Educating the Public to Navigate Roundabouts (2011)

**Project Manager:** Kim Lariviere, Traffic & Safety, Bureau of Development  

MDOT initiated this study to better understand roundabout driver behavior and develop effective educational countermeasures to improve safety and efficiency. Researchers at Wayne State University examined roundabout crash data and survey results from almost 12,000 users to identify key factors associated with roundabout crashes, including excessive speed, difficulty in understanding which driver should yield at entry and exit points, confusion about lane selection and lane changes, and failure to recognize pedestrians and bicyclists. Based on these findings, the research team developed a comprehensive public education campaign to counteract the crash factors, including animated videos, presentations and brochures.

**BENEFITS:** This project’s carefully designed public education campaign will help improve road user satisfaction and safety while reducing crashes at new roundabout installations. Through continued outreach by MDOT and local transportation agencies, Michigan residents will gain a better understanding of roundabouts as a safe and effective alternative to traditional intersections.

Improving Performance of Unbonded Concrete Overlays (2012)

**Project Manager:** Ben Krom, Construction Field Services, Bureau of Field Services

This comprehensive forensic study by the University of Michigan was commissioned by MDOT to determine the causes of poor performance of some of Michigan’s unbonded concrete overlays. Identified areas of concern included longitudinal cracking originating at the transverse joint and scaling at cracks and joints. The study confirmed that the cause of both distress types was trapped surface water in the pavement structure. The trapped water induced these distresses through freeze-thaw effects and scaling due to high salt content. The study also confirmed that the overall performance of unbonded concrete overlays in Michigan has been good, and that the recent use of a standard open-graded asphalt interlayer between the old and new concrete is having significant beneficial effects by contributing to positive drainage of surface water entering the pavement through joints and cracks.

**BENEFITS:** Results of the study and field forensic investigations indicate that if proper consideration is given to ensuring that the interlayer and its accompanying drainage systems are properly constructed and functioning as intended, the likelihood of premature distress will be greatly reduced. Findings from this study will enable MDOT to extend the anticipated service life of unbonded concrete overlays.
Improving Pavements with Stabilized Base Designs (2009)

Project Managers: John Staton and David Smiley (retired), Construction Field Services, Bureau of Field Services

MDOT has long used recycled crushed concrete from old pavements as the aggregate base for new pavements. In the early 1990s, MDOT began stabilizing these unbound crushed aggregates with either emulsified asphalt or portland cement. The motivation for this practice was an environmental one—to prevent potential leaching of the cementitious fines in the crushed aggregate.

Over time, however, data from the department’s pavement management system (PMS) began to show another benefit: The majority of pavement sections constructed on stabilized permeable bases were significantly outperforming their unbound-base counterparts.

**BENEFITS:** This joint MDOT–University of Michigan project evaluated the PMS data, documented the performance of these pavements, and found that stabilization of the permeable recycled concrete base was not only environmentally smart, but also produced long-life “sustainable” concrete pavements. These pavements are characterized by significantly less cracking, better initial ride quality, and superior ride quality throughout the pavement service life. As a result of this research, MDOT has continued to identify opportunities to stabilize recycled concrete pavement bases with portland cement concrete. Two recent projects included I-96 in Clinton and Eaton counties and I-94 in Jackson County.

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Preventing Premature Joint Deterioration (2010)

Project Managers: John Staton and David Smiley (retired), Construction Field Services, Bureau of Field Services

**Study link:** [www.michigan.gov/mdot/0,4616,7-151-9622_11045_24249-233245--,00.html](www.michigan.gov/mdot/0,4616,7-151-9622_11045_24249-233245--,00.html)

In an effort to evaluate and document common factors associated with materials-related distress in concrete pavements, researchers from Michigan Technological University conducted a forensic analysis of cores removed from pavements exhibiting this type of distress. MDOT shared the results with fellow state DOT partners in the National Concrete Consortium and found that materials-related distress was a widespread problem. Several multistate pooled fund research projects followed to investigate and document the importance of material quality, mixture proportions, and proper screening and testing for producing long-lasting concrete pavements.

**BENEFITS:** The results from these research efforts have led to a better understanding of the causes of premature joint deterioration, which has helped to shape the development of new MDOT specifications for quality control and acceptance of portland cement concrete. The specifications include quality-based features such as optimized aggregate gradations, enhanced emphasis on the importance of quality control, improvements to ensure proper freeze-thaw protection, and screening criteria to evaluate fine aggregates for alkali-silica reactivity.
Improving Shallow-Depth Bridge Repairs (2008)

**Project Manager:** Steven Kahl, Operations Field Services, Bureau of Field Services  

Historically, MDOT has made shallow-depth repairs on bridge superstructures using polymer mortar patch materials. This type of patch typically lasts only two to five years due to cracking and shrinking. To extend the patch’s longevity, this research by Michigan State University explored the effectiveness of using a fiber-reinforced polymer (FRP) overlay on top of the polymer mortar patch.

