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Research Digest

Item 1

Improvement of Portland Cement Concrete Pavement Performance

*UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 1700-7 • 2007*

A general hydration model for cementitious materials and a model to predict the temperature gain in hardening concrete is developed and calibrated. A model to predict initial and final setting of hardening concrete is presented, and calibrated, with data collected under laboratory and field conditions. The effects of concrete temperature, different cements, and mineral admixtures on the initial and final times are characterized.

Mathematical models were developed for the calculation of moisture and temperature profiles to help investigate the effect of different combinations of climate, construction, and materials on the development of the moisture and temperature profiles and their subsequent effects on early-aged cracking.

The sensitivity of the design variables to the behavior of continuously reinforced concrete pavement (CRCP) has been investigated using mechanistic models of CRCP. The zero-stress temperature and the coefficient of thermal expansion of concrete are the most sensitive design variables, and the steel bar diameter and the vertical stiffness of underlying layers are the least sensitive variables.

The effect of early opening to traffic on the life of portland cement concrete pavement systems was evaluated using experiments and mathematical model. A series of laboratory fatigue tests and accelerated fatigue tests on full-scale concrete slabs were performed. An analytical model for the numerical simulation for the prediction of the loss of life of a PCC pavement due to early opening was developed. The current opening criteria used by the Texas Department of Transportation appear to be reasonable based on the sensitivity analysis results.

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http://www.utexas.edu/research/ctr/pdf_reports/0_1700_7.pdf

Item 2

Strengthening Existing Non-Composite Steel Bridge Girders Using Post-Installed Shear Connectors

*UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 4124-1 • 2007*

This study investigated methods to strengthen existing non-composite steel bridge girders by the development of composite action between the steel girder and concrete slab. More specifically, the objective of this study was to identify structurally efficient and practical ways to post-install shear connectors in existing bridges. Various types of post-installed shear connection methods were tested under static, high-cycle fatigue, and low-cycle fatigue loads using a direct-shear test setup. Based on the results of single-shear connector tests, full-scale beam tests were performed under static load to evaluate system performance of the beams retrofitted for partial composite action with post-installed shear connectors.

The results of this study clearly demonstrate that the strength and stiffness of existing non-composite steel bridge girders can be increased significantly by post-installing shear connectors. Development of composite action between the existing steel girder and concrete slab through the installation of post-installed shear connectors appears to be a structurally efficient and cost-effective approach to retrofit existing bridges. The addition of post-installed shear connectors can increase the load capacity of existing steel girders on the order of 40 to 50%. Preliminary guidelines are provided.

Full-text PDF of this report is available for free download from
http://www.utexas.edu/research/ctr/pdf_reports/0_4124_1.pdf



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Item 3

Evaluation of Influence of Hole Making Upon the Performance of Structural Steel Plates and Connections

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

CTR 4624-1 • 2007

A large experimental study was undertaken to determine the effect of hole making upon the strength, ductility, and fatigue performance of structural steel plates and connections. The variables included steel strength, plate thickness, hole size, punch to die clearance, galvanizing, temperature, and edge distance. Approximately 300 tension and fatigue tests were performed. The study agreed with the results of previous research that plates with punched holes have lower strength and ductility than ones with drilled holes. The fatigue performance of plates with punched holes was also less than ones with drilled holes. Galvanizing further reduced the fatigue strength of plates with punched holes. The effect upon hole making upon the fatigue strength and to some extent the tensile strength reduced when fully pretensioned bolts were used. Empty holes had a lower fatigue strength than holes used in a bolted connection. The practice of increasing the hole diameter by 1/16 in. when calculating the net section of a tension member did not account for the reduction in strength when the hole was punched. It is recommended that this increase in hole be eliminated and the tension strength of members with punched holes be taken as 90% of normal design values. Due to the low ductility of plates and connection with punched holes, punched holes should only be used in secondary members that do not need the ductility required in main members. The appendix of the report gives the recommended specifications.

