

RESEARCH UPDATE

NOVEMBER 2013

Collaborating with Consultants Brings Innovation to Michigan's Transportation System

As part of the department's mission to provide the highest-quality integrated transportation services for economic benefit and improved quality of life, MDOT conducts research into the most cost-effective ways to build and maintain durable pavements and bridges, improve driver safety, decrease congestion and meet a host of other transportation system needs.

Crucial to the success of MDOT's research program is choosing the right



The firm T.Y. Lin International assisted MDOT in creating a comprehensive guidebook of safety improvements for pedestrians and cyclists. Research has shown that low-cost treatments such as advance stop bars can reduce conflicts between motorists and pedestrians.

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research teams to collaborate with the department on high-quality research with practical, implementable results. MDOT has selected nationally recognized consultants who understand the innovative ideas of our time to be part of successful research teams.

"Research is a critical component of MDOT's mission to innovate," says Chief Operations Officer Greg Johnson. "Consultants can offer a wide range of real-world experience in both the public and private sector, providing innovative solutions to Michigan's transportation-related challenges."

The following articles feature examples of how MDOT's research partnerships with private sector consultants are enhancing Michigan's transportation system. These include projects to improve

the safety of bicyclists and pedestrians, research into the use of sensors on vehicles to monitor everything from pavement conditions to traffic accidents, and a study increasing driver awareness of a Michigan law designed to minimize the negative effects of roadway incidents. By making their expertise and broad private sector experience available to MDOT, consultants are assisting Michigan every day in building and maintaining its exemplary transportation system.

Find More Online

Final reports for the studies featured in this newsletter are available on the MDOT Research Administration Web site at www.michigan.gov/mdotresearch.

Consultant and University Partners Collaborate for Pedestrian Safety



Practical experience on the research team ensured that MDOT's guidance for pedestrians and bicycles would meet practitioners' needs.

When MDOT set out to develop a comprehensive guidebook of safety improvements for pedestrians and cyclists, the department's first priority was securing the right researcher with the necessary expertise.

"At the time we awarded this research contract, consulting firms had more experience in this area than universities in our state," says MDOT Pedestrian and Bicycle Safety Engineer Deirdre Thompson. MDOT selected the firm T.Y. Lin International, with John LaPlante as principal investigator, to manage the "Sharing the Road: Optimizing Pedestrian and Bicycle Safety and Vehicle Mobility"

project.

"The manual we developed, *Best Design Practices for Walking and Bicycling in Michigan*, was the main product of this research," Thompson says. "It had to pull together a broad range of options and outline the relative benefits and costs of different intersection and corridor improvements.

"It was particularly important that the research team bring extensive practitioner experience," Thompson says. "That's exactly what we got from John, who had served for years as traffic manager for the city of Chicago. His experience as a designer gave him a unique perspective on how to make the manual most useful to other designers. That's true both in terms of the kind of information we included and how we presented it." The manual has indeed proven useful. Several of the options described in the publication are already being tried in Michigan.

The regional connection was an added benefit that LaPlante and Illinois-based T.Y. Lin International brought to the project. Research findings from other areas of the country often lack applicability in Michigan—the climate and traffic patterns don't always translate to the

Midwest. That wasn't an issue here. "Our thinking is that if you can make it work in Chicago," Thompson says, "you can probably make it work in Detroit and other urban settings in Michigan."

This project also serves to illustrate the collaboration possible between contractors and university researchers. Professor Ron Van Houten of Western Michigan University served as a subcontractor to T.Y. Lin International, performing data analysis and quality assurance.

MDOT's Thompson noted the value of Van Houten's experience and the good working relationship he had with LaPlante. "Ron Van Houten and John LaPlante have worked together closely on many projects and serve on national committees together," Thompson says. "They each bring a unique perspective on the state of the practice and the latest research on pedestrian and bicycle safety. Having consultant and university experts sharing ideas with one another was extremely valuable for this project. They acted as sounding boards for one another and helped bring this project to a new level."

Contact Deirdre Thompson at thompsond@michigan.gov or see report RC-1572 online to learn more about this project.

