Research Digest

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TxDOT Reports

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Research Digest

Item 1

Comprehensive Report on the Long-Term Behavior of High Performance Concrete Bridges in Texas

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 2941-5 • 2008

Final report summarizing the work done on Project 7-2941, "Long-term Behavior of High Performance Concrete (HPC) Bridges." The purpose of this project was to monitor the long-term performance of high performance concrete (HPC) beams and decks on bridges in Texas. The Texas Department of Transportation (TxDOT) specified the use of supplemental cementitious materials, such as fly ash, silica fume, and slag, as a substitution for cement, with the understanding that higher strength and more durable concrete could be obtained. Early camber loss in one high strength (HS) HPC beam and cracking in HPC decks prompted performance monitoring. Researchers inspected and recorded distress symptoms and performance for 10 years.

Full-text PDF of this report is available for free download from
http://www.utexas.edu/research/ctr/pdf_reports/7_2941_5.pdf

Item 2

Findings on Determining Durations of Right-of-Way Acquisition and Utility Adjustment on Highway Projects

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 4617-01-1 • 2008

When planning and programming a transportation project for delivery to the traveling public, Districts have historically relied on little more than the experience of their Right-of-Way (R/W) staff to establish the durations of R/W acquisition and utility adjustment processes, and subsequently, the timing of project letting. This lack of an established methodology exposes the department to risk relating to economics and negative public opinion. Research Project 0-4617 has developed "the Right of Way and Utility Adjustment Process Duration Information (RUDI) Tool" with significant potential for improving the department's ability to forecast the date of R/W and utility adjustment clearance. In order to provide the department with a decision-making instrument for enhancing project development and delivery processes, RUDI's ease of use, utility in highway project planning, and accuracy were evaluated. In addition, the application methods of RUDI in project development and planning processes were documented and a RUDI training guide was developed for tool implementation and evaluation. Moreover, 42 key drivers that may affect durations of R/W acquisition and utility adjustment were identified and assessed in terms of importance. Suggestions and recommendations for further research into improvements of the RUDI system were also gathered.

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http://www.utexas.edu/research/ctr/pdf_reports/5_4617_01_1.pdf

Item 3

Right-of-Way Acquisition and Utility Adjustment Process Duration Information Tool (RUDI) User Guide

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 4617-01-P1 • 2008

"Right of Way and Utility Adjustment Duration Information System" (RUDI) is an innovative tool that reviews a historical data directory to make intelligent predictions of time to acquire R/W and adjust utilities. RUDI is the first functional model of this type of decision assistance tool. RUDI is believed to be a wise first step toward providing a knowledgeable advisory of R/W project completion thereby supporting the mission of TxDOT to work cooperatively to provide safe, effective and efficient movement of people and goods. This guide includes chapters on getting started with RUDI, navigating RUDI, and using RUDI.

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http://www.utexas.edu/research/ctr/pdf_reports/5_4617_01_P1.pdf

Item 4

Debonding in Bonded Concrete Overlays Over Continuously Reinforced Concrete Pavements

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 4893-4 • 2008

Field evaluations of bonded concrete overlay (BCO) performance reveal that debonding between old and new concrete is responsible for distresses in BCO. An in-depth investigation is needed to fully understand debonding mechanisms and their effects on distresses in BCO. A literature review conducted as part of this study revealed that, although most currently available BCO design procedures recognize the importance of attaining a perfect bond between the overlay and the substrate, they do not address this aspect directly. Therefore, this study is aimed at investigating the mechanics of debonding under environmental loading at early ages and, based on an evaluation of these mechanisms, at developing a model capable of determining the extent of debonding for a variety of material, structural and environmental conditions. To that end, two 2-dimensional finite element models were developed. These models characterize debonding from the perspective of reflective cracks and nonreflective (top-down) cracks. The evaluation of analysis results demonstrates that the most critical scenario is debonding in non-reflective cracks. Next, the behavior of BCO was investigated through sensitivity analysis. The non-reflective crack debonding model is sensitive to slab thickness, modulus, and CTE of overlay concrete and the interface bond strength. All the other variables included in the analysis, including slab thickness and CTE of existing concrete slab had little effect on debonding.

