. The assumptions for the use of truck speed limits include consideration of trucks' heavier loads, which translates to longer stopping distances. It is also partly based on environmental concerns stemming from the smog-forming emissions created from large trucks traveling at high rates of speeds. The objective of this research project is to determine the effectiveness of the current Texas statewide nighttime and truck speed limits.

Project Director

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Project Advisors

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Joseph Marchione, TRF

Julia Perschnick, LBB

Mark Shafer, BRY

Steven Swindell, BRY

Research Supervisor

Kay Fitzpatrick, TTI

Total Project Budget
\$495,850

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$168,024

0-6402 - Development of Pedestrian Safety Based Warrants for Protected or Protected/Permissive Left-Turn (PPLT) Control

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

For intersections with a permissive or a protected-permissive left-turn mode, pedestrians cross during the permissive period along with the parallel through vehicular movement. This requires the left-turn driver to yield to both opposing vehicles and pedestrians prior to accepting an appropriate gap. Pedestrian crash risks are increased in these complicated driving conditions because left-turn drivers sometimes make misjudgments and fail to yield to pedestrians.

Existing left-turn mode selection guidelines focus mainly on the vehicular traffic conditions at the intersection. Few of them include specific consideration of pedestrian safety. For example, existing guidelines for protected-permissive control typically focus on the left-turn and opposing through traffic volumes. Very few of these guidelines include a sensitivity to pedestrian volume or other pedestrian safety-related factors (e.g., sun glare, driver sight distance).

The objective of this research is to develop pedestrian safety-based warrants for protected or protected-permissive left-turn control. More generally, the products of this project will provide guidelines that can be used to improve the safety of signalized intersections. The proposed research will be comprehensive in its consideration of pedestrian safety issues at signalized intersections in Texas. The proposed guidelines will be documented in a stand-alone quick reference guide, as well as in an updated version of the Traffic Signal Operations Handbook (previously developed for TxDOT in project 0-5629).

Project Director

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Project Advisors

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John Gianotti, SAT

Scott Cunningham, AUS

Wendy Simmons, TYL

Research Supervisor

James Bonneson, TTI

Total Project Budget
\$244,000

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$135,200

0-6407 - Evaluation of the Effectiveness of Automated Flagger Assistance Devices

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

When a lane is closed on a two-lane, two-way roadway flaggers are typically used to control the flow of traffic through the work zone. While various measures have been implemented in recent years to improve the safety and effectiveness of flaggers, accidents involving flaggers still occur and quite often result in serious injury to the flagger. There is also a similar issue with the safety of school crossing guards trying to stop drivers before school children enter the crosswalk, especially on high volume roadways.

In 2004, the Federal Highway Administration (FHWA) approved the use of automated flagger assistance devices (AFADs) to reduce flagger exposure to highway user traffic. AFADs can be located in the travel lane and remotely operated by a flagger located off the roadway. Thus, AFADs remove the flaggers from direct contact with moving vehicles. AFADs might also increase the sight distance to the lane closure. However, there are concerns that AFADs may confuse drivers or garner less respect and thus result in decreased compliance with flagger instructions. Either of these situations could lead to drivers entering the lane closure under STOP conditions.

Project Director

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Research Supervisor

Melisa Finley, TTI

Research is needed to determine the operational and safety effectiveness of AFADs relative to the use of flaggers at lane closures on two-lane, two-way roadways. Research is also needed to identify and assess potential portable devices that can be remotely operated by school crossing guards.

The specific objectives of the proposed research are to: identify appropriate portable devices that can be remotely operated by school crossing guards, identify potential AFAD improvements, determine driver understanding of AFADs and other remotely operated devices, determine the operational and safety effectiveness of AFADs and other remotely operated devices, develop guidance regarding the application of AFADs in work zones, and develop guidance regarding the use of remotely operated devices by school crossing guards.

Total Project Budget
\$347,581

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$196,073

0-6408 - Development of a Statewide Sign Maintenance Program

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

A new national requirement was added to the Manual on Traffic Control Devices (MUTCD) that requires traffic sign retroreflectivity to be maintained to specific levels, depending on the sign color and type of sheeting. While TxDOT currently practices an annual nighttime inspection program, there is no consistency statewide in the documentation and disposition of the data. Specific research is needed to determine the most cost effective manner to ensure, document, and certify that TxDOT meets the new retroreflectivity requirements. The research proposed has been carefully designed to consider the elements unique to TxDOT while leveraging national expertise and experience to develop a recommended statewide traffic sign retroreflectivity maintenance method that is easy to implement, meets the MUTCD requirements, and protects the State from tort.

Project Director

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Project Advisors

Ali Esmaili-Doki, PAR

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Gary McLendon, LBB

Lowell Choate, AUS

Wally Shaw, TRF

Research Supervisor

Paul Carlson, TTI

Total Project Budget
\$254,564

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$124,317

0-6414 - Development of Guidelines for Implementation of Roundabouts in Texas

Start Date - 09/01/2009 End Date - 08/31/2011



Abstract

Modern roundabouts are becoming increasingly common in the United States as a means to safely and efficiently serve traffic at intersections. Early roundabout design and construction in the U.S. brought about a national set of guidelines published in 2000 as well as a series of subsequent state guidelines for analyzing, designing, and implementing roundabouts. These initial guidance documents are based on research conducted on roundabouts outside of the U.S.; this was necessary due to the limited number of U.S. roundabouts. During the last ten years, data regarding U.S. roundabouts has become sufficient to enable roundabout research specific to the U.S. Recent findings indicate some of the initial roundabout methodologies are not representative of U.S. roundabout performance. The roundabout guidelines for Texas should incorporate the past successful roundabout practices, recent research reflecting U.S. roundabout performance, and conditions specific to Texas.

Research team members were involved in the initial roundabout guidelines developed at the national and state levels; they have also been (and are currently) involved in the recent research indicating the need to update previous methodologies. This provides the team with a unique and valuable perspective as well as a comprehensive understanding of the key components for developing meaningful and useful roundabout guidelines. These components are:

- i. Synthesis: Conducting a thorough and systematic review of previous guidance documents, current practices, and recent research findings to form a foundation for roundabout safety and operations methodologies and geometric design principles.
- ii. Methodological Development: Developing an initial set of methodologies and guidance for assessing roundabout safety, evaluating roundabout operations, and designing roundabouts (this innovative stage, as well as iii below, are critical due to the identified gaps in U.S. roundabout research).
- iii. Validation and Enhancement: Applying microsimulation techniques to validate and, as necessary, refine the initial methodologies to reasonably reflect conditions specific to Texas.
- iv. Implementation Support: Produce a benefit/cost evaluation framework to holistically assess the value of a roundabout versus other intersection alternatives. Develop a consistent implementation process outlining a means to strategically identify and evaluate candidate roundabout locations.
- v. Knowledge Transfer: Transfer the roundabout knowledge contained in the research process and final products to TxDOT planners and engineers.

Project Director

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Project Advisors

Andrew Wanees, AUS
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Dustin Wiggins, TRF
Jesse Herrera, PAR
Pete Krause, DES
Rebecca Wells, ATL
Wayne Rehnborg, AUS

Research Supervisor

S. Travis Waller, CTR

The components outlined above form a cohesive process capitalizing on the success of existing U.S. roundabouts, cutting edge research, and driving conditions in Texas. The validation and enhancement phase as well as the knowledge transfer phase are key components to creating a set of roundabout guidelines specific to Texas and readily accessible to TxDOT personnel.

Total Project Budget
\$281,558

Research Universities
Center for Transportation Research
Texas A&M University – Kingsville

FY 2010 Budget
\$123,625
\$15,004

0-6427 - Integration of Rural Work Zone ITS into the Statewide ITS Architecture

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

State and local governments receiving federal-aid funding are required to comply with the Work Zone Safety and Mobility Rule published in the Federal Register in 2004. The rule encourages states to look at work zone traffic control in a system perspective, and manage work zone impacts at corridor, network and regional levels.

