

Research Digest

FORWARD ALL REQUESTS TO:

The University of Texas at Austin
Center for Transportation Research Library
1616 Guadalupe St. | Suite 4.202 | Austin, Texas 78701
Phone: (512) 232-3126
Email: ctrlib@austin.utexas.edu

In this Issue:

TxDOT Research

Table of Contents

Item 1.	Traffic Control Device Evaluation Program: Technical Report (1001-4)	1
Item 2.	Development and Evaluation of a MASH TL-3 31-Inch W-Beam Median Barrier (1002-12-8)... ..	1
Item 3.	Crash Test and Evaluation of The TxDOT T631 Bridge Rail (1002-12-10)	2
Item 4.	Evaluation of Binder Aging and its Influence in Aging of Hot Mix Asphalt Concrete: Technical Report (6009-2)	2
Item 5.	Long-Term Performance of a Drilled Shaft Retaining Wall in an Expansive Clay (6603-2)	3
Item 6.	0-6613, Evaluate Binder and Mixture Aging for Warm Mix Asphalt (6613 PSR)	3
Item 7.	Development of a Specification for Flexible Base Construction (6621-2)	4
Item 8.	Development of Texas Mechanistic-Empirical Flexible Pavement Design System (TxME) (6622-2)	4
Item 9.	0-6626, Fleet Equipment Performance Measure Preventive Maintenance Model (6626 PSR)	5
Item 10.	0-6629, Texas Specific Drive Cycles and Idle Emissions Rates for Using with EPA's MOVES Model (6629 PSR)	5
Item 11.	0-6672, ITS Strategic Plan for Texas (6672 PSR)	6
Item 12.	Evaluating Truck and Rail Movements along Competitive Multimodal Corridors (6692-1).....	6
Item 13.	Evaluating the Effectiveness of Performance Based Pavement Marking Maintenance Contracts in Texas (6705-1).....	7
Item 14.	0-6714, Evaluating the Need for Surface Treatments to Reduce Crash Frequency on Horizontal Curves (6714 PSR)	7
Item 15.	Warrants and Criteria for Installing and Sunsetting TxDOT ITS Equipment (6773-1)	8

Research Digest

Item 1

Traffic Control Device Evaluation Program: Technical Report

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 1001-4 • 2014

This project was established to provide a means of conducting small scale research activities on an as-needed basis so that the results could be available within months of starting the specific research. This report summarizes the research activities that were conducted between September 2009 and August 2013. Researchers evaluated bridge clearance signing and visibility; incorporating multiple-curve processing capabilities into the GPS method for setting advisory speeds; and guidelines for sign sheeting material for rural applications.

This report is available for free download (1.9 MB):

<http://tti.tamu.edu/documents/9-1001-4.pdf>

Item 2

Development and Evaluation of a MASH TL-3 31-Inch W-Beam Median Barrier

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 1002-12-8 • 2014

Typically, when the G4(1S) W-beam barrier is impacted in a roadside application, the W-beam rail element deforms, the support posts are displaced through the soil, and the vehicle is redirected. During the impact sequence, the rail becomes detached from the post by means of the post bolt pulling out of the rail slot as the post displaces rearward. However, in the MB4 steel post W-beam median barrier, the additional lateral stiffness and post constraint. This changes the post behavior and vehicle-post interaction. In a test of the 27-inch tall MB4 median barrier, the impacting pickup truck climbed and vaulted over the barrier. A taller 30-inch version of the MB4 W-beam median barrier (AASHTO Designation SGM06a&b) incorporates a C6x8.2 rub-rail channel to help mitigate vehicle-post snagging. However, the rub-rail may still permit the pickup to climb the barrier. The purpose of this project was to develop and evaluate a W-beam median barrier that would meet the strength and safety performance criteria of the AASHTO Manual for Assessing Safety Hardware (MASH). A 31-inch tall W-beam median barrier with rail splices offset from the posts and 8-inch offset blocks (AASHTO Designation SGM06a) was successfully crash tested in accordance with MASH.

