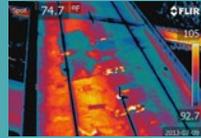


Innovation through Research Partnerships



Transportation Pooled Fund Success Stories

MDOT's participation in multi-state research through the national Transportation Pooled Fund (TPF) Program is a small part of MDOT's research investment, but one that yields significant results. By pooling funds with other states to solve high-priority shared problems, MDOT is able to develop innovations and efficiencies at less cost than going it alone.

The Research Success Stories on the following pages are just a few examples of how MDOT's investment in national pooled fund studies produces measurable benefits to the department and the traveling public. Through these partnerships with other states, MDOT has been able to:

- » **Embrace technology to improve operational efficiency.** For nearly 25 years, the ENTERPRISE Program has facilitated collaboration between government and industry organizations to research, develop and deploy effective Intelligent Transportation System technologies. MDOT has served as the lead agency for this pooled fund project since 2010.
- » **Save money on maintenance and replacement.** Through the six-year Crack-Free Bridge Deck study, MDOT has been able to test a variety of strategies for reducing bridge deck cracking and put the best of them into practice.
- » **Put customer safety and mobility first.** Michigan and other states are testing the latest Handheld Thermographic Inspection Technologies for early detection of concrete delamination. Expanded use of this remote technology will be safer for workers and drivers and mean fewer lane and bridge closures.
- » **Provide cost-effective, integrated and sustainable transportation solutions.** Ongoing development of sophisticated maintenance management software is leading to more informed and cost-effective deployment of MDOT personnel, equipment and materials. Begun more than 12 years ago, the Maintenance Decision Support System (MDSS) project now includes 19 states.
- » **Recruit, develop and retain a high-performing workforce.** Every aspect of MDOT's operations depends on knowledgeable transportation professionals. The pooled fund project supporting the Transportation Curriculum Coordination Council makes it possible for MDOT and 17 other state DOTs to access high-quality training materials in the areas of construction, materials, maintenance, traffic and safety, and employee development.

Contact MDOT Research Administration

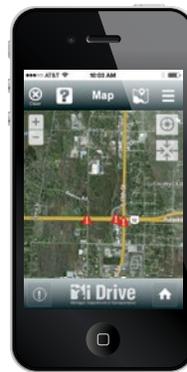
TPF-5(231): ITS Pooled Fund Program (ENTERPRISE)

MDOT Technical Contact: Lee Nederveld, nederveldl@michigan.gov, 517-335-5317

Study link: www.pooledfund.org/Details/Study/459



ENTERPRISE studies have helped MDOT evaluate emerging technologies designed to improve driver safety, such as intersection conflict warning systems (left). The program has also helped shape the department's efforts to provide real-time traveler information (right).



**LEAD
AGENCY:
MDOT**

**SHARED NEED:
ITS Solutions**

**MDOT investment: \$210,000
through Fiscal Year 2015**

**Project total committed funds
(all states) through Fiscal Year
2015: \$1,770,000**

How can advanced technologies be used to safely speed the movement of people and goods? That's the central question the ENTERPRISE pooled fund project explores through its focus on Intelligent Transportation Systems (ITS). For nearly 25 years, ENTERPRISE has applied pooled fund resources to develop, evaluate and implement ITS.

Since its inception, the ENTERPRISE program's funding members grew from 12 state departments of transportation (DOTs) and the Federal Highway Administration (FHWA) to include Transport Canada, the Ontario Ministry of Transportation, and the Dutch Ministry of Transport.

ENTERPRISE projects are designed to guide agencies on the implementation of better practices and smarter resource allocation. One series of projects helped to produce a planning guidance for ITS devices, available at <http://enterprise.prog.org/itswarrants>. Another study produced "The Next Era of Traveler Information," which pointed the way to delivering real-time information to motorists in a world of constrained funding and ever-evolving technology. Results from this study indicate a clear trend away from 511 phone system use and toward Web-based updates and smartphone apps.

HOW MDOT BENEFITS

This project has helped MDOT gain insights to improve current information dissemination strategies and to develop new ones as well. During 2015, ENTERPRISE hosted a series of webinars that were designed to facilitate peer exchange on both introductory and advanced topics on travel information

strategies. MDOT has launched a free app for its popular Mi Drive website. The new app is available for iOS and Android smartphones and mobile devices. With this customizable app, motorists can obtain real-time roadway and traffic information on I, M and US routes. In addition, MDOT's Twitter accounts now tweet updates to motorists on crashes and other traffic incidents.

