Updates from the States: Oklahoma (Jan-Feb 2012)

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In the State of Oklahoma, concrete pavement research is coordinated through the Oklahoma Department of Transportation (ODOT) Research, Development and Technology Transfer (RDTT) Program. This program identifies research needs, arranges for the conduct of, and secures appropriate funding for research projects with specific objectives and prescribed timeframes. Research projects with well-defined objectives are selected by Department personnel with the aim of providing a coordinated and balanced effort among the various technical, socioeconomic, and environmental subject areas. Furthermore, research results are implemented through new specifications, standard plans, test methods, new or revised procedures, computer programs, manual changes, or policy and procedure directives.

Although the RDTT Program conducts work through in-house research, the majority of projects are conducted for the ODOT under contract by universities, other governmental agencies, or private organizations. Collaborative research also offers the Department the ability to further leverage State funds and includes partners such as the Transportation Research Board (TRB), Transportation Pooled Fund (TPF) Program, state highway agencies, and the Oklahoma Transportation Center (OkTC). The OkTC is a nationally-designated university transportation center (UTC) composed of researchers at the University of Oklahoma, Oklahoma State University, and Langston University. To learn more about each of these research facilities, follow the links below:

- Oklahoma DOT State Planning and Research Program: http://www.okladot.state.ok.us/hqdiv/p-r-div/spr-rip/index.htm
- Oklahoma DOT Planning & Research Library: http://www.okladot.state.ok.us/hqdiv/p-r-div/spr-rip/online.htm
- Oklahoma Transportation Center: http://www.oktc.org
- Oklahoma Transportation Center Final Reports: http://www.oktc.org/otc/View.aspx?Type=Content&Name=FinalReports
- Transportation Pooled Fund: http://www.pooledfund.org/

Highlights

The following sections highlight four recently completed concrete pavement research projects.

1. Quantifying the Costs and Benefits of Pavement Retexturing as a Pavement Preservation Tool
2. Air Void Characteristics of Oklahoma Concrete/AVA Sources of Error
3. Evaluation of Construction Strategies for PCC Pavement Rehabilitation Projects
4. Optimizing Concrete Mix Designs to Produce Cost Effective Paving Mixes

Quantifying the Costs and Benefits of Pavement Retexturing as a Pavement Preservation Tool

The 2010 report, *Quantifying the Costs and Benefits of Pavement Retexturing as a Pavement Preservation Tool*, documents a comparative evaluation of various methods used to restore pavement skid resistance by

retexturing the existing pavement. This study builds upon research done in Australia and New Zealand and has assembled surface characteristic data for select surface treatments, chemical treatments, and mechanical processes. A series of asphalt and concrete pavement test sections, each one-quarter mile long and one lane wide, were constructed on existing pavement sections on State Highway 77H between Norman and Oklahoma City, OK. Each test section has been retextured with a unique pavement preservation process, including shotblasting and "Next Generation" diamond grinding, and subjected to surface friction and macrotexture measurements on a monthly basis. In addition, the researchers have conducted an economic analysis to determine the costs and benefits of each treatment. The principal objective of this project is to develop a pavement surface texture maintenance guide that will serve as a surface retexturing "toolbox" used by pavement managers to select the best treatment method based on technical data and life cycle cost analyses. Overall, this study has clearly demonstrated the value of long-term pavement preservation field research and will effectively enable agencies to "put the right treatment, on the right road, at the right time." For more information about this research and to obtain a copy of the final report, please follow the link below:

http://www.oktc.org/otc/files/finalReports/OTCREOS7.1-16-F.pdf

This research can be categorized under CP Road Map Track 7: Concrete Pavement Maintenance and Preservation.