This project will explore the value and define an approach to integrating data collected and traveler information displayed in a work zone with a regional transportation management center and/or other state websites. The project will conduct a literature review to define the state of the practice in work zone ITS (smart zones) and work with TxDOT traffic managers to identify their safety and mobility needs in a work zone and where ITS can play a role. A market review will be conducted to find current product offerings which provide solutions to address the identified work zone needs. An architecture will be developed for integrating work zone ITS data from these products into a regional transportation management center. Finally, the project will explore new uses of work zone information and make recommendations for operating existing ITS systems in concert with the smart zone.

Project Director

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Robert Wheeler, TRF

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Ugonna Ughanze, HOU

Research Supervisor

Leonard Ruback, TTI

Total Project Budget
\$263,040

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$129,452

0-6432 - Low Cost Wireless Network Camera Sensors for Data Collection and Traffic Monitoring

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

Video traffic surveillance is expensive because of the high cost of initial investment, long term maintenance, communication service fee, and the requirement of operator monitoring of the visuals. Low- and medium cost cameras are proliferating. Coupled with the advance of wireless communication technologies, it is timely for TxDOT to investigate how to bring the costs of traffic surveillance down to allow large coverage and safety. The objective of this project is to enable TxDOT districts to deploy video surveillance cameras with ease and low cost. Towards this objective, we will achieve four goals in the project. The first goal is to compile a list of low-cost camera technologies appropriate for traffic monitoring and compare them. The second goal is to survey the current communication technologies applicable to traffic video surveillance and compare the installation and maintenance costs. The compatibility of the video cameras with the telemetry methods will be investigated as well. The third goal is to propose and prototype a system architecture that will allow the detection of vehicles and pedestrians and transmit the processed data to a TMC. The fourth goal is to investigate video analytics to allow autonomous monitoring of typical situations and generate alarms when necessary. This approach can free operators for other important duties and allow continuous monitoring thus improving safety. The system will be prototyped and tested on a selected freeway site.

Project Director

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Mitch Murrell, TRF

Valerie Taylor, HOU

Joe Hunt, DAL

Research Supervisor

Yan Huang, UNT

Total Project Budget
\$138,178

Research Universities
University of North Texas

FY 2010 Budget
\$70,505

0-6462 - Evaluation of Modern Traffic Control Devices to Improve Safety at Rural Intersections

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

In Texas, about one-third of all crashes on rural highways occur at intersections. The combination of high speed and multiple, complex guidance and navigational choices at rural intersections complicate the driving task and increase the potential for a severe crash. Various design and traffic control device (TCD) improvements are implemented to decrease the likelihood of a crash. Engineers are frequently required to make improvements to an intersection to increase the conspicuity (to decrease Stop sign violations), and to provide more information about approaching traffic on the major road. In order to use available funds judiciously, engineers make incremental improvements. The steps used during the incremental improvements and whether a TCD will be used uniquely or in combination with other devices vary. This research project is to evaluate different TCD alternatives for use at a rural, stop-controlled intersection along with evaluating reasonable sequence(s) for implementing progressively more expensive devices.

Project Director

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Ellen Perry, PAR

George Villarreal, LBB

Michelle Cooper, AUS

Research Supervisor

Kay Fitzpatrick, TTI

Total Project Budget
\$316,445

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$152,160

0-6568 - Use of Flashing Yellow Operations to Improve Safety at Signals with Protected-Permissive Left Turn (PPLT) Operations

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

Use of flashing yellow operations with protective/permissive left-turn (PPLT) has been proved by previous studies to be able to improve safety and efficiency of intersections. Currently, there is no clear guidance on how to implement flashing yellow operations with PPLT in Texas. The proposed project is to develop guidelines for the implementation of the flashing yellow arrow with protected-permissive left-turn (FYAPPLT) display operations in Texas. For this purpose, the research will 1) review and synthesize the state or national practices on the FYAPPLT display, 2) identify the software and hardware issues with the deployment of the FYAPPLT display, 3) conduct stage 1 field test at two selected intersections, 4) identify problems encountered in the stage 1 field test, 5) deploy the FYAPPLT display at the two original stage 1 field test intersections and three additional selected intersections (five total intersections) as a stage 2 field test, 6) evaluate the safety performance of the FYA operations from the deployment of the FYAPPLT stage 2 field test, 7) develop guidelines for the implementation of the FYAPPLT display, and 8) provide training strategies and materials for TxDOT personnel as a workshop.

Project Director

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Project Advisors

Carlos Ibarra, ATL

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Cynthia Flores, TRF

Michael Chacon, TRF

Research Supervisor

Yi (Grace) Qi, TSU

Total Project Budget
\$251,301

Research Universities

Center for Transportation Research

Texas Southern University

FY 2010 Budget

\$25,000

\$110,780

0-6576 - Safety Implications of Using Active Traffic Strategies on TxDOT Freeways

Start Date - 09/01/2009 End Date - 08/31/2011



Abstract

While traffic congestion tends to continuously increase, growth in transportation infrastructure is limited by financial and land availability constraints, especially in urban areas. This has led to the use of Intelligent Transportation Systems (ITS) to manage existing transportation systems efficiently, including Active Traffic Management (ATM) strategies, which manage the transportation system by responding to prevailing road, traffic, and weather conditions in real time, in order to increase safety and operational reliability.

Public agencies have little guidance to suggest how, when, and where, ATM should be employed to *maximize benefits both to individual corridors and to the entire system*. Furthermore, innovative strategies continue to be developed, suggesting that *evaluation frameworks are needed both for existing strategies as well as for new methods* which may be developed in the future. A natural pattern for determining the effects of ATM is to trace the impacts from design decisions to the key measures of effectiveness, through the following four steps: 1) **Design and Geometry**. As ATM strategies are not familiar to all drivers, a standardized design is needed to ensure comprehension. 2) **Behavior and Compliance**. Drivers respond to ATM according to the information presented to them (that is, based on the design and geometry) and to their own motivations (such as arriving at a destination quickly). By quantifying these motivations along with the role of enforcement on compliance, the effects of ATM can be more accurately predicted. 3) **Operations and Congestion**. The collective behavior of drivers in response to ATM determines the operational state of the traffic stream after implementation, including any changes in volume, travel speed, speed differentials, and merging frequency or bottleneck locations. These changes in system state are critical for determining step 4. 4) **Safety and Reliability**. Changes in traffic operations will manifest as changes in incident frequency and severity, travel reliability, and other key measures of effectiveness which determine the overall success of an ATM strategy.

The primary innovation described here is the collective examination of quantified models within the aforementioned areas. *This is novel but critical since the relationship between agency decisions (design and geometry) and final outcomes (safety and reliability) is mediated through driver behavior and operational traffic flow relations* which must be accounted for to construct general

Project Director

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guidelines, especially where innovative ATM strategies are considered. Therefore, methods are required in *each* of the 4 steps or the safety analysis of ATM is critically incomplete because each area represents an essential step in the determination of safety impacts.

Finally, the effects must be measured at both the corridor and network-level scales in order to ensure that benefits to a facility where ATM is implemented are not outweighed by disbenefits elsewhere, and an economic cost-benefit analysis must be applied to synthesize the safety, reliability, and other impacts into a comprehensive assessment.

Total Project Budget
\$278,435

Research Universities
Center for Transportation Research
Texas A&M University – Kingsville

FY 2010 Budget
\$122,182
\$15,004

9-1001 - Traffic Control Device Evaluation Program

Start Date - 09/01/2009 **End Date** - 08/31/2013



Abstract

This project will provide the Texas Department of Transportation a mechanism to quickly and effectively conduct high priority limited scope evaluations of traffic control devices (TCD). The information provided through the project will support the development of TCD related policy, standards, guidelines, handbooks, and training.

The traffic control device issues to be evaluated in this project may represent a new device or technology, a new application of an existing device or technology, or a change in TxDOT practices regarding a traffic control device. The research efforts of this project are specifically oriented to provide results that will lead directly to implementation of results.