ENTERPRISE has completed more than 60 studies covering a wide range of ITS-related topics. Study areas include using intersection conflict warning systems, maintaining travel times in construction zones, implementing visibility monitoring systems, and assessing crash notification technology. For more information on ENTERPRISE projects, refer to the research reports online at http://enterprise.prog.org/projects_completed.html.

Other MDOT-Led Pooled Funds

TPF-5(254): Evaluation and Analysis of Decked Bulb T-Beam Bridges. Final report: http://www.michigan.gov/mdot/0,4616,7-151-9622_11045_24249_24251-347552--,00.html

TPF-5(308): The Use of Bridge Management Software in the Network Analysis of Big Bridges. Project overview: <http://pooledfund.org/Details/Study/557>

MDOT Technical Contact (both projects): Dave Juntunen

TPF-5(174): Construction of Crack-Free Bridge Decks, Phase II

MDOT Technical Contact: Tim Stallard, stallardt@michigan.gov, 517-322-6448

Study link: www.pooledfund.org/Details/Study/400



This project provided extensive testing of crack-reducing construction techniques, materials and mix design strategies. The tests validated several strategies that MDOT is already using and helped the department eliminate poorly performing mixes.

SHARED PROBLEM: Bridge Deck Cracking

MDOT investment: \$70,000
through Fiscal Year 2015

Project total committed funds (all states) through Fiscal Year 2015: \$995,000

Bridge deck cracking is a pervasive phenomenon. As for the factors that create the cracking, they're hardly a mystery today. In fact, decades of research exists on the causes of cracking. The challenge has been getting that research into the standard practices for designing and constructing low-cracking high-performance concrete (LC-HPC) bridge decks. Understanding why bridge decks crack could help unlock solutions that could greatly reduce crack occurrences. Building on the research momentum established in Phase I of this study, the objective of Phase II was to develop specifications that directly impact deck design and construction.

The six-year study applied numerous crack-reduction strategies both in the laboratory and the field. In the laboratory portion of the study, 53 concrete mixtures were evaluated for shrinkage, freeze-thaw durability, scaling resistance, compressive strength and air-void system stability. In the field portion of the study, 16 bridges were constructed using LC-HPC specifications. Serving as controls for the study were 11 bridge decks constructed according to current Kansas DOT standard specifications for bridge deck construction, along with one deck bid under LC-HPC specifications, though not ultimately constructed with them.

Highlights from the study include performance data identifying certain concrete mixtures as clearly superior to others for crack reduction. Researchers also found that bridge decks compliant with LC-HPC specifications exhibited roughly one-third as much cracking as the control decks at similar ages.

HOW MDOT BENEFITS

MDOT's expenditures for the construction of concrete bridge decks are significant, so extending bridge life is an important goal. By improving durability and reducing cracking, MDOT

is able to save on future rehabilitation and maintenance costs. This pooled fund study provided immediately implementable recommendations related to mix design strategies and construction techniques, which states are already applying. For example, Kansas DOT has successfully reduced cracking by lowering the slump of their bridge deck concrete and using a two-week wet cure period.

For MDOT, a major benefit of the study has been quantifiable validation of several strategies that the Materials Section has already begun implementing for better bridge deck performance. These include reducing total cementitious content, using supplemental cementitious material, opting for slag cement over fly ash, and optimizing aggregate gradation.

Thanks to the sheer depth and breadth of the study's bridge deck research, such as the detailed performance data on dozens of concrete mixtures, MDOT has been able to eliminate poorly performing concrete mix options. Because MDOT can be confident in the reliable, well-supported documentation provided by this pooled fund study, the department can forgo its own research on the same topics, saving time and money.

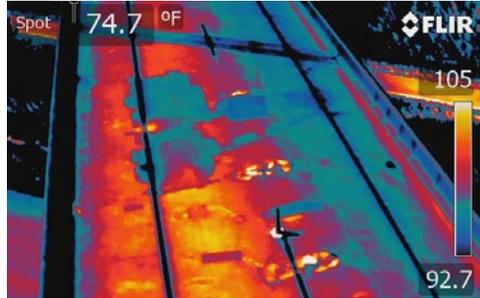
“Through pooled fund partnerships, MDOT is able to test new and promising approaches at a lower cost. We can then put the best solutions into practice.”

—Steve Bower, Engineer of Research

TPF-5(247): Field Testing Handheld Thermographic Inspection Technologies, Phase II

MDOT Technical Contact: Richard Kathrens, kathrensr@michigan.gov, 517-322-5715

Study link: www.pooledfund.org/Details/Study/475



Through thermal imaging (right) that can detect areas of bridge delamination (left), handheld thermographic tools allow for safer, more efficient bridge inspections than traditional methods. This project is providing the field testing, validation and guidelines that MDOT needs to effectively implement this technology.

