



Research FY 2011 Program

Research and Technology
Implementation Office

The Texas Department of Transportation

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Institutions Active in TxDOT's 2011 Research Program

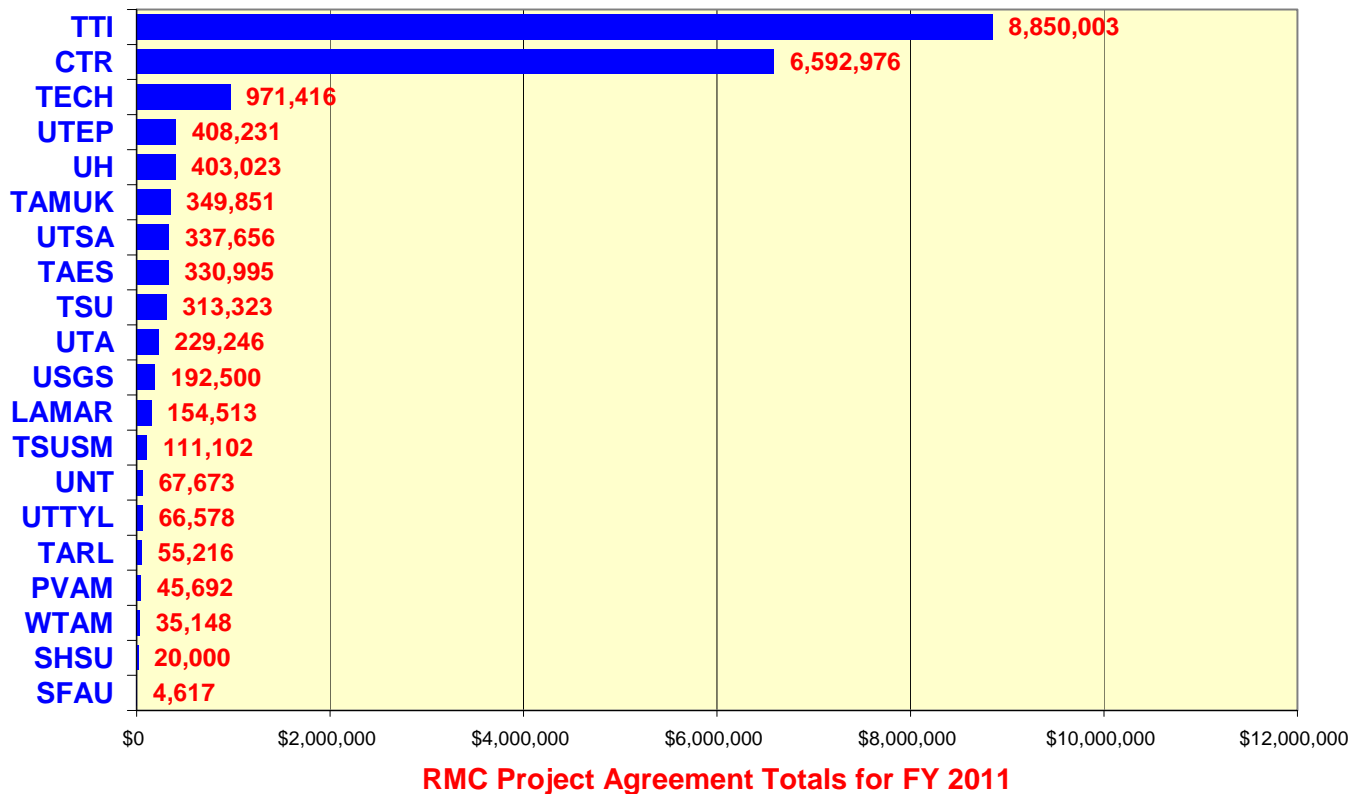
Acronym	University / Research Institution
CTR	Center for Transportation Research, University of Texas at Austin
LAMAR	Lamar University
PVAM	Prairie View A&M University
SFAU	Stephen F. Austin State University
SHSU	Sam Houston State University
TAES	Texas AgriLife Research
TAMUK	Texas A&M University – Kingsville
TARL	Tarleton State University
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 2011 RESEARCH PROGRAM

University Participation

TxDOT's fiscal year 2011 research program consists of 128 projects, with budgets totaling \$19.5 million. This work is contracted to nineteen 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 2011 Research

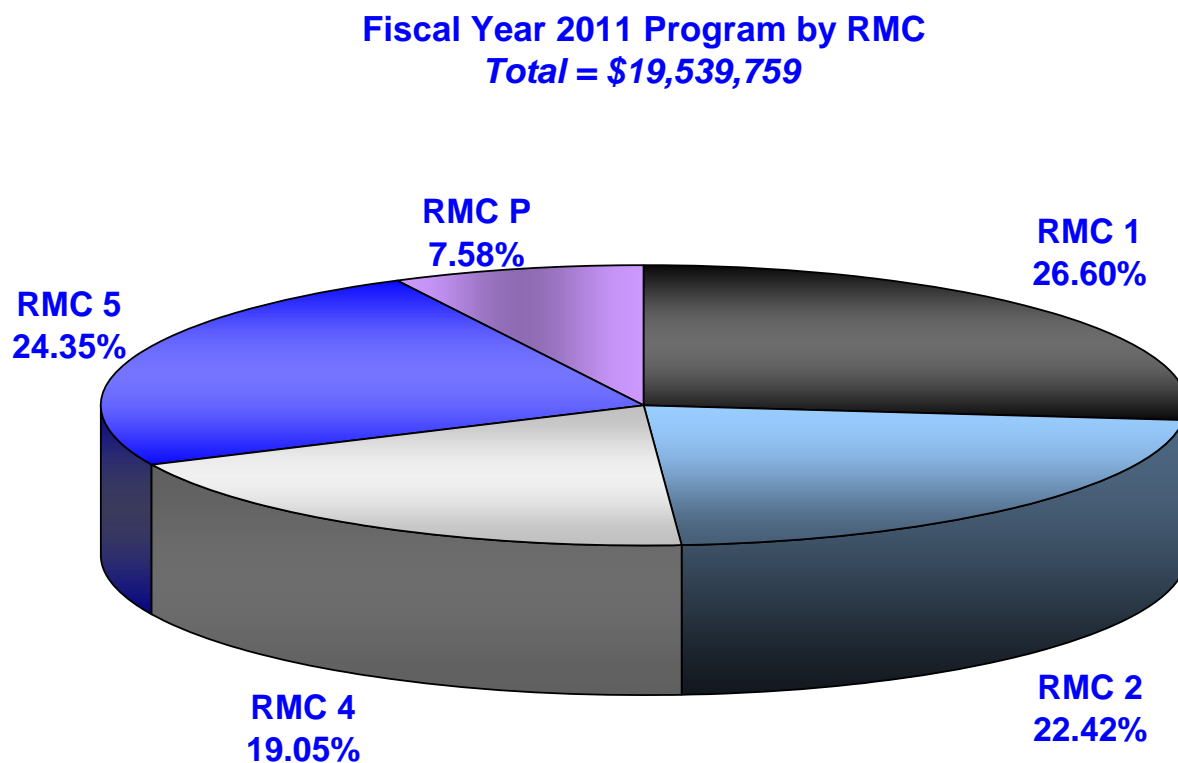


Research Management Committee (RMC) Funding

The table below shows a summary by RMC of the number of continuing and new projects, and total funding, for fiscal year 2011.

RMC	Focus Areas of RMC	Number of Continuing Projects	Number of New Projects	Total Project Funding
1	Construction and Maintenance	22	14	\$ 5,198,101
2	Planning and Environment	12	15	\$ 4,380,505
4	Safety and Operations	19	10	\$ 3,722,577
5	Structures and Hydraulics	20	8	\$ 4,757,710
P	Administration	5	3	\$ 1,480,866
Total		78	50	\$ 19,539,759

The figure below shows each RMC's proportion of the total fiscal year 2011 program.



RMC 1 – Active Projects

Project	Title	Start Date	Page
0-5836	Performance of Permeable Friction Course (PFC) Pavements Over Time	9/1/2008	7
0-5893	Laboratory Evaluation of Constructability Issues With Surface Treatment Binders	12/16/2008	8
0-6005	Developing a Testing Device for Total Pavements Acceptance	9/1/2008	9
0-6009	Evaluation of Binder Aging and its Influence in Aging of Hot Mix Asphalt Concrete	10/2/2007	10
0-6022	Recommendations for Design, Construction, and Maintenance of Bridge Approach Slabs	9/1/2007	11
0-6080	Performance Histories of Thermally Segregated HMA	12/11/2007	12
0-6092	Performance Evaluation and Mix Design for High RAP Mixtures	9/1/2008	13
0-6132	Development and Field Evaluation of the Next Generation of HMA Mix Design Procedures	9/1/2008	14
0-6255	Use of Manufactured Sands for Concrete Paving	9/1/2008	15
0-6271	FDR (Full-Depth-Reclamation) Performance-Based Design, Construction and Quality Control	10/16/2008	16
0-6274	Project Level Performance Database for Rigid Pavement in Texas, Phase II	11/14/2008	17
0-6326	Rational Use of Terminal Anchorages in Portland Cement Concrete Pavement	10/1/2008	18
0-6361	Development of a New Mix Design Method and Specification Requirements for Asphalt Treated Base (Item 292)	9/1/2008	19
0-6386	Evaluation and Development of Pavement Scores, Performance Models and Needs Estimates	11/7/2008	20
0-6435	CAM Mix Design with Local Materials in Texas	9/1/2009	21
0-6444	Treatments for Clays in Aggregates Used to Produce Cement Concrete, Bituminous Materials and Chip Seals	9/1/2009	22
0-6496	Quantifying the Effects in Order to Optimize the Use of Grade 3 and Grade 4 Seal Coats	9/1/2009	23
0-6587	Flexible Base Acceptance Testing	9/1/2009	24
0-6590	Material Selection for Concrete Overlays	9/1/2009	25
0-6591	Developing a Fundamental Understanding of the Chemistry of Warm Mix Additives	9/1/2009	26
0-6607	Search for a Test for Fracture Potential of Asphalt Mixes	9/1/2010	27
0-6610	Impact of Changes in Profile Measurement Technology on QA Testing of Pavement Smoothness	9/1/2010	28

RMC 1 – Active Projects

Project	Title	Start Date	Page
0-6611	Improvements of Partial and Full-Depth Repair Practices for CRCP Distresses	9/1/2010	29
0-6613	Evaluate Binder and Mixture Aging for Warm Mix Asphalts	9/1/2010	30
0-6614	Use of Recycled Asphalt Shingles in HMA	9/1/2010	31
0-6615	Use of Fine Graded Asphalt Mixes	9/1/2010	32
0-6616	Validate Surface Performance-Graded (SPG) Specification for Surface Treatment Binders	9/1/2010	33
0-6617	Revamping Aggregate Property Requirements for Portland Cement Concrete	9/1/2010	34
0-6618	Mitigation of High Sulfate Soils in Texas	9/1/2010	35
0-6619	Evaluation of Skid Measurements Used by TXDOT	9/1/2010	36
0-6620	Dwarf Turf-type and Early Maturing Annual Ryegrass to Establish Perennial Vegetation	9/1/2010	37
0-6621	Developing a Mixture Based Specification for Flexible Base	9/20/2010	38
0-6623	Optimizing Resource Allocations for Routine Highway Maintenance	9/1/2010	39
0-6664	Peer State Review of TxDOT Maintenance Practices	7/1/2010	40
0-6665	TxDOT Native Plant Integration Program for South, Central and West Texas	9/1/2010	41
0-6992	Develop Practical Field Guidelines for the Compaction of HMA or WMA	9/1/2009	42

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

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



Abstract

Objective: This project will address the need to track the performance of permeable friction course (PFC) pavements 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).

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 an 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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John Wirth, CST

Research Supervisor

Amy Martin, TTI

Total Project Budget
\$663,214

Research Universities
Center for Transportation Research
Texas Transportation Institute

FY 2011 Budget
\$60,544
\$107,180

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

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



Abstract

Objective: This project will 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 coats, 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

Gilbert Jordan, ELP

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Stephen Kasberg, BRY

Research Supervisor

Sanjaya Senadheera, TECHMRT

Total Project Budget	Research Universities	FY 2011 Budget
\$401,087	Center for Multidisciplinary Research in Transportation	\$12,455
	Center for Transportation Research	\$27,632

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

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



Abstract

Objective: This research project will produce a state-of-the-art Total Pavement Acceptance Device (TPAD) that will provide TxDOT with enhanced testing capabilities for accepting new pavements and evaluating existing pavements.

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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Research Supervisor

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Total Project Budget	Research Universities	FY 2011 Budget
\$1,411,570	Center for Transportation Research	\$141,642
	Texas Transportation Institute	\$127,000

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

Objective: This project will address issues associated with binder aging, maintenance treatments, and fatigue in different mixtures of hot mix asphalt pavements.

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.

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Research Supervisor

Charles Glover, TTI

Total Project Budget
\$1,278,498

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$256,999

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

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



Abstract

Objective: The purpose of this research is to better understand mitigation technologies and then develop and evaluate technologies to reduce bumps for bridge approaches in Texas.

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 issue 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 and cost-benefit studies along with a research report summarizing research findings.

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Anand Puppala, UTA

Total Project Budget
\$575,361

Research Universities

University of Texas at Arlington

University of Texas at El Paso

FY 2011 Budget

\$48,294

\$25,000

0-6080 - Performance Histories of Thermally Segregated HMA

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



Abstract

Objective: This project will document thermally segregated locations on TxDOT HMA construction projects and track their performance history.

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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Project Advisors

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Stephen Smith, ODA

Research Supervisor

Tom Scullion, TTI

Total Project Budget
\$272,100

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$27,777

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

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



Abstract

Objective: This research project will address and develop good practices for designing and constructing mixes containing higher than normal RAP contents.

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

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

This project will address all three of these critical factors. 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.

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 2011 Budget
\$109,940

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

Objective: This project will critically review new ideas and recommendations from recent findings concerning HMA mix designs to extract what is practical and cost effective, and build and field test the next generation of mix design procedures.

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.

Project Director

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Research Supervisor

Tom Scullion, TTI

Total Project Budget
\$1,342,768

Research Universities
Texas Transportation Institute
University of Texas at San Antonio

FY 2011 Budget
\$214,825
\$10,000

0-6255 - Use of Manufactured Sands for Concrete Paving

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



Abstract

Objective: This research will find solutions for using manufactured fine aggregates (MFAs) to produce good quality paving concrete that has adequate surface friction.

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.
- 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.

Project Director

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Project Advisors

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David Head, ELP
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Richard Szecsy, LMC

Research Supervisor

David Fowler, CTR

Total Project Budget
\$415,000

Research Universities
Center for Transportation Research

FY 2011 Budget
\$140,000

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

Start Date - 10/16/2008 **End Date** - 12/31/2010



Abstract

Objective: The goal of this project is to develop comprehensive guidelines for the full-depth reclamation (FDR) rehabilitation process.

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.

Project Director

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Project Advisors

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Martha Gandara, ELP

Miguel (Mike) Arellano, AUS

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Stephen Kasberg, BRY

Research Supervisor

Tom Scullion, TTI

Total Project Budget
\$290,050

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$20,000

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

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



Abstract

Objectives: The purpose of this project is to update the existing Rigid Pavement Database to include information that will help in the development and calibration of the TxDOT M-E Design for continuously reinforced concrete pavement (CRCP) and develop an advanced and user-friendly database to track the performance of typical and special concrete pavements in Texas .

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 promote better understand of the performance of jointed concrete pavement (JCP) and CRCP sections constructed with various designs and environmental conditions. Sections that encompass a wide range of conditions in Texas in design, materials, and environmental conditions, 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

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Research Supervisor

Moon Won, TECHMRT

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 web-based, 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.

