



Updates from the States: Minnesota (September 2010)

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Minnesota highway research is conducted by Minnesota Department of Transportation (Mn/DOT) Materials and Road Research division. In order to achieve their research goals, Mn/DOT often collaborates with organizations including the Local Road Research Board (LRRB), Transportation Engineering and Road Research Alliance (TERRA), the University of Minnesota Center for Transportation Center (CTS), the Institute for Transportation (InTrans) at Iowa State University and the National Concrete Pavement Technology Center (CP Tech Center). Mn/DOT participates in various national research programs including the Long-Term Pavement Performance Program (LTPP), Transportation Research Board (TRB), and Transportation Pooled Fund (TPF) programs. Links to more information on each of these organizations are provided below.

- Mn/DOT Materials and Road Research (<http://www.dot.state.mn.us/materials/research.html>)
- Local Road Research Board (LRRB) (<http://www.lrrb.org/>)
- Transportation Engineering and Road Research Alliance (TERRA) (<http://www.terraroadalliance.org/>)
- University of Minnesota Center for Transportation Studies (CTS) (<http://www.cts.umn.edu/>)
- Institute for Transportation (InTrans) (<http://www.intrans.iastate.edu/>)
- Long Term Pavement Performance Program (LTPP) (<http://www.fhwa.dot.gov/pavement/ltppl/>)
- Transportation Research Board (TRB)
(<http://www.trb.org>)

Minnesota highway research efforts focus on four main topics: MnROAD, pavement surface characteristics, intelligent compaction, and ground penetrating radar (GPR). Concrete pavement projects for each of these topics can be categorized under the CP Road Map. In July 2010, the CP Tech Center met with Mn/DOT representatives to begin discussions on collaborative research regarding elements of the CP Road Map. The following paragraphs list current Minnesota research projects, including pooled fund efforts, and identifies reports published within the past few years. How each of the research activities and publications align with the CP Road Map is identified.

Current MnROAD Research

MnROAD is a test track constructed for evaluating pavement materials, design, and construction. Both existing and new technologies are evaluated at MnROAD in an effort to identify the most durable, cost effective, and best performing alternatives. Current MnROAD research is in Phase II and includes the following projects:

- Track 1: Performance-Based Concrete Pavement Mix Design System
 - Use of Taconite Aggregates in Pavement Applications
- Track 4: Optimized Surface Characteristics for Safe, Quiet, and Smooth Concrete Pavements
 - PCC Surface Characteristics (Rehabilitation) (this is a pooled fund project: TPF-5(134))
 - PCC Surface Characteristics (Construction) MPR 6-021
- Track 6: Innovative Concrete Pavement Joint Design, Materials, and Construction
 - Performance of flat plate dowel bars in highway pavements

- Use of joint stabilizers to restore joint load transfer efficiency
- Track 7: High-Speed Concrete Pavement Rehabilitation and Construction
 - Development of Design Guide for Thin and Ultrathin Concrete Overlays of Existing Asphalt Pavements (this is a pooled fund project TPF-5(165))
 - Performance of Thin Unbonded Concrete Overlays on High Volume Roads
- Track 8: Long-Life Concrete Pavements
 - 60 Year Design Concrete Pavement – Performance Model Development
- Track 9: Concrete Pavement Accelerated and Long-Term Data Collection
 - Ongoing data collection of all aspects of performance of various concrete pavement test sections at MnROAD
- Track 10: Concrete Pavement Performance
 - Concrete Pavement Optimization – Determining the Lower Threshold of Slab Thickness for High Volume Roads
- Track 13: Concrete Pavement Sustainability
 - Pervious Concrete Mix Design for Wearing Course Applications
 - Pervious Concrete Pavement Study financed by Local Roads Research Board
 - CP Tech Center / Mn/DOT Construction and Study of Porous Overlay
 - SHRP 2 Cells 2-lift Construction. Recycled aggregate in lower lift, high SCM in the upper lift .

For more information on MnROAD and the MnROAD projects, follow these links:

www.dot.state.mn.us/mnroad/index.html

www.dot.state.mn.us/mnroad/projects/

Transportation Pooled Fund (TPF) Studies

Mn/DOT is involved in several TPF projects. A list of various concrete related TPF projects Mn/DOT is involved with follows. The list does not include projects already mentioned. The TPF projects are categorized according to the CP Road Map Track for which the research efforts align.

