Research Digest

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TxDOT Research Reports and Products

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Item 1

Evaluation of Corrosion Resistance of Improved Post-tensioning Materials after Long-term Exposure Testing

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

CTR 4562-4 • 2011

Ten full-scale post-tensioned beam specimens were subject to 4 years of aggressive cyclic ponded saltwater exposure. Three of those specimens were additionally exposed to saltwater spray once per month on one anchorage face. Non-destructive monitoring was conducted during the exposure period. This consisted of half-cell potential measurements, AC impedance measurements (for specimens with fully encapsulated tendons), and regular visual inspections. Chloride samples were extracted from the specimens at the end of exposure. After 4 years, the specimens were autopsied, and all reinforcing elements from the middle of each specimen were examined for corrosion and damage. Anchorage regions were also autopsied and examined for corrosion. Duct systems included galvanized metal ducts, plastic ducts, and encapsulated duct systems. Strand types included conventional strand, hot dipped galvanized strand, copper clad strand, and stainless steel strand. Complete observations are presented.

This report is available for free download (9.7 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_4562_4.pdf

Item 2

Effects of Bending and Heat on the Ductility and Fracture Toughness of Flange Plate

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

TTI 4624-2 • 2012

Bridge fabricators for the Texas Department of Transportation (TxDOT) have occasionally experienced the formation of cracks in flange plate during bending operations, particularly when heat is applied. Bending the flange plate is necessary for certain details used in the fabrication of steel highway girders such as dapped end details. Heat is sometimes used to assist in the bending operation, particularly to help reduce the forces required to bend the plate. This report documents the findings of a TxDOT-sponsored research project that investigated the possible causes of the cracking and developed recommendations to prevent the occurrence of such cracking.

The research project investigated the cracking problem using both experimental and analytical studies. The experimental study involved the use of small tensile specimens loaded to different strain levels under varying temperature conditions. Strain levels up to 15 percent were investigated. Temperature conditions included testing at room temperature, 450ºF, and 1150ºF. The results showed that strain levels above 10 percent generally reduced the ductility and fracture toughness of the plate. Additionally, it was found that the application of heat during the bending process significantly reduced ductility and was the major contributor to the formation of cracks. A finite element study of the heating process was used to extend the results for the experimental study.

As a secondary study, the fatigue behavior of non-loaded bolted connection details was investigated along with the influence of plate thickness. These details occur when gusset plates are bolted to flanges of girders. Unlike flange or web splices where the load must transfer out of the main member, the load in these details passes through the main plate, resulting in higher stresses around the bolt holes. Pre-tensioning the bolts normally shields the bolt holes from fatigue damage due to the resulting compressive stress field. This study found that for plate thicknesses greater than 1.0 inches, a reduction in fatigue strength was warranted.

This report is available for free download (1.8 MB):
http://tti.tamu.edu/documents/0-4624-2.pdf

Item 3

Implementation of the Soil Compactor Analyzer Into Test Method TEX-113-E: Technical Report

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

TTI 5135-01-1 • 2012

Test method Tex-113-E prepares laboratory aggregate base test specimens with an impact hammer compactor. These specimens are used for compaction characteristics and design tests. Although the historical Tex-113-E required a certain amount of compaction energy, no method to validate attainment of that energy existed until Texas Department of Transportation (TxDOT) Project 0-5135 developed the Soil Compactor Analyzer (SCA). The SCA measures the kinetic energy applied by each drop of the impact hammer. In this project, the SCA system was modified to control the compactor, where the SCA starts the machine and then turns off the compactor when the prescribed amount of energy is attained. This project then evaluated how changing the machine operational parameters, such as hammer weight, drop height, and number of blows per lift, impacted test results. In this evaluation, the SCA was used in all cases to control the compactor, so the prescribed amount of total energy was always applied regardless of machine operational parameters. The results showed that while using the current TxDOT-approved SCA to control total energy per lift between 740 and 765 ft-lbf, the number of blows per lift may vary between 45 and 60 with no impact on test results. Finally, this project conducted an inter-laboratory study to develop precision statistics of Tex-113-E compaction. This study showed that the SCA enables excellent precision of total compaction energy. Total compaction energy should be repeatable and reproducible within about 27 ft-lbf, or approximately 1 percent of the specification value. Compacted dry density should be repeatable within about 2.5 pounds per cubic foot (pcf) and reproducible within about 3.3 pcf.