Total Project Budget
\$817,015

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

FY 2011 Budget
\$84,278
\$80,000

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

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



Abstract

Objective: This project will conduct a thorough in-depth study to determine whether thermal expansion of Portland cement concrete (PCC) pavement slabs are really causing damage to bridge structures and if so, which terminal system is most cost-effective.

It has long been stated that Portland cement concrete (PCC) pavements can grow and push bridge structures, resulting in damage to bridge structures. Three terminal systems are currently used in Texas to protect bridge structures from the expansion of PCC pavements. 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 the 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 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 an 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 indicated quite small slab movements at the end of the

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pavement, regardless of terminal types used. The magnitude of slab movement was too small to cause damage 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 as needed to determine whether thermal expansion of PCC pavement slabs is really causing damage 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.

Total Project Budget

\$413,548

Research Universities

Center for Multidisciplinary Research
in Transportation

Center for Transportation Research

University of Texas at El Paso

FY 2011 Budget

\$60,868

\$50,000

\$27,000

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** - 08/31/2011



Abstract

Objective: This research will evaluate Item 292 “Asphalt Treatment (Plant Mixed),” of the 2004 Standard Specification book and improve laboratory design protocols for these types of bases.

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 these types 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 these types of materials.

Project Director

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Research Supervisor

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Total Project Budget
\$282,000

Research Universities
University of Texas at El Paso

FY 2011 Budget
\$45,000

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

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



Abstract

Objective: This project will develop improvements to the Texas Pavement Management Information System (PMIS) to meet the evolving needs of TxDOT.

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.

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Total Project Budget	Research Universities	FY 2011 Budget
\$768,716	Texas Transportation Institute	\$122,174
	University of Texas at El Paso	\$94,761
	University of Texas at San Antonio	\$69,478

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

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



Abstract

Objective: This project will characterize the frictional, strength, and durability properties of aggregates for crack attenuating mixes (CAM) designed using local aggregates with different binders. Researchers will also evaluate and improve design procedures if necessary.

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. Current performance criteria in terms of Hamburg Wheel Tracker (HWT) and Overlay Tester (OT) will be applied to develop minimum aggregate quality criteria for CAM mixes. Additional performance tests will supplement HWT and OT testing to more rapidly assess the rutting and cracking properties of CAM using a wide range of local aggregates. Finally, these procedures will 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.

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Total Project Budget
\$299,819

Research Universities
Center for Transportation Research

FY 2011 Budget
\$154,465

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

Objectives: This project will determine what clay minerals (i.e. smectite, illite, kaolinite, etc.) are responsible for deterioration of pavement structures such as coarse and fine aggregates used in Portland cement concrete, bituminous mixes and chip seals. Researchers will also identify a quick test method to measure deleterious clay minerals in stockpiles.

The Texas Department of Transportation has recently expressed concern about clay contamination in pavement structures. 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

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Research Supervisor

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Total Project Budget
\$390,755

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$130,195

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

Objective: This project will develop guidelines for optimal selection of aggregate gradations for seal coat type selection based on pavement conditions and roadway locations.

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. Initial results from this research 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.

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Total Project Budget
\$241,332

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$124,260

0-6587 - Flexible Base Acceptance Testing

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



Abstract

Objective: This project will recommend modifications to base acceptance test methods.

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.

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Total Project Budget
\$235,150

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$94,975

0-6590 - Material Selection for Concrete Overlays

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



Abstract

Objective: This researcher will determine which overlay materials bond well under realistic conditions and determine if these materials are beneficial for bonded concrete overlays.

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) improving the durability and/or surface characteristics of the existing pavement; (3) expediting 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 determine if these materials are beneficial for bonded concrete overlays.

Project Director

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David Fowler, CTR

Total Project Budget
\$300,000

Research Universities
Center for Transportation Research

FY 2011 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

Objective: The objective of the research is to ensure that warm mix asphalt (WMA) mixtures are performing better or on par with HMA mixtures.

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

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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.

Total Project Budget
\$304,900

Research Universities
Center for Transportation Research

FY 2011 Budget
\$155,086

0-6607 - Search for a Test for Fracture Potential of Asphalt Mixes

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This project will develop a Test for Fracture Potential of Asphalt Mixes.

The incorporation of the Hamburg Wheel Tracking test in the TxDOT mix-design specifications has resulted in HMA mixes that exhibit resistance to rutting, but in many cases, lack the optimum resistance to fracture and cracking. Field evidence indicates that most of Texas' HMA pavements are prone to cracking with the occurrence of other premature failures related to cracking. As a means to address this issue, TxDOT currently uses and has implemented the Overlay Tester (OT) to evaluate the cracking susceptibility and resistance to reflective cracking of HMA mixes. While, the OT has fairly been satisfactory with SMA and Crack Attenuating Mixture (CAM) mixes, performance has been relatively poor with most conventional dense-graded HMA mixes such as Type A, B, C and D (Items 340/341), which makes up about 75% of all the HMA mixes used in Texas. This is partly attributed to the severity of the OT which results in high variability of the OT on dense graded mixes. A laboratory mixture test to characterize the cracking susceptibility of HMA mixes is thus greatly needed for all the Texas HMA mix types.

As a minimum, such a test protocol must have the following characteristic features:

- Applicability for routine HMA screening and not necessarily performance prediction such as fatigue life.
- Practical and easily implementable by TxDOT.
- Easy sample preparation with potential to test both lab-prepared and field cores.
- Reasonable test duration of no more than one day.
- Acceptable level of variation and test reliability.

Project Director

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Research Supervisor

Tom Scullion, TTI

To address this issue, a research task under Study 0-6132 was initiated to develop a defensible cracking performance test. As a continuation of this effort and in order to address the objective of this project, various crack tests will be evaluated including the following: Overlay Tester, direct-tension test, indirect-tension test, semi-circular bending test, bending beam, and the C(T) ASTM 7313 (b). Expected deliverables from this study will include recommendations for a practical and reliable test for routine crack evaluation of HMA mixes with acceptable levels of variability. A preliminary test protocol along with the laboratory test procedures and mix screening criteria will be submitted to TxDOT.

Total Project Budget
\$275,738

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$139,125

0-6610 - Impact of Changes in Profile Measurement Technology on QA Testing of Pavement Smoothness

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objective: This research will establish the impact of recent changes in profiling technology lasers on TxDOT's implementation of the Department's Item 585 ride specification.

The project will provide recommendations on whether and how the Department can accommodate new sensor technology within the existing framework of Item 585, considering that the pay adjustment schedules in this current specification are based on inertial profiles collected with the traditional single-point lasers. Of particular importance to this research is verification of the ride statistics and defect locations determined from profile measurements with the traditional single-point and newer wide-footprint lasers. This verification would require ground truth measurements to establish benchmarks that may be used to identify where changes are required in the existing ride specification and determine what these changes should be. Additionally, this research project aims to evaluate the bump criteria in the existing ride specification to establish an improved methodology that engineers can use to objectively determine the need for corrections based on measured surface profiles to fix defects that diminish road-user perception of ride quality.

Project Director

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Glen Dvorak, YKM

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Seth Campbell, TSD

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Total Project Budget
\$593,841

Research Universities
Texas Transportation Institute
University of Texas at Arlington

FY 2011 Budget
\$143,999
\$91,068

0-6611 - Improvements of Partial and Full-Depth Repair Practices for CRCP Distresses

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This project will develop and enhance the effectiveness of full-depth repair (FDR) and partial-depth repair (PDR).

Field evaluations of the performance of full-depth repair (FDR) of continuously reinforced concrete pavement (CRCP) distresses in Texas reveal that improvements are needed to the current FDR practices. For example, Item 361 of the TxDOT Standard Specifications, "Full-Depth Repair of Concrete Pavement," has requirements that are detrimental to the performance of FDR of CRCP. Also, the effectiveness of the current practice of drilling and epoxy application for tie bars is compromised by non-compliance with the specifications or selection of non-optimum epoxies.

A substantial amount of CRCP distresses in Texas are limited to the upper half of the slab thickness above longitudinal reinforcement. However, the primary method to repair these distresses in Texas has been FDR. FDR is more expensive and more destructive to CRCP than reasonable partial-depth repair (PDR). Currently, TxDOT does not have guidelines on when to perform PDR. This project will develop specifications and design standards for PDR.

Since TxDOT has more than 11,000 lane miles of CRCP and has lately placed more emphasis on repairs and maintenance than building new pavements, this project is quite timely and the implementation of the findings from this study will improve TxDOT's pavement repair effectiveness while saving valuable financial resources.

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Research Supervisor

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Total Project Budget	Research Universities	FY 2011 Budget
\$269,255	Center for Multidisciplinary Research in Transportation	\$100,284
	University of Texas at El Paso	\$30,000

0-6613 - Evaluate Binder and Mixture Aging for Warm Mix Asphalts

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objectives: The purpose of this project is to evaluate binder oxidation, binder absorption by aggregates, and the impact of these issues on mixture durability for the various common warm mix (WMA) technologies and to develop a new binder specification, suitable for unmodified and modified binders, that incorporates binder oxidative aging and its impact on WMA pavement durability.

Warm mix asphalt (WMA) technologies employ reduced mixing and placement temperatures thereby allowing reduced fuel consumption, enhanced compaction, increased haul distances and an extended paving season. Issues of concern in WMA are binder oxidation and absorption and their impact on pavement durability. Ongoing TxDOT project 0-6009 is quantifying oxidation rates in HMA pavements and their impact on pavement durability, but does not address warm mixes or binder absorption.

To accomplish the objectives in this project researchers will be taking measurements of laboratory and field warm mix materials: binders, aggregates, lab-compacted mixtures, and pavement cores. Studies will include measurements of fundamental absorption-related properties of binders and aggregates, absorption of warm mix and hot mix asphalts by aggregates at both warm mix and hot mix temperatures, and characterization of laboratory and field warm mixture specimens as to both mixture rheology and recovered binder oxidation and rheological hardening.

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Total Project Budget
\$525,511

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$154,161

0-6614 - Use of Recycled Asphalt Shingles in HMA

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This research project will conduct an in depth study of the use of recycled asphalt shingles (RAS) in hot-mix asphalt (HMA) or warm-mix asphalt (WMA) mixtures and recommend changes to Texas Department of Transportation (TxDOT) specifications to allow optimal use of these mixtures.

Use of recycled asphalt shingles (RAS) in hot-mix asphalt (HMA) or warm-mix asphalt (WMA) mixtures has the potential to significantly reduce the cost of asphalt paving mixes while conserving energy and preserving the environment. Research on this subject is relatively limited in the literature. The main objectives of this research project are defined as below:

- Define best practices relative to the use of RAS in HMA and WMA mixes,
- Develop a balanced mixture design method(s) for RAS mixes including characterizing RAS binder and developing new RAS binder blending charts,
- Construct and monitor field test sections containing RAS,
- Define the environmental benefits associated with the use of RAS, and
- Recommend changes in Texas Department of Transportation (TxDOT) specifications to allow optimal use of RAS.

To achieve these objectives, the following eight-task work plan is proposed.

- Task 1 - define current best practices by visiting shingle manufacturers and shingle processors in Texas and testing RAS materials as well as conducting literature reviews.
- Task 2 - characterize RAS binder properties and develop RAS binder blending charts through extensive laboratory binder testing. Mixture design method(s) for RAS mixes will be proposed based on laboratory evaluation of engineering properties of RAS mixes in Task 3, and will be validated through field test sections in Task 4.
- Task 5 - define the environmental benefits and cost savings.
- Task 6 - recommend changes to current specifications and mix design methods based on research results from Task 1 through 5.
- Task 7 - Conduct two workshops to effectively implement findings.
- Task 8 - Document all research activities in a research report.

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Total Project Budget
\$317,026

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$159,037

0-6615 - Use of Fine Graded Asphalt Mixes

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This research will explore the use of fine graded Open Graded Friction Courses (OGFCs) as a new alternative to chip seals for maintaining low-volume roads.

TxDOT has to explore new ways to maintain low volume roads besides just doing chip seals. Chip seals are a good way to keep roads sealed but when this treatment is used near populated areas it can create some problems with road noise. The state of New Mexico has significantly improved the performance of their low volume pavements in the past 10 years. Many people have noticed the good performance of a specific type of fine graded Open Graded Friction Course (OGFC) that is currently used on many low volume roads in New Mexico. The OGFC is finer and placed significantly thinner than TxDOT's PFC mixes. The typical OGFC in New Mexico is placed at a thickness between ½" and ¾". This mix is used as an alternate to seal coat or microsurfacing. The mix is much quieter and smoother than a typical seal coat or microsurfacing. A cost and performance comparison between this type of OGFC and a seal coat and/or microsurfacing would be beneficial. Such a mix could give TxDOT more or better options regarding surfacing low volume roadways. Other states are using fine grained dense mixes to execute thin overlays on aged pavements that do not require strengthening. These types of overlays last longer than chip seals and they are more appealing especially for urban environments.

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Total Project Budget
\$280,884

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$139,245

0-6616 - Validate Surface Performance-Graded (SPG) Specification for Surface Treatment Binders

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This project will use final laboratory and field results to produce a revised surface performance-graded (SPG) specification for surface treatment binders in service.

Currently TxDOT utilizes the Performance Grading (PG) system for grading hot mix asphalt (HMA) binders and older penetration and viscosity systems for grading surface treatment binders in service as either emulsion residues or hot-applied asphalt cements. In 2003 TxDOT Project 0-1710 developed and initially validated a Surface Performance Grading (SPG) system for surface treatment binders in service to reconcile differences in required equipment and account for other differences in design and construction methods, structural functions and response behavior, distress types, and environmental exposure. At that time, lack of national field validation and the use of regional materials precluded adoption of the SPG specification by the American Society of Testing and Materials (ASTM). Now there is renewed national and state interest in completing the validation and improving the SPG specification.

Specifically, the project will address this need by standardizing the emulsion residue recovery method through evaluation of the Force Draft Oven and Texas Oven methods, exploring the exclusive use of the Dynamic Shear Rheometer (DSR) for determining performance-based properties, and further field validation of the thresholds for these properties. Laboratory and field results will be used to produce a revised SPG specification for surface treatment binders in service.

Project Director

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Total Project Budget
\$306,866

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$162,700

0-6617 - Revamping Aggregate Property Requirements for Portland Cement Concrete

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objective: This research will evaluate several aggregate tests and their relationship to concrete performance.

Current TxDOT specifications for aggregates in Portland cement concrete have been in Item 421 for over 37 years. Two tests have been required to qualify aggregate for concrete. The magnesium sulfate soundness test which was developed to evaluate the effect of freezing and thawing of aggregates and is only an indirect test for durability. It has had very mixed results as a predictor of concrete performance. The Los Angeles abrasion test has been used to evaluate aggregate strength and toughness. This test has also been shown not to be a good predictor of concrete performance. This research will evaluate several tests including the micro-Deval, aggregate imaging system (AIMS), unconfined freeze-thaw, crushing strength (wet and dry), and absorption tests singly and in combination. Concrete performance will be established from subjective ratings by TxDOT personnel based on many years of service. The concrete performance will be correlated with the aggregate test results. From these correlations aggregate tests and test limits will be recommended.

Project Director

Michael Dawidczik, CST

Project Advisors

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Elizabeth (Lisa) Lukefahr, CST

Ryan Barborak, CST

Steven Swindell, BRY

Research Supervisor

David Fowler, CTR

Total Project Budget
\$542,000

Research Universities
Center for Transportation Research

FY 2011 Budget
\$210,000

0-6618 - Mitigation of High Sulfate Soils in Texas

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objective: The main objective of this research is to advance the state of knowledge in the heaving phenomenon in high sulfate soils.