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http://www.utexas.edu/research/ctr/pdf_reports/0_4624_1.pdf

Item 4

Literature Review of Curing in Portland Cement Concrete Pavement

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

CTR 5106-1 • 2005

Curing of concrete has an effect on hardened concrete properties and overall long-term performance of portland cement concrete (PCC) pavement. A significant amount of research has been conducted to evaluate curing effectiveness and its effect on concrete properties. This report synthesizes the findings from the literature review, including the relative humidity measuring techniques. The most frequently measured concrete properties are strength and permeability. They are important properties; however, in portland cement concrete pavement, volume change potential affected by curing effectiveness is as important for its performance. Not much information has been found in this regard. It appears that the curing effect is confined to the surface of the pavement, which is called curing-affected zone (CAZ). The extent of this zone varies, depending on the concrete properties and curing effectiveness, with average values varying from ¼ in. to ½ in. CAZ has a significant effect on the performance of PCC pavement. Further evaluation is needed to investigate the effect of curing on CAZ and overall pavement performance. Other state departments of transportation (DOTs) specifications for curing concrete pavement were investigated and all are nearly identical. They are prescriptive and method-type specifications and no compliance testing is required.

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Item 5

Effects of Increasing the Allowable Compressive Stress at Release of Prestressed Concrete Girders

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

CTR 5197-1 • 2007

In this report, the feasibility of increasing the allowable compressive stress limit at prestress transfer of 0.60f'ci is evaluated. For this purpose, the live-load performance and initial camber of pretensioned beams was investigated. Static-load tests were performed on 24 scaled and 12 full-scale specimens that were subjected to a maximum compressive stress at release ranging from 0.46f'ci to 0.91f'ci. From the comparison of the measured and predicted cracking loads of these test specimens, an increase of the allowable compressive stress to 0.65f'ci was justified. For the specimens subjected to release stresses exceeding 0.65f'ci, premature cracking in flexure was detected due to nonlinear deformation at release and associated microcracking. In addition, an initial camber database of information from 223 pretensioned girders was compiled. The data suggested that increasing 0.60f'ci did not affect the ability to accurately estimate initial camber. However, for a given section, higher cambers were detected as the compressive stress at release increased. Lastly, a simple technique for improving the initial camber estimates of conventional girders was presented as a feasibility study for future work.

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Item 6

Application of Storm Statistics to TxDOT Construction and Stormwater Management Maintenance

TEXAS TECH UNIVERSITY (TECHMRT)

TechMRT 4194-01-2 • 2007

The purpose of this report is to present a set of findings and examples for application of U.S.G.S Professional Paper 1725, "Statistical characteristics of storm interevent time, depth, and duration for Eastern New Mexico, Oklahoma, and Texas." The examples are intended to provide guidance for end users of the Professional Paper for application of project results to design activities associated with construction as well as stormwater best management practices.

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<http://www.techmrt.ttu.edu/Research/Reports/Complete%20Reports/5-4194-01-2.pdf>



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Item 7

Constructability Review of Surface Treatments Constructed on Base Courses - Final Report

TEXAS TECH UNIVERSITY (TECHMRT)

TechMRT 5169-2 • 2007

It is common practice for TxDOT to construct surface treatments (1-, 2- or 3- course) directly over base courses. Such surface treatments may act as either wearing surfaces or underseals (or interlayers). The decision to use surface treatments is based on a number of factors including low life-cycle cost, low initial construction cost, inexpensive maintenance, historically favorable experience, availability of experienced contractors, and availability of sound local materials. Problems associated with surface treatments include flushing/bleeding in the wearing courses, debonding at the interface with the base layer, poor ride quality, loss of aggregate (raveling) and ineffective sealing of the pavement. When a surface treatment is used as an underseal, its failure may lead to accelerated failure of the overlying surface layer. Constructability issues related to surface treatments often dictate their performance. However, a formal statewide constructability review of surface treatments over base has not been conducted either by TxDOT or by other state highway agencies in the recent past. The objective of this research project was to conduct a comprehensive constructability review of surface treatment as practiced by TxDOT districts and to identify best practices. A comprehensive survey of existing surface treatment practices was conducted, both by interviewing highway professionals and by visiting construction projects. Information collected from the constructability review was used to develop a district training workshop and to develop a design and construction guide for surface treatments. The workshop was delivered by researchers at eight regional locations. This report highlights the key findings from the constructability review and its related tasks.