Project Director

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Roy Wright, ABL

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Research Supervisor

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Total Project Budget
\$800,000

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$200,000

9-1002 - Roadside Safety Device Crash Testing Program

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

This project provides TxDOT with a mechanism to quickly and effectively evaluate high priority issues related to roadside safety devices. Roadside safety devices shield motorists from roadside hazards such as nontraversable terrain and fixed objects. To maintain the desired level of safety for the motoring public, these safety devices must be designed to accommodate a variety of site conditions, placement locations, and a changing vehicle fleet. As changes are made or in-service problems encountered, there is a need to assess the compliance of existing safety devices with current vehicle testing criteria and, if problems are identified, to modify the device or develop a new device with enhanced performance and maintenance characteristics. Under this project, roadside safety issues will be identified and prioritized for investigation. The selected safety issues will be evaluated through crash data analyses, engineering analyses, computer simulation, dynamic impact testing, and full-scale vehicular crash testing as appropriate. Factors such as impact performance, maintenance, and cost will be considered. Each roadside safety issue will be addressed with a separate work plan, and the results will be summarized in an individual technical memorandum. Each technical memorandum will include new guidelines or drawings to be incorporated into design manuals and new or revised standard detail sheets, as appropriate.

Project Director

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Bobby Dye, DES

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Research Supervisor

Roger Bligh, TTI

Total Project Budget
\$1,000,000

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$500,000

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0-4562 - Corrosion Resistance of Grouted Post-Tensioning Systems

Start Date - 09/01/2002 **End Date** - 08/31/2013



Abstract

Numerous examples of corrosion in post-tensioning systems and failures of tendons have been observed in Europe and the United States in recent years. Examples have been cited recently in some of Florida's major bridges. The cause of corrosion and accelerated deterioration of post tensioning systems can be traced to several sources, including: incomplete flushing of water prior to the grouting process, incomplete grouting of post-tensioning tendons, excessive bleed water, leaky precast joints, cracking of polyethylene pipe, and poor post-tensioning system details that permit recharge of tendons, to list a few. The proposed first phase of this project will identify oils or other products that will provide temporary corrosion protection in post-tensioned tendons which have not yet been stressed and grouted during the construction process. This first phase of the research will investigate how these oils affect friction losses during post-tensioning, determine the impact that emulsifiable oils have on bond strength of multi-strand tendons, and examine how flexural capacity is affected by the expected loss in bond strength. The second phase of the project will identify post-tensioning systems and materials candidates for alternate corrosion-resistant post-tensioning systems, examine physical and mechanical properties of new materials, identify and evaluate potential accelerated corrosion test methods, plan and implement a series of tests to examine the durability of post-tensioning materials and systems, consider the constructability and behavior of post-tensioning systems incorporating corrosion-resistant materials or details identified through durability testing, and develop recommendations for implementation of alternate corrosion-resistant post-tensioning systems.

Project Director

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Research Supervisor

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Total Project Budget

\$1,170,144

Research Universities

Center for Transportation Research

FY 2010 Budget

\$55,000

0-5255 - Steel Fiber Replacement of Mild Steel in Prestressed Concrete Beams

Start Date - 09/01/2006 **End Date** - 08/31/2010



Abstract

In traditional prestressed concrete beams, longitudinal prestressed tendons serve to resist bending moment, and transverse mild steel bars (or stirrups) are used to carry shear forces. However, traditional prestressed I-beams exhibit brittle shear failure and early-age cracking, despite a high percentage of stirrups at the end zones. Moreover, producing and placing stirrups require costly labor and time. To overcome these difficulties, it is proposed to replace stirrups in prestressed concrete beams, partially or completely, with steel fibers. This replacement concept was shown to be feasible in a TxDOT project recently completed at the University of Houston (Dhonde et al. 2006). The replacement of stirrups by steel fibers in highway beams requires a set of shear design provisions and guidelines for Prestressed Fiber Concrete (PFC) beams. The development of rational shear provisions with wide applications must be guided by a mechanics based shear theory and must be validated by experimental tests on I-beams and box-beams. A rational shear theory, called Softened Membrane Model (SMM), has been developed at the University of Houston for reinforced concrete beams (Hsu and Zhu 2002). This theory satisfies Navier's three principles of mechanics of materials, namely, the stress equilibrium, strain compatibility and the stress-strain curves (constitutive laws) of materials. The researchers propose to expand the SMM model to PFC beams by establishing the constitutive laws of PFC elements. In this project the

proposed approach consists of three steps: (1) To test 10 full-size PFC panels, in order to establish the effect of fiber index and the level of prestress on the constitutive laws of fiber concrete and prestressing tendons. (2) To generalize the SMM shear theory for application to PFC beams. This can be achieved by feeding the new constitutive laws of fiber concrete and prestressing tendons into the theoretical model. (3) To evaluate the accuracy of the new shear theory for PFC beams by testing full-size I- and box-beams that fail in various shear modes.

Project Director

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Total Project Budget

\$686,774

Research Universities

University of Houston

FY 2010 Budget

\$160,795

0-5701 - Cross-frame and Diaphragm Layout and Connection Details

Start Date - 09/01/2007 **End Date** - 08/31/2010



Abstract

Cross-frames and diaphragms play an important role in the behavior of straight and curved steel bridge systems. These braces provide stability to straight girders during construction and serve as primary structural members in resisting torsion in curved bridges. Due to complexities in fabrication details and difficulties during erection and construction, these braces are often a large component of the cost of the overall bridge system. The costs associated with the braces can be increased further by maintenance issues during the service life of the bridge, as the cross-frame or diaphragm connections are often the most frequent locations of fatigue problems in steel bridges. Because of the many factors that affect the behavior of the braces, designers are often faced with difficult decisions regarding cross-frame and diaphragm detailing in steel bridges—particularly in bridges with skewed supports. The research will consider both the stability and fatigue performance of the bracing connections, as well as practical issues related to fabrication and erection. While the bent plates are likely satisfactory for small skew angles, at large skew angles the brace forces cause large bending deformation of the plates, greatly reducing the stiffness of the brace. Large skew angles would require very thick bent connection plates to provide the required stiffness and strength. The limiting magnitude of the skew angle that economical bent plates can be used will be identified. The performance of cross-frames and diaphragms oriented along a staggered layout will also be evaluated. The use of staggered cross-frames can be useful: they permit the perpendicular stiffener orientation while also minimizing live load induced forces because they connect to adjacent girders at similar positions along the respective girder lengths. The work will be accomplished with laboratory testing, parametric finite element analysis, as well as soliciting feedback from designers and fabricators so that the resulting connection satisfies both functional and practical criteria. The resulting recommendations will provide designers with practical detailing options and guidance relating to skewed diaphragm connections and configuration of torsional bracing systems.

Project Director

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Total Project Budget
\$538,407

Research Universities
Center for Transportation Research

FY 2010 Budget
\$192,663

0-5722 - Lap Splice and Development Length Performance in ASR and/or DEF Damaged Concrete Elements

Start Date - 09/01/2006 **End Date** - 08/31/2010



Abstract

Bridge structures in Texas are exhibiting damage from alkali silica reactions (ASR) and delayed ettringite formation (DEF). Significant work has been performed on evaluating the mechanisms of deterioration and methods to slow or stop these mechanisms. However, limited work has been performed to evaluate the implications of this damage on the performance of a structure exhibiting these deteriorating mechanisms. Some work has been performed on bending and shear of reinforced concrete structural members exhibiting damage from ASR and/or DEF. However, very limited work has been performed to assess the influence of ASR and/or DEF on the bond, development length, and lap length. Existing structures encounter significant forces at several locations where bond is critical to the structure performance. Cracking resulting from ASR or DEF can reduce this bond and development length. The research proposed herein is to perform a comprehensive, statistically valid research program that will assess the influence of ASR/DEF on bond. The study will generate sufficient data such that visual inspections can be correlated with structural reliability, and will evaluate various repair strategies such that recommendations can be made when there is a future potential for bond failure.