Despite increased knowledge and awareness of sulfate heave, the Texas Department of Transportation (TxDOT) continues to experience pavement failures during and immediately after construction on roads designed to last 20 years or more. Failures are particularly evident in sites where high sulfate soils of 8000 ppm or higher predominate. Many of these failures are attributed to sulfate-induced heave where an expansive mineral called ettringite is formed from calcium-based stabilizers reacting with water, clay, and sulfates.

The researchers have identified several tasks to: address development of methods to quantify reactive alumina and silica in treated soils; establish stabilizer dosage and sulfate concentrations at which heaving occurs; understand the rate of heaving or ettringite formation kinetics; address reactions between sulfates and other additives such as fly ash; and develop mitigation strategies to address heaving in sulfate soils. Project deliverables will include: 1) development of methods to better understand the causes of heaving in chemically treated high sulfate soils, and 2) develop methods or strategies to limit the sulfate heaving in these high sulfate soils.

Project Director

Miguel (Mike) Arellano, AUS

Project Advisors

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Jimmy Si, CST

John Bilyeu, CST

Mary Fletcher, TYL

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Noel Paramanantham, PAR

Richard Williammee, FTW

Research Supervisor

Anand Puppala, UTA

Total Project Budget
\$381,350

Research Universities
Texas Transportation Institute
University of Texas at Arlington

FY 2011 Budget
\$79,462
\$59,912

0-6619 - Evaluation of Skid Measurements Used by TXDOT

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This study will evaluate the skid measurement systems used by TxDOT to ensure accuracy or make modifications.

Accurate estimates of tire-roadway friction values (SN) are critical to the safety of the traveling public. The seven skid measurement systems currently used by TxDOT do not directly measure the vertical test wheel load (W) but calculate it using the locked wheel drag force (F) and the trailer geometry. This technique has been proven at TTI to work well on flat, tangent pavement sections. When vertical wheel loads are not measured directly, external dynamic forces such as grade, curvature and roughness could contribute to errors in the reported skid number.

The first phase of this project will quantify the magnitude of any errors by means of field experiments where the two channel, Texas Transportation Institute, ASTM E-274, skid trailer is compared to the one channel TxDOT, E-274 skid trailer. The comparisons will be made on selected roadways that exhibit mild, medium and severe geometric attributes.

If the errors found are significant, the second phase of the project will be the development of methods to either measure the vertical load directly by the use of strain gages or inertial methods using accelerometers or other transducers. If logistically practical, the chosen modification will then be applied to a TxDOT system for testing.

Project Director

Magdy Mikhail, CST

Project Advisors

Cal Hays, TYL

Edward Morgan, CST

Elizabeth (Lisa) Lukefahr, CST

John Wirth, CST

Michael Lee, LFK

Paul Schneider, TYL

Rodney Tucker, SJT

Tom Hunter, LFK

Research Supervisor

Richard (Dick) Zimmer, TTI

Total Project Budget

\$189,069

Research Universities

Texas Transportation Institute

FY 2011 Budget

\$110,340

0-6620 - Dwarf Turf-type and Early Maturing Annual Ryegrass to Establish Perennial Vegetation

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: The findings from this research will result in a procedure manual for utilizing short dwarf-type ryegrass lines to establish permanent vegetation on roadsides.

Annual ryegrass is not currently recommended by TxDOT for roadside re-vegetation nurse crop because its late maturity and height are too competitive for establishing perennial or spring plant mixtures. Two genotypes are available which are significantly less competitive and could be seeded with fall seeded perennials and wild flowers: a short dwarf-type ryegrass developed for home lawns and an early maturity type ryegrass which produces seed heads in January or February. Both the dwarf- and early maturing-type annual ryegrasses could be less competitive for nutrients, moisture, and sunlight. We will determine if dwarf or early maturing ryegrass are less competitive nurse crops for warm season perennials and allow spring development of wildflower seed production. We will fall plant perennials and the TxDOT wild flower mix in all treatments for each of four zones to determine the ideal annual ryegrass genotype, seeding rates, fertilizer rates, and stand management. We will also determine long-term effect of treatments on establishment and persistence of warm-season perennials and wild flowers. We will then test these findings on TxDOT right-of-way construction sites in all 11 Natural Regions of Texas and write a procedure manual for utilizing ryegrass lines to establish permanent vegetation on roadsides.

Project Director

Dennis Markwardt, MNT

Project Advisors

David Harper, LBB

Jon Geiselbrecht, AUS

Marvin Hatter, SAT

Steve Orchard, CRP

Sydney Newman, PAR

Research Supervisor

Hennen Cummings, TARL

Total Project Budget	Research Universities	FY 2011 Budget
\$200,523	Stephen F. Austin University	\$4,617
	Tarleton State University	\$55,216
	Texas AgriLife Research	\$43,866

0-6621 - Developing a Mixture Based Specification for Flexible Base

Start Date - 09/20/2010 **End Date** - 08/31/2012



Abstract

Objective: This project will develop a mixture-based specification for flexible base in a quality control/quality assurance (*QC/QA*) format for the Texas Department of Transportation (TxDOT).

The main features of this project are the early development of a draft specification for flexible base material; the utilization of an industry working group comprised of TxDOT, producer, and contractor representatives to provide feedback during formulation of the specification; and the utilization of the research team to provide detailed information from which critical decisions can be made to form the specification. After identifying important flexible base properties for inclusion in the specification, this project will use laboratory testing in conjunction with pavement performance predictions to develop operational tolerances from the job-mix formula that will not compromise the strength requirements of Item 247. Additionally, this project will propose pay factors based upon performance predictions from "as designed" to "as constructed" properties. Finally, this project will develop a mixture design procedure for flexible base course material for incorporating the new Flexible Base *QC/QA* Specification into the Texas Asphalt Pavement Association's Soil and Base Certification Program.

Project Director

Caroline Herrera, CST

Project Advisors

Chris Reed, CHS

Darlene Goehl, BRY

Joe Leidy, CST

John Bilyeu, CST

Richard Williammee, FTW

Ronald Hatcher, CHS

Stevan Perez, LBB

Research Supervisor

Jon Epps, TTI

Total Project Budget
\$411,344

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$208,049

0-6623 - Optimizing Resource Allocations for Routine Highway Maintenance

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This project will develop a methodological procedure for minimizing the impact of budget fluctuations on highway conditions and provide guidelines for assisting TxDOT districts in making critical maintenance decisions when there is a budget cut to decide what activities or projects are the most cost-effective.

TxDOT has been experiencing fluctuations of budget over the years in terms of the resources available for maintaining and preserving the highway infrastructure. This fluctuation in budget can potentially make the highway condition unstable if the maintenance budget falls short for a sustainable period of time. As a result, it is important for TxDOT to look into maintenance and rehabilitation policies that lower the risk of unstable road network conditions. However, the question of how to minimize the risk of such budget fluctuations on network-level roadways has not been addressed in the current literature. There is an immediate need to develop a methodology that can help minimize the impact of budget fluctuations on highway maintenance programs. Therefore, guidelines are needed to assist TxDOT districts in making critical maintenance decisions when there is a budget cut. Such guidelines should consider not only the direct impact of reducing certain maintenance activities, but also the cascading effect of doing so.

Project Director

Tammy Sims, MNT

Project Advisors

Karl Bednarz, SJT

Michael Lee, LFK

Pedro (Pete) Alvarez, PHR

Sidney (Sid) Hodgson, TSD

Ted Moore, LBB

Zheng (Jenny) Li, CST

Research Supervisor

Zhanmin Zhang, CTR

Total Project Budget
\$268,557

Research Universities
Center for Transportation Research

FY 2011 Budget
\$133,363

0-6664 - Peer State Review of TxDOT Maintenance Practices

Start Date - 07/01/2010 End Date - 02/28/2011



Abstract

Objective: The purpose of the PEER Review is to provide TxDOT with an assessment of TxDOT maintenance practices and to identify potential areas for improvement based on the opinions of other State DOT experts.

TxDOT has requested that a PEER review be conducted of the TxDOT Maintenance Program and Maintenance Practices. The PEER review will cover the following focus areas:

1. Maintenance Planning Process
2. Maintenance Practices at both the State and District Levels
3. 4-Year Pavement Management Program Development
4. Maintenance Performance Measurement and Reporting
5. Funding Allocation (Funding Levels and Allocation Formula) at both State and District Levels

Directors of Maintenance (DOMs) from 5 peer states will be invited to participate in a 3-day Workshop tentatively to be conducted at the Center for Transportation Research and the Austin District. During the Workshop, presentations will be made by TxDOT personnel on each of the focus areas mentioned previously. The DOMs will be provided with a booklet which summarizes key maintenance issues and questions that TxDOT is interested in evaluating. The booklet will be filled out by the DOMs as they learn about TxDOT's maintenance practices over the course of the Workshop. After each presentation a discussion period will be held during which the DOMs and TxDOT will further discuss the presentation topic. This will provide an additional opportunity to gain insights about possible improvements to TxDOT practices and maintenance procedures and programs which are currently working well.

The Workshop will be supplemented by a 'Road Rally' tentatively planned for the Austin District. The Road Rally will involve traveling over preselected pavement sections in vans. The DOMs will be given rating forms and will be asked to rate the level of maintenance for pavement, roadside or traffic operations. The rating procedure will be based on the District PEER reviews conducted by the

Maintenance Division. The focus will be to determine if the level of maintenance is at, above or below the expected level for the type of route being evaluated. TxDOT personnel will follow in separate vans and rate the same routes for comparison purposes.

Project Director

Tammy Sims, MNT

Project Advisors

Dennis R. Cooley, LFK
Lonnie Gregorcyk, YKM
Lynn Passmore, BWD
Mario Jorge, PHR
Toribio Garza, MNT

Research Supervisor

Mike Murphy, CTR

During the Workshop, CTR personnel will use different means to capture the opinions, insights, questions and comments by the PEER Group and TxDOT personnel. This information will be summarized and prepared in a preliminary draft report soon after the Workshop is completed. The preliminary draft report will be sent to the DOMs for review to ensure accuracy and to solicit further input. A final report will be published based on the findings of the Workshop and Road Rally and will summarize insights, areas for possible improvement and practices that currently work well.

Total Project Budget
\$84,271

Research Universities
Center for Transportation Research

FY 2011 Budget
\$63,592

0-6665 - TxDOT Native Plant Integration Program for South, Central and West Texas

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objective: This project will collect, evaluate, and release native seed sources for use by TxDOT in Central, West, and South Texas.

Project seed collectors will obtain seeds from target native plant species throughout these regions. Evaluation plantings will be made using these seeds at numerous locations throughout the project area, and plant performance of the various species and collections will be assessed. Following evaluation and testing, the most suitable species and collections will be increased in field-scale production fields, and seeds harvested from these fields will be distributed to commercial growers to make well-tested, adapted native plants and seeds readily available for use by TxDOT for right-of-way vegetation management and restoration.

Project Director

Dennis Markwardt, MNT

Project Advisors

Research Supervisor

Forrest Smith, TAMUK

Total Project Budget	Research Universities	FY 2011 Budget
\$750,000	Texas A&M University – Kingsville	\$150,000
	Subcontracts to:	
	Sul Ross State University	\$10,000
	Tarleton State University	\$10,000
	Texas AgriLife Research	\$10,000

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

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



Abstract

Objective: This project will develop 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 2011 Budget
\$168,237
\$20,000

RMC 2 – Active Projects

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RMC 2 – Active Projects

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0-4570 - The South Texas Native Plant Restoration Project

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



Abstract

Objective: 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 2011 Budget
\$150,000

0-5949 - Bioretention for Stormwater Quality Improvement in Texas

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



Abstract

Objective: 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

Jon Geiselbrecht, AUS

Project Advisors

Amy Foster, ENV

Barrie Cogburn, DES

Craig Dunning, DES

David Zwernemann, AUS

John Moravec, BRY

Research Supervisor

Ming-Han Li, TTI

Total Project Budget

\$462,967

Research Universities

Texas Transportation Institute - \$118,703

FY 2011 Budget

0-5974 - Estimating Texas Motor Vehicle Operating Costs

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



Abstract

Objective: 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.

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.

While not addressing the measurement of external costs associated with vehicle use, the results from this project 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 2011 Budget
\$162,129

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

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



Abstract

Objective: This research will study and address issues pertaining to exhaust emissions from heavy duty diesel vehicles in nonattainment areas such as the Houston-Galveston-Brazoria (HGB) area.

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

Vacant

Project Advisors

Charles Airiohuodion, HOU
Don Lewis, GSD
Graciela Lubertino, HGAC
Madhu Venugopal, NCTCOG
Morris Brown, TCEQ
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Research Supervisor

Josias Zietsman, TTI

Total Project Budget
\$513,601

Research Universities
Texas Southern University
Texas Transportation Institute

FY 2011 Budget
\$14,000
\$84,000

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

Objective: 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.

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.

Other focal bird species that will be included in this study, depending on abundance and 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

Stirling Robertson, ENV

Research Supervisor

Michael Morrison, TAES

Total Project Budget

\$1,150,496

Research Universities

Texas AgriLife Research

FY 2011 Budget

\$287,129

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

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



Abstract

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

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 (particularly mid-heavy and superload) permits, the adequacy of the Utility Accommodation Rules is unknown.

Project Director

Charon Williams, ROW

Project Advisors

Dean Wilkerson, TSD

Guy Sledge, LBB

Justin Obinna, MNT

Ray Hutchinson, MCD

Stephen Stakemiller, HOU

Research Supervisor

Edgar Kraus, TTI

Total Project Budget
\$302,792

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$157,932

0-6404 - Accommodating Oversize & Overweight Loads

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



Abstract

Objective: This project will identify the most common oversize & overweight (OS/OW) dimension and weight groups, identify criteria for assigning these groups to existing road networks, and criteria for assigning current and projected OS/OW groups to the future road network upgraded to meet future demand.

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.

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 2011 Budget
\$65,493

0-6412 - Equipment Replacement Optimization

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



Abstract

Objective: This project will recommend a new equipment replacement optimization methodology for TxDOT.

TxDOT has a fleet value of approximately \$500,000,000 with an annual turnover of about \$50,000,000. Substantial cost savings in fleet management have 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.

Improvements in TxDOT's vehicle cost data base 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 fleet optimization methodology must use these class codes.

The objectives of this project are to (1) determine the best optimization methodology; (2) evaluate commercial fleet management systems; (3) develop a TxDOT specific algorithm if this is cost-effective relative to 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.

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, SPPM
Scott Hamilton, SAT

Research Supervisor

Wei Fan, UTTYL

Total Project Budget	Research Universities	FY 2011 Budget
\$256,636	Center for Transportation Research	\$63,137
	University of Texas at Tyler	\$66,578

0-6467 - Identification of Priority Rail Projects

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



Abstract

Objective: 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

Gilbert Wilson, RRD

Project Advisors

Darin Kosmak, RRD

Sarah Stroman, ENV

Steve Calles, HOU

Tom Beeman, DES

Research Supervisor

Curtis Morgan, TTI

Total Project Budget
\$273,815

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$132,815

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

Objective: 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, SPPM

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 2011 Budget
\$135,000
\$19,953

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

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



Abstract

Objective: This research will measure the impact of increased levels 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.

In recent years, there has been a boom of energy-related activities in the state. While these efforts contribute to enhancing 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.

Project Director

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Project Advisors

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Charon Williams, ROW
Dean Wilkerson, TSD
Justin Obinna, MNT
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 2011 Budget
\$148,000

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

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



Abstract

Objective: This research study will 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 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.

Texas's energy sector has a critical impact - historically and currently - on both the state economy and the Texas 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

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Project Advisors

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Charon Williams, ROW

Connie Flickinger, BRY

Dean Wilkerson, TSD

Heather Hilbert, TSD

Mark Johnson, TRF

Mary Anne Griss, ADM

Research Supervisor

Jolanda Prozzi, CTR

Total Project Budget
\$265,000

Research Universities

Center for Transportation Research

University of Texas at San Antonio

FY 2011 Budget

\$114,450

\$10,550

0-6624 - Improving the Response and Participation by Utility Owners in the Project Development Process

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: The purpose of the research is to develop strategies to improve the participation and response of utility owners in the project development process.