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Item 8

Managed Lanes Handbook Training: Year 1 Report of Activities

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

TTI 4160-01-1 • 2007

This report summarizes the Year 1 activities under implementation project 5-4160-01, Managed Lanes Handbook Training. The overall objective of the project is to develop a 16-hour workshop covering The Managed Lanes Handbook, and teach the materials at seven locations across the state, including two pilot workshops. The Managed Lanes Handbook was developed for the Texas Department of Transportation (TxDOT) to help the staff make informed planning, design and operational decisions when considering managed lanes facilities for its jurisdiction. The handbook presents the critical research results obtained over the five years of the related research project, presented in a usable format, providing a clear, concise, and step-wise approach to planning, designing, operating, and enforcing a managed lanes facility. It also refers the user to other pertinent documents that provide additional detailed information on various aspects of managed lanes. The workshop is designed to facilitate statewide use of the handbook with TxDOT and partnering agency staff involved in managed lanes project development and design. Year 1 activities included workshop development, pilot course offerings, and updating of workshop material as appropriate.

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Item 9

Polymer Modified Asphalt Durability in Pavements

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

TTI 4688-1 • 2007

This project was designed to develop 1) a better quantitative understanding of the relation between laboratory accelerated binder aging and field aging, 2) a test procedure to measure properties of an aged binder that relate to failure on the road, and 3) a proposed specification for estimating the relative durability of binders in the presence of oxidative aging. Tests were conducted on original base and polymer modified binders, laboratory compacted mixtures, and pavement-aged binders. The project necessarily evolved to a more comprehensive approach to improving pavement service life.

Methods for significantly improving pavement durability should be implemented: 1) construct pavements with the lowest possible accessible (interconnected) air voids, consistent with other best construction and mix design practices; 2) use mix designs that have an inherently low decrease in fatigue life with binder oxidation, couple with an appropriately high initial fatigue life; 3) use binders with a minimum stiffness at the PAV* 16 hour condition (consistent with the appropriate performance grade); 4) use the pavement aging model for pavement design; 5) use binders that have inherently slow hardening rates kinetics; and 6) use modifiers that provide the most reduction in the hardening rate. Items 1 and 2 have a dramatic impact on pavement service life but require additional research for the most effective implementation: 1) determine the parameters that govern the decline of mixture fatigue life with binder hardening; 2) determine methods to reliably, and with minimal risk to other construction parameters, achieve very low accessible air voids in pavements.

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<http://tti.tamu.edu/documents/0-4688-1.pdf>

Item 10

Non-Vital Advance Rail Preemption of Signalized Intersections near Highway-Rail Grade Crossings: Technical Report

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

TTI 4746-3 • 2007

The Texas Department of Transportation (TxDOT) primarily uses simultaneous preemption of traffic signals near highway-rail grade crossings to clear queued vehicles prior to the arrival of a train at the crossing. At some intersections, 20 seconds of advanced warning may not be sufficient to allow the traffic signal to clear pedestrians using the normal clearance intervals between phases. The research developed an alternative method (non-vital advance preemption) of ensuring adequate pedestrian clearance in the presence of an approaching train without interfering with the normal preemption sequence at the intersection or installing costly additional track circuitry needed to provide advance preemption. Two strategies were investigated to ensure pedestrian clearance time. The first utilizes a lower-level preemption sequence to guarantee full pedestrian clearance to a terminating phase before the traffic signal starts the preemption sequence. The second strategy uses the pedestrian-omit feature to prevent the controller from activating the pedestrian interval if there is not sufficient time to advance of the start of the preemption sequence to provide full pedestrian clearance.