- Track 1
 - TPF-5(159) Technology Transfer Concrete Consortium www.pooledfund.org/projectdetails.asp?id=390&status=4 (this work can also be aligned under Track 11: Concrete Pavement Business Systems and Economics)
 - TPF-5(179) Evaluation of Test Methods for Permeability (Transport) and Development of Performance Guidelines for Durability www.pooledfund.org/projectdetails.asp?id=406&status=4
- Track 4
 - TPF (139) PCC Surface Characteristics: Tire -Pavement Noise Program Part 3 - Innovative Solutions /Current Practices www.pooledfund.org/projectdetails.asp?id=368&status=4
- Track 6
 - TPF-5(224) Investigation of Jointed Plain Concrete Pavement Deterioration at Joints and the Potential Contribution of Deicing Chemicals
www.pooledfund.org/projectdetails.asp?id=452&status=4

Publications

Minnesota highway research publications within the last few years include the *2008 MnROAD Phase II Construction Report* completed in June 2009. This report falls under multiple CP Road Map Tracks and is discussed further as a highlight. Other publications and how they align with the CP Road Map include:

- Track 2: Performance-Based Design Guide for New and Rehabilitated Concrete Pavements
 - Putting Research into Practice: Calibrating the MEPDG for Minnesota (June 2009)
 - Implementation of the MEPDG for New and Rehabilitated Pavement Structures for Design of Concrete and Asphalt Pavements in Minnesota (January 2009)
- Track 3: High-Speed Nondestructive Testing and Intelligent Construction Systems
 - Demonstration of Concrete Maturity Test Process on the TH-694/TH-35E Interchange – Unweave the Weave (August 2009)
- Track 4: Optimized Surface Characteristics for Safe, Quiet, and Smooth Concrete Pavements
 - Mn/DOT Combined Smoothness specification (April 2010)
 - Putting Research into Practice: Establishing a Combined Smoothness Specification for Minnesota Pavements (June 2009)
 - Report of Diamond Grinding on Cells 7 and 8 MnROAD Mainline Interstate Highway 1-94, Draft final Report (November 2007)
 - Implementing the International Roughness Index for Concrete Pavement Evaluation (April 2007)
- Track 6: Innovative Concrete Pavement Joint Design, Materials, and Construction
 - Investigation of Joint Deterioration in MnROAD Phase 1 Jointed Concrete Pavement Test Sections (April 2010)
- Track 13: Concrete Pavement Sustainability
 - MnROAD Cell 64 Pervious Concrete: Third Year Performance Report (June 2009)

[Click here for a complete list of Mn/DOT publications.](#)

Highlights

The following highlights specific research project reports by providing additional details and direct links for more information. The projects highlighted include:

1. *Effect of Concrete Materials on Permeability of Concrete Mixes Used in Mn/DOT Paving Projects* by Ryan Rohne
2. *Demonstration of Maturity Test Process on the TH-694/TH-35E Interchange – Unweave the Weave* by Ryan Rohne and Bernard I. Izevbekhai
3. *2008 MnROAD Phase II Construction Report* by Ann Johnson, Timothy Clyne, and Benjamin Worel
4. *Implementation of the MEPDG for New and Rehabilitated Pavement Structures for Design of Concrete and Asphalt* by Raul Velasquez, Kyle Hoegh, Iliya Yut, Nova Funk, George Cochran, Mihai Marasteanu, and Lev Khazanovich
5. *Sixty-Year Design Concrete Pavement-Performance Model Development: MnROAD Cell 53 Construction Report* by Ryan Rohne
6. *Evaluation of Concrete Pavement Texturing Practices in Minnesota Using the Wet Weather Accident Evaluation Criterion* by Bernard Izevbekhai and Mark Watson
7. *Investigation of Joint Deterioration in MnROAD Phase 1 Jointed Concrete Pavement Test Sections* by Ryan Rohne and Tom Burnham

In December 2009, the final report [Effect of Concrete Materials on Permeability of Concrete Mixes Used in Mn/DOT Paving Projects](#) was completed under TPF-5(179) Evaluation of Test Methods for Permeability (Transport) and Development of Performance Guidelines for Durability. The purpose of TPF-5(179) is to relate pavement performance to permeability. This report documents the evaluation of permeability and pavement performance of 230 Minnesota-specific mixture designs. Results determined by statistical analysis suggest the use of granite aggregate and a 7-18 gradation both decrease permeability. This research work is an example of an effort to develop and deliver tools and techniques for specifying and proportioning concrete mixtures. Therefore, it is an example of work under [CP Road Map Track 1:](#)

[Performance-Based Concrete Pavement Mix Design Systems.](#)

Completed in August 2009, [Demonstration of Maturity Test Process on the TH-694/TH-35E Interchange – Unweave the Weave](#) documents the use of maturity meters in the TH-694/TH-35E Interchange project. While Mn/DOT aims to utilize maturity for specific concrete applications, the use of maturity meters in this project is the first attempt to evaluate their usefulness in field applications. If successful, the use of maturity meters will allow contractors the ability to more accurately predict when a pavement can be opened to traffic. This research implementation project is an example of high-speed nondestructive testing that can provide rapid feedback, and as such is an example of [CP Road Map Track 3: High-Speed Nondestructive Testing and Intelligent Construction Systems.](#)

The [2008 MnROAD Phase II Construction Report](#) was completed in June 2009. This publication reports on the 2007 to 2008 construction process of MnROAD Phase II test sections. Phase II, lead by a partnership between MnROAD and TERRA, includes a number of research projects. These projects are listed above under Current MnROAD Research. Several practical lessons were learned during the construction of the test sections. These lessons, identified in detail under the summary section of this report, include scheduling and communication conflicts; design and constructability issues; and identifying and addressing a learning curve for new techniques. This report documents efforts on such a variety of projects that it can be categorized under several CP Road Map Tracks including 1, 4, 7, 8, 10, and 13.