Detection of utility conflicts as early as possible during the project development process can help to improve the timely adjustment of utilities and/or allow time to develop alternatives to avoid utility adjustments. However, because TxDOT does not have contractual relationships with private utility companies, there are only limited legal mechanisms to induce the private utilities to comply in a timely way with relocation requests. Further, utility owners hesitate to get involved in the utility adjustment process and typically do not participate actively until the transportation project is at least 60-90 percent design complete, which can result in significant project delays or the need to re-design the project to avoid a utility relocation.

Research activities include: reviewing strategies used by TxDOT and other states to encourage early participation by utilities; developing strategies that include a combination of elements such as performance measures, "carrots and sticks," and accountability; identifying potential changes in laws and regulations related to the recommended strategies; developing recommendations for changes to business processes and relevant TxDOT manuals; and developing and testing training materials.

Project Director

Tommy Jones, ABL

Project Advisors

Charon Williams, ROW

David Roberts, HOU

Dean Wilkerson, TSD

Guy Sledge, LBB

Stephen Stakemiller, HOU

Research Supervisor

Cesar Quiroga, TTI

Total Project Budget
\$293,000

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$143,000

0-6626 - Fleet Equipment Performance Measurement Preventive Maintenance Model (PM2)

Start Date - 09/02/2010 **End Date** - 08/31/2012



Abstract

Objective: This research will develop an algorithm (through statistical modeling) that can be used to recommend appropriate oil change intervals based on engine data collected through on-board diagnostic systems to help refine predictions for when equipment maintenance should be performed.

The concept of preventive maintenance is very important in the effective management and deployment of vehicle fleets. The Texas Department of Transportation (TxDOT) operates a large fleet of over 17,000 pieces of on-road and off-road equipment. Consequently, fleet maintenance procedures represent a significant cost to the agency. TxDOT currently uses a fleet tracking program (FleetTrackS) to identify when specific fleet equipment require maintenance. This scheduling is dependent on simple variables such as vehicle miles or operational hours logged.

Newer engines and vehicles are equipped with on-board diagnostic systems that can provide data on engine operation - including engine speed and throttle position (an indication of load value). There is the possibility of tracking these parameters (performance measures) over time and correlating to another performance measure (oil degradation). This can refine predictions for when equipment maintenance should be performed. The aim of this research is to provide a "proof of concept" for this idea by developing an algorithm (through statistical modeling) that can be used to recommend appropriate oil change intervals based on engine data collected through on-board diagnostic systems. Recommendations for an expanded implementation project will be made if the concept proves to benefit TxDOT and make good economic sense.

Project Director

Don Lewis, GSD

Project Advisors

Lori Clark, NCTCOG
Richard Walbrick, LBB
Ron Hagquist, SPPM

Research Supervisor

Tara Ramani, TTI

Total Project Budget
\$255,414

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$127,222

0-6627 - Mega-Region Freight Issues in Texas: A Synopsis

Start Date - 09/01/2010 **End Date** - 08/31/2011



Abstract

Objective: This research will address mega-region planning questions such as how this approach might change planning in Texas, what benefits and costs are associated with its adoption and what characteristics are of specific interest to TxDOT.

Mega-regions originate from the work of French geographer Jean Gottmann, which described a new urban form, Megalopolis, to characterize the network of interconnected cities from Boston to Washington, D.C. along the Atlantic Coast in 1961. Megaregion interest has grown strongly in the last decade and is now seen by a growing numbers of planners as offering provocative and visionary answers to problems such as modal congestion, development disparity, and air pollution that individual metropolitan areas or cities cannot solve alone. Megaregion planning presents a different way of mitigating metropolitan problems of large-scale transportation systems, green infrastructure, and economic development and has attracted a number of transportation advocates since 2000. Central questions addressed in this study include how this approach might change planning in Texas, what benefits and costs are associated with its adoption and what characteristics are of specific interest to TxDOT. This project is therefore structured to present the Department with a comprehensive literature review, take directions of interest from the Project Monitoring Committee, undertake preliminary analysis, and present these to a workshop audience comprising TxDOT planners, Metropolitan Planning Organization staff, transportation providers, public transit agencies, and federal officials. A major outcome is a program of future work that complements TxDOT planning, especially at the state transportation planning level. This will allow Texas to compete with other states using Megaregional planning to promote economic growth, federal support, and private sector investment.

Project Director

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Project Advisors

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Research Supervisor

Robert Harrison, CTR

Total Project Budget
\$162,775

Research Universities
Center for Transportation Research
Texas Southern University

FY 2011 Budget
\$119,284
\$43,491

0-6628 - Economic Considerations in Transportation System Development and Operations

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objectives: This research will produce a Transportation Economics Encyclopedia, and use presentations and reports to inform TxDOT and other agencies about economic considerations in transportation system development and operations.

An essential backbone of regional and national economies, transportation has a myriad of associations and impacts. An understanding of the causal mechanisms behind, and the extent of, these associations and impacts can be vital to defensible and optimal decision-making by budget-constrained transportation agencies. From travel time savings to job creation (both direct and indirect), income growth to property value changes, motor vehicle crashes to air quality and noise impacts, microeconomic choices to macroeconomic shifts, transport policies and investments carry great weight.

The notion of trade-offs is fundamental to a solid understanding of economic practice and theory. Salient comparisons include marginal benefits (to travelers and the larger community) versus marginal costs (to suppliers of transport, like TxDOT, as well as those enduring any negative externalized costs). They include maintenance and operations versus new construction, private interests versus social objectives, short-run versus long-term impacts, highways versus transit provision, speeds and flows versus access and connectivity, single-occupant vehicles versus non-

Project Director

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Research Supervisor

Kara Kockelman, CTR

motorized modes, trucks versus trains, access to seaports versus airports, local versus regional interests, national versus global interests, and so on. The Encyclopedia, presentations, and reports developed under this project will illuminate all these contexts, in the most straightforward of terms, with meaningful applications to illustrate their value and implications. The first year will be largely devoted to producing a Transportation Economics Encyclopedia (as a practitioner's desktop reference), and the second year will focus on provision of final case study applications, presentation slides by subject, workshops and a webinar series for bringing the subjects alive to TxDOT personnel, and any others TxDOT wishes to include in this educational process.

Total Project Budget
\$270,000

Research Universities
Center for Transportation Research

FY 2011 Budget
\$135,000

0-6629 - Texas-Specific Drive Cycles and Idle Emissions Rates for Using with EPA's MOVES Model

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This study will provide TxDOT with local drive cycles for different regions of Texas for different vehicle classes and roadway types as well as cold start and idling emissions rates for heavy-duty diesel trucks.

The U.S. Environmental Protection Agency's (EPA) newest emissions model, MOtor Vehicle Emission Simulator (MOVES), utilizes a disaggregate approach that enables the users of the model to create and use local drive schedules (drive cycles) in order to perform an accurate analysis. However, only the national average drive schedules are currently included in the default database of the model. Furthermore, the cold start and idling emissions and activity data of heavy duty diesel trucks (HDDVs) that are included in the MOVES model are based on a very limited number of data sources even though they are very important components of the total on-road mobile source emissions inventory.

Research activities will include the estimated emissions from MOVES for different vehicle classes being compared to real-world on-road emissions measurement. Furthermore, the technical and tactical issues of integrating the results of this study into MOVES for formal emissions analyses purposes will be investigated and recommendations will be made based on the findings.

Project Director

Bill Knowles, TPP

Project Advisors

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Jackie Ploch, ENV

Janie Temple, TPP

Laura Norton, TPP

Madhu Venugopal, NCTCOG

Paul Tiley, TPP

Research Supervisor

Mohamadreza Farzaneh, TTI

Total Project Budget

\$379,710

Research Universities

Texas Transportation Institute

FY 2011 Budget

\$189,950

0-6630 - Condemnation in Transportation Projects: Causes and Solutions

Start Date - 09/01/2010 **End Date** - 02/29/2012



Abstract

Objective: This study will evaluate factors impacting the nature, duration, and cost of ROW acquisition in Texas and develop strategies to reduce condemnation rates, durations, and costs.

The right-of-way (R/W) acquisition process is a major component of any transportation project and is usually on the critical path of the project. This R/W acquisition process begins with a proper valuation of the property, followed by the DOT or local agency's offer presentation to the owner. Negotiation then takes place in an effort to reach an agreement with the owner and process the acquisition and parcel user's relocation. However, the property owner may not accept the offer as a just compensation of the market value. If negotiation does not lead to an agreement between the acquiring agency and the owner, eminent domain (ED) proceedings can be initiated to complete the acquisition process. The high incidence of ED proceedings observed on many property acquisitions in Texas, as well as the associated increase in acquisition costs and durations, justify the need to investigate its causes and solutions.

The tasks for accomplishing this research will involve gaining a full understanding of successful strategies and practices by TxDOT and other agencies, identifying relevant legal aspects, analyzing impact factors, and generating new innovative strategies that should also be given consideration for implementation.

Project Director

Suzanne Mann, OGC

Project Advisors

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Raul Cantu, TPP

Research Supervisor

Carlos Caldas, CTR

Total Project Budget
\$213,832

Research Universities
Center for Transportation Research

FY 2011 Budget
\$145,295

0-6631 - Best Practices for Utility Investigations in the TxDOT Project Development Process

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: The purpose of this project is to review the state of the practice in utility investigations and develop best practices for timing and use of utility investigation services in the TxDOT project development process.

Underground utility facilities that are discovered late during design or construction can have significant negative impacts on project costs and the timely completion of the project. The benefits and cost effectiveness of using utility investigation services to collect data of existing utility facilities have been documented in several national studies. Using subsurface utility engineering (SUE) services, utility data can be collected at different quality levels (QL), including QLD (existing records), QLC (surveying of aboveground utility features), QLB (use of noninvasive geophysical methods) and QLA (exposing utility facilities at critical locations). Although TxDOT has successfully collected QLB and QLA data on several projects, most TxDOT projects currently do not collect this type of data or use it to its full potential.

Key research activities include synthesizing current techniques and best practices in utility investigations, reviewing utility investigation practices at TxDOT, developing best practices for utility investigations, developing utility investigation training materials, and recommending changes to relevant TxDOT manuals including the ROW Utility Manual.

Project Director

Stephen Stakemiller, HOU

Project Advisors

Jeff Richardson, ENV

Jim Heacock, HOU

Matt Mitchell, TYL

Tomas Trevino, CRP

Research Supervisor

Edgar Kraus, TTI

Total Project Budget
\$299,638

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$149,274

0-6632 - Positive Feedback: An Examination of Current Approaches in Iterative Travel Demand Model Implementation

Start Date - 09/01/2010 **End Date** - 08/31/2011



Abstract

Objective: This project will research current trends, practices, and tools in implementing a feedback approach for potential implementation in TxDOT metropolitan area travel demand models (TDMs).

Metropolitan area travel demand models (TDMs) are a critical quantitative analysis tool used to support the development of long-range transportation plans and air quality analyses. The Texas Department of Transportation Transportation Planning and Programming Division (TxDOT-TPP) provides TDM development support to 22 Metropolitan Planning Organizations (MPOs) in the state. Currently, the models developed by TxDOT-TPP are traditional three-step models (i.e. trip generation, trip distribution, and traffic assignment) that are sequentially applied. A limitation of this sequential approach is an inconsistency between the travel time data used in the different stages of the process, which may result in: TDMs which do not accurately reflect systemwide or corridor-level travel patterns, travel times in alternative analyses that may not reflect accurate results, and inaccurate results being used for the air quality determination process. Proposed as an approach to resolve these differences in the model sequence, an iterative feedback mechanism "feeds back" output from traffic assignment for use in the trip distribution step of the next loop, or iteration, of the TDM. Model iterations are continued until specific criteria are met indicating TDM convergence.

Project Director

Greg Lancaster, TPP

Project Advisors

George Petrek, TPP

James Burnett, TPP

Janie Temple, TPP

Laura Norton, TPP

Research Supervisor

Phillip Reeder, TTI

Total Project Budget
\$159,671

Research Universities
Center for Transportation Research
Texas Transportation Institute

FY 2011 Budget
\$76,000
\$83,671

0-6633 - Determine Performance Measures for Public Transit Mobility Management

Start Date - 09/01/2010 **End Date** - 08/31/2011



Abstract

Objective: The purpose of this research project is to define the characteristics of a successful mobility management project and to identify performance indicators that will measure efficiency, effectiveness and quality.

Mobility management is an approach for managing and delivering coordinated public transportation services particularly for customers with special needs such as older adults, people with disabilities, children and youth, and individuals with lower incomes. Mobility management focuses on meeting the needs of the customer using a range of transportation options and service providers. The purpose of coordinating transportation services through mobility management is to better serve the customer and to achieve a more efficient public transportation delivery system. However, there are no industry accepted performance indicators to measure and monitor performance for mobility management. Traditional measures of performance for public transportation (cost per mile, passengers per mile) do not fully capture the impacts/benefits of mobility management.

Project Director

Karen Dunlap, PTN

Project Advisors

Eric Gleason, PTN

Gregory (Greg) Davis, WAC

Joe Gardzina, FBC

Research Supervisor

Lalita Sen, TSU

<i>Total Project Budget</i>	<i>Research Universities</i>	<i>FY 2011 Budget</i>
\$105,500	Sam Houston State University	\$20,000
	Texas Southern University	\$40,500
	Texas Transportation Institute	\$45,000

0-6634 - Potential Value Extraction from TxDOT's Right of Way and Other Property Assets

Start Date - 09/01/2010 **End Date** - 02/29/2012



Abstract

Objective: This project will recommend strategies for pursuing value extraction from TxDOT's right-of-way and other property assets

A number of interested parties have suggested that TxDOT extract additional value (be it economic or societal) from our ROW and other land holdings. A short list of potential uses that have been suggested include the following:

- solar arrays for electricity generation - including pre-fabricated pavement panels;
- wind energy and vehicle turbulence for electricity generation;
- extraction of geothermal energy, oil and gas;
- carbon sequestration;
- wildlife habitat;
- leasing air space for additional uses;
- long distance pipeline transportation; and
- Long distance communications and power transmission.

The research project will:

- Do outreach to all stakeholders to discuss applications, potential benefits, challenges, risks, and opportunities.
- Conduct a technical feasibility and economic viability examination of each potential value extraction application.
- Assess the value extraction potential of all viable applications against the overriding requirements to provide safe and adequate transportation.
- Assess legal issues of ownership / liability / revenue distribution that may result from potential viable applications.
- Develop guidelines to assist TxDOT in determining when, where, and under what circumstances to pursue value extraction strategies.
- Develop recommendations for potential changes to legislation and regulations to accommodate feasible value extraction applications.

Project Director

Ron Hagquist, SPPM

Project Advisors

Becky Blewett, OGC
Elizabeth Hogeda-Romo, MNT
Mary Anne Griss, ADM
Monica Aleman-Smoot, GPA
Paul Campbell, FIN
Rodney Concienne, ENV

Research Supervisor

Jolanda Prozzi, CTR

Total Project Budget
\$202,000

Research Universities
Center for Transportation Research

FY 2011 Budget
\$142,000

0-6635 - Water Quality Performance of Permeable Friction Course on Curbed Sections

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objective: The project will extend the applicability of Performance of Permeable Friction Course (PFC) by demonstrating that a comparable improvement in quality is also possible on highway sections that include curb and gutter allowing widespread use for highway widening projects in urban areas where limited ROW makes the rural cross-section infeasible.

