Updates from the States: Texas (April 2011)

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The Texas Department of Transportation (TxDOT) concrete pavement research program is a vital link to the success of providing safe, durable, and cost-effective pavement infrastructure to the citizens of Texas. To achieve this, TxDOT partners with universities, other state DOTs, and national centers through programs such as the Transportation Pooled Fund (TPF). Key research facilities include the Center for Transportation Research (CTR), Texas Transportation Institute (TTI), and The Center for Multidisciplinary Research in Transportation (TechMRT). To learn more about each of these organizations, follow the links below:

- TxDOT: http://www.txdot.gov/txdot_library/publications/research.htm
- TxDOT Current Research: ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/research_program_2011.pdf
- CTR: http://www.utexas.edu/research/ctr/index.html
- TTI: http://tti.tamu.edu/
- TechMRT: http://www.depts.ttu.edu/techmrtweb/
- TPF: http://www.pooledfund.org/

Figure 1 depicts Texas concrete pavement research projects that are currently ongoing, and recently completed, in addition to Transportation Pooled Fund participation. These projects are categorized according to the appropriate CP Road Map Track. Following Figure 1, titles for each of the projects are listed.

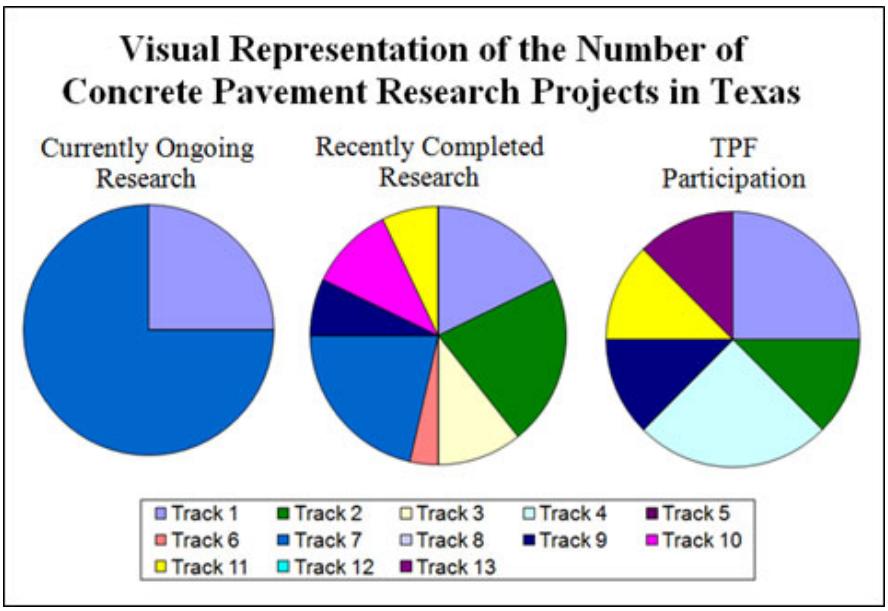

Figure 1. Concrete Pavement Research inTexas Categorized by CP Road Map Tracks

Transportation Pooled Fund (TPF) Studies

Current concrete pavement research work underway in Texas includes work done under various TPF projects. These projects, and how they align under the CP Road Map, include the following.

Track 1: Performance-Based Concrete Pavement Mix Design System

- TPF-5(066) Material and Construction Optimization for Prevention of Premature Pavement Distress in PCC Pavements
- TPF-5(205) Implementation of Concrete Pavement Mixture Design and Analysis (MDA) Track of Concrete Pavement Road Map

Track 2: Performance-Based Design Guide for New and Rehabilitated Concrete Pavements

- TPF-5(165) Development of Design Guide for Thin and Ultrathin Concrete Overlays of Existing Asphalt Pavements

Track 4: Optimized Surface Characteristics for Safe, Quiet, and Smooth Concrete Pavements

- TPF-5(139) PCC Surface Characteristics: Tire -Pavement Noise Program Part 3 - Innovative Solutions /Current Practices
- TPF-5(134) PCC Surface Characteristics - Rehabilitation (MnROAD Study) x

Track 9: Concrete Pavement Accelerated Testing and Long-Term Data Collection

- TPF-5(042) Long-Term Maintenance of Load and Resistance Factor Design Specifications

Track 11: Concrete Pavement Business Systems and Economics

- TPF-5(159) Technology Transfer Concrete Consortium

Track 13: Concrete Pavement Sustainability

- TPF-5(129) Recycled Unbound Pavement Materials (MnROAD Study)

Currently Ongoing Research

Currently ongoing research projects, and how they align under the CP Road Map, are listed here.