This report is available for free download (8.8 MB):
http://tti.tamu.edu/documents/5-5135-01-1.pdf

Item 4

Validation of Field Test Methods for Use of Tire Bales

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

CTR 5517-01-1 • 2012

This implementation project validates field test methods for checking the conformity of tire bales used in transportation applications. It also provides guidelines for instrumentation of installations involving tire bales. Specific components include field evaluation of tire bale dimensions, tire bale unit weight, tension in the bailing wires as well as field assessment of mechanical and thermal properties. New test methods for field application to test the bales are developed.

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This report is available for free download (1.5 MB):
http://www.utexas.edu/research/ctr/pdf_reports/5_5517_01_1.pdf

Item 5

Application Guide and Specifications for Geotextiles in Roadway Applications

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

CTR 5812-1 • 2012

Geotextiles, one among the different geosynthetic products, can be used for a number of functions or applications in pavement design. The benefits of using geotextiles in pavements and other transportation applications have triggered a proliferation of products. While this abundance of new products has led to reduction in costs, it has also made it difficult for TxDOT personnel to choose appropriate products based on their engineering properties. Consequently, this report provides the basis for (i) guidelines for proper use and selection of geotextiles in pavements, (ii) material specifications for geotextiles in pavement applications, and (iii) draft construction specifications.

This report is available for free download (2.1 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_5812_1.pdf

Item 6

Develop Mechanistic-Empirical Design for CRCP

TEXAS TECH UNIVERSITY. CENTER FOR MULTIDISCIPLINARY RESEARCH IN TRANSPORTATION (TECHMRT)

TechMRT 5832-1 • 2012

Currently, TxDOT uses the AASHTO 93 design guide for the slab thickness design of continuously reinforced concrete pavement (CRCP). The AASHTO 93 design guide was developed based on the AASHTO road test, where JCP (jointed plain concrete pavement) was the major pavement evaluated and CRCP was not included. From a purely technical standpoint, the AASHTO 93 design guide is not appropriate for the design of CRCP. With ever-increasing traffic on major highways in Texas where CRCP is widely used, there is a need for a more mechanistic-empirical (ME) based pavement design procedure for CRCP. An ME-based pavement design method will allow TxDOT to optimize pavement structures to best utilize the limited financial resources available.

To develop an ME-based CRCP design procedure, the mechanism of punch outs was identified by field evaluations of CRCP, which included coring, deflection testing using falling weight deflectometer (FWD), and other nondestructive testing. Once the punch out mechanism was identified, mechanistic modeling was performed using a 3-dimensional finite element program. Another important element in the ME based pavement design procedures is the accuracy of a transfer function. A transfer function was developed using the data from TxDOT PMIS. A CRCP design program based on ME principles was developed, called TxCRCP-ME, with a User's Guide for the program. In the program, the effect of nonuniformity of subbase support, or the effect of erosion, was not directly addressed. From a theoretical standpoint, the effect is included in a transfer function. Sensitivity analysis was conducted to evaluate the effects of input variables and the reasonableness of the results. Since the reasonableness of TxCRCP-ME depends on the accuracy of transfer function, further efforts are recommended to refine the transfer function by collecting more accurate information on traffic, construction information and distress data. Once an accurate transfer function is developed, further sensitivity analysis will be needed to evaluate the reasonableness of the TxCRCP-ME. For the spalling issue, extensive field evaluations were conducted for the performance of spalling. A spalling model was developed and calibrated with field evaluation data.

This report is available for free download (11.8 MB):
http://www.depts.ttu.edu/techmrtweb/Reports/Complete%20Reports/0-5832-1.pdf

Item 7

CRCP ME Design Guide

TEXAS TECH UNIVERSITY. CENTER FOR MULTIDISCIPLINARY RESEARCH IN TRANSPORTATION (TECHMRT)

TechMRT 5832-P1 • 2012

"From the 1960s on, Texas has constructed more continuously reinforced concrete pavement (CRCP) than any other state, possibly more than all other states combined. As of 2010, Texas had 12,345 lane miles of CRCP, which is about 6.3 % of the total lane miles in the state... CRCP design consists of two elements: slab thickness design and steel reinforcement design. The two design elements are inter-related; however, the design for each element evolved independently until a mechanistic-empirical pavement design guide (referred to as MEPDG in this document) developed under NCHRP 1-37(A) was released (ERES, 2004). In this document, historical developments in design procedure for each element are separately described."