Air Void Characteristics of Oklahoma Concrete/AVA Sources of Error

In the 2008 report, *Air Void Characteristics of Oklahoma Concrete/AVA Sources of Error*, the air void characteristics of standard air-entrained concrete mixes currently used in Oklahoma were quantified using a device known as the Air Void Analyzer (AVA). This device uses a small mortar sample (20 mL) extracted from the surface of fresh concrete, which is injected into an assembly containing glycerol and water. The air bubbles released during the injection process are analyzed and used to determine the total air content, spacing factor (SF), and specific surface. Over 300 specimens representing a cross-section of approved air-entrained concrete mixes used throughout Oklahoma were sampled and tested. Test results indicated that the majority of samples did not meet the minimum recommended SF and may experience durability issues in the future. However, the researchers discovered multiple sources of error inherent to the AVA test procedure and equipment after completing a thorough evaluation, including a round robin study that involved 19 AVA machines simultaneously sampling and testing identical batches of concrete. It was found that the most common sources of error related to inaccurate temperature measurement, volume of glycerol, and specimen size. Fortunately, this investigation has proved invaluable to gaining a better understanding of the AVA test procedures and equipment, and as a result, multiple recommendations have been made to further improve its accuracy and reliability. To read more about this research, click on the following link:

http://www.okladot.state.ok.us/hqdiv/p-r-div/spr-rip/library/reports/airvoid-avasource.pdf

This research is helping to fill knowledge gaps outlined in CP Road Map Track 1: Materials and Mixes for Concrete Pavements.

Evaluation of Construction Strategies for PCC Pavement Rehabilitation Projects

A study designed to develop improved construction planning and staging methods to implement on future portland cement concrete pavement (PCCP) projects is documented in the 2010 report, *Evaluation of Construction Strategies for PCC Pavement Rehabilitation Projects*. This research, which is a joint effort between Oklahoma State University and the Georgia Institute of Technology, investigated project management solutions to optimize resources, reduce construction time, and minimize costs. To achieve these objectives, an extensive evaluation of the Construction Analysis for Pavement Rehabilitation Strategies (C4PRS) software program was carried out. The overall usability of this software was assessed by conducting knowledge inventory surveys. In addition, four major highway rehabilitation projects were carried out to evaluate the applicability of C4PRS to current staging and planning procedures. The analysis

results proved the C4PRS software to be an excellent tool, but many areas for improvement were identified. Major recommendations include the development of a database specific to Oklahoma that is entirely dedicated to C4PRS input data, use of a simulation program to determine the optimal number of resources, and utilization of the Critical Path Method (CPM) in addition to the C4PRS software. To read more about this research, click on the link below.

http://www.oktc.org/otc/files/finalReports/OTCREOS7.1-23-F.pdf

This project falls within CP Road Map Track 8: Concrete Pavement Construction, Reconstruction, and Overlays.

Optimizing Concrete Mix Designs to Produce Cost Effective Paving Mixes

A study was undertaken by University of Oklahoma researchers to determine the effect of mechanically activated fly ash on concrete properties as documented in the 2009 report, *Optimizing Concrete Mix Designs to Produce Cost Effective Paving Mixes*. This research subjected six different types of fly ash currently used in Oklahoma to extensive laboratory testing. The testing program was implemented to address five main areas of interest: strength variation of concrete due to fly ash replacement levels, effect of fly ash grinding (and grinding duration) on concrete strength, effect of mixture properties such as w/cm ratio on fly ash mixtures, concrete performance due to different sources of fly ash, and material properties for the most promising materials. Compared to mixtures constructed with unground fly ash, key findings include grinding of fly ash reduces slump without affecting workability, a higher fly ash content can be used for a given compressive strength, and ground fly ash will generally increase the early and ultimate strength of concrete. However, each type of fly ash has a unique response to grinding and shall be subjected to extensive testing in order to effectively predict future concrete performance. The final report can be obtained at the link below.

http://www.okladot.state.ok.us/hqdiv/p-r-div/spr-rip/library/reports/fhwa-ok0811.pdf

This project is meeting research needs identified in CP Road Map Track 1: Materials and Mixes for Concrete Pavements.