Project Director

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Total Project Budget
\$999,988

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$218,812

0-5831 - Shear Behavior of Prestressed Concrete U-Beam Ends Blocks

Start Date - 09/01/2007 End Date - 08/31/2012



Abstract

The Texas Department of Transportation (TxDOT) has been a leader in the design of cost effective prestressed concrete bridges for nearly 50 years. During this time, typical spans have increased from 50 to more than 100 ft, intermediate and end diaphragms have been eliminated, and prestressed concrete deck panels have been introduced as stay-in-place formwork for cast-in-place bridge decks. Each of these improvements has increased the speed of construction, reduced the cost of bridge construction in Texas, and demonstrated TxDOT's commitment to incorporating innovative design concepts into practice. A current concern for TxDOT is the simplification of the details used in the end regions of prestressed concrete U-beams and box beams with end blocks. To achieve this goal, two major aspects of the behavior (shear and bursting behavior) of prestressed concrete U-beams and box beams with skewed ends will be studied in a comprehensive manner. The research proposed herein is tailored to:

- i. Understand the behavior of the end regions of beams with skewed and non-skewed interior voids with skewed ends at release.
- ii. Understand the behavior of the end regions of beams with skewed and non-skewed interior voids with skewed ends under shear loads
- iii. Use the understanding gained in items (i) and (ii) to simplify the design of the end regions of U-beams and box beams with various skew angles.
- iv. Test the simplified details at release (bursting and spalling study) and under shear loads to ensure satisfactory performance at release, under service loads and over-loads.

Project Director

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Research Supervisor

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It is anticipated that the volume of concrete used in the end regions of box beams and U-beams will be reduced as a result of the testing conducted and understanding gained in this research study. In addition, the reinforcing details in the end blocks will be simplified. These simplifications will expedite the fabrication of U-beams and box beams, reduce cost, and improve durability by reducing curing temperatures within the end blocks and keeping them below the DEF threshold (roughly 160°F). These implications will promote the use of U-beams and box beams in more projects.

Total Project Budget

\$995,691

Research Universities

Center for Transportation Research

FY 2010 Budget

\$199,397

0-5997 - Structural Assessment of "D" Region Affected by Premature Concrete Deterioration

Start Date - 09/01/2007 **End Date** - 08/31/2011



Abstract

Recent TxDOT studies (0-1857,0-4069, and 0-5218) have developed techniques for evaluating the extent of structural damage to concrete elements with premature concrete deterioration and for delaying or mitigating such damage. In addition, TxDOT study 0-5722 is developing similar techniques for evaluating the bond performance of critical column splice sections affected by premature concrete deterioration. TxDOT studies 0-4371 and 0-5253 have provided insight into the use of strut-and-tie modeling and results indicate reassurance with respect to many reinforced and prestressed concrete elements commonly used by TxDOT. However, much less assurance exists with respect to large structural elements that are affected by premature concrete deterioration, such as the bents of the San Antonio "Y" (such as Bents H19C and I5C). The safety of such structures can be evaluated using strut-and-tie models suggested either by the configuration of existing cracks, or by the configuration of cracks that form during destructive testing. However, few reliable guidelines currently exist for such evaluations and strut-and-tie provisions of AASHTO LRFD Specifications are based on sound concrete. While premature concrete deterioration reduces the elastic modulus and tensile strength of concrete much more than the compressive strength, it is not clear if these reductions will impact the ultimate strength of such large elements as computed by strut-and-tie modeling and if modification factors can be used to accurately predict their ultimate strength. Using a combination of strut-and-tie modeling and large-scale physical testing, the objective of the proposed work is to develop guidelines for applying strut-and-tie models to large structural elements subject to varying conditions of premature concrete deterioration.

Project Director

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Total Project Budget

\$849,808

Research Universities

Texas Transportation Institute

FY 2010 Budget

\$198,320

0-6060 - Realtime Monitoring of Scour Events Using Remote Monitoring Technology

Start Date - 09/01/2007 End Date - 08/31/2010



Abstract

Bridge scour is the number one cause of bridge collapse. Improvements in prediction methods, scour countermeasures, and scour monitoring are needed. This project addresses fixed scour monitoring as a very useful approach to improving the safety of the traveling public while minimizing the expense. Fixed scour monitoring consists of placing instruments around the bridge monitoring the depth of the scour hole which may develop around bridge supports during high flow events. Warnings are sent to the authorities in time to shut the bridge in case of emergency. Scour monitors are still in development and there is a need to make them less expensive, easier to install, more robust, and to optimize the remote and wireless data collection and warning system.

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Total Project Budget
\$375,733

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$116,670

0-6070 - Use of the Rational and Modified Rational Methods for TxDOT Hydraulic Design

Start Date - 09/01/2007 **End Date** - 08/31/2010



Abstract

The rational method is a tool hydraulic engineers use to estimate design discharge for sizing a variety of drainage structures. The method is relatively simple: The peak discharge Q , is equal to the product of the drainage area A , the rainfall intensity I , and a runoff coefficient c . The last two terms, I and c , are dependent on analyst estimates of time-of-concentration and watershed conditions. Furthermore there is evidence that the runoff coefficient, c , is dependent on rainfall depth, thus the two terms are correlated and the simple model becomes quite nonlinear.

The modified rational method is an extension of the rational method used to generate a runoff hydrograph for applications where the peak discharge is not sufficient to execute a design. The modified rational method uses the peak discharge produced by application of the rational method. A hydrograph is created by using the time of concentration for the time to peak discharge and using twice the time of concentration for the time base of runoff. The purpose of this project is to evaluate appropriate conditions for use of the rational and modified-rational methods for design on small watersheds, evaluate and refine, if necessary, current tabulated values of the runoff coefficient, and construct guidelines for TxDOT analysts for the selection of appropriate parameter values for Texas conditions.

Project Director

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Total Project Budget	Research Universities	FY 2010 Budget
\$447,100	Center for Multidisciplinary Research in Transportation	\$22,900
	Lamar University	\$20,000
	United States Geological Survey	\$20,000

0-6094 - Mitigation Methods for Temporary Concrete Traffic Barrier Effects on Flood Water Flows

Start Date - 09/19/2008 **End Date** - 08/31/2010



Abstract

The requirement to use successfully crash tested concrete traffic barriers poses a concern with respect to hydraulic performance because the additional height and less open space may adversely impact the surrounding floodplain elevation. In the event of extreme flood, these barriers obstruct water flows and magnify the flooding by increasing the head water elevation. The issue of hydraulic performance of concrete traffic barrier came to limelight when a number of major arterial highways were shut down due to statewide flooding last year.

The primary objective of this project is to determine the hydraulic performance of standard and modified temporary concrete traffic barriers (TCTBs). The additional objectives include, evaluation of susceptibility to clogging, stability analysis in terms of sliding and overturning, and develop a method to model of standard and modified TCTBs in HEC-RAS.

A combined experimental and analytical approach will be put together to achieve the objectives of the project. Two standard types and a modified TCTB will be evaluated. The fraction of open space of the two standard (F-shaped and single slope) TCTBs are much smaller than the modified TCTB. If the modified TCTBs are better in-terms of hydraulic performance and have adequate factor of safety for sliding and overturning, then the modified TCTB might be recommended as a choice in the future to achieve its objectives without considerably hindering water flows during any flood event.

A parametric study will be conducted with HEC-RAS software for different geometric situations using parameters obtained from laboratory measurements. The total length of TCTB barricade, geometry and other properties of the flood plain, such as longitudinal slope, cross slope, elevation of the location where TCTB will be placed compared to that of other locations of the flood plain will be varied for each type of TCTB. The corresponding geometry and hydraulic efficiency parameters will be used as the input of the model to characterize the magnification of highway flooding due to installation of TCTB. This parametric study will also provide the information about the situations when the use of TCTB will be detrimental.

Project Director

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Total Project Budget
\$199,172

Research Universities

Center for Transportation Research

University of Texas at San Antonio

FY 2010 Budget

\$33,389

\$64,293

0-6137 - Prevention and Repair of Microbial Acid-Produced Attack of Concrete

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

The Texas Department of Transportation (TxDOT) has approximately 50,000 bridges in its inventory. The deterioration of concrete under the bridge structures, most of which is reinforced, has been a critical issue affecting the service condition of these bridges. Recent research showed that microbial attack was a significant factor promoting the surface deterioration of bridge columns continuously exposed to water and identified many of the microbes involved in the attack. The microbes present were acid-producing and directly correlated with the degree of damage. Compared to other durability issues, little is known about the mechanism of microbe induced deterioration (MID) and the type of microbes which induce deterioration. In the proposed study, literature reviews will first be conducted to summarize previous studies on microbial attack in concrete. Further information collected from both field and laboratory measurements will be used to determine the environmental factors that initiate the process, sustain microbial growth, and lead to an increase in acidity. The information obtained will provide TxDOT an understanding of the significance of MID in state own bridge structures. In addition, effective methods (procedures) will be developed to identify markers associated with microbial attack. An early warning approach would be helpful in determining concrete structures that would be susceptible to failure and appropriate for remediation. Finally, laboratory tests will be performed to evaluate the resistance of typical TxDOT concrete mixtures and their ability to mitigate microbial attack. The proposed study aims to identify the microbes degrading concrete, understand the mechanism of attack, develop new methods for in situ evaluation of MID, and provide recommendations for concrete mixes and/or new approaches that prevent and remediate degradation.