This report is available for free download (10.3 MB):

<http://tti.tamu.edu/documents/9-1002-12-8.pdf>

Research Digest

Item 3

Crash Test and Evaluation of The TxDOT T631 Bridge Rail

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 1002-12-10 • 2014

In August 2010, Midwest Roadside Safety Facility (MwRSF) developed and crash tested a low-cost, energy-absorbing bridge rail for the Manual for Assessing Safety Hardware (MASH) TL-3 applications. This low-cost bridge rail was designed to be compatible with the Midwest Guardrail System (MGS) such that an approach transition would not be required between the two barriers. It was desired that the system minimize bridge deck and rail costs. As part of this project, several concepts for an energy-absorbing bridge post were developed and tested. These concepts included strong-post systems designed with plastic hinges and weak-post systems designed to bend near the attachment to the bridge deck. The final post concept incorporated S3 x 5.7 steel sections designed to yield at their bases. These posts were located on 6 ft-3 inches on center. A W-beam section was used as the rail element and was attached to the posts with a bolt designed to break during and impact event. Two full-scale crash tests were performed according to the TL-2 impact conditions provided in MASH. The new bridge rail system successfully met all the safety performance criteria for MASH TL-2. The Texas Type T631 Bridge Rail was developed as a low-cost, energy absorbing bridge rail system for TL-2 applications. Many of the features used for the system tested at Midwest Roadside Safety Facility for TL-3 were incorporated into the design developed for this project for MASH TL-2 application. The TxDOT Type T631 Bridge Rail designed and developed for this project was evaluated under MASH TL-2.

This report is available for free download (10.6 MB):

<http://tti.tamu.edu/documents/9-1002-12-10.pdf>

Item 4

Evaluation of Binder Aging and its Influence in Aging of Hot Mix Asphalt Concrete: Technical Report

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6009-2 • 2014

TxDOT Project 0-6009 was a comprehensive interdisciplinary research effort that has developed the ability to predict asphalt oxidative hardening over time and pavement depth, and the impact of this hardening on mixture durability. The many interrelated research and development accomplishments form three major elements: 1) Pavement Binder Oxidation Model Development (improved pavement temperature model, binder oxidation kinetics parameters, binder diffusion coefficients, model for predicting binder oxidation in pavements); 2) Mixture Test Development and Measurements (method for testing prismatic specimens cut from pavement cores, measurements of binder oxidation in pavements, measurements of binder oxidation in laboratory mixtures, evaluation of seal coat effectiveness); and 3) an "HMA Mixture Design Approach That Includes Binder Oxidation" (accelerated binder aging test, mixture design and analysis system, software user interface). Suggestions for implementation and future work include: 1) Introduce the software user interface to TxDOT engineers, 2) Adopt the accelerated aging test, 3) Implement a strategy for evaluating existing pavements by testing recovered binders for their oxidation and hardening kinetics, 4) Incorporate the pavement transport and thermal oxidation model into a new pavement design guide, 5) Further evaluate the effectiveness of maintenance treatments, 6) Further validate the pavement oxidation and hardening model, 7) Improve our fundamental understanding of oxidation kinetics chemistry and reaction kinetics, 8) Improve our fundamental understanding of the correlation between PAV and POV reaction kinetics parameters.

This report is available for free download (21.1 MB):

<http://tti.tamu.edu/documents/0-6009-2.pdf>

Research Digest

Item 5

Long-Term Performance of a Drilled Shaft Retaining Wall in an Expansive Clay

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)

CTR 6603-2 • 2014

The purpose of this research is to advance the understanding of the behavior of drilled shaft retaining walls installed through expansive clay. The primary source of information for this study is data from a full-scale instrumented test wall, which was installed through highly over-consolidated, expansive clay in Manor, Texas, and monitored for a period of 4 years. This study includes a summary of existing research, technical information on the design and construction of the instrumented test wall, an analysis of the relationship between soil behavior and wall deformation during the 4-year monitoring period, and preliminary recommendations on how to account for the effects of expansive soil in design of drilled shaft retaining walls.