SHARED NEED: Bridge Inspection Tool

MDOT investment:
\$60,000 through Fiscal
Year 2015

**Project total committed
funds (all states) through
Fiscal Year 2015:**
\$760,000

What's happening inside that bridge deck? That's essentially what inspectors want to know as they consider the potential for concrete delamination, which is generally caused by rebar corrosion and freeze-thaw effects. Nondestructive evaluation tools for detecting delamination have included techniques like chain dragging and hammer sounding. These are time-consuming methods that require inspectors to have direct access to the bridge deck, which elevates the safety risk. These methods also require lane and bridge closures, which in some cases are simply not feasible.

Phase I of this pooled fund study explored an alternative method for detecting delamination, specifically using handheld thermographic inspection technologies. Here's how they work: As a bridge deck heats up in the sun, its surface emits infrared wave energy. The presence of delamination in a bridge interrupts the conduction path of infrared energy. Handheld thermographic tools can detect the resulting temperature variations on the surface of the concrete and display them as thermal images, providing visual evidence of subsurface delamination.

Initial field testing in Phase I demonstrated successful applications of thermographic technologies for detecting delamination in bridge decks, soffits, piers, precast panels, and carbon fiber wraps. The research team drafted guidelines for optimal usage of the tools and provided preliminary training to individuals from participating states.

Phase II of the research involved further field testing to validate the drafted guidelines, identify barriers to implementation and evaluate the reliability of thermographic inspection. States

have begun using the technology for a variety of applications, including quality assurance for composite retrofits, testing of soffits, and epoxy overlays of bridge decks. The updated guidelines have been distributed, and the technology is available for widespread implementation.

HOW MDOT BENEFITS

Compared to other methods of detecting delamination, handheld thermographic inspection technologies provide numerous advantages to MDOT. Thermal images can be observed in real time by the inspector, allowing on-site assessment. These technologies require no direct contact with the bridge and can be used from a distance, which means there's no need for bridge closures or traffic control. The handheld technologies require minimal training and allow large areas of a bridge to be scanned fairly rapidly. These efficiencies can create a more streamlined process for prioritizing bridge maintenance and repair schedules.

MDOT region bridge engineers can now use the thermographic technologies during the inspection and scoping process. MDOT will continue implementation and research, and plans to develop state-specific guidelines for application and data collection procedures. The infrared-based data will be incorporated into the MDOT bridge database, allowing bridge staff to access the information through MiBRIDGE, MDOT's Web-based bridge management software. MDOT is also planning to use thermographic technologies to evaluate the effectiveness of carbon fiber wraps on bridge beams and columns.

TPF-5(054): Development of Maintenance Decision Support System (MDSS)

MDOT Technical Contact: Allison Porrett, porretta1@michigan.gov, 517-636-4444

Study link: www.pooledfund.org/Details/Study/240



SHARED NEED: Winter Operations Efficiency

MDOT investment:
\$135,000 through Fiscal
Year 2015

**Project total committed
funds (all states) through
Fiscal Year 2015:**
\$5,600,000

Through participation in this pooled fund project, MDOT developed a streamlined approach to implementing MDSS statewide. MDSS helps the department save money by giving winter maintenance managers critical information that allows for the most efficient use of resources.

How can transportation agencies provide the safest, most reliable roadways? DOTs address this ongoing question in myriad ways. But when it comes to weather-related roadway conditions, maintenance staff must answer the question by providing immediate remedies. That's historically meant making decisions on the fly based largely on prior experience. Considering the looming cost-efficiency and level-of-service demands placed on DOTs, that's simply no longer enough. Enter the Maintenance Decision Support System (MDSS) pooled fund study. MDSS integrates information technologies and computational tools, enabling maintenance staff to make more effective, cost-efficient decisions, particularly during winter weather events. This pooled fund study is responsible for MDSS research and development. Since the study began more than 12 years ago, participation has grown from five to 19 state DOTs, with more than a dozen states now implementing winter maintenance MDSS.

MDSS serves as a one-stop source of critical information for winter maintenance decisions. Robust automatic vehicle location technology plays a key role in reporting snowplow operational data in near real time, in addition to capturing air and pavement temperatures. This information can be integrated with location- and time-specific weather predictions and physical and chemical models of a roadway. MDSS can also incorporate information on resource limitations and desired level of service.

