



Updates from the States: Michigan (March 2014)

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Concrete pavement research and technology development in Michigan is a joint effort of the Michigan Department of Transportation (MDOT), the Michigan Concrete Association (MCA), research consultants, and numerous universities through Michigan's Research Centers of Excellence (COE).

The Michigan DOT established eight Research Centers of Excellence in partnership with five Michigan universities. These universities include Lawrence Technological University, Michigan State University, Michigan Technological University, the University of Michigan, and Western Michigan University. The centers provide applied research, expertise, and facilities that complement MDOT resources in the areas of materials, pavements, structures, and geotechnics. These centers also provide education and outreach activities that respond to the practical needs of MDOT staff, prepare future leaders in transportation, and promote innovative practices around the state.

Additional information about Michigan's various Centers of Excellence, including contact information for Center directors, can be found [here](#).

Ongoing Research

The Michigan DOT, like most other states, is working to find low cost and durable materials and processes to address the ever growing need of maintaining an aging infrastructure with minimal traffic interruptions.

The DOT has been researching Rapid Set concrete pavement repairs through the University of Michigan (U of M) COE for the last 18 months, with promising results. The initial research by Dr. Will Hansen has led the DOT to look into utilization of lightweight fine aggregates for internal curing, supplemental replacement with slag cement, and reduced total cementitious contents in Rapid Set repairs. MDOT is also working with the U of M COE on penetrating sealants to address freeze/thaw deicer scaling at the joints.

Additional information regarding ongoing research in Michigan's Centers of Excellence can be found [here](#).

Recently Completed Research

Below are summaries of research projects recently completed in Michigan.

Impact of cement paste and entrained air on concrete durability

Most of the research used to establish air content requirements for concrete pavements was conducted prior to 1970. Since that time, significant changes, such as the use of supplemental cementitious materials and modern admixtures, have changed the characteristics of the hydrated cement paste. This project examined whether traditional criteria for air-void systems still apply to modern concrete mixes.

The research showed that the use of SCMs leads to a cement paste that can potentially have a higher tensile strength and lower permeability. The research indicated that traditional specifications for air content should provide a conservative estimate for pavement performance. Therefore, current mixtures utilizing SCMs and modern admixtures, produced with a conventional level of total air content (e.g. 6.5% \pm 1.5%), should be freeze-thaw durable as expected. However, the research also found that these same mixes produced with lower air contents can also be durable.

The project, "Impact of Hydrated Cement Paste Quality and Entrained Air-Void System on the Durability of Concrete," was completed through the Michigan Tech Transportation Institute by Karl Peterson and Lawrence Sutter. The project was sponsored by the Michigan Department of Transportation. [Click here to view the complete study.](#)

This work is categorized under CP Road Map [Track 1: Materials and Mixes for Concrete Pavements.](#)

Performance of JPCP Overlays

Michigan has been constructing jointed plain concrete pavement (JPCP) overlays since the mid-1990s and has generally had good results. However, some recent overlays showed signs of premature distress, including longitudinal cracking after the first year. Eight overlay segments with varying levels of performance (good to bad) were investigated to try and determine the cause of this distress and what actions can be taken to prevent these types of early failures.

The investigation identified a number of construction factors that resulted in poor drainage along the deteriorated segments. These factors included the following:

1. Omission of trench drains along the outside edge of the pavement.
2. Leaving the dense-graded HMA shoulder in place, thus trapping water in the open graded interlayer.
3. Constructing outside shoulder slightly higher than the outside lane, trapping water on the pavement.
4. Leaving the outside lane-shoulder joint unsealed.

These actions combined to trap water in the asphalt interlayer, which resulted in pumping erosion and loss of joint support.

These findings are being used to modify Michigan's specifications and construction practices to prevent future occurrences of premature deterioration caused by pumping.

The "Improved Performance of JPCP Overlays" project was completed at the University of Michigan by Will Hansen and Zhichao Liu. The project was sponsored by the Michigan Department of Transportation. [Click here to view the complete report.](#)

This work is categorized under CP Road MAP [Track 8: Concrete Pavement Construction, Reconstruction, and Overlays.](#)

Detecting slippery roads from existing vehicle and driver data

The objective of this study was to identify a low-cost method of collecting data from multiple vehicles that could be used to identify slippery road conditions. In time, it is hoped that an effective slippery road detection system would be able to identify where roads get slippery first, report the conditions to local maintenance staff, and warn drivers approaching the slippery area. This study is part of an ongoing research initiative to identify how state DOTs can benefit from future connected vehicle systems.