This report is available for free download (3.2 MB):
http://www.depts.ttu.edu/techmrtweb/Reports/Products/CRCP%20ME%20Design%20Guide%20-%200-5832-P1.pdf

Item 8

Estimating Texas Motor Vehicle Operating Costs: Final Report

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

CTR 5974-2 • [2012]

This report and its appendices summarize the findings of a 2-year extension to the TxDOT-sponsored study 0-5974 entitled "Estimating Texas Motor Vehicle Costs" undertaken by a Center for Transportation Research (CTR) team of mechanical engineers and economists at The University of Texas at Austin. The work was conducted in two phases over a 4-year period beginning in 2007 and this report details the second phase conducted over the period 2009-2011. It reports results in three areas: 1) total operating costs for the major vehicle classes currently seen on Texas highways, 2) engine models for hybrid light vehicles, and 3) results from examining the impact of transmission types through gearbox and differential sub-models. This second phase is the focus of this report but the reader interested in why this work was undertaken should peruse technical report 0-5974-1. This second, and final, report contains several detailed appendices on mechanical engineering sub-models and a product--a Vcost model and manual--for TxDOT use in highway and freight planning, economics and departmental revenue estimation. (Note: Traditionally vehicle operating costs were termed VOCs but the current use of this acronym to represent volatile organic compounds in emission studies encouraged the authors to adopt a different term--Vcost.)

"The Center for Transportation Research (CTR) / Texas Department of Transportation (TXDOT) Vehicle Operating Cost Toolkit (CT-Vcost) is user-friendly and robust software that provides operating cost estimates for specific representative vehicles or vehicle fleets. The toolkit default data is based on verified secondary vehicle cost data and certified vehicle databases such as the Environmental Protection Agency's (EPA) Fuel Economy database and Annual Certification Test Results database. The toolkit also al-lows users to change key variable parameters so that cost calculations are specific to any particular situation, and can be updated as the economic or technological landscape changes. Sample cost categories included in the CT-Vcost toolkit include depreciation, financing, insurance, maintenance costs, fuel cost, driver costs, road use fees (e.g. tolls) and other fixed costs such as vehicle registration. It also comes packaged with sophisticated fuel economy prediction models for heavy duty, light duty and hybrid vehicles. The fuel prediction models, developed using both experimental and survey data, have the ability to measure fuel consumption for default or custom drive cycles specified by users. Output from the fuel prediction models can be used in with the toolkit to perform different types of analyses as described later in this manual. In summary, the CT-Vcost toolkit was designed to be intuitive and flexible enough for simulating different scenarios and situations." --Vcost User Manual, p.1

This report is available for free download (Report: 10.6 MB; Manual: 4.6 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_5974_2.pdf
http://library.ctr.utexas.edu/digitized/ctr/0-5974-2_VcostUserManual.pdf

Item 9

Recommendations for Design, Construction, and Maintenance of Bridge Approach Slabs

UNIVERSITY OF TEXAS AT ARLINGTON. CENTER FOR TRANSPORTATION INFRASTRUCTURE SYSTEMS (CTIS)

UTA 6022-2 • 2012

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 causing injuries and even casualties, lowered perception of the department's road works, increased maintenance works, and constant delays to rehabilitate the distressed lanes. All these make this bump problem a major maintenance problem in Texas. Several mitigation methods have been employed, and the results are not always satisfactory. In the present research, two treatment methods are investigated for controlling settlements of approach slabs of new bridge construction. Researchers from UTA and UTEP performed two phases to accomplish these studies. During the first phase, the documented information that covers various methods used so far for approach slab settlement mitigation technologies is compiled and presented. The second and final phase focused on field evaluation studies of deep soil mixing and light weight embankment fill treatment methods in reducing settlements. A few other technologies were also evaluated for reducing settlements of existing bridge approach slabs. Both design and construction specifications of the new methods that provided effective treatments in field conditions are presented.

This report is available for free download (14.2 MB):
http://tti.tamu.edu/documents/0-6022-2.pdf

Item 10

Use of Dowel Bars at Longitudinal Construction Joints

TEXAS TECH UNIVERSITY. CENTER FOR MULTIDISCIPLINARY RESEARCH IN TRANSPORTATION (TECHMRT)