Project Director

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Total Project Budget
\$252,557

Research Universities
Texas State University - San Marcos

FY 2010 Budget
\$141,455

0-6146 - Design of Short, Laterally Loaded Drilled Shafts in High-Plasticity Clay

Start Date - 10/10/2008 **End Date** - 08/31/2010



Abstract

An in-depth research investigation is proposed here to assess the possible causes of failures of drilled shafts or piers supporting cable median barriers in high plasticity clay environment and, consequently, develop new or revised methods for the design of drilled shafts with no failures for the same environment. The initial task of the research will involve a thorough documentation of available research on drilled shafts subjected to lateral and uplift loads. The middle tasks will focus on estimation of tensions mobilized in each cable, selection of a test site, construction of twelve different piers, and lateral load testing of the piers by simulating cable loads. Both numerical and analytical models will be used to predict the pier load test results. Once good calibration is achieved, these models will be used to predict lateral load capacities of piers of other dimensions. Uplift checks will also be addressed based on laboratory measured swell pressures. Design charts and guidelines will be developed to provide appropriate shaft dimensions for different soil conditions, tensions mobilized in the cable and for satisfying uplift considerations. Project deliverables will include reports summarizing research findings and design/construction guidelines of piers in high plasticity clay.

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Total Project Budget

\$237,446

Research Universities

University of Texas at Arlington

FY 2010 Budget

\$111,414

0-6152 - Shear in High Strength Concrete Bridges

Start Date - 09/01/2008 **End Date** - 08/31/2012



Abstract

Prestressed concrete has become the predominant construction method in highway bridge girders. However, current AASHTO design guidelines for shear are very complicated and inaccurate. Because of their empirical nature, they are difficult to extrapolate to high-strength concrete. This proposed research will use Loov's rational approach to study the shear behavior of prestressed girders with high strength concrete, and to develop a set of design recommendations suitable for Texas highway bridges.

TxDOT Project 0-4759 has established a simple and accurate shear design method for prestressed concrete girders by proposing an equation with a new set of V_c and V_s terms. This rational method can be extended for application to high-strength concrete girders. Full-size girders of Type A, Tx46 and Tx62, made of concrete up to 14,000psi, will be tested to investigate their shear behavior and to establish two design provisions: First, a simple formula to determine the maximum shear strength of girders with concrete up to 14,000psi. Second, a design provision to prevent the premature slippage of prestressing strands at end regions. Once these two provisions are established, new AASHTO LRFD provisions can be formulated which unify the shear design of girders for normal-strength and high-strength concrete.

Project Director

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Yi-Lung Mo, UH

Total Project Budget

\$999,961

Research Universities

University of Houston

FY 2010 Budget

\$249,972

0-6306 - Shear Strengthening of Large Reinforced Concrete Elements using Carbon Fiber Reinforced Polymer (CFRP) Sheets

Start Date - 09/01/2008 **End Date** - 08/31/2011



Abstract

The objective of the study is to demonstrate the feasibility of using CFRP for shear strengthening of large bridge girders or supporting elements. Although many tests have been done on small elements to show the efficiency of CFRP anchors and sheets, data are needed where large elements are to be strengthened to carry substantial shear forces. Also there has been little work done regarding the effect of creep of polymer materials and anchors under sustained or fatigue loads. A large amount of research has been conducted on the use of CFRP materials for structural strengthening. In most of these studies the forces are transferred from the concrete member into the CFRP through interface bond. As a result, it has been found that although the CRFP material has high tensile strength, only about 40 to 50% of that strength can be realized. With the use of CFRP anchors that result in development of stresses that will fracture the CFRP sheets, the application of these materials to strengthen damaged or inadequate reinforced concrete members becomes more feasible and economical. The ability to quickly apply the materials with a minimum of disruption to the use of a structure and with virtually no change in the geometry or weight of the element makes CFRP a viable and attractive method for strengthening existing elements.

The scope of the proposed research includes the following tasks:

- Determine situations where TxDOT may consider the use of CFRP for shear strengthening.
- Establish the anchor requirements for use of CFRP sheets as shear reinforcement.
- Conduct tests to determine creep and fatigue characteristics of CFRP shear reinforcement.
- Determine the behavior of CFRP shear reinforcement on full-scale typical TxDOT elements.
- Develop design guidelines and material and construction specifications for the use of CFRP sheets as shear reinforcement.

Project Director

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Project Advisors

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Research Supervisor

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Total Project Budget
\$695,000

Research Universities
Center for Transportation Research

FY 2010 Budget
\$270,000

0-6332 - Development of Predictive Model for Bridge Deck Cracking and Strength Development

Start Date - 09/01/2008 **End Date** - 08/31/2011



Abstract

In ASCE's 2003 Progress Report, our national infrastructure was given an overall of grade of D+ (ASCE, 2003). A few years earlier, a specific evaluation of bridge decks in the United States identified more than 100,000 bridge decks that exhibited early-age transverse cracking (Krauss and Rogalla, 1996). This early-age cracking, typically caused by drying shrinkage (and often coupled with autogenous and thermal shrinkage), can have several detrimental effects on longterm behavior and durability. Cracking can also provide ingress of water that can drive chemical reactions, such as alkali-silica reaction (ASR) and sulfate attack.

Because of the problems associated with cracking observed in bridge decks, and the impact of early-age cracking on long-term performance and durability, it is imperative that bridge decks be constructed with minimal early-age cracking and that exhibit satisfactory long-term performance and durability. To achieve these goals for bridges in the state of Texas, a research team has been assembled that possesses significant expertise and background in cement chemistry, concrete materials and durability, structural performance, computational mechanics (finite difference/element), bridge deck construction and maintenance, monitoring of in-site behavior of field structures, and the development of test methods and specifications aimed at practical implementation by state highway departments. This proposal describes a laboratory- and fieldbased research program aimed at developing a bridge deck cracking model that will ultimately be integrated into ConcreteWorks, a suite of software programs developed for TxDOT by this same research team.

Project Director

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Jeffrey Seiders, CST
Ralph Browne, FTW

Research Supervisor

Kevin Folliard, CTR

Total Project Budget
\$498,500

Research Universities
Center for Transportation Research

FY 2010 Budget
\$169,250

0-6348 - Controlling Cracking in Prestressed Concrete Panels and Optimizing Bridge Deck Reinforcing Steel

Start Date - 09/01/2008 **End Date** - 08/31/2012



Abstract

The project statement for this project was produced by combining two different project statements, one dealing with precast prestressed concrete deck panels and the other dealing with top mat reinforcement. The comprehensive work plan proposed here is intended to address both those issues and their interaction. The work will be carried out at two institutions. The work plan presented in the main body of this proposal envisages concurrent research on top mat reinforcement and on precast deck panels, to facilitate timely completion of the research.

Deck Panel Research: The project statement indicates that about 200,000 square feet of deck panels are rejected every year. In most cases, they are not rejected at prestress transfer, but afterwards, due to cracking parallel to the strands from a combination of tensile stresses from release, handling at the precast yard, and transportation to the job site. Our proposed research is focused on reducing the initial circumferential tensile stresses at release, and thereby reducing the total tensile stresses and the rate of rejected panels. Our proposed research is not directed towards finding ways of getting cracked panels accepted. At prestress transfer, “tensile rings of concrete” form around the strands as the highly tensioned strands transfer the prestressing force into the concrete. While the concrete is compressed along the strands, the bursting effects are resisted by circumferential tension in concrete. This is particularly critical at the ends of the panels, and over the transfer length due to the complex nature of the stress state there. The proposed experimental research is aimed at proving that the actual prestress losses are less than those typically assumed in design (45 ksi). In this way, the initial prestress and bursting effects can be reduced and the final prestressing force can be kept consistent with the current design calculations. By reducing bursting, the panel rejection rate can be reduced, resulting in a reduction in the average cost of panels.