[Implementation of the MEPDG for New and Rehabilitated Pavement Structures for Design of Concrete and Asphalt](#) is a report completed in January 2009 by the University of Minnesota for Mn/DOT. The report documents research efforts supported by Mn/DOT and LRRB for calibrating design inputs and sensitivity analysis to represent Minnesota conditions. This research work is an example of improving the integration of mechanistic approaches with local materials, construction, and environmental conditions, and is therefore, an example of work under [CP Road Map Track 2: Performance-Based Design Guide for New and Rehabilitated Concrete Pavements.](#)

In September 2009, the report [Sixty-Year Design Concrete Pavement-Performance Model Development: MnROAD Cell 53 Construction Report](#) was completed for Minnesota Department of Transportation (Mn/DOT). The primary objective of this research study is to develop an improved service life prediction model for Mn/DOT's current 60-year concrete pavement designs. Secondary objectives include understanding the behavior of these pavements with regard to maturity, slab warp and curl, and thermal expansion. These objectives will be accomplished through extensive testing of materials during construction, and conducting seasonal load response testing under controlled loads of an instrumented concrete pavement test cell (Cell 53) built to Mn/DOT's current 60-year design standards. Load response testing of traditional designs constructed in MnROAD Phase I will be used in the development of the improved life prediction model. This construction report describes the construction and material testing done on MnROAD Low Volume Road test Cell 53. A summary of U.S. and international long-life concrete pavement designs is also included. This work is an example of [CP Road Map Track 8: Long-Life Concrete Pavements.](#)

The report [Evaluation of Concrete Pavement Texturing Practices in Minnesota Using the Wet Weather Accident Evaluation Criterion](#) was completed in June 2008. Concrete Pavements built in Minnesota are currently textured by dragging inverted artificial turf or a broom in the longitudinal direction. This process imparts a macrotexture, which is required to have a mean texture depth of greater than 1mm measured by the Volumetric or "sand patch" test (ASTM E 965-95). At present, this texture guideline is communicated through a special provision in pavement construction. Newly textured pavements are usually evaluated for adequacy in providing a safe riding surface through texture measurements for acceptance and friction measurements as required. The current FHWA Technical Advisory on Texture requires that performance of non-conventional textures be monitored and reported. This report identifies pavement sites in the network where the original texture, mainly the transverse tining plus burlap, was either overlaid or rebuilt and the new surface finished with longitudinal inverted turf drag, or broom drag. It extracts wet weather accident data from the Mn/DOT Office of Traffic, Safety and Operations (OTSO) database and analyzes the annual wet weather accident and crash rates, pre-construction, during construction and after construction. It

performs a descriptive statistics of the period before and the period of the new texturing to determine if, wet weather accident counts, percentage of wet weather accidents in total count and crash rates and /or ratio of annual wet to dry accident counts, and crashes clearly increased with current texturing practices. Data were analyzed with statistical tools for data comparison including the descriptive statistics, U-test & and before and after comparison (Z-test). The analyses of the data for the sections show that current texturing practices did not cause an increase in the annual wet weather accidents, crash rates, or ratio of wet to dry weather accidents. This work is an example of [CP Road Map Track 4: Optimized Surface Characteristics for Safe, Quiet, and Smooth Concrete Pavements](#).

The report [Investigation of Joint Deterioration in MnROAD Phase 1 Jointed Concrete Pavement Test Sections](#) was completed in April 2010. After 13 years of live traffic, the original concrete pavement test sections on the interstate portion of the MnROAD facility still exhibited very good performance. Prior to removal in 2008, a comprehensive forensic investigation was conducted on each test section. This investigation focused principally on joint performance, as little panel cracking had occurred. The most interesting observation was a unique distress phenomenon in the transverse joints. To determine whether this distress was unique to MnROAD test sections, six other Minnesota concrete pavement projects, of similar age and materials, were examined. While distresses were not as severe, in all cases the sections with base layers that adequately drained water within the joints performed significantly better. Joint sealing was found to have a significant effect on joint performance in low volume sections. This is an example of work under [CP Road Map Track 6: Innovative Concrete Pavement Joint Design, Materials, and Construction](#).

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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