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http://www.utexas.edu/research/ctr/pdf_reports/0_4893_4.pdf

Item 5

Summary of Implementation of an Artificial Lighting System for Automated Visual Distress Rating System

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 4958-01-1 • 2007

The artificial lighting system called a light bar is a specially designed lighting device for the automated pavement distress measurement system (VCrack) developed in a previous TxDOT project. The basic function of this device is to provide intense, uniform, and linear illumination for the VCrack's line-scan camera and helps it provide high quality pavement images under any exterior lighting conditions. It consists of three major units: one 6-foot long central unit and two one-foot long wing units (see Figure 1). Each unit utilizes three rows of red LED's, a cylindrical lens and two mirrors, forming a one-inch wide beam at a distance 16-inch (see Figure 2). The energy consumption of the light bar is <250 watts, eliminating the need for a special generator. Along with a matching band pass filter, the light bar enables the camera to avoid the variations of the ambient light. The lighting intensity is sufficient enough for nighttime surveys. The light bar has been merged with the existing rut bar that is installed on the front bumper, and its wing assemblies break-away should they collide with a foreign object. The light bar is eyesafe, durable, and easy to maintain.

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Item 6

Implementing Best Concrete Pavement Spall Repairs

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 5110-01-1 • 2008

The implementation project, 5-5110, Implementation of Best Spall Repair Practices for Concrete Pavement, was initiated to assist TxDOT in using more durable repair practices and materials for concrete spalls, especially in CRCP pavements. In the related previous research project 0-5110, Best Practices for Concrete Pavement Spall Repairs, researchers discovered that TxDOT already had several technical tools in place to make it easier for district personnel to find and specify the most promising materials for their concrete spall repair projects.

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http://www.utexas.edu/research/ctr/pdf_reports/5_5110_01_1.pdf

Item 7

Analysis of Continuously Reinforced Concrete Pavement Behavior Using Information in the Rigid Pavement Database

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 5445-2 • 2008

Microscopic behavior and distress types in continuously reinforced concrete pavement (CRCP) were investigated using the information in TxDOT's rigid pavement database. Crack width behavior was evaluated using the information from two test sections. Transverse crack width decreased over time, which is quite contrary to what's been accepted as a general crack width behavior in CRCP. The reason for this decrease is not known. Concrete temperature has a dominant effect on the crack width behavior. Most of the times, CRCP slabs exhibit flexural behavior at transverse cracks due to temperature variations through the depth. The neutral axis for crack width variations appears to exist below the mid-depth. Two major distress types were observed in the field: horizontal cracking induced distress and edge punchouts. Even though the mechanisms for the two distress types are different, the appearance of the two distresses could be quite similar. The mechanism of horizontal cracking appears to be curling of concrete slab, caused by large temperature variations in the upper portion of concrete slab. Large coefficient of thermal expansion and modulus of elasticity of concrete, and temperature variations appear to be causing this distress. Transverse crack spacing or concrete temperature does not appear to have substantial effects on load transfer efficiency (LTE) in CRCP. The insensitivity of LTE to temperature is different from the behavior of Jointed Concrete Pavement (JCP). In JCP, LTE at a transverse joint is quite sensitive to concrete temperatures. Crack widths get larger with lower temperatures, which should result in lower LTEs. However, field evaluations indicate almost constant LTEs evaluated in the summer and in the winter. Also, transverse crack spacing does not appear to have substantial effects on slab deflections. Based on the findings, it appears that load transfer efficiency, as in the current form, is not a good indicator for structural condition of CRCP. Efforts should be made to clarify the effects of transverse crack spacing on CRCP performance.

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http://www.utexas.edu/research/ctr/pdf_reports/0_5445_2.pdf

Item 8

Protecting and Preserving Rail Corridors Against Encroachment of Incompatible Uses

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

CTR 5546-1 • 2008

Rail Corridor preservation and planning for the purpose of reducing or restricting incompatible development is an area of growing importance. This report provides an overview regarding encroachment and the elements that contribute to potentially incompatible development along rail corridors. The report reviews the legal tools that currently exist within Texas for corridor preservation and provides recommendations for new legislation, including draft legislation. The report then reviews the state of practice of corridor planning and preservation with mitigation against encroachment both in Texas and in selected other states around the country. The report pays special attention to incidents in which rail corridors are envisioned to host both freight and passenger services and the implications on land use. Finally, the report provides a review of costs associated to deal with encroachment, whether by planning, preservation, collaboration, or mitigation.

The included CDROM contains 5546-P1: Protecting Rail Corridors from Encroachment: Options to Reduce or Mitigate Against Encroachment/ Incompatible Use. This guidebook has been divided into two main sections for ease of use. Section one covers corridor protection strategies in general and provides a review of practices that are used around the U.S as well as case study examples and costs and links to reports, websites, and legislation, where appropriate. Section two reviews the existing legal tools within Texas that could be used to implement effective rail corridor protection strategies and recommendations for enhanced legislative effectiveness.