Top Mat Reinforcement Research: Based on evaluations of test data from prior TxDOT studies,

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Kirk Krause, WAC

Robert Cochrane, BRY

Research Supervisor

Richard Klingner, CTR

the research team has hypothesized that current top-mat reinforcement based on strength requirements may be reduced everywhere except on top of the fascia girders and in overhangs. Our proposed research on top mat reinforcement is directed towards identifying and quantifying serviceability implications of reducing top mat reinforcement everywhere in a bridge deck except on top of fascia girders and overhangs. In addition, to develop different design alternatives, tests will be conducted on the cast-in-place portion of a typical bridge deck to evaluate the structural feasibility of using fiber reinforced concrete, welded wire mesh, and standard reinforcing bars.

Total Project Budget
\$938,755

Research Universities

Center for Transportation Research

University of Texas at Arlington

FY 2010 Budget

\$217,138

\$29,982

0-6359 - Characterization of Backfill Materials for Prevention of Corrosion of MSE Wall Metallic Earth Reinforcement

Start Date - 09/01/2008 End Date - 08/31/2011



Abstract

Mechanically Stabilized Earth (MSE) walls have been and are being constructed throughout the State of Texas. These walls are economical to construct and have the potential to exhibit good serviceability over long durations. However, this long-term performance depends on the characteristics of the backfill material. The use of coarser backfill materials raises the question as to the proper method of measuring the electrochemical properties of these backfill materials and establishing the proper threshold values to insure the 75-year wall design life. More specific research is needed in how to measure and assess backfill characteristics and how they influence the corrosion and resulting service life of MSE wall systems. In addition, work is needed to connect more accurately laboratory tests with on-site corrosion behavior or "real-world" performance so as to assess and to repair MSE walls. The proposed research will use corrosion techniques that will more adequately assess the degradation of galvanized carbon steel and uncoated carbon steel from a porous backfill, and will develop a two-fold model predicting short-term and long-term corrosion behavior of the MSE strands. To address the objectives of this project, a multi-disciplinary team consisting of faculty with expertise in geotechnical engineering, geochemistry and corrosion has been assembled to address the goals of this project.

Project Director

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Project Advisors

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Miguel Arellano, AUS

Zhiming Si, CST

Research Supervisor

Soheil Nazarian, UTEP

Total Project Budget
\$444,824

Research Universities
University of Texas at El Paso

FY 2010 Budget
\$144,275

0-6374 - Effects of New Prestress Loss Predictions on TxDOT Bridges

Start Date - 09/01/2008 End Date - 08/31/2012



Abstract

In the 2005 interim of the AASHTO LRFD Design Specifications, a refined prestress loss procedure was updated based on the recommendations of the NCHRP Report 496. For the most part, the long-term material property equations developed in the NCHRP Report 496 were adopted into the AASHTO Specifications. The new expressions created a substantial amount of curiosity as the new prestress losses appear to be considerably less than the old losses in most cases. The University of Texas researchers have previously looked into these expressions from the perspective of estimating initial cambers of beams fabricated in Texas (elastic shortening loss is the only relevant component.) The initial cambers of 223 prestressed concrete beams fabricated at various fabrication plants in Texas were estimated more accurately with the new NCHRP expressions. This is solely related to the modulus of elasticity expression and local material correction factors used in the NCHRP approach.

The focus of this research is not on camber estimations. The primary focus is on prestress loss estimations. With that in mind, past results can be re-examined to conclude that NCHRP expressions were calibrated for accuracy rather than conservativeness for the purposes of modulus of elasticity. In other words, losses due to elastic shortening can be estimated more accurately (rather than conservatively) by using the NCHRP expressions. While the PI of this proposal can reach this conclusion based on the 223 data points previously examined by his research team, he can not comment on the long-term loss components associated to shrinkage and creep of concrete and relaxation of strands. This proposal is tailored to answer those questions. In short, the work outlined in this proposal is focused to examine the conservativeness and accuracy of the new prestress loss equations in ASASHTO LRFD. This is an important issue as TxDOT beam standards are typically based on the worst-case scenarios. In this particular case, at the time a bridge is designed the origin of the beams, i.e. the fabrication plant, is not known. Bearing that in mind, we want to make sure that the final or effective prestress loss is estimated conservatively, so that beams do not develop flexural cracks due to an insufficient amount of prestress, which is directly linked to the total prestress loss estimate as explained in the problem statement.

Project Director

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Project Advisors

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Tim Bradberry, BRG

Research Supervisor

Oguzhan Bayrak, CTR

Total Project Budget
\$787,521

Research Universities
Center for Transportation Research

FY 2010 Budget
\$186,153

0-6375 - Design of Cut-Type Retaining Walls in High Plasticity Soils

Start Date - 09/01/2008 End Date - 08/31/2010



Abstract

The current TxDOT design procedure for common retaining structures in cuts, such as soil nailing, tied-back, and drill shaft walls, is based on lateral pressures calculated from classical Rankine's or Coulomb's methods considering drained shear strength parameters and does not include any lateral pressure due to moisture change in expansive soils. The majority of these types of walls have been designed following current TxDOT methods for retaining walls on expansive have been performing well for more than 20 years with no sign of distress. In recently years, some of the TxDOT consultants raised the issue of considering additional lateral swelling pressure for designing retaining structures on expansive soils. The proposed lateral swelling pressures are as much as 10 to 20 times higher than the average lateral pressures that are considered in current procedures. In order to respond to the concerns of the TxDOT consultants and to reconfirm the current design procedure for the retaining walls that are common on cuts, a combined experimental, field study, and computer modeling approach will be put together to evaluate the design procedure in the context of field environment. A concerted effort will be put forward by a well-rounded research team having expertise and experience in the geotechnical and structural engineering areas. The project will begin with a literature review to compile relevant and timely information that can be used to evaluate the different field situations. Two field sites will be identified with the help of TxDOT personnel where retaining structures have been constructed on expansive soils. One of the sites will be a soil nailed or tied-back retaining wall and the other will be drilled shaft retaining wall. The reason for selecting these two types of walls is because of the different support conditions and design criteria usually used for designing them. Soil samples will be collected from the field sites and will be subjected to testing using state-of-the-art technology to characterize the soil to evaluate how the soil will perform in the context of field environment. The field sites will be instrumented with thermocouple psychrometer probes to collect the seasonal moisture content profiles. Data collected from field and laboratory testing will be used to simulate the retaining walls using a finite element model to study the stability analysis. The model

will be verified using information collected from the literature review. Once the model is verified and calibrated, a parametric study will be conducted by varying different pertinent input parameters of soils and structures. Based on the sensitivity of each of the parameters, the conditions will be identified where the design of the walls needs special attention. The proposed project will provide TxDOT with relevant information and guidelines that can be used to design retaining structure in cuts in expansive soils with renewed confidence. Without this study, TxDOT may be forced to spend substantial amounts of money to address a perceived, rather than a real problem caused by expansive soil. Consequently, TxDOT will be able to implement the results of this research immediately and realize potentially large cost savings.