The utility of MDSS culminates in the Web-based delivery of recommendations for maintenance options, material

application rates, and timing of services aimed at maximizing the effectiveness of snowplow operations. All storm event data can also be stored for later analysis and applied to future maintenance strategies. Garage supervisors and snowplow operators are empowered like never before with information on how to best prepare for and react to a winter storm event.

HOW MDOT BENEFITS

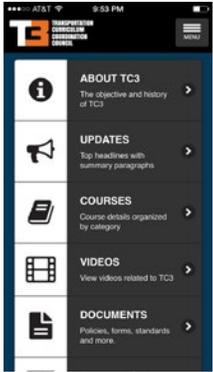
Thanks to the sharing of data and lessons learned by other DOTs participating in this pooled fund project, MDOT developed a streamlined, accelerated process for implementing MDSS statewide. By issuing a single request for proposals for all MDSS-related services, MDOT was able to contract with just one well-qualified vendor that supplies equipment, secures cellular communications services, provides equipment installation training, and coordinates the integration of technologies. MDOT has already used the MDSS system to effectively plan route closures and traffic detours based on forecasted winter weather events.

In its first year of full-scale deployment, MDSS has generated significant winter maintenance cost benefits for the partnering agencies. Indiana DOT realized annual savings of \$11 million in salt usage and overtime. DOTs in New Hampshire, Minnesota, Maine and Colorado experienced benefit-cost ratios from 1.33 to 7.11. A comprehensive cost-benefit analysis of MDOT's system is planned for the near future.

TPF-5(209): Support of the Transportation Curriculum Coordination Council (TCCC)

MDOT Technical Contact: Mark Chaput, chaputm@michigan.gov, 517-322-3331

Study link: www.pooledfund.org/Details/Study/435



SHARED NEED: Staff Training

MDOT investment:
\$80,000 through Fiscal
Year 2015

**Project total committed
funds (all states) through
Fiscal Year 2015:**
\$1,055,000

MDOT has incorporated more than a dozen online TC3 training courses into its own training program. MDOT's leadership on this pooled fund project helps shape the TC3 curriculum.

The demand is unrelenting. Knowledgeable transportation professionals equipped with the latest skills are at a premium at every state DOT. FHWA estimates that by the next decade up to 50 percent of the current transportation workforce will be retiring. Is there a ray of hope in the face of these challenging factors? Absolutely.

The Transportation Curriculum Coordination Council (TC3), a pooled fund project with a vital mission, provides an outstanding training curriculum for enhancing the professional competency of the country's transportation workforce. Members of the TC3 pooled fund include FHWA, the American Association of State Highway and Transportation Officials (AASHTO), MDOT and 17 other state DOTs. For more than 10 years, the program has served as a no-cost training resource for state DOTs and local transportation agencies, as well as private contractors, consultants and academic institutions.

TC3 course offerings are much more than a standard resource. TC3's Core Curriculum was designed with the bold vision of being a nationally based, comprehensive training resource for the transportation workforce. Today, more than 90 Web-based courses are offered through the Core Curriculum Matrix, which comprises the areas of construction, materials, maintenance, traffic and safety, and employee development.

The TC3 program provides a number of benefits. State DOTs and other entities can avoid duplicating training development efforts and save money along the way. The Core Curriculum also encourages knowledge sharing and uniformity in

transportation training methods while allowing for a large degree of adaptability to the training programs of individual agencies and regional certification programs.

TC3 was originally organized under FHWA. However, in 2013 the AASHTO Executive Board approved TC3 as a new AASHTO Technical Service Program. This has been an invigorating development for TC3, strengthening its connection to state DOTs in particular and setting the stage for growth in course offerings.

HOW MDOT BENEFITS

MDOT continues to play a key role in the TC3 program. In fact, since its transition to the AASHTO umbrella, TC3 now has MDOT representation at its highest levels. Mark Chaput, deputy director of the Bureau of Field Services at MDOT, serves as vice chair of TC3's Executive Board, addressing day-to-day operational needs and coordinating MDOT's prominent role in the evaluation, expansion and evolution of the curriculum.

MDOT has benefited from the incorporation of more than a dozen TC3 courses into its own professional development training modules, and more will be added as appropriate. MDOT also uses TC3 courses for training transportation professionals at other agencies within the state. Additionally, MDOT staff serving as members of the Michigan Construction Quality Partnership (CQP) Steering Committee have taken the lead in reviewing the full TC3 curriculum to determine courses for the Michigan CQP Training Program, a public-private sector training curriculum for transportation professionals.