- Accompanying CD-ROM contains Appendices by Robert Gilbert. Appendix K includes:
- A Subsurface Investigation in Taylor Clay / by Trenton Blake Ellis (Thesis, 2011)
- Use of Time Domain Reflectometry Probes for the Moisture Monitoring of a Drilled Shaft Retaining Wall in Expansive Clay / by Gregory Fred Dellinger (Thesis, 2011)
- Earth Pressures Applied on Drilled Shaft Retaining Walls in Expansive Clay during Cycles of Moisture Fluctuation / by Iraklis Koutrouvelis (Thesis, 2012)
- Behavior of Drilled Shaft Retaining Walls in Expansive Clay Soils / by Andrew Charles Brown (Dissertation, 2013)

This report is available for free download (8.3 MB; 31.1 MB):

<http://library.ctr.utexas.edu/ctr-publications/0-6603-2.pdf>

http://library.ctr.utexas.edu/ctr-publications/0-6603-2_appdx.pdf

Item 6

0-6613, Evaluate Binder and Mixture Aging for Warm Mix Asphalt

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT). RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE (RTI)

TTI 6613 PSR • 2013

"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. However, there have been issues of concern in WMA including binder oxidation, binder absorption, and the impact of both of these issues on pavement durability... Researchers used a wide range of methods, both new and new to asphalt materials, for assessing warm mix binder, mixture properties, and field performance."

This report is available for free download (135 KB):

<http://tti.tamu.edu/documents/0-6613-S.pdf>

Research Digest

Item 7

Development of a Specification for Flexible Base Construction

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6621-2 • 2014

The Texas Department of Transportation (TxDOT) currently uses Item 247 "Flexible Base" to specify a pavement foundation course. The goal of this project was to evaluate the current method of base course acceptance and investigate methods to replace materials approval based on stockpile sampling and testing with a mixture design methodology and quality control procedure. Researchers gathered existing information that would assist in defining the types of tests to be used, specification acceptance criteria, and acceptance limits. Researchers then gathered data to identify tests that should be considered for inclusion in the specification and defined property variability of base course materials from nine pits/quarries in Texas. They also conducted other activities concerning precision and bias statement development, production/placement variability, technician certification, laboratory accreditation, and the development of relationships that allow test property parameters to predict pavement performance. The project developed draft flexible base course specifications in a quality control/quality assurance and quality monitoring program format. Researchers recommend an implementation project to determine the accuracy of the developed pavement performance prediction techniques and the suitability of the specification, including the types and limits of the test parameters in the specification.

This report is available for free download (5.3 MB):

<http://tti.tamu.edu/documents/0-6621-2.pdf>

Item 8

Development of Texas Mechanistic-Empirical Flexible Pavement Design System (TxME)

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6622-2 • 2014

The FPS design system implemented in the mid-1990s has limitations in that it does not use any results from laboratory testing so it is impossible to determine benefits from improved base materials or superior asphalt mixes. The development of the new flexible pavement design system, TxME, will enable Texas Pavement designers to take full advantage of new or premium materials, with a full consideration of the influential factors including pavement structure, traffic loading, and environmental conditions. The features of TxME include 1) Mechanistic-Empirical modeling, 2) performance-based material characterization, 3) traffic load spectrum incorporation, 4) design input variability-based reliability methodology, 5) incremental distress prediction, 6) fast running speed, 7) user-friendly interface, and 8) convenient connection with FPS. This report documents the work and findings during this study. Sensitivity analysis shows that TxME can make rational predictions under different combinations of pavement structure, climate, and traffic load. As a first stage, the researchers recommend that TxME be used as a performance check tool for design options recommended by the FPS design system. More calibration and model fine-tuning work still needs to be done.