Project Director

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Project Advisors

Clara Carbajal-Sanchez, SAT

Farren Basse, SAT

Jon Kilgore, SAT

Mark McClelland, BRG

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Research Supervisor

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Total Project Budget
\$259,810

Research Universities

Texas Transportation Institute

University of Texas at San Antonio

FY 2010 Budget

\$49,981

\$80,600

0-6382 - Establish Effective Lower Bounds of Watershed Slope for Traditional Hydrologic Methods

Start Date - 09/01/2008 **End Date** - 08/31/2011



Abstract

Traditional hydrologic methods such as the modified rational method, unit hydrographs, as well as modeling tools such as HEC-HMS, NRCS TR-20, EPA-SWMM, etc. rely either on an estimate of the time response characteristics of the watershed that is related to distances and slopes or directly upon slope. For example, kinematic wave routing assumes uniform flow hydraulics; thus the travel speeds are inversely related to localized slopes. As slope approaches zero, relationships that contain slope in the denominator (nearly all) predict very small speeds and correspondingly large travel times. These large travel times can be quite unrealistic and alternate approaches are appropriate. The consequence of poor timing computations is likely to be under-sizing (as slope diminishes, estimated time increases, and estimated peak discharge decreases), but over-sizing using arbitrary timing values is also quite possible. Appropriately estimating characteristic times on low-slope watersheds will enhance confidence in predicting design discharges resulting in better decisions on structure size and corresponding cost, better use of money, and reduced risk of underestimation or of costly overestimation. The purpose of this project is to identify from literature, data, modeling and experiments, the dimensionless slope when alternate approaches should be considered, and to provide guidance on what approaches are appropriate in such low-slope situations.

Project Director

Jaime Villena-Morales, AUS

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Research Supervisor

Theodore Cleveland, TECHMRT

Total Project Budget	Research Universities	FY 2010 Budget
\$464,622	Center for Multidisciplinary Research in Transportation	\$75,785
	Texas Transportation Institute	\$56,331
	United States Geological Survey	\$70,000

0-6389 - Framework for Reliable and Comprehensive Bridge Management and Information System (BMIS)

Start Date - 10/31/2008 End Date - 08/31/2010



Abstract

There are over 50,000 bridges in the state of Texas. The Texas Department of Transportation (TxDOT) inspects most of these bridges. TxDOT uses several different systems that are not interlinked, to store different information on these bridges. Because these systems are not interconnected, information essential to the optimal management of these bridges is not readily available to TxDOT engineers and decision makers. Additionally, information on bridge-related maintenance expenditures is extremely limited to the most basic of categories, and links to SiteManager are effectively nonexistent with the current system.

An effective use of TxDOT resources would be to use the encompassing datasets currently available to better manage bridge maintenance rehabilitation and reconstruction. TxDOT lacks a blueprint for the development of a comprehensive, reliable Bridge Management Information System (BMIS). An effective BMIS system would serve the needs of the districts, those responsible for developing and monitoring statewide letting of bridge projects, and TxDOT management personnel. The objective of this project is to develop the frame work for a BMIS for TxDOT. This system should be user-friendly, accessible to a wide variety of users, and GIS enabled. An effective system must meet the needs of all users and provide information needed by all parties interested in bridge management.

Project Director

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Alan Kowalik, BRG

Joe Riba, BRG

Research Supervisor

Andrew Wimsatt, TTI

Total Project Budget
\$365,521

Research Universities

Texas Transportation Institute

University of Texas at San Antonio

FY 2010 Budget

\$119,631

\$65,825

0-6416 - Shear Cracking in Inverted-T Straddle Bents

Start Date - 09/03/2009 **End Date** - 08/31/2012



Abstract

In the state of Texas there are 13 documented inverted tee straddle caps with unexpected web cracking. Such cracks have been observed in Austin, Houston, El Paso, and Waco. Many of the affected inverted tee straddle bent caps are less than eight years old. The primary technical objective of this project is to determine the cause of cracking and to develop new design criteria to prevent or minimize such cracking under service loads. The proposed work includes structural inspection/evaluation of the existing inverted tee straddle caps to determine the causes of diagonal cracking. There will also be extensive laboratory testing of various different straddle cap configurations. The findings of this research project will be used to modify the structural design criteria of straddle caps to ensure the durability and safety of these structures. The repair of shear cracking observed in straddle caps is very costly, such repairs result in lane closures and inconvenience to travelling public. The findings of this project will be used to minimize/eliminate the necessity of such costly repairs in the future.

Project Director

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Mike Stroope, LBB
Nicholas Nemec, BRG
Ralph Browne, FTW
Roger Lopez, HOU

Research Supervisor

Oguzhan Bayrak, CTR

Total Project Budget	Research Universities	FY 2010 Budget
\$696,964	Center for Transportation Research	\$180,342
	Center for Transportation Research	\$223,843

0-6438 - Evaluation of Superheavy Load Criteria for Bridges

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

The number of permits for superheavy loads crossing Texas bridges has steadily increased over the years, and compared with several other states, the criteria that establish superheavy-load status is generous. The result is that many Texas bridges experience routine, high-stress loads that cause accelerated deterioration. In this project, bridge load and rating factors and the validity of the criteria for establishing superheavy load status are evaluated. The purpose of the study is to validate that the Texas superheavy load criteria and evaluation methodology adequately protects and preserves Texas bridges.

Project Director

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Project Advisors

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Dingyi Yang, BRG

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Raymond (Ray) Hutchinson, MCD

Thomas Young, LBB

Research Supervisor

Mark Bourland, LAMAR

Total Project Budget

\$181,189

Research Universities

Lamar University

West Texas A&M University

FY 2010 Budget

\$54,683

\$35,646

0-6491 - Non-destructive Evaluation of In-service Concrete Structures Affected by Alkali-Silica Reaction (ASR) or Delayed Ettringite Formation (DEF)

Start Date - 09/01/2009 **End Date** - 08/31/2012



Abstract

This proposal describes a comprehensive, collaborative research project aimed at evaluating the potential use of non-destructive testing (NDT) to assess structures affected by ASR and/or DEF. This project involves a variety of NDT-based studies, ranging from small laboratory scale specimens to large-scale structural specimens, to field structures. The work plan described in this proposal seeks to take advantage of synergies between other past and ongoing projects (most funded by TxDOT), and the research team will have the unique opportunity to perform a range of NDT measurements on specimens of varying age, conditions, reinforcement details, etc. It is hoped that the products of this research, coupled with the findings of other TxDOT-funded activities related to ASR and DEF, will aid in the development of an overall protocol to help TxDOT to manage their deteriorating infrastructure.

Project Director

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Geetha Chandar, BRG

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Leon Flournoy, BRG

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Kevin Folliard, CTR

Total Project Budget

\$997,998

Research Universities

Center for Transportation Research

Texas Transportation Institute

FY 2010 Budget

\$218,820

\$105,704

0-6493 - Pullout Resistance of Mechanically Stabilized Earth Reinforcements in Backfills Typically Used in Texas

Start Date - 09/01/2009 **End Date** - 08/31/2012



Abstract

This research study involves a comprehensive and detailed review of pullout resistance of backfill reinforcement used in MSE walls constructed in Texas. There are two major thrust areas in the proposed study: (a) evaluation of pullout resistance factors for specific backfill-reinforcement combinations used by TxDOT, and (b) review and testing of typical reinforcement details used to circumvent vertical and horizontal obstructions. The research plan to accomplish the above research objectives relies heavily on a comprehensive, large-scale pullout test program. At the outset, the researchers will collect available information pertaining to pullout resistance and reinforcement detailing around obstructions and document them. Then the researchers will select specific backfill- reinforcement combinations and obstruction reinforcement details to be included in the test program. Once substantial data has been generated through testing, data analysis will begin. New reinforcement pullout resistance factors will be developed for conditions representative of TxDOT construction and the impact on their use in wall design will be evaluated. Data obtained from tests conducted on obstruction details will be used to identify optimum reinforcement configurations to address commonly encountered obstruction situations. Based on these findings guidelines will be developed for implementation of reinforcement details around obstructions. These guidelines will be refined based on review by industry representatives as well as through a field constructability review. Final products will include: a database of pullout resistance, a field guide (field manual) and necessary training material.