The permeable friction course (PFC) has been demonstrated in TxDOT Project 0-5220 to provide a substantial improvement in the quality of highway runoff. This reduction in pollutant concentrations is sufficient to meet the requirements of the Texas Commission on Environmental Quality (TCEQ) for use as a permanent BMP on the Edwards Aquifer recharge and contributing zones. However, that approval was only extended to the configuration tested, which was a rural highway cross-section with a vegetated shoulder.

One goal of this project is to develop the information necessary to receive approval from TCEQ to use PFC on highway sections with curb and gutter. We will install water quality monitoring equipment to document the quality of runoff from selected test sites in the Austin area.

We also recognize that retrofitting existing sections of highway with PFC might also impact the drainage characteristics, particularly the flooded width of the shoulder during intense storm events. Consequently, the project will also investigate the hydraulic performance of PFC in this new configuration. In addition, the analysis will consider the effect of PFC pavement on drainage system sizing. PFC may reduce the rate of runoff or increase the time of concentration so that smaller pipes and inlets might be sufficient to convey the design storm.

Project Director

Gary Lantrip, AUS

Project Advisors

Diane Venable, DES

James Harris, CRP

Lucas Short, AUS

Richard De La Cruz, SAT

Richard Izzo, CST

Research Supervisor

Michael Barrett, CTR

Total Project Budget
\$502,247

Research Universities
Center for Transportation Research

FY 2011 Budget
\$178,537

0-6636 - Photocatalytic NO_x /HRVOC/O₃ Removal in Transportation Applications

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: The focus of this research is intensive and thorough testing of two commercial photocatalytic coatings applied to portland cement concrete to provide accurate data that are representative of highway applications.

While published laboratory data suggest that TiO₂-based materials can remove NO_x and VOCs from air samples, the tests have not been designed to be representative of outdoor air conditions. Laboratory tests in this project will emulate roadway conditions. The results of these data will be used to model the effects of using photocatalytic materials in the Houston-Galveston and Dallas-Fort Worth areas, predict the impact on air pollutant concentrations, and provide a cost-per-ton of pollutant removal among other metrics. Long-term outdoor exposure tests will also examine the performance of the materials in real near-roadway locations in two different locations with varying pollutant concentrations and environmental conditions. Another critical component of the testing will be material evaluation, examining the effects of the concrete substrate on photocatalysis, the effect of the photocatalytic process on material degradation, and the longevity of the material.

Project Director

Pat Henry, HOU

Project Advisors

Andy Naranjo, CST

Christopher Klaus, NCTCOG

Clifton (Cliff) Coward, CST

Don Lewis, GSD

Elizabeth (Lisa) Lukefahr, CST

Jackie Ploch, ENV

Research Supervisor

Maria Juenger, CTR

Total Project Budget
\$672,546

Research Universities
Center for Transportation Research

FY 2011 Budget
\$356,449

0-6637 - Management Science Applications for TxDOT - Scoping Study

Start Date - 09/01/2010 **End Date** - 08/31/2011



Abstract

Objective: The objective of this project is to identify opportunities through a broad scoping study within TxDOT for actionable Operations Research (OR) applications and define a continuing process for operational research review.

Due to the scale and complexity of the responsibilities and constraints placed on TxDOT, efficient allocation of resources has proven an increasingly demanding task. The potential benefits of improvements in efficiency are vast. For instance, a recent Texas transportation study estimated that solving the congestion problems in the state's urban regions would generate more than \$6.50 in economic benefits for every \$1.00 spent. The magnitude of the impact that the transportation sector has in Texas' economy coupled with the absolute need to constrain overall expenditures creates the ideal environment for exploiting the benefits of Operations Research.

Although TxDOT has successfully funded a variety of OR projects in specific problem areas, the direction and scope of future research projects must be addressed comprehensively to achieve the maximum possible benefit for the state.

Ideally, identified areas should satisfy the following requirements:

1. Actionable: implementation must be within an acceptable time-frame and within the restrictions placed by available resources.
2. High Impact: implementations must provide TxDOT with significant benefits so as to warrant examination.

The final outcomes of this project will include a set of candidate problem statements as well as a general process which can aid TxDOT to identify future OR opportunities.

Project Director

Ron Hagquist, SPPM

Project Advisors

Blair Johnson, AMA
Caryn Franco, RSC-EAST
Don Lewis, GSD
Jessica Castiglione, SAT
Kathleen Newton, BMT
Mark Johnson, TRF

Research Supervisor

S. Travis Waller, CTR

Total Project Budget	Research Universities	FY 2011 Budget
\$199,267	Center for Transportation Research	\$99,975
	Texas Transportation Institute	\$77,000
	University of Texas at El Paso	\$22,292

0-6638 - Preparing for EPA Effluent Limitation Guidelines

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objectives: In this project, monitoring and testing experiments will be conducted to determine "typical turbidity" representative of TxDOT's construction site discharges, collect performance data on innovative erosion and sediment control measures that might be expected to meet a forthcoming federal discharge standard, and produce Guidance Measures and Sampling Protocols for TxDOT to negotiate with TCEQ in the development of statewide monitoring/sampling procedures.

On December 1, 2009, the US Environmental Protection Agency (EPA) finalized and published a rule in the Federal Register establishing non-numeric and, for the first time, numeric effluent limitation guidelines (ELGs). The numeric ELGs include turbidity limits and sampling requirements for stormwater discharges from construction sites. All sites that disturb 20 or more acres of land at one time are required to comply with a turbidity limit. The EPA is requiring Texas to implement these new requirements when the Texas Commission on Environmental Quality (TCEQ) renews the Texas Construction General Permit (CGP).

Three research institutes (Texas Transportation Institute, The University of Texas at Austin and Texas Tech University) will collaborate on this project to cover the statewide differences in climate, soil types, slopes, and other factors that affect the performance of erosion control measures.

Project Director

Amy Foster, ENV

Project Advisors

Cindy Hooper, TCEQ

John Mason, MNT

Jon Geiselbrecht, AUS

Kathleen Newton, BMT

Norm King, ENV

Tasha Vice, DES

Research Supervisor

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Total Project Budget	Research Universities	FY 2011 Budget
\$736,293	Center for Multidisciplinary Research in Transportation	\$42,926
	Center for Transportation Research	\$128,565
	Texas Transportation Institute	\$135,205

0-6657 - Investigating Regional Dynamic Traffic Assignment Modeling for Improved Bottleneck Analysis

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objectives: The project will develop methodologies to adapt and apply a mesoscopic simulation-based dynamic traffic assignment (DTA) model to examine, characterize, and mitigate bottlenecks at a system level.

Bottleneck mitigation is a classic transportation problem. In fact, many congestion issues that impact Texas drivers daily can be traced back to a bottleneck, be it stationary or moving. Further, the causes of bottlenecks can be complex and if one is alleviated, one or more unexpected bottlenecks can quickly emerge elsewhere. Traditional transportation modeling approaches that may be applied for the examination of bottlenecks can typically be categorized as planning or operational in nature. Unfortunately, either approach is ill-suited for a comprehensive treatment of bottlenecks. Operational models lack the regional scope and travel behavior capabilities (e.g., route-choice) necessary to holistically treat bottleneck mitigation's unexpected consequences. Moreover, planning models lack the precise representation of traffic needed to capture the intricacies of vehicular dynamics.

The research team will develop a project evaluation framework to rank competing projects, which will aid the planning-level decision-making process while concurrently accounting for traffic operational issues. Data and model formats will be standardized to facilitate interfacing with specific external application models - planning and operational. The project will also examine the potential of DTA as an aid in the transportation planning process.

Specifically, outcomes from this research will include:

1. A comprehensive study of traffic bottleneck phenomena in a specific setting considering system-wide impacts and mitigation strategies
2. Guidelines for adapting DTA to model and mitigate bottlenecks more generally
3. Potential data formats and guidelines for interfacing DTA with the planning process
4. A framework for ranking bottleneck projects with DTA (including differences with static assignment)

Project Director

Joseph Carrizales, AUS

Project Advisors

Dean Wilkerson, TSD

Ed Collins, AUS

Janie Temple, TPP

Research Supervisor

S. Travis Waller, CTR

Total Project Budget
\$300,000

Research Universities
Center for Transportation Research

FY 2011 Budget
\$150,000

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

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



Abstract

Objective: This study will provide TxDOT with valuable information about contributing factors associated with roadway departure crashes on rural two-lane highways on a district by district basis.

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. 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

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Project Advisors

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Research Supervisor

Dominique Lord, TTI

Total Project Budget
\$559,509

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$70,000

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

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



Abstract

Objective: This project will develop a new technical tool to help TxDOT better predict when major elements of evacuation operations should be implemented.

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
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Chandra Carrasco, HGAC
Christy Willhite, HGAC
David Fink, HOU
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Leo Ramirez, TSD
Marla Jasek, YKM
Seth Jones, USACE
Stacey Worsham, MNT
Terry Truett, DPS
William Diggs, DPS

Research Supervisor

Russell Henk, TTI

Total Project Budget
\$346,187

Research Universities
Texas Transportation Institute
University of Houston

FY 2011 Budget
\$43,745
\$16,828

0-6135 - Super 2 Design for Higher Traffic Volumes

Start Date - 09/01/2008 **End Date** - 02/28/2011



Abstract

Objective: This project will develop design guidelines for length and spacing of passing lanes on two-lane highways with higher volumes.

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 TxDOT 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 flows. In addition, the effects of varying proportions of heavy vehicles will also be considered.

Project Director

Mark Wooldridge, YKM

Project Advisors

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David Harper, LBB

Roy Wright, ABL

Research Supervisor

Marcus Brewer, TTI

Total Project Budget

\$290,155

Research Universities

Texas Transportation Institute

FY 2011 Budget

\$20,000

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

Start Date - 09/01/2008 **End Date** - 12/31/2010



Abstract

Objectives: This project will develop a benefit-cost analysis methodology for safety rest areas in Texas and demonstrate its application in select corridors throughout the state. Researchers will also consider novel safety rest area development approaches that could reduce the public cost burden borne by individual public agencies.

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 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

Brenda Harper, TRV

Jim Hollis, TRF

Martha Martin, TRV

Paul Campbell, MNT

Research Supervisor

Jodi Carson, TTI

Total Project Budget
\$220,070

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$6,300

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

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



Abstract

Objective: This study will review and update mounting details and standards for large and small sign supports, and provide a mechanism to quickly and effectively evaluate and address high priority needs related to sign support systems.

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 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

Doug Skowronek, TRF

Project Advisors

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Charlie Wicker, TRF
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Karl Janak, CST
Larry Colclasure, WAC

Research Supervisor

Roger Bligh, TTI

Total Project Budget
\$394,976

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$145,000

0-6390 - Asset Management for Safety and Operations

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



Abstract

Objective: 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.

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. The system developed from this research 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

Larry Colclasure, WAC

Project Advisors

Brandye Payne, MNT
James (Kelly) Selman, DAL
Justin Obinna, MNT
Larry Buttler, MNT
Leo Ramirez, TSD
Loretta Brown, TTA
Marla Jasek, YKM
Michael Chacon, TRF
Mike Alford, HOU
Ricardo (Rick) Castaneda, SAT
Tammy Sims, MNT

Research Supervisor

Beverly Kuhn, TTI

Total Project Budget
\$297,252

Research Universities
Prairie View A&M University
Texas Transportation Institute

FY 2011 Budget
\$45,692
\$37,691

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

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



Abstract

Objective: The objective of this research project is to determine the effectiveness of the current Texas statewide nighttime and truck speed limits.

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.

Project Director

Darren McDaniel, TRF

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 2011 Budget
\$188,214

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

Objective: The objective of this research is to develop pedestrian safety-based warrants for protected or protected-permissive left-turn control.

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 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

Adam Chodkiewicz, TRF

Project Advisors

James Bailey, WAC

Jianming Ma, TRF

John Gianotti, SAT

Scott Cunningham, AUS

Wendy Simmons, TYL

Research Supervisor

James (Jim) Bonneson, TTI

Total Project Budget
\$244,000

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$108,800

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

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



Abstract

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

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

Project Director

Michael Chacon, TRF

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 Advisors

Carlos Rodriguez, BRY
David Selman, PAR
Gary Tarter, TRF
Grady Mapes, HOU
Joni Hutson, LBB
Timothy Lowak, SAT
Wade Blackmon, PAR

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.

Research Supervisor

Melisa Finley, TTI

Total Project Budget
\$347,581

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$151,508

0-6408 - Development of a Statewide Sign Maintenance Program

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



Abstract

Objective: This project will develop a recommended statewide traffic sign retroreflectivity maintenance method that is easy to implement, meets the MUTCD requirements, and protects the State from tort.

A new national requirement was added to the Manual on Uniform 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.

Project Director

Charlie Wicker, TRF

Project Advisors

Ali Esmaili-Doki, PAR

Andrew Holick, BRY

David Selman, PAR

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 2011 Budget
\$130,247

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

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



Abstract

Objective: This project will create a set of roundabout guidelines specific to Texas and readily accessible to TxDOT personnel.

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.

Project Director

Andrew Holick, BRY

Project Advisors

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

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.

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 2011 Budget
\$127,980
\$14,949

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

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



Abstract

Objective: 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.

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.

Researchers 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

Rebecca Wells, ATL

Project Advisors

Bradley Miller, WAC

Darius Samuels, PAR

Josh Verastique, TRF

Robert Wheeler, TRF

Ugonna Ughanze, HOU

Research Supervisor

Dan Middleton, TTI

Total Project Budget
\$263,040

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$133,588

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

Objective: The objective of this project is to enable TxDOT districts to deploy video surveillance cameras with ease and low cost.

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. Towards the 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

Frank Phillips, LBB

Project Advisors

Heath Bozeman, LBB
Joseph (Joe) Hunt, DAL
Mitch Murrell, TRF
Leo Ramirez, TSD
Valerie Taylor, HOU

Research Supervisor

Yan Huang, UNT

Total Project Budget
\$138,178

Research Universities
University of North Texas

FY 2011 Budget
\$67,673

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

Objectives: This research project will evaluate different traffic control device (TCD) alternatives for use at a rural, stop-controlled intersection along with evaluating reasonable sequences for implementing progressively more expensive devices.

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.

Project Director

Carlos Ibarra, ATL

Project Advisors

Barbara Russell, HOU

Bernardo Ferrel, AMA

Derryk Blasig, TRF

Doug Skowronek, TRF

Ellen Perry, PAR

Michelle Cooper, AUS

Research Supervisor

Kay Fitzpatrick, TTI

Total Project Budget
\$316,445

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$164,285

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

Objective: This project will develop guidelines for the implementation of the flashing yellow arrow with protected-permissive left-turn (FYAPPLT) display operations in Texas.

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.

As part of this project researchers 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

Henry Wickes, TRF

Project Advisors

Adam Chodkiewicz, TRF
Carlos Ibarra, ATL
Christopher Freeman, AMA
Cynthia Flores, TRF
David Danz, TRF
Derryl Skinnell, TRF
Michael Chacon, TRF
Robert Guydosh, AUS

Research Supervisor

Yi (Grace) Qi, TSU

Total Project Budget
\$251,301

Research Universities
Texas Southern University

FY 2011 Budget
\$115,521

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

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



Abstract

Objective: This research will assess the use of active traffic management (ATMs) strategies on TxDOT freeways.

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

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Stuart Corder, HOU

Research Supervisor

S. Travis Waller, CTR

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 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 2011 Budget
\$126,300
\$14,949

0-6582 - Synthesis of Successful Bicycle Planning in Mid-size Cities

Start Date - 11/04/2009 **End Date** - 11/30/2010



Abstract

Objective: The primary objective of this project is to synthesize successful bicycle planning practices in mid-size cities with populations of 100,000 to 300,000.