The project involved the installation of sensors in Michigan DOT fleet vehicles that monitored properties such as brake lockup, throttle position, vehicle speed, and surface temperature. Data from these vehicles was collected and transmitted via a smart phone application to a centralized server for analysis. Researchers were also able to utilize the smart phone's on-board accelerometer to get a relative reading of road roughness.

The project concluded that while development of a slippery roads detection system is feasible, in order to be useful, the system would need to be employed on significantly more vehicles in order to provide a real time snapshot of road conditions over a wide area.

This research, entitled "Slippery Road Detection and Evaluation", was completed at the University of Michigan by Ralph Robinson and was sponsored by the Michigan Department of Transportation. [Click here to view the complete report.](#)

This work is categorized under CP Road MAP [Track 4: Optimized Surface Characteristics for Safe, Quiet, and Smooth Concrete Pavements.](#)

Cost effectiveness of preventative maintenance programs

Michigan DOT utilizes a variety of different strategies for preventative maintenance on their pavements. In 1992, Michigan established its Capital Preventative Maintenance (CPM) program. The primary intent of this program is to extend the service life of pavements and postpone major rehabilitation and reconstruction activities by protecting the existing pavement surfaces, slowing deterioration, and correcting surface deficiencies. The CPM approach has been highly successful, and the program budget has grown from \$6 million in 1992 to current levels of between \$80 and \$100 million per year.

The focus of this study was to determine whether Michigan's CPM program was also a financial success. This was accomplished by evaluating the cost of preventative maintenance and the associated increase in pavement life versus a "wait and rehabilitate" approach to determine a benefit-cost ratio. The study outcome showed that the preservation strategy results in agency cost savings of approximately 25 percent per lane mile over the rehabilitation approach.

The "Cost Effectiveness of the MDOT Preventive Maintenance Program" project was completed by Applied Pavement Technology, Inc. by Prashant Ram and David Peshkin, P.E. The project was sponsored by the Michigan Department of Transportation. [Click here to view the complete report.](#)

This work is categorized under CP Road MAP [Track 7: Concrete Pavement Maintenance and Preservation.](#)

Twenty year performance review of European concrete pavement

In 1993, a special demonstration project was constructed in Detroit on NB I-75 to present some highly acclaimed features of European rigid pavements. The European approach to pavement design and construction emphasizes a long service life by using quality materials and stringent construction practices with little regard for the initial cost increase from those practices.

Michigan's "Euro-pavement" consisted of a 16-inch thick crushed limestone (well graded) subbase over a compacted subgrade. A six-inch, non-reinforced, lean concrete base was constructed over the aggregate subbase. The ten-inch thick surface pavement consists of two-layers (placed wet on wet) using different concrete mixes. The bottom layer was 7 ½ inches thick and utilized the same limestone aggregate as the lean concrete base, while the top layer was 2 ½ inches thick and utilized crushed basalt stone for the coarse aggregate. After paving, the surface of the concrete was sprayed with a retarder and covered with plastic. The next day, the surface was brushed to expose the coarse aggregate. Contraction joints were installed at a 15-foot spacing along with 20-inch long by 1 ¼ inch polyethylene coated dowel bars. The pavement was jointed at 15-feet.

As a control section, MDOT constructed a conventional pavement on the same roadway just south of the Euro-pavement. The control section included a 4-inch open-graded base with an 11-inch JRCP with 1 ¼" dowels.

To date, there is no clear indication as to which pavement section will eventually achieve the most cost effective service life. After 20 years, both pavements still have a low distress index and similar ride quality. The Euro-pavement section is showing some signs of delamination and intermittent longitudinal cracking, but a distinct performance trend has not developed for either pavement. Considering its substantially higher initial cost, the future preservation cost of the Euro-pavement will need to be much lower than the control section to be cost equivalent over its service life.

The "Twenty Year Performance Review of Michigan's European Concrete Pavement" report was completed by John Staton, P.E., for the Michigan Department of Transportation. [Click here to view the complete report.](#)

This work is categorized under CP Road MAP [Track 9: Evaluation, Monitoring, and Strategies for Long Life Concrete Pavement.](#)

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 [Steve Klocke](#), 515-964-2020.

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