Project Director

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John Delphia, BRG

Robert Stuard, AUS

Steve Beard, BRG

Vincent Lewis, DAL

Research Supervisor

William (Bill) Lawson, TECHMRT

Total Project Budget
\$393,374

Research Universities
Center for Multidisciplinary Research
in Transportation

FY 2010 Budget
\$139,367

0-6564 - Improved Cross Frame Details

Start Date - 09/01/2009 End Date - 08/31/2012



Abstract

The critical stage for the stability of straight and curved steel I-girder systems generally occurs during placement of the concrete bridge deck. The capacity of the girders is improved by incorporating bracing in the form of cross-frames that restrain twist of the girders. The cutting, fitting, and welding of the cross frame members are very labor intensive. Cross frames are the most expensive component per unit weight on the steel bridge and a significant component of the final cost of the superstructure. Conventional cross frames are usually fabricated using two diagonals and two horizontal struts. The cross frames are typically fabricated from steel angles for the diagonals and either angles, WT, or W-sections for the horizontal struts. The angles are connected along one leg producing eccentric connections that cause bending of the angle and relatively poor structural behavior because of their low bending stiffness. In addition, connection requirements for the intersecting diagonals and top and bottom struts typically necessitate turning over the cross frame during fabrication. Torsional deformations in the girders often result in a tension diagonal and a compression diagonal of the cross frame; however because of the relatively low buckling strength of angles, traditional cross frames are normally designed by conservatively neglecting the compression diagonal thereby relying on a "tension-only" diagonal system cross frame. Better structural behavior and a significant reduction in the handling requirements may be possible if tubular members are used for the cross frame. Since tubular members have a substantial buckling strength, cross frames with a single diagonal member are possible, resulting in fewer connections and a reduction in the handling requirements for the braces. Tubular members will lead to better structural behavior since the connection can be made concentric with the centroid of the symmetric tubular member. The difficulty in utilizing the tubular members is developing a practical connection method for the tubes that is simple and reliable.

The research highlighted in this proposal consists of designing and developing improved details for cross frame systems. The use of tubular sections can lead to significant improvement in the structural behavior and ease of fabrication of these critical bracing elements. The research team has extensive experience at identifying the strength and stiffness requirements of stability

Project Director

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bracing systems. This experience will be used to aide in identifying the range of stability design forces that frequently occur in Texas steel bridges. These forces will be used to standardize the tubular member sizes required for stability considerations. A three-year study is proposed. Researchers will work with casting manufacturers to develop a practical yet effective connection design and conduct laboratory and computational studies to evaluate the performance of the cross frame system. The use of the improved cross frame details for bracing applications in straight and curved girders will be evaluated and design methodologies will be developed and verified.

Total Project Budget
\$451,912

Research Universities
Center for Transportation Research

FY 2010 Budget
\$119,977

0-6603 - Long-Term Performance of Drilled Shaft Retaining Walls

Start Date - 09/01/2009 **End Date** - 08/31/2012



Abstract

The objective of this project is to provide TxDOT with guidance for the design of drilled shaft retaining walls in expansive clay soils. The range of assumptions being used today in design practice when dealing with expansive clay soils produces more than factor of two differences in the maximum bending moment in the shaft, which could lead to either excessively costly walls or under-designed walls. The guidance produced from this project will include the following: 1) Design recommendations for the distribution of lateral earth pressures for drilled shaft retaining walls in expansive clay soils, including the magnitude of the earth pressures and the shape of the distribution with depth above and below the cantilever, 2) Design recommendations for how to consider the effects of time and moisture cycles in expansive clay soils on the distribution of lateral earth pressures, 3) Guidelines on how to analyze these walls using software such as LPILE, including assumptions for p-y curves in the foundation soil.

The work plan will involve instrumenting a full-scale drilled shaft retaining wall constructed in an expansive clay soil and monitoring its performance over three years. The wall will be instrumented with Optical Strain Gauges, which are the state-of-the-art in measuring strains in drilled shafts, particularly over a long time duration. These optical strain gauges are not susceptible to zero drift in electronics, to moisture and to changes in temperature, making them far superior to conventional gauges that measure electrical resistance. Inclinometers will be used to measure the deflected shape of the shaft versus time. We will also continuously monitor the moisture content of the soil behind the wall at different depths below the ground surface.

The strain gauge and inclinometer data will be analyzed to estimate the lateral earth pressures applied by the retained soil as a function of depth below the ground surface and time. This analysis will be conducted with LPILE, the state-of-the-art in modeling soil-structure interaction for drilled shaft retaining walls.

Project Director
Dina Dewane, BRG

Project Advisors
Eliza Paul, HOU
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Mark Sturrock, TYL
Steve Beard, BRG
Vincent Lewis, DAL

Research Supervisor
Robert Gilbert, CTR

In addition to the instrumented wall, we also propose to assess existing drilled shaft retaining walls constructed by TxDOT in expansive clay soils. This assessment will include determining their design basis and documenting available performance information.

An External Advisory Panel of distinguished practicing engineers has been assembled to ensure that the information and design guidance produced from this project are relevant and practical.

Total Project Budget
\$578,444

Research Universities
Center for Transportation Research

FY 2010 Budget
\$284,894

0-6604 - Unknown Foundation Determination for Scour

Start Date - 09/01/2009 **End Date** - 08/31/2011



Abstract

Unknown foundations affect about 9000 bridges in Texas. For bridges over rivers, this creates a problem regarding scour decisions as the calculated scour depth cannot be compared to the foundation depth and a very conservative and costly approach must be taken. The objective is to develop a global approach which will reduce significantly the level of uncertainty associated with unknown foundations. This approach is in two parts: a data mining and inference approach where no testing at the site is necessary and a testing approach where new tests are proposed. The data mining and inference task will make use of existing data such as soil type, known foundations on neighboring bridges, and design practice and age of the bridge to infer what the unknown foundation is. The testing task will consist of developing a simple motion sensor which will detect the natural frequency of the bridge from which the foundation depth can be inferred and to develop a resistivity imaging technique to obtain a picture of the soil and foundation within 20 m below the river bottom, The outcome will be a global framework using one of the approaches or any combination thereof as well as the most useful current techniques (NDT if necessary) to decrease dramatically the uncertainty associated with the unknown foundation. The inference process will be developed by using bridges where the foundation is known and verified by comparison against case histories. The 2 new testing techniques mentioned above will be tested in the laboratory first and then against two full scale bridges selected in cooperation with TxDOT.

Project Director

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Project Advisors

Grady Mapes, HOU

Lisa Woof, BRG

Thomas Young, LBB

Research Supervisor

Jean-Louis Briaud, TTI

Total Project Budget
\$293,552

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$141,565

9-4973 - Guidelines for Designing Bridge Piers and Abutments for Vehicle Collisions

Start Date - 03/26/2007 End Date - 02/28/2010



Abstract

This is a pooled fund research project. The AASHTO LRFD Bridge Design Specifications require that "abutments and piers located within a distance of 30.0 ft of the edge of the roadway, or within a distance of 50.0 ft to the centerline of a railway track, shall be designed for an equivalent static force of 400 kips..." Supporting documentation for this design requirement, both its applicability and the magnitude of the design force, is not extensive. Further detailed guidance for the design engineer is not available.

Two issues need to be addressed:

1. What risks warrant application of this requirement? and,
2. Is the magnitude of design force (400 kips) appropriate?

Scope of Work: This project will be conducted in two phases, as listed below. All Phase 1 work shall be completed, and recommendations for Phase 2 work shall be approved by the project sponsors, prior to commencement of any Phase 2 research activities.

Project Phasing and Tasks:

Phase 1 will include the following tasks:

- Literature review,
- Computer simulations of vehicle/bridge column and abutment collisions,
- Accident survey and analysis study,
- Development of a risk analysis methodology for vehicle/bridge column and abutment collisions (analogous to AASHTO LRFD vessel impact requirements).

Project Director

Gregg Freeby, BRG

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Alfredo Valles, FTW

Bryan Hodges, TYL

James Pohl, YKM

Nicholas Nemec, BRG

Research Supervisor

Carl Buth, TTI

- Detailed justification and work plan for research to be conducted under **Phase 2** of the project.
- Provide facilities and host a meeting to present **Phase 1** results to project sponsors, including pooled fund project participants from other state DOTs.

Phase 2 will include the following tasks:

- Crash testing with a single 5-axle tractor-trailor rig to verify loading from Phase 1 literature survey and computer simulations.
- Crash testing of a second 5-axle tractor trailer rig to verify loading from Phase 1 literature survey and computer simulations.

Total Project Budget
\$574,689

Research Universities
Texas Transportation Institute

FY 2010 Budget
\$256,261

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