Bicycling is an effective transportation alternative to motor vehicles and its use can benefit individuals, local communities and the environment. Although the federal and state transportation agencies stipulate the provision and maintenance of pedestrian and bicycle facilities, developing and implementing bicycle plans with clear vision and realistic goals remains a challenge for American cities. This research project was developed to address this issue with focus on planning, design, and operation of bicycle facilities in mid-size cities. With the primary objective in mind, a comprehensive literature review and survey of state-of-the-practice will be conducted in this project. Focuses will be placed on finding and documenting those successful practices in terms of 1) developing and implementing clear vision and goals and getting the public involved in the bicycle planning process; 2) developing effective outreach plans to reach potential users; 3) providing systematic design and operational strategies that meet the needs for both bicyclists and motorists; and 4) developing effective ways for modification of existing road networks to facilitate bicycle movement and reduce conflicts between bicycles and motorcycles.

Project Director

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Karen Peoples, LBB

Research Supervisor

Hongchao Liu, TECHMRT

Total Project Budget
\$79,998

Research Universities
Center for Multidisciplinary Research
in Transportation

FY 2011 Budget
\$11,519

0-6639 - Testing of Alternative Support Materials for Portable Signs for Maintenance Work Zones

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objectives: This research project will examine wind loading on portable roll-up signs, find alternative materials to support the flexible faces of these signs, and propose designs for portable roll-up signs on modified supports, if necessary.

Portable roll-up signs are currently used by the Texas Department of Transportation (TxDOT) for identification of short-term maintenance/work zones and emergency operations. These signs have fiberglass frames to directly support the diamond-shaped and rectangular flexible sign faces. It has been reported that the fiberglass frames have failed due to bending-even in breezes caused by passing vehicles. The cost of these failures is more than the marginal cost of replacing the broken frame members that directly support the sign face. It includes the safety cost to workers and the traveling public. Research studies to date on sign structures have focused on permanent signs with rigid faces. However, there has been little formal and in-depth research on wind loading on roll-up signs with flexible facing materials. This research project is proposed to address three major issues: (1) understanding of wind loading on portable roll-up signs, (2) finding alternative materials to support the flexible faces of these signs, and (3) proposing designs of portable roll-up signs on modified supports, if necessary. The results of this research project will be presented in the form of specifications that can be incorporated into TxDOT General Services Division Specification Number 801-60-66 - Sign Face, Roll-up, Reflective, Construction and Work Zone.

Project Director

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Research Supervisor

Sangwook Bae, TECHMRT

Total Project Budget	Research Universities	FY 2011 Budget
\$312,755	Center for Multidisciplinary Research in Transportation	\$118,296
	Texas Transportation Institute	\$0

0-6640 - State of the Practice for Workers in Very Short Duration Work Zone Operations

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objectives: This project will develop a decision matrix to determine the appropriate traffic control to minimize risk to workers and highway users in very short duration one-time or seldom performed operations, as well as develop an educational module to train TxDOT workers to perform very short duration operations safely under various conditions.

Very short duration maintenance operations last for less than 15 minutes and usually involve operations such as removing an object from the roadway (either on the pavement or adjacent shoulder) or patching a pothole or small hand level up areas. These activities have the potential to interrupt traffic flow and can pose a safety risk for both workers and drivers.

As part of the research, risk to maintenance personnel as well as highway users will be assessed through an expert panel guided by a modified Delphi Process. Tasks included in this project are: i) review the current state of practice in very short duration operations available in literature; ii) identify dimensions needed in a matrix; iii) identify technologies and methods for minimizing risk to workers in very short duration work zone operations; iv) develop a matrix to determine the appropriate traffic control in multiple scenarios and recommended response by workers; v) refine the matrix based on expert feedback; vi) develop an educational module and train TxDOT workers in a workshop session.

Project Director

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Project Advisors

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Gary Tarter, TRF

Michael Lee, LFK

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Paul Lewis, TYL

Richard Jenkins, CHS

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Research Supervisor

Randy Machemehl, CTR

Total Project Budget
\$212,575

Research Universities
Center for Transportation Research

FY 2011 Budget
\$80,053

0-6641 - Assessment of the Impact of Nighttime Work Zone Lighting on Motorists

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objectives: This project will assess the impact of work zone lighting on motorists and develop work zone lighting guidelines for nighttime operations, considering both worker and motorist needs.

The Texas Department of Transportation (TxDOT) is increasingly conducting road work on high-volume facilities at night to reduce traffic delays and complaints by the public that would typically be caused by doing the work during the day. Lighting is one of the most important factors for nighttime construction and maintenance operations as it affects driver and worker safety, work quality, worker productivity, and worker morale. However, currently TxDOT does not have a policy regarding the use of temporary lighting in nighttime operations. Thus, decisions pertaining to work zone lighting are usually left to the discretion of the site engineer and the contractor, which may feel that existing fixed lighting and/or conventional vehicle headlights are adequate to illuminate nighttime work.

Work zone illumination guidelines for nighttime highway work do exist, but they are solely based on the visual needs of workers. Research has not been conducted to assess the impact of work zone lighting on motorists approaching and driving through the work zone.

Project Director

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Michael Olivo, TRF
Michele Regis, OCC

Research Supervisor

Melisa Finley, TTI

Total Project Budget
\$320,524

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$158,778

0-6642 - Developing Warrants for Active Warning Devices at Low-Volume Highway-Rail Grade Crossings

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This two-year research project will develop a highway-rail crossing prioritization system based on a combination of a revised safety index and warrants for active warning devices at low-volume highway-rail grade crossings.

The research scope emphasizes, but is not restricted to, low-volume crossings in the lower-third of the priority list generated with the current Texas Priority Index (TPI). Tentative warrants and a list of eligible crossings (with cost estimates) will be delivered at the end of the first year for a trial implementation aimed at identifying how they should be further refined. Implementability is important when selecting variables to incorporate in the warrants and in the revised index. The variables to be used in the safety index present several peculiar mathematical characteristics and must be modeled using appropriate methods. The deliverables will facilitate rail-highway crossing management in Texas, ensuring proper consideration of low-volume roads when applying funding mechanisms such as Section 130 funds.

Project Director

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Project Advisors

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Marvin Wright, RRD

Robert Martinez, ODA

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Research Supervisor

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Total Project Budget
\$269,555

Research Universities

Texas Transportation Institute
University of Texas at San Antonio

FY 2011 Budget
\$54,000
\$80,050

0-6643 - Guidelines for the Effective Use of Flexible Pylons For Congestion Mitigation, Access Management, and Safety Improvement

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This research will develop guidelines for effective use of flexible pylons for different channelizing applications.

Flexible pylons are gaining popularity as traffic channelizing devices in a variety of applications, such as on HOV/Managed Lanes, freeway ramps, work zones, arterial turn lanes, and median closures. The increased popularity of flexible pylons is likely because they are less rigid (as compared to concrete barriers) enabling easier access by emergency vehicles, increased feeling of openness (as compared to concrete barriers), and providing more positive control than pavement markings in channelizing traffic. In general, flexible pylons are less expensive and easier to install than concrete barriers. However, there are also concerns with flexible pylons effectiveness as channelizing devices. Flexible pylons get hit frequently by motorists, sometimes due to distractions, and sometimes on purpose with disregard to the marking device intent, reckless lane changes, or poor visibility of pylons themselves. In some cases when pylons are struck, they break off, leaving large gaps and creating less safe conditions. While there are some standards to test durability of pylons, there is a lack of guidelines for implementation of pylons that can render them ineffective.

The objectives of this project are to develop guidelines on/to:

- When and where pylons are suitable for implementation,
- Which type of pylons (curb mounted or fixed to pavement) is suitable for various applications,
- Determine optimal spacing for pylons
- Determine buffer space requirements, and
- Determine daytime and nighttime visibility requirements.

This project will survey various agencies to synthesize qualitative and quantitative experiences to identify the best implementation practices of pylons. The synthesis will be supplemented with case studies and controlled experiments to develop guidelines for effective use of pylons for different channelizing applications.

Project Director

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Project Advisors

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Research Supervisor

Robert Benz, TTI

Total Project Budget
\$291,782

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$145,993

0-6644 - Development of Operationally Effective Raised Medians and Use of Alternative Movements on Urban Roadways

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: The project will develop guidelines for operationally effective raised medians and the use of alternative movements on urban roadways.

Raised medians can be used on urban arterials where it is desirable to control or restrict mid-block left-turns, U-turns or crossing maneuvers. To achieve the project goals, the research will: (1) examine the important issues related to the design and operations of raised medians, such as the placement and frequency of median openings, the appropriate length for the turning lanes at median openings, the width of raised medians; (2) synthesize the best practices on the use of alternative movements; (3) assess the operational and safety impacts of raised medians and the use of alternative movements; and (4) develop implementation-oriented guidelines for the use of raised medians and alternative movements.

Project Director

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Project Advisors

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Cynthia Landez, DES

Doug Skowronek, TRF

Geoffrey (Shane) Cunningham, TYL

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Research Supervisor

Yi (Grace) Qi, TSU

Total Project Budget
\$242,804

Research Universities
Center for Transportation Research
Texas Southern University

FY 2011 Budget
\$25,000
\$99,811

0-6645 - Guidelines for Continuous and Safety Roadway Lighting

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This research project will evaluate the relationship between safety and lighting throughout the nighttime periods and develop criteria and guidelines for implementing lighting curfews.

The term "lighting curfews" refers to the concept of turning off or reducing the amount of roadway lighting during certain portions of the night when traffic volumes drop off. The TxDOT Highway Illumination Manual describes the concept of lighting curfews, but it does not give any criteria for when to implement them.

Research activities include the identification of previous research on the topic and surveys of other agencies, identification of existing TxDOT lighting characteristics, field measurements of lighting performance, a safety analysis of crashes with and without lighting as a function of time of night and traffic volume, a visibility assessment at selected sites, identification of other technical and non-technical issues associated with lighting curfews, a feasibility assessment of lighting curfews including the identification of benefits and costs, and a field evaluation of the preliminary lighting curfew guidelines. The final guidelines developed by this project will be prepared for inclusion in the Highway Illumination Manual and may include options such as turning off lighting at specific times/volumes, trimming lighting, or dimming lighting.

Project Director

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Project Advisors

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Gabriel Garcia, CRP

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Michael Olivo, TRF

Research Supervisor

Harvey (Gene) Hawkins, TTI

Total Project Budget

\$199,988

Research Universities

Texas Transportation Institute

FY 2011 Budget

\$157,214

0-6646 - Safety and Integrity of Median Barrier-Mounted Hardware

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This project will develop a design guideline and a standard that could be incorporated into TxDOT standards and specifications for median barrier-mounted hardware.

Concrete median barriers have been used throughout the State as permanent or temporary barrier for providing separation of traffic. Due to space restriction, a sign or a light pole is placed on top of such barriers. Typically these barriers are tested and considered crashworthy through crash testing according to NCHRP Report 350 or MASH. However, when signs or light poles are mounted on top of barriers, the crashworthiness of the system is not necessarily guaranteed. There is very limited research on how a combination of device and barrier would perform if impacted by an errant vehicle. Moreover, no full scale crash tests have been performed to accurately identify the influence of attachments on vehicular deceleration. Therefore, there is a need to identify existing practices of placing hardware on top of median barriers, as well as defining the crashworthiness of such combinations. In this project, a survey of the practice of mounting hardware on top of barriers will be performed. Analytical, computer simulation, and testing tasks will be conducted to define crashworthy hardware and placement guidelines.

Project Director

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Project Advisors

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Michael Chacon, TRF

Tomas Trevino, CRP

Research Supervisor

Akram Abu-Odeh, TTI

Total Project Budget
\$271,100

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$99,977

0-6647 - Developing a Luminance-Based Mobile Highway Delineation Equipment and Level of Service Guidelines for Safe Nighttime High-Speed Travel

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This research will develop and calibrate a mobile luminance-based highway delineation measurement system.

This research project is focused on nighttime safety from the perspective of providing a quantifiable technique to assess the nighttime delineation of the roadway scene as a whole, and in terms of what the driver sees and needed. All of the nighttime traffic control devices that are intended to provide visibility in terms of the roadway scene are developed, deployed, and tested in isolation.

This research aims to develop a comprehensive way to assess the amount of delineation and provide a level of service framework that can be used to manage delineation in terms of safety and maintenance. It is envisioned that the mobile luminance-based highway delineation measurement system can be used to assess the nighttime delineation along the TxDOT system. The type of traffic control devices that would be quantified together would include signs, pavement markings, delineators, chevrons, guardrail reflectors, and others.

Project Director

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Research Supervisor

Paul Carlson, TTI

Total Project Budget
\$298,565

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$143,213

0-6659 - Synthesis of TxDOT Uses of Real-Time Commercial Traffic Routing Data

Start Date - 09/01/2010 **End Date** - 08/31/2011



Abstract

Objective: This research will study and evaluate the usage of data offerings by private sector providers to supplement its own data

Traditionally, the Traffic Operations Division (TRF) and the districts have collected traffic operations data through a system of fixed-location traffic sensors, supplemented with probe vehicles using transponders where such tags are already being used primarily for tolling purposes and where their numbers are sufficient. TxDOT owns and maintains the traffic sensors and toll tag readers and manages the data that come from these systems. In recent years, private providers of traffic data have entered the scene, offering traveler information such as speeds, travel time, delay, and incident information. The question that this research project should answer is whether TxDOT could and should utilize the data offerings by private sector providers to supplement its own data collection efforts and, if so, how. Specifically, the research should determine:

- what data are available from private providers (either free or for purchase);
- what other states are doing with data from private providers;
- opinions of TxDOT decision-makers on the utility of these data sources;
- how the data should be normalized, combined, and delivered for TxDOT or other public sector partner agencies use; and
- a recommended path for implementing the TxDOT response.

Project Director

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Project Advisors

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Research Supervisor

Dan Middleton, TTI

Total Project Budget
\$119,403

Research Universities
Texas Transportation Institute
University of Texas at El Paso

FY 2011 Budget
\$100,508
\$18,895

9-1001 - Traffic Control Device Evaluation Program

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



Abstract

Objective: 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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Research Supervisor

Paul Carlson, TTI

Total Project Budget

\$800,000

Research Universities

Texas Transportation Institute

FY 2011 Budget

\$200,000

9-1002 - Roadside Safety Device Crash Testing Program

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



Abstract

Objective: 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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Jon Ries, BRG

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Research Supervisor

Roger Bligh, TTI

Total Project Budget

\$1,000,000

Research Universities

Texas Transportation Institute

FY 2011 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

Objective: This project will identify and develop recommendations for implementation of alternate corrosion-resistant post-tensioning systems.

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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Project Advisors

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Paul Virmani, FHWA

Research Supervisor

John Breen, CTR

Total Project Budget

\$1,170,144

Research Universities

Center for Transportation Research

FY 2011 Budget

\$55,000

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

Start Date - 09/01/2006 **End Date** - 08/31/2011



Abstract

Objective: This research will assess the influence of ASR/DEF on bond.

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

Ricardo Gonzalez, FTW

Project Advisors

John Vogel, HOU

Keith Ramsey, BRG

Research Supervisor

Joseph Bracci, TTI

Total Project Budget
\$1,199,988

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$200,000

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

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



Abstract

Objective: To develop and test a more simplified design of the end regions of U-beams and box beams with various skew angles.

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

Dean Van Landuyt, BRG

Project Advisors

Amy Eskridge, BRG

Graham Bettis, CST

John Holt, BRG

Research Supervisor

Oguzhan Bayrak, CTR

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 2011 Budget
\$199,772

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

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



Abstract

Objective: The objective of project is to develop guidelines for applying strut-and-tie models to large structural elements subject to varying conditions of premature concrete deterioration.

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

Dingyi Yang, BRG

Project Advisors

Aldo Romero, SAT

Dean Van Landuyt, BRG

John Vogel, HOU

Jon Kilgore, SAT

Yuan Zhao, BRG

Research Supervisor

Joseph Bracci, TTI

Total Project Budget

\$849,808

Research Universities

Texas Transportation Institute

FY 2011 Budget

\$214,890

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

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



Abstract

Objective: The study will identify the microbes degrading concrete, understand the mechanism of attack, develop new methods for in situ evaluation of microbe induced deterioration (MID), and provide recommendations for concrete mixes and/or new approaches that prevent and remediate degradation.