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http://www.utexas.edu/research/ctr/pdf_reports/0_5546_1.pdf

Item 9

Review of TxDOT WWARP Aggregate Classification System

TEXAS TECH UNIVERSITY (TECHMRT)

TechMRT 1707-8 • 2008

This report documents the findings from a research study that reviewed TxDOT's Wet Weather Skid Accident Reduction Program's (WWARP's) aggregate classification system. It evaluated various lab test procedures that are used in the classification of aggregates as well as the field skid resistance performance of 27 different aggregate sources that belonged to synthetic, sandstone, igneous, gravel and carbonate categories. The findings showed that hard, durable aggregates characterized by >80% AIR or <8% MD losses, provided excellent to very good skid resistance regardless of the aggregate residual polish value. In general, all test methods evaluated showed better capability in separating excellent/very good quality aggregates than in identifying very poor/poor quality aggregates. In other words, the special limitation in these test methods was found to be in their ability to classify borderline aggregates into satisfactory and unsatisfactory categories. The WWARP aggregate classification system based on Residual PV, MSS loss and AIR proved to be effective in separating Excellent/Very Good (Class A) from Good/Fair (Class B) materials. However, this classification system failed to separate the few aggregate sources with poor field performance from those with good/fair performance.

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http://library.ctr.utexas.edu/pdf02/1707-8.pdf

Item 10

Field Manual for Configuring Traffic-Responsive Control on TxDOT Closed-Loop Systems

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)
TTI 4421-01-P1 • 2007

Closed-loop traffic control systems can be operated in either Time-of-Day (TOD) mode or Traffic Responsive Plan Selection (TRPS) mode. When properly configured, the TRPS mode has the greatest potential to provide optimal operation due to its ability to accommodate abnormal traffic conditions such as incidents, special events, and holiday traffic. Most importantly, TRPS mode can reduce the need for frequent redesign/updates to signal timing plans.

The TRPS mode is designed to continuously monitor the traffic flow pattern and select the most appropriate timing plan from a pre-programmed library. Thus, proper configuration of TRPS mode requires:

~a sufficient number of system detectors placed outside the influence of cyclic queues at the stop bar,
~a library of timing plans that can accommodate all traffic conditions possible at the selected site, and
~proper configuration of numerous TRPS parameters, which include cycle level parameters, directionality parameters, smoothing factors, and weighting factors.

If any of the above requirements is not met, the TRPS mode may select inappropriate timing plans or cause the closed-loop system to run in a continuous transitioning state. This field manual is intended to provide a step-by-step guide for installation and operation of TRPS mode at typical TxDOT arterials consisting of three to six signalized intersections.

Full-text PDF of this report is available for free download from
http://tti.tamu.edu/documents/5-4421-01-P1.pdf

Item 11

Calibration Factors Handbook: Safety Prediction Models Calibrated with Texas Highway System Data

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)
TTI 4703-5 • 2008

Highway safety is an ongoing concern to the Texas Department of Transportation (TxDOT). As part of its proactive commitment to improving highway safety, TxDOT is moving toward including quantitative safety analyses earlier in the project development process. The objectives of this research project are: (1) the development of safety design guidelines and evaluation tools to be used by TxDOT designers, and (2) the production of a plan for the incorporation of these guidelines and tools in the planning and design stages of the project development process.

This document summarizes the research conducted and the conclusions reached during the development of safety prediction models for intersections and highway segments in Texas. Models were developed for urban and suburban arterial intersections, urban and suburban arterial street segments, rural multilane highway segments, and urban and rural freeway segments. They were subsequently calibrated using Texas highway system data. Selected accident modification factors were also developed and calibrated. These factors address several geometric design elements, including turn bay presence, median width, barrier presence, and weaving section length.