CP Road Map Track Status

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

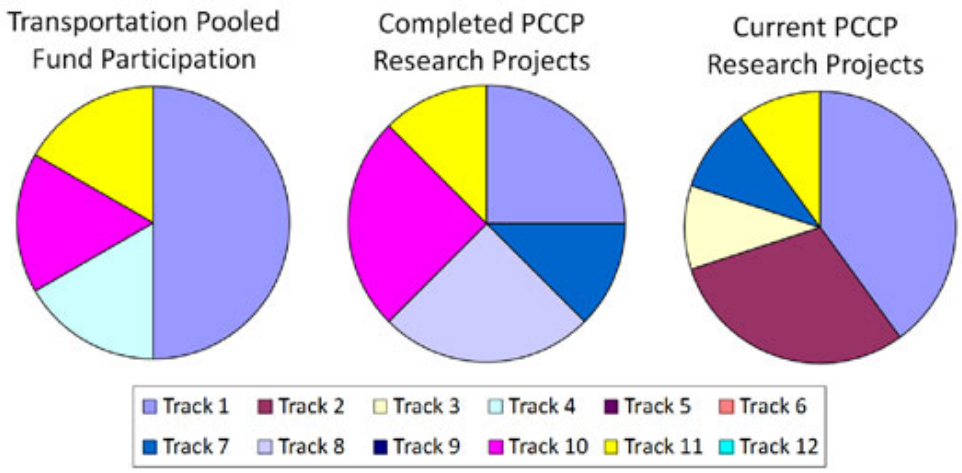

Figure 1. Concrete Pavement Research in Oklahoma Categorized by CP Road Map Track

Transportation Pooled Fund (TPF) Studies

Concrete pavement research work in Oklahoma includes work done under various TPF projects. These projects, and how they align under the CP Road Map, include the following.

Track 1: Materials and Mixes for Concrete Pavements

- TPF-5(066) Material and Construction Optimization for Prevention of Premature Pavement Distress in PCC Pavements
- TPF-5(117) Development of Performance Properties of Ternary Mixes
- TPF-5(205) Implementation of Concrete Pavement Mixture Design and Analysis (MDA) Track of Concrete Pavement Road Map

Track 10: Concrete Pavement Foundations and Drainage
TPF-5(229) Characterization of Drainage Layer Properties for MEPDG

Track 11: Concrete Pavement Economics and Business Management
TPF-5(159) Technology Transfer Concrete Consortium

Currently Ongoing Research

Concrete pavement research projects that are currently ongoing, and how they align under the CP Road Map, are listed here.

Track 1: Materials and Mixes for Concrete Pavements

- Stability of Concrete Slabs on Grade Considering Shrinkage and a Moisture Gradient
- Suppression of ASR through Aggregate Coatings
- Innovative Prediction of Fly Ash Performance in Concrete
- Investigation of Optimized Graded Concrete for Oklahoma

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

- Development and Implementation of a Mechanistic and Empirical Pavement Design Guide (MEPDG) for Rigid Pavements
- Investigation of the Inputs for the MEPDG for Rigid Pavements
- Effect of Y-Cracking on CRCP Performance

Track 3: Intelligent Construction Systems and Quality Assurance for Concrete Pavements
Laser Characterization of Fine Aggregate Properties

Track 7: Concrete Pavement Maintenance and Preservation
Quantifying the Costs and Benefits of Pavement Retexturing as a Pavement Preservation Tool: Phase 2

Track 11: Concrete Pavement Economics and Business Management
Alternate Bidding Strategies for Asphalt and Concrete Pavement Projects Utilizing Life Cycle Cost Analysis (LCC)

Recently Completed Research

Concrete pavement research projects completed since 2007 are listed below, in addition to how they align under the CP Road Map.

Track 1: Materials and Mixes for Concrete Pavements

- Air Void Characteristics of Oklahoma Concrete/AVA Sources of Error
- Optimizing Concrete Mix Designs to Produce Cost Effective Paving Mixes

Track 7: Concrete Pavement Maintenance and Preservation
Quantifying the Costs and Benefits of Pavement Retexturing as a Pavement Preservation Tool

Track 8: Concrete Pavement Construction, Reconstruction, and Overlays

- Evaluation of Construction Strategies for PCC Pavement Rehabilitation Projects
- Performance of Ultra-Thin Whitetopping (UTW) in Oklahoma

Track 10: Concrete Pavement Foundations and Drainage

- Evaluation and Field Verification of Strength and Structural Improvement of Chemically Stabilized Subgrade Soil
- Engineering Properties of Stabilized Subgrade Soils for Implementation of the AASHTO 2002 Pavement Design Guide

Track 11: Concrete Pavement Economics and Business Management
Evaluating Percent Within Limits (PWL) Specifications - Volume 2: Portland Cement Concrete Pavements

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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