This report is available for free download (9.9 MB):

<http://tti.tamu.edu/documents/0-6622-2.pdf>

Research Digest

Item 9

0-6626, Fleet Equipment Performance Measure Preventive Maintenance Model

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT). RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE (RTI)

TTI 6626 PSR • 2013

"The Texas Department of Transportation (TxDOT) operates a large fleet of on-road and off-road equipment. Consequently, fleet maintenance procedures (specifically preventive maintenance such as oil changes) represent a significant cost to the agency. TxDOT currently uses a preventive maintenance schedule dependent on simple variables such as vehicle miles or operational hours logged. However, with newer engines and vehicles that are equipped with on board diagnostic systems, there is the possibility of tracking these parameters or performance measures over time and correlating them to oil degradation levels to determine the need for preventive maintenance. The aim of this research is to: (1) Provide a proof of concept for this idea by studying whether a statistical approach to recommending oil changes in TxDOT's fleet vehicles can be achieved based on collection of engine data (through on board diagnostics) and oil sampling analysis. (2) Assess whether predictive intervals can improve preventive maintenance practices and save money."

This report is available for free download:

<http://tti.tamu.edu/documents/0-6626-S.pdf>

Item 10

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

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT). RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE (RTI)

TTI 6629 PSR • 2013

"The U.S. Environmental Protection Agency's newest emissions model, Motor Vehicle Emission Simulator (MOVES), enables users to use local drive schedules (representative vehicle speed profiles) in order to perform an accurate analysis of emissions from vehicles. However, only the national average drive schedules are currently included in the default database of the model. The cold start and idling emissions and activity data of heavy-duty diesel vehicles (HDDVs) that are included in the MOVES model are based on a very limited number of data sources, even though they are important components of the total on-road mobile source emissions inventory. This research provides local drive schedules 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 research also compares estimated emissions from MOVES for a sample of vehicles to real-world in-use emissions measurements." --Background

This report is available for free download:

<http://tti.tamu.edu/documents/0-6629-S.pdf>

Research Digest

Item 11

0-6672, ITS Strategic Plan for Texas

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT). RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE (RTI)

TTI 6672 PSR • 2013

"The purpose of this research was to provide a framework to guide the development and deployment of an integrated statewide program for intelligent transportation systems (ITS). ITS is a critical component of the transportation infrastructure that helps ensure the system operates in the most efficient way possible every day and night, and during all types of situations and weather conditions."

This report is available for free download:

<http://tti.tamu.edu/documents/0-6672-S.pdf>

Item 12

Evaluating Truck and Rail Movements along Competitive Multimodal Corridors

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)

CTR 6692-1 • 2014

Texas faces increased freight demands from population growth and economic success, with little prospect of adding substantial capacity to the Texas Department of Transportation (TxDOT) principal highway networks. In Texas's truck-dominated intrastate corridors, can railroads offer competitive service and reduce truck volumes? Current mode choice models do not capture the effects of weight, speed, engine power, grade, or curvature—key elements of any mechanistic approach. Moreover, they are incapable of fully internalizing external or social costs into their calculations. Therefore, in two critical areas for transportation planners—fuel costs and emissions—existing models are deficient. This project combines mechanistic models for both trucks and rail into a PC model, calibrated for Texas and implemented through a series of study workshops for TxDOT and metropolitan planning organization (MPO) planning staff. The output of the toolkit allows planners to compare truck and rail service over a series of corridors in terms of overall cost, fuel costs, emissions per ton-mile, and related secondary costs such as pick-up and delivery costs for rail freight. It provides truck and rail operating cost comparisons that should strengthen corridor analysis—an important component of the MAP-21 legislation.

CONTENTS

- Chapter 1. Introduction
- Chapter 2. Literature Review
- Chapter 3. Development of Vehicle Operating Cost Model and the Highway Improvement Model
- Chapter 4. Current State of Rail Models
- Chapter 5. Development of the Rail Model
- Chapter 6. Rail Alignments, Hay's Location Process, and Acquiring Track Data
- Chapter 7. Rail Capacity
- Chapter 8. Rail Model Sensitivity Analysis
- Chapter 9. Corridor Case Study
- Chapter 10. Findings and Recommendations
- References

This report is available for free download (1.4 MB):

<http://library.ctr.utexas.edu/ctr-publications/0-6692-1.pdf>

Research Digest

Item 13

Evaluating the Effectiveness of Performance Based Pavement Marking Maintenance Contracts in Texas