TechMRT 6190-1 • 2011

The primary objective of this research project was to develop rational guidelines on the use of dowel bars in longitudinal construction joints (LCJs) for better-performing concrete pavements without potential longitudinal cracking problems. To thoroughly investigate the behavior of tied and/or doweled concrete pavements, field testing was conducted in several new continuously reinforced concrete pavement (CRCP) construction projects in Texas. Concrete strain gages, concrete displacement gages, and steel strain gages were installed in each test section. To achieve the primary objective of this study in a more effective way, theoretical analysis was performed along with field experimentation. It was found from field experimentation that subgrade drag theory (SGDT) – currently used for tie bar design – is not adequate to accurately analyze the behavior of concrete pavements. Accordingly, an improved numerical model based on plane strain theory was developed to analyze a concrete pavement with tie bars at LCJs. To verify the validity of the numerical model, the analysis results were compared with the field data – transverse displacements across the LCJs, concrete stresses, and tie bar stresses. The comparison indicated a good correlation when both frictional restraint and curling effects were included in the analysis. The influences of multiple lane ties and pavement geometries on the stresses in concrete and tie bars were investigated through parametric studies using the numerical model. Although the stresses in tie bars and concrete increase as more lanes are tied together, the growth slows due to bond slip at the interface between tie bars and concrete. This means that the dowel bar placement instead of tie bars could reduce concrete stresses if it applies to wide pavements, while it could result in lane separation problems. On the other hand, concrete stresses do not increase any further if four or more lanes are tied together, and concrete stresses may not be high enough to cause longitudinal cracking. There are many miles of CRCP in Texas where more than four lanes and inside and outside concrete shoulders are tied together, with no longitudinal cracking. Accordingly, it is recommended from the findings in this study not to use dowel LCJs, as is the current practice.

This report is available for free download (5.3 MB):
http://www.depts.ttu.edu/techmrtweb/Reports/Complete%20Reports/0-6190-1.pdf

Item 11

FDR (Full-Depth-Reclamation) Process Video

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

TTI 6271-P1 • 2012

"This video provides an overview of key steps in the Full Depth Recycling [FDR] process. These key steps in FDR include up-front testing, laboratory mix design, construction, and curing and monitoring." --Introduction to "Up-front Testing" segment

CONTENTS

- Up-front Testing
- Laboratory Mix Design
- Construction
- Curing and Monitoring

This report is available for free download (754 MB):
http://tti.tamu.edu/documents/0-6271-P1.zip

Item 12

Relational Multimodal Freight Database Webinar

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

CTR 6297-01-P1 • 2012

"Implementation Project 5-6297-01, entitled Multimodal Freight Database, extends the work that has been conducted as part of TxDOT Research Project 0-6297 [Freight Planning Factors Impacting Texas Commodity Flows]. Specifically, the objectives of Implementation Project 5-6297-01 are to disseminate information about the MFD by hosting six workshops (Task 1), host a webinar to demonstrate the MFD to selected FHWA (Federal Highway Administration) freight leaders (Task 2), and update the MFD given the feedback received during Tasks 1 and 2. This document summarizes the outcome of Task 2: Conduct Multimodal Freight Database Webinar. The objective of Task 2 was to demonstrate the MFD to FHWA freight leaders and TxDOT Division staff to gain support for the development of a national database and to discuss the integration of proprietary data into the existing MFD. The webinar was hosted by Mr. Kirk Fauver (Statewide Planning Engineer, FHWA) and Ms. Jolanda Prozzi (Assistant Director, CTR). The webinar was conducted using Adobe Connect on December 8, 2011." --p.3

This report is available for free download (128 KB):
http://www.utexas.edu/research/ctr/pdf_reports/5_6297_01_P1.pdf

Item 13

Relational Multimodal Freight Database Workshops

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

CTR 6297-01-P2 • 2012

"The objectives of this Implementation Project are to disseminate information about the Multimodal Freight Database (MFD) by hosting six workshops (Task 1), hosting a webinar to demonstrate the MFD to selected FHWA freight leaders (Task 2), and updating the MFD given the feedback received during Tasks 1 and 2. This document summarizes the outcome of Task 1: Conduct Multimodal Freight Database Workshops. The objective of Task 1 was to demonstrate the MFD to key potential users for review and comment. Thus, the research team hosted six workshops and invited potential users in TxDOT's District and Regional Offices, at Texas MPOs, and at Texas cities to attend one of 6 workshops held in the fall of 2011. Given that the workshops had a similar format, only the material for the Corpus Christi workshop is included in the appendices. The next sections of this document provide information about the participants, the answers to the challenges/exercises, the input received from participants regarding the MFD, and finally the feedback and comments received regarding the workshops." --p.3

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This report is available for free download (1.6 MB):
http://www.utexas.edu/research/ctr/pdf_reports/5_6297_01_P2.pdf

Item 14

Multimodal Freight Database and User Manual

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

CTR 6297-01-P3 • 2012

"The Multimodal Freight Database is a one-stop shop for Texas freight data. It extracts and consolidates relevant freight data variables from major public databases. Commodity codes are mapped across databases thus providing a user-friendly interface for data search, comparison, and analysis. It requires minimal computer processing time and can be installed on any Microsoft Windows PC." --Texas Urban Freight website <accessed 6/7/2012>