**BENEFITS:** The study confirmed that repairs using a polymer mortar patch with an FRP overlay perform significantly better than repairs that use only a mortar patch. This combined system enhances the structural characteristics of the patch, increases longevity, reduces maintenance intervals and lowers life-cycle costs. Repairs using the combined system are expected to last about 15 years and provide significant cost savings to MDOT.

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Extending Bridge Life with MMFX Steel (2007)

**Project Manager:** Steven Kahl, Operations Field Services, Bureau of Field Services  

The key to substantially extending bridge life is to use reinforcement materials that effectively resist corrosion over a long period of time. However, finding materials that are both highly corrosion-resistant and affordable has been a challenge. MMFX steel reinforcement bars offer a promising alternative. This study by MDOT staff investigated the corrosion resistance, mechanical properties and design criteria of MMFX steel reinforcement as an effective, economically viable alternative to the epoxy-coated reinforcing bars (ECR) typically used in highway structures.

**BENEFITS:** The MMFX steel exhibited better corrosion resistance and higher yield strength than ECR. MMFX steel adds $12 per square yard to the structure cost but provides an estimated 12 additional years of service life compared with ECR. Researchers noted that bridge decks incorporating MMFX will have to be designed using the AASHTO Load and Resistance Factor Design code to account for the higher yield strength, and they recommended that mechanical reinforcement splices be specified for lap locations.

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**Project Manager:** Alonso Uzcategui, Traffic & Safety, Bureau of Development

This project analyzed and evaluated overhead sign support structures from across the country, searching for effective and economical cantilever and truss designs that would meet AASHTO 2001 specifications. To determine the most cost-effective sign alternatives, researchers from Michigan Technological University investigated the estimated fatigue life of critical structure connections and modeled the costs based on steel weight and constructability factors.

**BENEFITS:** This research allowed MDOT to upgrade its overhead sign standards to meet the AASHTO 2001 specifications for improved stability and longevity. The affordable signs identified can be much larger (1,200 square feet versus 500 square feet) to better accommodate the Clearview typeface, and require a smaller footing, which reduces the risks of utility conflicts.
Evaluating High-Skew Link Slab Bridge Systems (2012)

**Project Manager:** Steven Kahl, Operations Field Services, Bureau of Field Services

Recent national bridge specifications encourage removal or avoidance of expansion joints to improve durability and rideability. One approach to removing joints is to make the deck continuous over the piers by means of a link slab while the girders remain simply supported. This research by Western Michigan University addressed many of the challenges associated with designing jointless bridges, focusing on bridges with high skew—when the deck is at an angle with respect to the supporting structures. Investigators provided a detailed analysis of high-skew link slab bridges, and examined two abutment configurations (deck sliding over backwall and semi-integral systems) for a range of skew angles from 0 to 45 degrees.

**BENEFITS:** Research results will be reviewed for inclusion in the MDOT Bridge Design Guide, leading to the reconstruction of more Michigan bridges using the link slab system. This will mean smoother rides for travelers, longer bridge service life and fewer disruptions to traffic.

Preventing Cracking in Concrete Bridge Beam Ends (2011)

**Project Manager:** Steven Kahl, Operations Field Services, Bureau of Field Services


Debonding of steel prestressing strands is a common approach to reducing unwanted cracking at the ends of prestressed concrete bridge beams. Debonding of the prestressing strands is typically achieved by wrapping the ends of the strands with a soft polymer sheathing designed to minimize the stress transfer that can cause cracking at the beam ends. However, end cracking seen in longer beams currently in service as well as in new beams suggested a lack of true debonding. MDOT commissioned Michigan State University to investigate this problem with a combination of lab tests and computer modeling, including the testing of more rigid tubing as an alternative sheathing material to determine if it could produce a higher degree of debonding.

**BENEFITS:** The research into replacing soft sheathing material with a rigid polymer was a success. The alternative material proved to be an effective way to create more clearance between steel and concrete and ensure debonding behavior. This solution will minimize premature end cracking in bridge beams, which has a major impact on beam durability. Given the costs of beam repair and replacement once cracking has occurred, the change in fabrication method to a rigid sheath represents a highly cost-effective solution. The added effort and expense are minimal compared with the costs, both in terms of dollars and project delays, associated with bridge beams that fail to meet MDOT’s standards.

These research success stories are just a few examples of how research helps MDOT provide the highest-quality integrated transportation services for economic benefit and improved quality of life. For more information or to suggest a research idea, please contact us.

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