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http://tti.tamu.edu/documents/0-4703-5.pdf

Item 12

An Assessment of Yield Treatments at Frontage Road-Exit Ramp and Frontage Road-U-Turn Merge Areas

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

TTI 4986-1 • 2008

The goal of this research project was to assess the effectiveness of the wide variety of frontage road-exit ramp and frontage road-U-turn yield treatments that exist in Texas. In meeting this goal, researchers collected field data at a number of sites around the state of Texas that represent the array of current yield treatments in practice. In order to assess the plethora of prevailing operating characteristics (i.e., variances in speeds, volumes, driveway densities, etc.), the research team utilized simulation modeling procedures to compensate for the impracticability of the data collection effort that would be required for every possible combination thereof. Several key operational and geometric features of each case study site were carefully collected and analyzed to produce a calibrated model for each case study condition. Two levels of simulation analysis were used in this project. First, the research team developed a Level 1 procedure that involved selection of real-world sites for data collection, analysis, and simulation model calibration. After calibration of the model for each site, different yielding treatments were applied to each calibrated site. Comparisons were then made to determine if any one treatment performed better than the others. This procedure enabled researchers to look at some problematic sites that currently exist in the field and incorporate signal timing, current weaving patterns, speed and volume into the analysis. Since Level 1 analysis was limited to the geometric and traffic conditions at the selected sites, a Level 2 analysis was performed to consider the performance of various yield treatments on a wide variety of feasible scenarios/combinations of geometric and operating conditions.

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http://tti.tamu.edu/documents/0-4986-1.pdf

Item 13

Traffic Control Strategies for Congested Freeways and Work Zones

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

TTI 5326-2 • 2008

The primary objective of the research was to identify and evaluate effective ways of improving traffic operations and safety on congested freeways. There was particular interest in finding condition-responsive traffic control solutions for the following problem areas: (1) end-of-queue warning, (2) work zones with lane closure, and (3) queue spillover at exit ramps. Available techniques considered by this research include combination of static and dynamic queue warning systems, dynamic merge control in advance of freeway lane closures, and various traffic control strategies, such as traffic diversion and ramp metering, to mitigate queue spillover at exit ramps.

Three sets of evaluation studies were conducted: first, two queue warning systems deployed on IH 610 and US 59 in Houston, Texas, were evaluated based on field observations. Second, strategies to resolve a ramp spillover problem at an exit ramp in El Paso, Texas, were analyzed using traffic simulations. Third, the Dynamic Merge work zone traffic control concept was evaluated using traffic simulations, and recommendations were developed for its potential use for various work zone types with different lane closure configurations.

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http://tti.tamu.edu/documents/0-5326-2.pdf

Item 14

A Review of Performance Models and Test Procedures with Recommendations for Use in the Texas M-E Design Program

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

TTI 5798-1 • 2008

In the first year of this project, a comprehensive review was made of the available models for predicting the major distresses in flexible pavements, including cracking of asphalt layers and chemically bound layers, permanent deformation of asphalt layers, and permanent deformation of granular base and subgrade layers. In conducting these reviews, the latest models under consideration in both national efforts and various state development efforts were reviewed. The models identified for each of the major distresses are described in this report. Additionally, the associated laboratory test procedures, which can be used to provide TxDOT with the material properties needed as inputs to both the pavement response and performance prediction models, were also identified and discussed. Finally, a detailed laboratory testing plan was proposed for Year 2 Study.

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http://tti.tamu.edu/documents/0-5798-1.pdf

Item 15

Evaluation of Ways and Procedures to Reduce Construction Cost and Increase Competition: Technical Report

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

TTI 6011-1 • 2008

Construction cost inflation is affecting many state highway agencies including the Texas Department of Transportation. While some of this increase can be attributed to factors such as soaring cost of energy, reports of large variations in cost of bid items among different districts indicate that the problem is more complex. Indeed, there are many other factors affecting the recent increase in construction cost including design requirements, work restrictions, bidding procedures, and competition. The goal of this research is to identify these factors, or the root causes contributing to the increase in construction cost, and propose the methods that can address them. The research approach is based on four sequential steps: identification of the methods, collection of the data from the interim workshops, assessment of the impact of the methods on adopted performance measures, and development of recommendations and guidelines on how to modify construction projects to reduce or contain the construction cost while maintaining quality. The results from a Delphi study show that the cost reduction methods (both on a project or program level) could be used to reduce or contain the cost of highway construction.

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Item 16

Strategies for Improving Travel Time Reliability

UNIVERSITY OF TEXAS AT EL PASO (UTEP)

UTEP 5453-2 • 2008

Deterministic network models, in which deterministic link travel time is a function of link volume, have been used by TxDOT in its transportation planning process. The use of stochastic network models, in which link travel time is subjected to variation even at a given volume could potentially provide a better precision and additional measures that relate to travel time reliability for transportation project selection. This research has developed and tested two traffic assignment approaches that include travel time variation in a network, and driver's route choice and departure time choice in response to such travel time uncertainty. Software tools to assist in the modeling of the proposed traffic assignment approaches in TransCAD have also been developed.

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