"In consultation with TxDOT, it was decided to include the following variables in the Multimodal Freight Database: Year, Modes of Transportation [Air, Mail, Multimodal, Piggyback, Pipeline, Rail, Truck, Rail/Truck, Unknown, Vessel, Water], Origin [By State, By Country], Destination [By State, By Country], Port [Port Location by State], Type of Movement [Export, Import], Number of Loads [Carloads, Container], Value ($U.S.), Weight (1,000 lbs), Commodity Type." --User Manual, p.2-3

This report is available for free download (User Manual: 1.2 MB; Program can be downloaded from the Urban Freight website):

http://library.ctr.utexas.edu/digitized/products/0-6297-P3_UserManual.pdf
http://texasurbanfreight.com/2011/10/multimodal-freight-database/

Item 15

Shear Strengthening of Reinforced and Prestressed Concrete Beams Using Carbon Fiber Reinforced Polymer (CFRP) Sheets and Anchors

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

CTR 6306-1 • 2012

The ability to quickly apply carbon fiber reinforced polymer (CFRP) 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 material for strengthening existing elements. However, without adequate anchorage of CFRP sheets to the concrete surface, premature failures by debonding of the CFRP from the concrete significantly limit the capacity of CFRP strengthening systems. The objective of the study was to demonstrate the feasibility of using anchored CFRP for shear strengthening of large bridge girders or supporting elements. An extensive experimental program was undertaken on several full-scale T-beams and I-girders to achieve project objectives. CFRP anchors used in the study performed well and were able to develop the full capacity of CFRP sheets thereby precluding debonding failures. Studied anchored CFRP systems were thus able to generate significant shear strength gains of up to 50% of the unstrengthened beam capacity. Experimental results, installation procedures for CFRP sheets and anchors, specifications for fabrication and installation of CFRP anchors, and anchored CFRP shear design guidelines are presented.

This report is available for free download (20 MB):

http://www.utexas.edu/research/ctr/pdf_reports/0_6306_1.pdf

Item 16

Rational Use of Terminal Anchorages in Portland Cement Concrete Pavements

TEXAS TECH UNIVERSITY. CENTER FOR MULTIDISCIPLINARY RESEARCH IN TRANSPORTATION (TECHMRT)
TechMRT 6326-1 • 2012

It has long been stated that Portland cement concrete (PCC) pavements can grow and push bridges, resulting in damage to bridge structures. To protect bridge structures from damages due to the expansion of PCC pavements, three terminal systems are currently used in Texas: anchor lug (AL), wide-flange (WF), and expansion joint (EJ) systems. However, the effectiveness of these three systems has not been fully evaluated. This study investigated the parameters affecting the movements of continuously reinforced concrete pavement (CRCP) due to temperature variations near bridge terminal areas, whether thermal expansion of CRCP causes damage to bridge structures, and if it does, which terminal type is the most cost-effective. Field evaluations revealed that subbase friction plays an important role, and the movement of CRCP due to temperature variations was not excessive if the subbase friction is adequate and may not cause damage to the bridge structures. Most of the distresses near the bridge terminal areas were due to volume changes or instability in the embankment materials.

The end movement of CRCP could be accommodated by a simple EJ system if there is adequate subbase friction. The benefits of WF and AL systems are doubtful considering their higher initial construction costs compared with that of a simple EJ system. On the other hand, it should be noted that in a few CRCP projects, observations were made of CRCP expanding beyond the thermal expansion limits, implying that there are other expansion mechanisms than thermal expansions. The investigation of CRCP expansions due to factors other than thermal volume changes was out of the scope of this project. Simple structural analysis showed that if CRCP expands beyond thermal expansion limits, it is practically impossible to restrain the slab expansions with known methods including the AL system.

This report is available for free download (9.2 MB):
http://www.depts.ttu.edu/techmrtweb/Reports/Complete%20Reports/0-6326-1%20FINAL%20REPORT%20(2).pdf

Item 17

Texas Roundabout Guidelines: Final Report

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 6414-1 • 2011

Although roundabouts have now been implemented in many parts of the U.S., very few have been built in Texas. This report contains best practices for choosing appropriate locations and design concepts for Texas roundabouts. This research effort is comprised of the following components: synthesis of available literature and analysis methods, development of capacity analysis methods, validation and enhancement of existing tools, and a spreadsheet tool to aid in roundabout planning and implementation.