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Item 11

Guidelines for Dual-Advisory Speed Signing on Freeway-to-Freeway Connectors in Texas

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

TTI 4813-1 • 2007

This project recognizes the disparity in the relationship between truck and passenger car speeds and current advisory speed signing practices. The results of this project provide a mechanism that traffic engineers may use to provide enhanced differential warning to trucks and passenger vehicles at freeway connector ramps. Considering the strong evidence that there is a significant differential between speeds that cars and heavy trucks can comfortably and safely traverse freeway connector ramps, there was a need for further research to investigate current advisory speed signing practices and examine whether a dual-advisory speed signing scheme, one that provides different recommended advisory speeds for trucks and passenger vehicles, can safely address this differential. Based on the results of the analysis of average and 85th percentile speeds at the midpoint of each study curve, the dual-advisory warning signs generally had a positive impact on reducing speeds at the point of curvature on the curve and/or having an accompanying reduction in speed-related crashes at the study sites.

Full-text PDF of this report is available for free download from

<http://tti.tamu.edu/documents/0-4813-1.pdf>

Item 12

Wireline ITS Communications Training: Year 2 Report of Activities

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

TTI 4969-01-2 • 2007

This report summarizes Year 2 activities under Implementation Project 5-4969-01, “Wireless ITS Communications Training.” The overall objectives of the project were to modify the workshop offerings developed in a previous project to an eight-hour format, and teach the workshop materials at 10 locations across the state, including a pilot workshop. Year 2 activities included teaching the workshops and preparing the final deliverable for the Texas Department of Transportation (TxDOT).

Full-text PDF of this report is available for free download from

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Item 13

Type F Mix Design for Fort Worth

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

TTI 5123-01-1 • 2007

This report documents the Type F mix design for Pumphrey Drive, Westworth Village, Fort Worth.

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<http://tti.tamu.edu/documents/5-5123-01-1.pdf>



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Item 14

Horizontal Curve Signing Handbook

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

TTI 5439-P1 • 2007

Horizontal curves are a necessary component of the highway alignment; however, they tend to be associated with a disproportionate number of severe crashes. Warning signs are intended to improve curve safety by alerting the driver of a change in geometry that may not be apparent or expected. However, several research projects conducted in the last 20 years have consistently shown that drivers are not responding to curve warning signs nor complying with the Advisory Speed plaque.

The procedures described in this handbook are intended to improve consistency in curve signing and driver compliance with the advisory speed. The handbook describes guidelines for determining when an advisory speed is needed, criteria for identifying the appropriate advisory speed, an engineering study method for determining the advisory speed, and guidelines for selecting other curve-related traffic control devices.

The handbook is intended for use by traffic engineers and technicians that have been given the responsible charge of evaluating and maintaining horizontal curve signing and delineation devices. The procedures described in this handbook are applicable to rural highways. However, they may be useful for establishing advisory speeds for urban streets.

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<http://tcd.tamu.edu/Documents/0-5439-P1.pdf>

Item 15

The Role of Private-For-Hire Vehicles in Transit in Texas

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

TTI 5545-1 • 2007

This report updates prior national research to the private-for-hire vehicle (PHV) industry. The first section of the report provides an overview of the PHV industry in Texas and the perspectives of transit providers, both within Texas and nationally, on the use of these businesses in operating transit services. The second section of the report contains five Texas case studies where PHV companies are providing demand-responsive, circulator, fixed-route replacement, and medical transportation services in support of public transit operators. The final section of the report provides guidelines for the effective incorporation of contracted services using PHV companies, with a focus on addressing issues raised by public agencies as documented in the first section.

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