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6705-1 • 2014

Performance-based pavement marking maintenance contracts (PBPMCs) are one of the latest mechanisms used to maintain adequate pavement marking performance levels. TxDOT has issued two PBPMCs, but the effectiveness of these contracts as compared to other contracting mechanisms from a risk management, cost, performance, or safety perspective has not been evaluated. This project gathered information to evaluate the effectiveness of PBPMCs by evaluating the delivered pavement marking performance, safety performance, potential cost savings, and the most suitable performance measures and measurement protocols for inclusion into the PBPMCs. The evaluations found inconclusive evidence as to the benefit of the PBPMC from a safety, marking performance, or cost-effectiveness standpoint. Recommendations are provided to improve future PBPMCs.

CONTENTS

- Chapter 1. Overview
- Chapter 2. State of the Practice
- Chapter 3. Statewide Survey
- Chapter 4. Safety Evaluation
- Chapter 5. Performance Evaluation
- Chapter 6. Cost Evaluation
- Chapter 7. Specification Evaluation
- Chapter 8. Findings and Recommendations
- Reference
- Appendix A. Pavement Marking Maintenance Survey
- Appendix B. Dallas District Cost Analysis

This report is available for free download (5.9 MB):

<http://tti.tamu.edu/documents/0-6705-1.pdf>

Item 14

0-6714, Evaluating the Need for Surface Treatments to Reduce Crash Frequency on Horizontal Curves

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT). RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE (RTI)

TTI 6714 PSR • 2014

"Roadway safety continues to be a major national concern, with federal, state, and other authorities striving to reduce crashes and their associated costs in terms of fatalities, severe injuries, property damage, and traffic delays. According to the National Highway Traffic Safety Administration, motor vehicle crashes were a leading cause of death in the United States in 2006... horizontal curves tend to be associated with a disproportionate number of severe crashes. Each year in the United States, about 38,000 fatal crashes occur on the highway system, with 25 percent of the fatalities found to occur on horizontal curves. Texas accounts for about 3,200 of these fatal crashes, with about 44 percent of Texas' crashes occurring on horizontal curves... Given this crash information, to have an impact on overall crash reduction, research needs to be conducted into methods for improving driver performance at horizontal curves, and a major component of this effort is evaluating surface treatments that can be used to improve roadway conditions on curves."

This report is available for free download (150 KB):

<http://tti.tamu.edu/documents/0-6714-S.pdf>

Research Digest

Item 15

Warrants and Criteria for Installing and Sunsetting TxDOT ITS Equipment

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6773-1 • 2014

Over the past several decades, the Texas Department of Transportation (TxDOT) has made significant investment in deploying and developing intelligent transportation system (ITS) devices, such as closed-circuit television (CCTV), traffic sensors, and dynamics message signs (DMS), to assist in managing traffic operations. However, as these systems have matured and as financial resources have become more constrained, TxDOT needs to become more strategic in their decision-making and to when and where to deploy new ITS devices and systems and when and where to continue supporting and /or upgrading systems that have met their life expectancy. The goal of this project was to develop guidelines, criteria, and procedures to assist TxDOT in their decision-making specific to installing, repairing, and/or removing ITS field devices and systems.

CONTENTS

- Chapter 1. Introduction
- Chapter 2. Assessment of Current Practice in Other States
- Chapter 3. TxDOT Current Policies and Practices for Installing, Repairing, and Removing ITS Devices
- Chapter 4. Factors Affecting Installation and Maintenance Decisions Related to ITS Devices
- Chapter 5. Warrant Criteria and Sunset Requirements for ITS Devices
- Chapter 6. Assessment of Currently Available Asset Management/Risk Management Tools and Decision Support Systems
- Chapter 7. A Risk-Based Approach for Managing ITS Assets
- Chapter 8. Summary and Findings
- References
- Appendix. Applicability of Tools Used for Risk Assessment

This report is available for free download (651 KB):

<http://tti.tamu.edu/documents/0-6773-1.pdf>