This report is available for free download (12.6 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6414_1.pdf

Item 18

CAM Mix Design with Local Aggregates

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

CTR 6435-1 • 2011

This study provides revised mix design recommendations for crack attenuating mixtures (CAM) with local aggregates. The use of lower quality aggregates is cost beneficial but limits the application of these mixes in terms of reduced performance. Aggregate guidelines and aggregate quality criteria are provided to enhance the rutting and cracking performance of these mixes. It is recommended to design CAM using local aggregates with the Superpave gyratory compactor with the capability of measuring the shear stress of the mix during compaction. CAM is susceptible to shear failure if the voids in these mixes become over filled with asphalt to the point that hydrostatic pore pressures negate the shear strength of the mix. CAM with local aggregates are very susceptible to stripping and the Hamburg wheel tracking test is useful test to mobilize pore pressures in these mixtures to address stripping. The overlay tester is used to evaluate cracking performance but was found to be highly variable even for these fine-graded mixes. The semi-circular bending (SCB) test is evaluated as an alternative and SCB cracking parameters are recommended to characterize cracking performance. The overall poor performance of CAM with local aggregates prompted the evaluation of alternative rut-resistant crack attenuating mixes, specifically stone-matrix asphalt (SMA) and coarse matrix high binder (CMHB) stone skeleton mixes using local aggregates, which were less susceptible to rutting and cracking compared to CAM. The mix design recommendations as well as aggregate guidelines and quality criteria provided in the report are based on laboratory investigations and field validation is strongly recommended before implementation.

This report is available for free download (24.3 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6435_1.pdf

Item 19

Identification of Priority Rail Projects for Texas: Initial Methodology/User Manual and Guidebook

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

TTI 6467-1 • 2012

This project developed a system of evaluative tools for the Texas Department of Transportation (TxDOT) to prioritize its investments in rail-related projects on a statewide basis. This work is meant 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.From the findings, researchers recommend a transparent methodology for evaluating proposed rail projects and establishing an initial process through which rail-related investments can periodically be re-evaluated. Existing project ranking tools were examined and assessed in order to determine opportunities for direct application or adaptation toward TxDOT uses and objectives. A set of performance-based criteria for TxDOT-funded rail projects were developed in the course of the project and adopted into the 2010 Texas Rail Plan. A guidebook to assist local and regional planners in routinely executing the methodology with an example case study project evaluation is also included in the report. Further refinement of the prioritization process will take place under TxDOT's Short Term Rail development process in accordance with the Texas Rail Plan.

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This report is available for free download (1.0 MB):
http://tti.tamu.edu/documents/0-6467-1.pdf

Item 20

Impacts of Energy Developments on the Texas Transportation System Infrastructure

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

CTR 6513-1 vol.A • [2012]

Texas's energy sector has a critical impact—historically and currently—on both the state economy and the Texas transportation system. The state's various transportation modes, including rail, highways, pipelines, and ports, form a system that supports the energy sector in a number of ways. Examples include the (a) movement of various components during the construction and implementation of the energy source (e.g., wind turbines and solar farms), (b) provision of enabling infrastructure (e.g., transmission lines), and (c) movement of the intermediate and final products in some energy supply chains (e.g., low sulfur mid-west coal by Class 1 unit trains to the major coal burning plants in Texas). It is thus critical that TxDOT develop a better understanding of the current and future impacts of the energy sector on Texas's transportation system, as well as quantify these impacts to ensure both adequate maintenance and its future sustainability.

This report is available for free download (Report: 10.9 MB; Supplement: 176 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6513_1a.pdf
http://library.ctr.utexas.edu/digitized/ctr/0-6513-1_suppl.zip

Item 21

Texas Energy Sector: Past and Future

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

CTR 6513-1 vol.B • 2011

The objectives of this research study were to (a) illustrate and quantify the impacts imposed by the energy sector on Texas's transportation system and (b) identify key energy demand indicators by energy source that TxDOT can track in an effort to anticipate the associated future transportation impacts on Texas's transportation system. This report describes how Texas's energy sector uses the transportation system and quantifies the impact imposed by the energy sector on Texas's road infrastructure. It is, however, also important to understand what the future holds—which industries within the energy sector are expected to grow, which industries are expected to decline, and how Texas's transportation system could be impacted in the future. The focus of this report is the development of four energy scenarios that reflect different assumptions and outcomes for Texas's future energy sector over a 20- to 30-year period. Analyses of several factors, referred to as "drivers," that may impact the energy sector are presented within.