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

Project Director

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Project Advisors

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Doug Marino, BRY

Lloyd Wolf, BRG

Ryan Barborak, CST

Victoria McCammon, BRG

Research Supervisor

Jiong Hu, TSUSM

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 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.

Total Project Budget

\$252,557

Research Universities

Texas State University - San Marcos

FY 2011 Budget

\$111,102

0-6152 - Shear in High Strength Concrete Bridges

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



Abstract

Objective: This 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.

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

Matthew Connelly, HOU

Project Advisors

John Holt, BRG

Kenneth Ozuna, HOU

Nicholas Horiszny, HOU

Yongqian Lin, HOU

Research Supervisor

Yi-Lung Mo, UH

Total Project Budget
\$999,961

Research Universities
University of Houston

FY 2011 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

Objective: The objective of the study is to demonstrate the feasibility of using carbon fiber reinforced polymer (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.

Project Director

Dingyi Yang, BRG

Project Advisors

Carl Johnson, BWD

Keith Ramsey, BRG

Leon Flournoy, BRG

Nicholas Horiszny, HOU

Research Supervisor

James Jirsa, CTR

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.

Total Project Budget
\$695,000

Research Universities
Center for Transportation Research

FY 2011 Budget
\$205,000

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

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



Abstract

Objective: The study will develop 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.

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. A laboratory- and field based research program will develop a bridge deck cracking model that will ultimately be integrated into ConcreteWorks.

Project Director

Kevin Pruski, BRG

Project Advisors

Andy Naranjo, CST
Hector Garcia, FHWA
Jeffrey Seiders, CST
Ralph Browne, NTCACI

Research Supervisor

Kevin Folliard, CTR

Total Project Budget
\$498,500

Research Universities
Center for Transportation Research

FY 2011 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

Objectives: This research will focus on reducing the initial circumferential tensile stresses at release, and thereby reducing the total tensile stresses and the rate of rejected panels. The 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, and to develop different design alternatives.

The comprehensive work plan proposed here is intended to address both precast prestressed concrete deck panels and top mat reinforcement, and their interaction with each other. The work will be carried out at two institutions.

Deck Panel Research: 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. The 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. The 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 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.

Project Director

Manuel (Bernie) Carrasco, BRG

Project Advisors

Graham Bettis, CST

John Holt, BRG

John Vogel, HOU

Kirk Krause, WAC

Robert Cochrane, BRY

Research Supervisor

Richard Klingner, CTR

Top Mat Reinforcement Research: Based on evaluations of test data from prior TxDOT studies, 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. The 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 2011 Budget
\$223,472
\$29,972

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

Objective: This research project 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.

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. 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

Marcus Galvan, BRG

Project Advisors

Jimmy Si, CST

Miguel (Mike) Arellano, AUS

Research Supervisor

Soheil Nazarian, UTEP

Total Project Budget
\$444,824

Research Universities
University of Texas at El Paso

FY 2011 Budget
\$145,283

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

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



Abstract

Objectives: This project will examine the conservativeness and accuracy of the new prestress loss equations in ASASHTO LRFD.

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.

Project Director

Alanna Bettis, BRG

Project Advisors

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Greg Turco, BRG

John Holt, BRG

Michael Hyzak, BRG

Tim Bradberry, BRG

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.

Research Supervisor

Oguzhan Bayrak, CTR

Total Project Budget
\$787,521

Research Universities
Center for Transportation Research

FY 2011 Budget
\$131,196

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

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



Abstract

Objectives: 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.

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, 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.

Project Director

Jaime Villena-Morales, AUS

Project Advisors

Amy Ronnfeldt, DES

David Zwernemann, AUS

Rob Fanning, HOU

Shelley Harris, LBB

Research Supervisor

Theodore Cleveland, TECHMRT

Total Project Budget	Research Universities	FY 2011 Budget
\$464,622	Center for Multidisciplinary Research in Transportation	\$27,669
	Texas Transportation Institute	\$10,000
	United States Geological Survey	\$20,000

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

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



Abstract

Objective: This project will determine the cause of shear cracking in inverted-T straddle bents and develop new design criteria to prevent or minimize such cracking under service loads.

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 also result in lane closures and inconvenience to travelling public. The findings of this project will be used to minimize the necessity of such costly repairs in the future.

Project Director

Jamie Farris, BRG

Project Advisors

Courtney Holle, BRG

Dean Van Landuyt, BRG

Glenn Yowell, ATL

Mike Stroope, LBB

Nicholas Nemec, BRG

Roger Lopez, HOU

Research Supervisor

Oguzhan Bayrak, CTR

Total Project Budget
\$696,964

Research Universities
Center for Transportation Research

FY 2011 Budget
\$234,449

0-6438 - Evaluation of Superheavy Load Criteria for Bridges

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



Abstract

Objective: The purpose of the study is to validate whether the Texas superheavy load criteria and evaluation methodology adequately protects and preserves Texas bridges.

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.

Project Director

John Holt, BRG

Project Advisors

Brian Merrill, BRG

Dingyi Yang, BRG

Elizabeth Walker, LBB

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 2011 Budget
\$55,712
\$35,148

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

Objective: This project will evaluate the potential use of non-destructive testing (NDT) to assess structures affected by ASR and/or DEF.

The 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 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

Andy Naranjo, CST

Project Advisors

Brian Merrill, BRG

Dingyi Yang, BRG

Eliza Paul, HOU

Geetha Chandar, BRG

Jefferey Tomkins, BRG

Leon Flournoy, BRG

Paul Rollins, BRG

Research Supervisor

Kevin Folliard, CTR

Total Project Budget
\$997,998

Research Universities
Center for Transportation Research
Texas Transportation Institute

FY 2011 Budget
\$187,486
\$131,508

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

Objectives: This research study involves a comprehensive and detailed review of the pullout resistance of backfill reinforcements used in MSE walls constructed in Texas and the development of guidelines for implementation of reinforcement details around obstructions.

There are two major thrust areas in the 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

Marie Fisk, BRG

Project Advisors

Elizabeth Walker, LBB

John Delphia, BRG

Robert Stuard, AUS

Steve Beard, BRG

Research Supervisor

William (Bill) Lawson,
TECHMRT

Total Project Budget
\$393,374

Research Universities
Center for Multidisciplinary Research
in Transportation

FY 2011 Budget
\$124,627

0-6549 - Hydraulic Performance of Staggered-Barrel Culverts for Stream Crossings

Start Date - 10/13/2009 **End Date** - 08/31/2012



Abstract

Objective: This research project is to develop through literature interpretation, laboratory experimentation, and statistical analysis the knowledge to address the issue of solids accommodation in Texas stream crossings, and develop design guidelines to assist in building multiple barrel systems that mimic the necessary stream behavior to facilitate solids migration, yet still provide the sufficient clear-water hydraulic capacity to meet their transportation infrastructure drainage needs.

Quoting from the research project statement, "Some types of stream crossings exhibit large accumulations of bed sediment both upstream and downstream from the crossing. Over a period of time, the sediment may block the crossing culvert, resulting in reduced flow capacity during frequent events and forcing higher flows to overtop the roadway. In extreme cases, bed materials accumulate to the point that they overtop the crossing requiring emergency maintenance. Less frequently, but resulting in more cost, are cases in which catastrophic failure of the crossing results from hydraulic pressure, sediment transport, or erosion of the crossing. In many cases, past and current standard procedures appear to result in inhibited bedload sediment movement and attendant stream instability that result in long-term problems."

The research team believes that the needed knowledge for developing designs and design guidelines for culvert systems that adequately pass large quantities of solids at such stream crossings will best be obtained through 1) the construction and analysis of a database containing all relevant past work, and 2)

Project Director

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Project Advisors

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David Zwernemann, AUS

Gregg Freeby, BRG

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Jaime Villena-Morales, AUS

John Wright, PAR

Matthew Wingfield, SJT

Tracy Cain, AMA

through physical modeling of the culvert system in the laboratory. Database development through digital capture of literature data pertaining to significant solids transport will be used to guide both the development of screening tools for identifying problematic stream crossing in-use in Texas and for guidance of the laboratory experiments.

The laboratory study is to examine several configurations of staggered barrel and conventional culverts both in-line with the stream axis and skew to that axis to develop hydraulic charts and relationships that can be used to predict performance. Important to the laboratory study is the determination of what configurations behave in a manner where superposition applies and existing analytical, design, and gaging technologies apply, and what configuration features introduce significant departure from such behavior and will require separate approaches.

Research Supervisor

Theodore Cleveland, TECHMRT

The results are envisioned to be an extensively documented report, as well as design guidelines, charts, and equations for such structures.

Total Project Budget
\$580,000

Research Universities

Center for Multidisciplinary Research
in Transportation
United States Geological Survey
University of Houston

FY 2011 Budget

\$100,000
\$91,500
\$50,000

0-6564 - Improved Cross Frame Details

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



Abstract

Objective: The research consists of designing and developing improved details for cross frame systems.

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.

Project Director

Michelle Ramage, AUS

Project Advisors

Dacio Marin, BRG

Estanislado Ybarra, BRG

Jamie Griffin, BRG

Yuan Zhao, BRG

Research Supervisor

Todd Helwig, CTR

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 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 2011 Budget
\$173,539

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

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



Abstract

Objective: 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. Inclinoimeters 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
John Delphia, BRG
Mark Sturrock, TYL
Steve Beard, BRG
Vincent Lewis, DAL

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.

Research Supervisor

Robert Gilbert, CTR

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 2011 Budget
\$144,218

0-6604 - Unknown Foundation Determination for Scour

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



Abstract

Objective: The objective is to develop a global approach which will significantly reduce the level of uncertainty associated with unknown foundations.

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 research will be approached 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 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

John Delphia, BRG

Project Advisors

Grady Mapes, HOU

Lisa Woof, DAL

Thomas Young, LBB

Research Supervisor

Jean-Louis Briaud, TTI

Total Project Budget
\$293,552

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$151,987

0-6648 - Characterizing Fly Ashes

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objective: This project will characterize fly ash and relate these findings to key fresh, hardened, and durability properties of concrete, with particular emphasis on alkali silica reaction (ASR) and external sulfate attack.

Fly ash is a by-product material produced from coal-combustion power plants and is one of the most commonly used supplementary cementing materials (SCMs) in the world. Prudent use of fly ash as a replacement for portland cement can have several major technical benefits, including reduced heat of hydration, reduced permeability, and improved resistance to alkali-silica reaction (ASR), sulfate attack, and delayed ettringite formation (DEF). Fly ash also enhances the sustainability of concrete as a building material because for every ton of portland cement replaced by fly ash, CO₂ emissions are reduced by approximately 0.9 tons.

Although fly ash can and typically does impart all of the above benefits to concrete, there are several technical and practical issues that still must be addressed. First, all fly ashes are not created equally. The chemical/mineralogical/physical properties can vary significantly from one source to another, based on differences in fuel sources (coal), combustion conditions, and cooling regimes. Furthermore, the fly ash industry is quite dynamic and is rapidly changing due to recently imposed environmental regulations. As such, fly ash produced from a given power plant may be considerably different than fly ash produced from the same plant just a few years ago. Therefore, it is becoming increasingly important to be able to characterize fly ash in a way that best predicts how it will perform in concrete, and this is the primary focus of this project.

Project Director

Andy Naranjo, CST

Project Advisors

Brian Merrill, BRG
Clifton (Cliff) Coward, CST
David Fowler, BWD
Edward Morgan, CST
Ryan Barborak, CST

Research Supervisor

Kevin Folliard, CTR

The research team has proposed a comprehensive, ambitious program to characterize fly ash and relate these findings to key fresh, hardened, and durability properties of concrete, with particular emphasis on ASR and external sulfate attack. The research team will take advantage of its extensive database of mortars and concretes containing fly ashes from throughout Texas and subjected to a wide range of laboratory and field testing conditions, thereby eliminating the need for initiating new long-term tests under this project. This will allow the team to focus on advanced characterization techniques and to complete this project in two years, as opposed to the longer project durations that are inherent in projects involving durability-related issues.

Total Project Budget
\$320,000

Research Universities
Center for Transportation Research

FY 2011 Budget
\$160,000

0-6649 - Development of Design Guidelines and Mitigation Strategies for Wind-Induced Traffic Signal Structure Vibrations

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objectives: The research project will develop guidelines for the design, fabrication, and implementation of traffic signal structures, such as limitations on placement and sizes of items placed on signal pole arms, and develop mitigation strategies for reducing or eliminating wind induced vibrations.

It has now been well-documented that mast-arm type structural supports for traffic signals can exhibit large-amplitude vibrations under wind excitation. Such vibrations can result in reduced fatigue life of the arm to pole shaft connection, and are believed to be the cause of many failures of traffic signal structures that have been reported in the state of Texas as well as in other states within the US. Extensive research has been conducted to study the causes of the vibrations and to develop corresponding mitigation strategies. To this date, however, the excitation mechanisms and the vibration characteristics are yet to be fully understood, and countermeasures that are both effective and efficient remain to be successfully developed.

The objectives of this research project are: (1) to further understand the mechanisms of traffic signal structure vibrations and to develop analytical models that enable statistically assessing the failure risk of Texas standard traffic signal structures; (2) to develop guidelines for the design, fabrication, and implementation of traffic signal structures, such as limitations on placement and sizes of items placed on signal pole arms; and 3) to develop mitigation strategies for reducing or eliminating wind induced vibrations.

We will conduct four phases of study to achieve the prescribed objectives. In phase I, we will conduct full-scale field measurements of representative traffic signal structures and wind tunnel tests of sectional models to further understand the excitation mechanisms and the vibration characteristics. In phase II, we will develop analytical models based on understandings from phase I for predicting wind-induced vibration characteristics and estimating fatigue loads of traffic signal structures of various configurations. In phase III, we will develop statistical methodologies for assessment of failure risk by integrating structure-specific vibration

Project Director

Robert Sarcinella, CST

Project Advisors

Jim Yang, BRG

Tim Bradberry, BRG

Research Supervisor

Delong Zuo, TECHMRT

characteristics and fatigue capacity with site-specific wind climate data. In phase IV, we will use the combination of analytical simulation and full-scale measurements to develop guidelines for design, fabrication, and implementation of traffic signal structures, as well as to develop, test, and optimize mitigation devices for reducing or eliminating wind-induced vibrations of support structures for traffic signals.

Total Project Budget
\$358,472

Research Universities
Center for Multidisciplinary Research
in Transportation

FY 2011 Budget
\$124,708

0-6650 - Fatigue Failure and Cracking in High Mast Poles

Start Date - 09/01/2010 **End Date** - 08/31/2011



Abstract

Objective: This research will identify factors that are most critical to the fatigue cracking and failure of high mast illumination poles and submit recommendations regarding the best fabrication practices to minimize the occurrence and severity of galvanization-induced cracking.

In this project an extensive survey of the state-of-the-art related to fatigue cracking and failure of high mast illumination poles will be conducted. The research project will include a thorough review of published and un-published research data, inspection reports, failure reports, and standard practices of fabricators and galvanizers. The results will be combined with the findings of anonymous surveys of relevant entities to identify those factors that are most critical to the fatigue cracking and failure of high mast illumination poles. Recommendations will be provided regarding the best fabrication practices to minimize the occurrence and severity of galvanization-induced cracking. A reliability analysis will be conducted to assess the statistical probability of failure of poles throughout the state based on existing wind records and relevant published data on the fatigue resistance, damage accumulation and statistical variability of pole details. The costs of repair or replacement will be assessed using available records. This data will be used to identify appropriate intervention techniques, and the associated costs, to achieve an acceptable probability of failure for cracked poles. The findings of this project will provide valuable information to TxDOT officials and help guide decisions related to inspection, rehabilitation and replacement of poles.