Track 1: Performance-Based Concrete Pavement Mix Design System

- Use of Manufactured Sands for Concrete Paving

Track 7: High-Speed Concrete Pavement Rehabilitation and Construction

- Improvements of Partial and Full-Depth Repair Practices for CRCP Distresses
- Material Selection for Concrete Overlays
- Continuously Reinforced Bonded Concrete Overlay of Distressed Jointed Concrete Pavements

Recently Completed Research

Recently completed projects (i.e., ones that have been completed since 2007) and how they align under the CP Road Map, are listed here.

Track 1: Performance-Based Concrete Pavement Mix Design System

- Fiber in Continuously Reinforced Concrete Pavements
- Best Practices for the Use of Siliceous River Gravel in Concrete Paving
- Effects of Supplementary Cementing Materials on the Setting Time and Early Strength of Concrete
- Performance of Continuously Reinforced Concrete Pavement Containing Recycled Concrete Aggregate

Track 2: Performance-Based Design Guide for New and Rehabilitated Concrete Pavements

- Best Design and Construction Practices for Concrete Pavement Transition Areas
- Development of the Thickness Design for Concrete Pavement Overlays Over Existing Asphalt Pavement Structures

- Development of Application Guide and Specifications for Geotextiles in Soil and Base
- Develop Mechanistic/Empirical Design for CRCP
- Alternatives to Asphalt Concrete Pavement Subbase for Concrete Pavement
- Subbase and Subgrade Performance Investigation for Concrete Pavement

Track 3: High-Speed Nondestructive Testing and Intelligent Construction Systems

- Pilot Implementation of Bump Detection Profilers for CRCP Construction
- Identification of Compliance Testing Method for Curing Effectiveness
- Laboratory and Field Evaluation of Concrete Paving Curing Effectiveness

Track 6: Innovative Concrete Pavement Joint Design, Materials, and Construction

- Use of Dowel Bars at Longitudinal Construction Joints

Track 7: High-Speed Concrete Pavement Rehabilitation and Construction

- Construction and Evaluation of Post-Tensioned Pre-stressed Concrete Pavement
- Concrete Pavement Overlays and Failure Mechanisms
- Debonding in Bonded Concrete Overlays Over Continuously Reinforced Concrete Pavements
- Rehabilitation Procedures for Longitudinal Cracks and Joint Separation in Concrete Pavement

Track 9: Concrete Pavement Accelerated and Long-Term Data Collection

- Mechanistic-Empirical Data Collection Approach for Rigid Pavements
- Analysis of Continuously Reinforced Concrete Pavement Behavior Using Information in the Rigid Pavement Database

Track 10: Concrete Pavement Performance

- Improving Portland Cement Concrete Pavement Performance
- Horizontal Cracking Mechanism in CRCP
- Develop Guidelines for Routine Maintenance of Concrete Pavement

Track 11: Concrete Pavement Business Systems and Economics

- Development of a Concrete Pavement Rehabilitation Training CD-ROM
- Considerations for Rigid vs. Flexible Pavement Designs When Allowed as Alternate Bids

Highlights

The following provides more detail on four of the recently completed research projects.

1. Subbase and Subgrade Performance Investigation for Concrete Pavement
2. Construction and Evaluation of Post-Tensioned Prestressed Concrete Pavement Effects of Supplementary Cementing Materials on the Setting Time and Early Strength of Concrete
3. Debonding in Bonded Concrete Overlays Over Continuously Reinforced Concrete Pavements
4. Effects of Supplementary Cementing Materials on the Setting Time and Early Strength of Concrete

Subbase and Subgrade Performance Investigation for Concrete Pavement

The report, *Subbase and Subgrade Performance Investigation for Concrete Pavement*, authored by Youn su Jung, Dan G. Zollinger, Moon Won, and Andrew J. Wimsatt, documents research efforts by the Texas Transportation Institute under sponsorship of TxDOT. This research seeks to identify alternative materials that can be used to construct a concrete pavement subbase layer that meets fundamental requirements such as resistance to erosion, uniform slab support, and drainability. Several highway sections were investigated using multiple techniques including Ground Penetrating Radar (GPR), Falling Weight Deflectometer (FWD), and visual surveys; the objective is to quantify historical performance. Ultimately, a

variety of alternative subbase types was classified according to their field performance and other functional factors. This report, which is currently being updated to reflect new findings, identifies innovative concrete pavement foundations that seek to provide a long service life. Therefore, it can be categorized under CP Road Map Track 8: Long-Life Concrete Pavements. To obtain further information, follow the links below:

Project Summary: ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/6037.pdf

Final Report: http://tti.tamu.edu/documents/0-6037-1.pdf

Construction and Evaluation of Post-Tensioned Prestressed Concrete Pavement

Recent research performed by Texas Tech University and sponsored by TxDOT concluded with the report titled, *Construction and Evaluation of Post-Tensioned Pre-stressed Concrete Pavement*. In this report, authors Moon Won and Seong-Cheol Choi document the construction of post-tensioned concrete pavement (PCP) on IH-35 in Hillsboro, TX. This PCP section consists of 9-inch slabs constructed on top of a 4-inch asphalt-stabilized subbase. This is a larger scale version of a 6-inch PCP built in 1985 that has performed very well, but was never the subject of an in-depth evaluation. The primary objectives of this project were to evaluate and document early-age behavior in the field, and also provide technical assistance to TxDOT and the contractor during the design and construction phases. Various gages, including in-situ coefficient of thermal expansion (CTE) sensors and linear variable differential transducers, were installed in a 300-ft long slab and used to analyze behavior of the PCP due to environmental loading, post-tensioning application, slab temperature variations, and creep and shrinkage effects. In addition, the data were used to calibrate PSCP 3.0, a mechanistic model developed for use as a PCP analysis program. Data will continue to be periodically downloaded, analyzed, and stored in the TxDOT rigid pavement database for years to come. This report, and the research it documents, is an example of work categorized under the CP Road Map Track 7: High-Speed Concrete Pavement Rehabilitation and Construction. For more details about this research, click on the links below.

Project Summary: ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/5-4035-01.pdf

Final Report: http://www.depts.ttu.edu/techmrtweb/Reports/Complete%20Reports/5-4035-01-2_final.pdf

Debonding in Bonded Concrete Overlays Over Continuously Reinforced Concrete Pavements

A recent report, *Debonding in Bonded Concrete Overlays Over Continuously Reinforced Concrete Pavements,* by the Center for Transportation Research (CTR) investigates debonding mechanisms and their effects on distresses in bonded concrete overlays (BCO). Authors Lucas Lahitou, Seong-Cheol Choi, and Moon Won discuss common types of failure and important design considerations, and current design practices that recognize the importance of bonding but do not address it directly. This research is primarily dedicated to the development of a computer program to mechanistically model debonding from the perspective of both reflective and top-down cracking. Sensitivity analyses were also carried out to evaluate the effects of factors known to have the greatest effect on debonding such as PCC properties, system dimensions and geometry, steel properties, and environmental conditions. Results show that debonding in the presence of non-reflective cracking is the most critical scenario. Furthermore, it is recommended that the existing models be used to develop a design tool that will assist practitioners in the proper selection of design variables and consider a larger number of factors. This work is an example of research that can be categorized under CP Road Map Track 8: Long-Life Concrete Pavements. It is also an example of mechanistic-based concrete pavement design and can therefore be categorized under CP Road Map Track 2: Performance-Based Design Guide for New and Rehabilitated Concrete Pavements. Additional information is accessible via the following links:

Project Summary: ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/4893.pdf

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

Effects of Supplementary Cementing Materials on the Setting Time and Early Strength of Concrete

In the recent research report, *Effects of Supplementary Cementing Materials on the Setting Time and Early Strength of Concrete*, authors Maria Juenger, Moon Won, David Fowler, Andre Edson, and Chul Suh of CTR examined the influence of supplementary cementing materials (SCM) on concrete pavement performance. The use of SCM have been shown to enhance concrete durability, provide protection against alkali-silica reaction (ASR), and occasionally prove more economical than cement, in addition to other benefits. However, SCM can also prove to be disadvantageous in the form of increased setting time and decreased early strength gain, especially in cold weather conditions. This report examines various concrete mixes that contain varying amounts of ground granulated blast furnace slag (GGBFS) and fly ash. Maturity testing, semi-adiabatic calorimetry, time of set, early strength, and plastic shrinkage tests were all conducted under realistic conditions. Ultimately, it was shown that slag had no significant effect on setting time while fly ash increased setting time to varying degrees depending on the source. In addition, fly ash decreased strength gains while slag had little effect on early compressive strength and actually increased strength at 3 to 7 days. This work is an example of CP Road Map Track 1: Performance-Based Concrete Pavement Mix Design System. The project summary and final report can be read in their entirety here:

Project Summary: ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/5550.pdf

Final Report: http://www.utexas.edu/research/ctr/pdf_reports/0_5550_1.pdf

About the CP Road Map E-News

The ***CP Road Map E-News*** is the newsletter of the Long-Term Plan for Concrete Pavement Research and Technology (CP Road Map), a national research plan developed and jointly implemented by the concrete pavement stakeholder community. To find out more about the CP Road Map, or to get involved, contact Dale Harrington, dharrington@snyder-associates.com, 515-964-2020.

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