This report is available for free download (2.1 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6513_1B.pdf

Item 22

Traffic Operations and Safety Benefits of Active Traffic Strategies on TxDOT Freeways

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

CTR 6576-1 • 2011

Traffic congestion is an increasing problem in the nation's urban areas, leading to personal inconvenience, increased pollution, hampered economic productivity, and reduced quality of life. While traffic congestion tends to continuously increase, growth in transportation infrastructure is limited by financial and land availability constraints. This has placed an increasing emphasis on using active traffic management strategies (ATM), such as speed harmonization, peak-period shoulder use, and ramp metering, to efficiently manage congestion using existing freeway capacity. Safety implication of these strategies is of prime concern before they can be implemented on the ground. This project developed a series of interdependent models and a simulation framework to evaluate the traffic operations and safety benefits of ATM strategies. Four ATM scenarios were evaluated in this study: variable speed limits (VSL), peak-period shoulder use, VSL and shoulder use, and ramp metering. Overall these ATM strategies were found to homogenize traffic and create safer driving conditions, but did not increase the throughput of the freeway. The study calls for caution and comprehensive evaluation in the case of shoulder use as sudden one-lane drop at the end of the shoulder-use section may have adverse effect on traffic operations and safety. The ITS devices required to implement these strategies, enforcement issues, potential impediments in their implementations, and a framework for cost-benefit analysis to determine the economic viability are also discussed.

This report is available for free download (4.6 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6576_1.pdf

Item 23

TxDOT Administration Research Tasks Completed FY 2011

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

TTI 6581-TI-3 • 2012

This research project evaluates numerous transportation issues and develops findings and/or recommendations based on results. This project has been structured to address some of the emerging, critical, and unique considerations related to transportation.

This report is available for free download (27.9 MB):
http://tti.tamu.edu/documents/0-6581-TI-3.pdf

Item 24

Alternative Methods of Flexible Base Compaction Acceptance

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

TTI 6587-1 • 2012

In the Texas Department of Transportation, flexible base construction is governed by a series of stockpile and field tests. A series of concerns with these existing methods, along with some premature failures in the field, led to this project investigating the current system of flexible base acceptance. Specifically, concerns over the lack of moisture control during compaction, and the lack of stiffness or modulus parameters in the field testing stage, led to this project that investigated new mechanistic-based methods for flexible base acceptance.

This report summarizes the concerns expressed with the current TxDOT methods, presents approaches some TxDOT districts have taken to overcome problems, and summarizes the current status of other agencies' efforts at mechanistic-based acceptance for flexible base. Next, this report presents results and findings from a full-scale compaction experiment, where a Grade 1 and Grade 2 flexible base were placed and tested with new non-density based devices. The results to date indicate acceptance with non-density based devices should be feasible. Additionally, the results indicate that flexible bases should not be worked significantly wet of optimum, because when the base is worked in that manner inferior mechanical properties result even though high density is achieved. To guide the second year's work, possible approaches for non-density based acceptance, and a field test plan, are outlined.

This report is available for free download (1.7 MB):
http://tti.tamu.edu/documents/0-6587-1.pdf

Item 25

Training Manual

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

CTR 6590-P2 • 2011

"The purpose of this product is to summarize the activities that the research team has accomplished on Project 6590: Material Selection for Concrete Overlays, Task 6: Development of a Training Manual. This manual is intended to educate TxDOT personnel for training design engineers, construction personnel, and inspectors. All the information provided can be referenced to the 0-6590 project report." --p.1

This report is available for free download (2.3 MB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6590_P2.pdf

Item 26

Unknown Foundation Determination for Scour

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

TTI 6604-1 • 2012

Unknown foundations affect about 9,000 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 costly approach must be taken. The objective was to develop a global approach, which will reduce significantly the level of uncertainty associated with unknown foundations. This approach was developed in two parts: a data mining and inference approach where no testing at the site was necessary, and a testing approach where new tests for unknown foundations were used. The data mining and inference task made use of existing data such as soil type, known foundations on neighboring bridges, design practice, and the age of the bridge to infer the type and length of unknown foundation elements. The testing task consisted of developing two geophysical techniques, resistivity and induced polarization imaging, to obtain a picture of the soil and foundation below the surface level or river bottom. The outcome was a global framework in which one of the approaches or any combination thereof, as well as the most useful current techniques (nondestructive testing methods if necessary), can be used to decrease dramatically the uncertainty associated with the unknown foundation. The inference process was trained by using bridges where the foundation was known and verified by comparison against case histories. The two testing techniques mentioned above were tested at the National Geotechnical Testing Site on Texas A&M's Riverside campus and then against full-scale bridges selected in cooperation with TxDOT.