Project Director

Tim Bradberry, BRG

Project Advisors

Jim Yang, BRG

John Harper, TRF

Teresa Michalk, CST

Yuan Zhao, BRG

Research Supervisor

Mina Dawood, UH

Total Project Budget

\$50,662

Research Universities

University of Houston

FY 2011 Budget

\$50,662

0-6651 - Continuous Prestressed Concrete Girder Bridges

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objective: This project will review, evaluate, and recommend details for the design of durable and constructible connections that achieve structural continuity between specific precast, prestressed concrete girder sections.

Aesthetic and economic demands often result in the need for longer spans, fewer columns and minimal bent cap cross sections in bridges. Urban areas often require long-span bridges to cross over major roadways. Although prestressed bridges constructed to have continuous spans have been in service for many years in a number of states, there has been limited verification of the ability of the connection to provide the predicted continuity. As a result, some states, including Texas, design the girders as simple spans for both dead load and live load, neglecting any moment resistance of the connection.

The objectives of this project are to review, evaluate, and recommend details for the design of durable and constructible connections that achieve structural continuity between the specific precast, prestressed concrete girder sections that are used in Texas with a goal of longer span-to-depth ratios and greater economy. This will include consideration of continuity for deck weight, superimposed dead load, and live load. Alternatives include cast-in-place connections between girders over the piers and the use of inflection point and other in-span splices. Other promising approaches will also be investigated. Specifications and continuity details will be recommended, along with evaluation of proposed details through experimental testing.

Project Director

Dacio Marin, BRG

Project Advisors

Geoffrey (Shane) Cunningham, TYL

John Holt, BRG

Kevin Pruski, BRG

Michael Hyzak, BRG

Thomas Stout, BRG

Research Supervisor

Mary Beth Hueste, TTI

Total Project Budget

\$716,551

Research Universities

Texas Transportation Institute

FY 2011 Budget

\$160,282

0-6652 - Spliced Texas Girder Bridges

Start Date - 09/01/2010 **End Date** - 08/31/2014



Abstract

Objective: The findings from this study will be used to support the development of design specifications and standards for spliced girder construction within the State of Texas.

The recent introduction of the TX girder series has sparked tremendous interest in low-cost spliced girder technology within the State of Texas. In anticipation of TxDOT's full-scale implementation efforts, this project will resolve two outstanding issues related to the strength and serviceability of spliced TX girder bridges:

- **Shear Performance of Post-Tensioned TX Girders:** Large-scale shear tests will provide results relating to the shear performance of TX Girders with post-tensioning ducts. The effects of the duct diameter to web width ratio, duct material, and grout consolidation will be examined. A complementary panel-testing effort will provide a basis for comparison to the current design code approach.
- **Detailing of Cast-in-Place Splices:** A comprehensive literature review and industry survey will provide an understanding of the design and construction considerations unique to cast-in-place girder splices. Following a review of successful past practices, the best splice details will be evaluated experimentally through splice region testing. Large-scale testing will ensure that conditions necessary for safe efficient force transfer in field-spliced structures are simulated in the laboratory.

Project Director

Greg Turco, BRG

Project Advisors

Alanna Bettis, BRG

Leon Flournoy, BRG

Michael Hyzak, BRG

Research Supervisor

Oguzhan Bayrak, CTR

Total Project Budget
\$999,923

Research Universities
Center for Transportation Research

FY 2011 Budget
\$249,837

0-6653 - Hydraulic Performance of Rectangular Deck Drains

Start Date - 09/01/2010 **End Date** - 08/31/2012



Abstract

Objectives: This project will evaluate whether the adapted slotted drain FHWA method is adequate and accurate to predict the hydraulic performance of the scupper, determine if a correction factor should be applied or a new equation developed, and develop a procedure to allow simulation of the scupper with existing software.

A new type of rectangular deck drain - scupper - has been developed by the TxDOT Bridge Division. An approximation equation developed by FHWA for slotted drains is adapted to model its hydraulic performance. The difference between the two drain widths has been neglected. To better understand and model the hydraulic performance of the scupper, an accurate prediction model is necessary. The objectives of this project are to evaluate whether the adapted slotted drain FHWA method is adequate and accurate to predict the hydraulic performance of the scupper, to determine whether a correction factor should be applied or a new equation development is required, and to develop a procedure to allow simulation of the scupper with existing software such as VisualUrban or WinStorm. A physical modeling study is proposed to confirm the hydraulic performance of rectangular scupper drain based on drain size, number of drains in series, spacing of drains in series, flow rate, cross slope and grade profile.

Project Director

Jack Kayser, AUS

Project Advisors

Adrian Lopez, CRP

Amy Ronnfeldt, DES

David Zwernemann, AUS

Jaime Villena-Morales, AUS

James Mercier, DES

Matthew Jasso, AUS

Michael Hyzak, BRG

Paul (Siong Z) Wong, ATL

Stan Hopfe, AUS

Research Supervisor

Qin Qian, LAMAR

Total Project Budget
\$317,948

Research Universities
Center for Transportation Research
Lamar University

FY 2011 Budget
\$104,141
\$98,801

0-6654 - Empirical Flow Parameter Distributions --- A Tool for Hydraulic Model Validity Assessment

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objective: This research will develop an independent way to assess computed velocities (of streamflow measurements) based on prior, authoritative, observational experience.

Water-surface profile modeling assembles models based on generalizations of parameter values from textbooks, professional literature, computer program documentation, and from engineering experience. Stage-discharge relations or measurements of streamflow at or adjacent to the modeling locale are seldom available for use in refining model parameters. In streamflow measurement at least three components are important; depth, width, and velocity. At field scale depth and width are straightforward but the velocity measurement is a significant contributor to overall uncertainty, complicated because a mean section velocity (as reported in a model) requires a spatial integration of the measured velocity field. As a result, modeling efforts by even experienced engineers are assembled and often judged to be valid based entirely on experiences from earlier modeling efforts for hydraulically similar settings.

This situation often leads engineers in good faith to report velocities (needed for assessing forces on bridge piers, and assessing erosion and scour potential) that are unusually large and in some instances absurd.

Project Director

Stan Hopfe, AUS

Project Advisors

Amy Ronnfeldt, DES

David Zwernemann, AUS

Jack Kayser, AUS

Jaime Villena-Morales, AUS

John Delphia, BRG

Jorge Millan, DES

Matthew Jasso, AUS

Matthew Wingfield, SJT

The results of this research will permit an engineer to rapidly evaluate or review modeling efforts and determine if the modeled results are comparatively common or unusual, with the explicit caveat that unusual results could very well be reliable, but that additional explanation should be expended in these unusual situations. The results of this research (graphs and statistical distributions) will additionally provide an assessment of modeling risk that could be used to balance the cost of additional modeling with the cost of accepting an unusual result for design.

Research Supervisor

Theodore Cleveland, TECHMRT

Total Project Budget

\$519,485

Research Universities

Center for Multidisciplinary Research
in Transportation

United States Geological Survey

University of Houston

University of Texas at San Antonio

FY 2011 Budget

\$43,786

\$81,000

\$35,561

\$34,122

0-6656 - ASR Testing: A New Approach to Aggregate Classification and Mix Design Verification

Start Date - 09/01/2010 **End Date** - 08/31/2013



Abstract

Objective: The main objective of this study is to develop a fast, reliable test method to determine aggregate alkali silica reactivity (ASR) with respect to the overall alkalinity of the concrete.

A volumetric expansion measurement device (VEMD) developed at Texas Transportation Institute will aid in this research. The VMED simulates the aggregate-pore solution reaction in concrete and measures free ASR volume expansion over time. This test uses as-received aggregates and occurs over a short period of time (4 days). The expansion-time trend is modeled to determine the rate constant. The rate constants at multiple temperatures are then used to determine activation energy (E_a) based on rate theory. Researchers will determine the E_a of a large number of aggregates and develop an E_a -based aggregate classification system. A relationship between E_a and alkalinity will be developed and will be the basis to determine reactivity at field level of alkalinity and threshold alkalinity. The proposed fast, reliable test method could be used as a replacement for ASTM C 1567 and improve the protection provided under option 8 of item 421. An effective way of tailoring mix design depending on the level of protection needed will be developed based on threshold alkalinity and concrete pore-solution chemistry.

Project Director

Elizabeth (Lisa) Lukefahr, CST

Project Advisors

Andy Naranjo, CST

Brian Merrill, BRG

Edward Morgan, CST

Jason Dupree, ATL

Ryan Barborak, CST

Research Supervisor

Anol Mukhopadhyay, TTI

Total Project Budget

\$433,823

Research Universities

Texas Transportation Institute

FY 2011 Budget

\$142,058

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0-6581-CT - TxDOT Administration Research

Start Date - 10/23/2008 **End Date** - 08/31/2011



Abstract

Objective: 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

Research Supervisor

Khali Persad, CTR

Total Project Budget
\$500,000

Research Universities
Center for Transportation Research

FY 2011 Budget
\$150,000

0-6581-TI - TxDOT Administration Research

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



Abstract

Objective: 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

Research Supervisor

Josias Zietsman, TTI

Total Project Budget
\$700,000

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$200,000

0-6655-CT - System Operation and Preservation Optimization

Start Date - 12/18/2009 **End Date** - 08/31/2011



Abstract

Objective: The CTR team will undertake a study on how to optimize the limited Category 1 TxDOT funding for pavement preservation.

This research will evaluate the Category 1 funding as a function of the various investment scenarios that are achievable within current financial forecasts, as determined by the Texas Revenue Estimation and Needs Determination System (TRENDS) model. The costs, benefits, pavement condition, risk, potential consequences and economic effects of the various alternatives will be investigated. Findings will be reviewed with the Project Monitoring Committee and TxDOT Administration as requested. The study is structured to provide preliminary findings by March 31, 2010 and a final report by August 31, 2010.

Project Director

Jeffrey Seiders, CST

Project Advisors

Albert Quintanilla, LRD
Bobby Littlefield, PAR
Colin Parrish, TXDOT
Delvin Dennis, HOU
Jessica Castiglione, SAT
Mike McAnally, ODA
Ron Hagquist, SPPM
Russel Lenz, CST
Tonia Norman, SPPM
Wayne Dennis, TPP

Research Supervisor

Robert Harrison, CTR

Total Project Budget
\$249,138

Research Universities
Center for Transportation Research

FY 2011 Budget
\$149,138

0-6655-TI - System Operation and Preservation Optimization

Start Date - 12/16/2009 **End Date** - 08/31/2011



Abstract

Objective: Researchers from the Texas Transportation Institute (TTI) have been asked by TxDOT to undertake the development of mobility estimates.

This research will be coordinated with a similar study of the pavement condition to develop investment scenarios that are achievable within current financial forecasts. The costs, benefits and economic effects of the various alternatives will be quantified. Findings will be periodically reviewed with the Project Monitoring Committee.

Project Director

Jeffrey Seiders, CST

Project Advisors

Carlos Lopez, AUS

Douglas Eichorst, LBB

Jessica Castiglione, SAT

Ron Hagquist, SPPM

Tonia Norman, SPPM

Wayne Dennis, TPP

Research Supervisor

Timothy Lomax, TTI

Total Project Budget
\$60,000

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$10,000

0-6661 - TxDOT Strategic Research Program

Start Date - 02/17/2010 **End Date** - 08/31/2011



Abstract

Objective: This research project will develop the elements of the SRP and outline its procedures.

The Texas Department of Transportation (TxDOT) desires to establish a Strategic Research Program (SRP). The SRP is intended to prepare the department for the transportation challenges likely to be faced in the next 10-30 years. This is a joint project by the Center for Transportation Research at The University of Texas at Austin (lead institution), the Texas Transportation Institute, and The Center for Multidisciplinary Research in Transportation (TechMRT) at Texas Tech University.

The proposed SRP will complement the current research program by addressing longer-term and broader transportation issues that the State Legislature and TxDOT Administration foresee affecting the efficiency and viability of the statewide transportation system. Potential themes may address the challenges and opportunities presented by likely changes in the natural environment, energy resources, transportation funding, social and economic trends, and technological advancements. Products will be couched in a form appropriate to the audience. Implementation of recommendations may require legislative action and/or internal departmental adjustments.

Project Director

Steve Simmons, ADM

Project Advisors

Carlos Lopez, AUS
David Casteel, ADM
Jefferson Grimes, GPA
John Barton, ADM
Lauren Francis, ADM
Russel Lenz, CST
Rick Collins, RTI

Research Supervisor

Khali Persad, CTR

Total Project Budget	Research Universities	FY 2011 Budget
\$500,000	Center for Multidisciplinary Research in Transportation	\$120,000
	Center for Transportation Research	\$160,000
	Texas Transportation Institute	\$120,000

0-6666-CTR - 2030 Committee - Part 2

Start Date - 09/01/2010 **End Date** - 08/31/2011



Abstract

Objective: This research will further analyze pavement maintenance on the state system

The CTR contribution to this study comprises five tasks. The pavement team will present the results of their current work on multi-tier maintenance strategies and respond to 2030 Committee questions that arise. The team will also refine the estimation of user costs on the highway system to provide the marginal increase in vehicles operating costs associated with lower pavement maintenance. The third task will be support Dr. C. Michael Walton who is assuming responsibilities and duties the chairmanship of the 2030 Committee. There will be a number of scheduled 2030 meeting, both with the Committee and with Legislative groups which will be supported by this project. Finally, the team will respond to on-going guidance from the Committee on further analyzing pavement maintenance on the state system.

Project Director

Tonia Norman, SPPM

Project Advisors

David Casteel, ADM

Research Supervisor

Robert Harrison, CTR

Total Project Budget
\$165,000

Research Universities
Center for Transportation Research - \$165,000

FY 2011 Budget

0-6666-TTI - 2030 Committee - Part 2

Start Date - 08/23/2010 **End Date** - 08/31/2011



Abstract

Objective: This project builds on the efforts of the initial activities of the 2030 Committee, in which long range needs for transportation investment were established.

In this second phase, the research supports the Committee's efforts to more deeply explore impacts and funding options to address service level strategies. Public policy strategies, identified by the Committee are translated into impacts on mobility, personal and statewide economics, as well as investment needed to achieve each strategy. For each investment level, funding options will be identified for Committee consideration, refinement and adoption.

Project Director

Tonia Norman, SPPM

Project Advisors

David Casteel, ADM

Research Supervisor

Timothy Lomax, TTI

Total Project Budget
\$320,229

Research Universities
Texas Transportation Institute

FY 2011 Budget
\$293,272

0-6666-UTSA - 2030 Committee - Part 2

Start Date - 09/20/2010 **End Date** - 08/31/2011



Abstract

Objective: The UTSA team will take the lead role in estimating bridge conditions resulting from all funding scenarios chosen by the advisory committee and provide recommendations to the 2030 Executive Advisory Committee.

Recently, a University of Texas at San Antonio (UTSA) team lead by Dr. Jose Weissmann participated in an assessment of needs for bridge Maintenance, Rehabilitation and Replacement (MR&R) needs for the Texas Department of Transportation (TxDOT). The UTSA team also had contributions from Dr. Karl Frank from UT Austin. The target year for that assessment was 2030 so the results became known as the 2030 needs assessment and were summarized in a 2030 Committee report to the public. TxDOT has requested that the UTSA team be re-assembled to forecast the effects of future funding scenarios that are less than those identified in the 2030 needs assessment, working under the direction of the 2030 Committee that is also being reassembled.

Project Director

Tonia Norman, SPPM

Project Advisors

David Casteel, ADM

Research Supervisor

Jose Weissmann, UTSA

Total Project Budget
\$113,456

Research Universities
University of Texas at San Antonio

FY 2011 Budget
\$113,456

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