This report is available for free download (24.3 MB):
http://tti.tamu.edu/documents/0-6604-1.pdf

Item 27

Best Practice for Using RAS in HMA

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

TTI 6614-1 • 2012

The use of recycled asphalt shingles (RAS) in hot-mix asphalt (HMA) mixtures has the potential to significantly reduce the cost of asphalt paving mixes while conserving energy and preserving the environment. This report documents the best practices for the use of RAS in HMA in terms of RAS processing, characterizing the processed RAS (binder content, gradations, and performance grade [PG]), RAS mix design, production, and field construction. First, a six-step RAS processing guideline was proposed in this study, including collecting, asbestos testing for the tear-off asphalt shingles, sorting, grinding, screening, and storing the processed RAS. Researchers found that tear-off shingles have higher binder content than manufacture waste shingles. The manufacture waste shingles have a consistent 20 percent binder content; the tear-off shingles evaluated in this study have various binder contents, ranging from 23 percent to 28 percent. Furthermore, the overall RAS variability in terms of asphalt binder content and gradation is low for both manufacture waste and tear-off shingles. Obviously, the RAS binders are very stiff and their high temperature PG is beyond 140°C, and the low temperature PG is above 0°C. This study compared the ignition oven method with the extraction method, and found that, except for one shingle source, both methods produced similar aggregate gradations and asphalt contents. Issues related to RAS mix design, production, and field construction were identified and discussed in this report. One important area needing further investigation is the long-term performance of RAS mixes.

Generally, RAS mixes have good rutting resistance, but its resistance to reflective cracking, fatigue cracking, and potential raveling needs to be evaluated. Life-cycle cost analyses should be performed to determine the economic viability of using RAS.

This report is available for free download (1.3 MB):
http://tti.tamu.edu/documents/0-6614-1.pdf

Item 28

Stakeholder Analysis for Value Extraction Projects

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

CTR 6634-P1 • [2012]

"No matter what the project, a variety of stakeholders exist, even for the proposed value extraction projects. Each project does not have the same list of stakeholders, and not every stakeholder may be interested in a project or exert influence over it. This guide will outline the process of identifying stakeholders, sorting stakeholders according to interest and influence, outline the stakeholders and their characteristics for the projects proposed, and set out the identified stakeholders for the 11 identified value extraction projects assessed during the research project." --p.1

This report is available for free download (379 KB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6634_P1.pdf

Item 29

An Assessment and Framework of Management Science Applications for TxDOT

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

CTR 6637-1 • 2011

For this project researchers implemented a systematic approach to identify the domains within TxDOT where Operations Research and Management Science (OR/MS) techniques can lead to substantial improvements. A comprehensive study of TxDOT's operations was conducted based on existing documentation, and complemented by a two-part survey of TxDOT personnel. Researchers used their expertise in OR/MS modeling to define themes, or functional mappings, based on survey responses. Such themes, common across a wide range of TxDOT organizational substructures, consist of applications that share a common set of models and/or methods in the OR/MS literature, and they represent research avenues that have the largest potential to benefit TxDOT operations. Seven key areas of research were identified, including utility accommodation and right of way acquisition, work load and productivity analysis for forecasting future staffing needs, workload analysis for performance-based compensation, right of way acquisition management, management of design and planning processes, project prioritization for financial allocation, and enhancement of internal communications. For each of the key areas identified in this work, researchers developed problem statements, which address a range or family of issues, thus maximizing their potential impacts. Another major outcome of this project involves the detailed documentation of the methodology used to arrive at effective problem statements, which provides TxDOT with a framework to continuously improve its decision support system.

This report is available for free download (975 KB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6637_1.pdf

Item 30

Problem Statements Reflecting High Impact or Research of Value to TxDOT

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

CTR 6637-P1 • 2011

This product defines 6 problem statements for research to develop policies and practices that would enhance the organizational performance and other priorities of the Texas Department of Transportation (TxDOT).

This report is available for free download (325 KB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6637_P1.pdf

Item 31

Procedures for Identifying and Prioritizing Areas for Continuous Improvement

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

CTR 6637-P2 • 2011

"This document presents the systematic series of steps taken in order to identify potential areas of improvement in techniques for Operations Research and Management Science (OR/MS). The process used to determine the set of actionable research statements (produced as part of Project Deliverable P1) is a robust system that can be used to identify opportunities for improvement in the future. This multi-stage procedure is centered on incorporating the knowledge and experience of current TxDOT professionals, with the knowledge base of the OR/MS community, to identify the areas and activities of TxDOT that can realistically and significantly be improved with the incorporation of OR/MS techniques." --p.3

This report is available for free download (481 KB):
http://www.utexas.edu/research/ctr/pdf_reports/0_6637_P2.pdf