Measuring the Benefits of Preventive Maintenance for Pavement

MDOT's Capital Preventive Maintenance (CPM) program seeks to save money on major pavement rehabilitation and reconstruction projects by applying less expensive treatments to extend the pavement's service life. The program dates back at least two decades. It has grown into one of the largest preventive maintenance programs in the United States and receives \$80 to \$100 million in annual funding.

Preventive maintenance generally is considered a wise investment for a wide range of assets, including pavement. But

while there have been recent publications on evaluating the cost-effectiveness of preventive maintenance for pavements, there hasn't been a consistent method for measuring these benefits.

"We're relying on these procedures to extend the pavement life span for a certain amount of time," says CPM Program Engineer Erin Chelotti. "If we expect a procedure to extend the life span by 10 years, but it only works for two or three, it's wasting a lot of money."

MDOT contracted with Applied Pavement Technology of Urbana, Illinois, to research the cost-effectiveness of MDOT's preventive maintenance efforts. "APT is a well-known company, and their project manager, David Peshkin, is a nationally known expert in the field," says MDOT Hot-Mix Asphalt (HMA) Operations Engineer Kevin Kennedy. "They had a good plan and an understanding of what was needed for the project."

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Measuring the Benefits of Preventive Maintenance for Pavement

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Researchers analyzed CPM treatment performance by measuring pavement distress levels before and after treatment. Then they projected future pavement performance based on the after-treatment distress levels, calculating the service life extension due to the treatment.

Overall, researchers found that preventive maintenance over the service life of a stretch of pavement extended its life by about 16 years. Cost savings over this time averaged almost \$310,000 per lane-mile for flexible pavements and \$265,000 for composite pavements when compared to a rehabilitation-only strategy.

The study found that microsurfacing and HMA mill-and-overlay treatments provide the longest service life extension,

while HMA crack seals have the highest benefit-cost ratio. To help simplify the treatment selection process, investigators used this research and MDOT's existing guidelines to develop a chart that recommends treatments based on pavement type and the type and level of pavement distress.

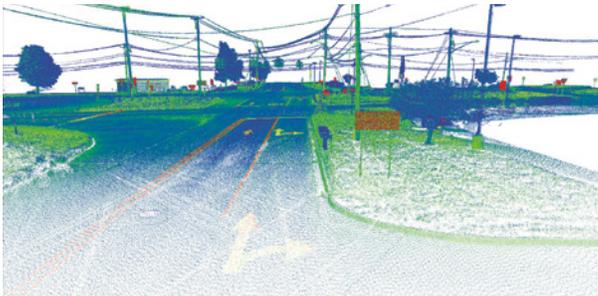
The research results confirm the value of MDOT's CPM efforts. "Our objective with this project was to have someone outside the department evaluate the program to verify its cost-effectiveness," Kennedy says. "The results weren't surprising, but it's valuable to quantify it."

For more information, see report RC-1579 online or contact Erin Chelotti at chelottie@michigan.gov.



This research found that crack seals are among the most cost-effective preventive maintenance practices.

National Experts Weigh Options for Remote Monitoring in Michigan



LiDAR can provide a very detailed set of asset data, but the data collection and storage come at a cost. This research will help weigh these factors.

MDOT's infrastructure assets include much more than pavements and bridges. These assets range from signs, lighting and guardrails to trails, weigh stations and rest areas. Informed decisions on asset maintenance and repairs depend on good data, but tight budgets make on-site inspection of Michigan's entire transportation network challenging.

MDOT saw a possible solution in the use of remote sensing technologies to automate the collection of asset inventory and site conditions. However, research was needed to assess the different technologies and determine which would be most appropriate and cost-effective in Michigan.

The department initiated the "Monitoring Highway Assets with Remote Technology for the Michigan Department of Transportation" study in 2012. Washington state-based Dye Management Group was selected to conduct the research.

Dye brings national expertise through its consulting work on public sector policy, planning and information technology projects. MDOT Region Support

Engineer Tim Croze notes Dye's track record with transportation agencies in particular. "A positive that Dye brought to the project was the firm's experience working with a number of other state DOTs," says Croze, project manager for the study. "The researchers know what's going on with asset management and remote technologies around the country and who to contact for more information."

The firm had valuable experience in Michigan as well, having conducted a related project for MDOT and the state's Transportation Asset Management Council. "This prior experience with MDOT gave the researchers a head start

on this project," Croze says, "and helped accelerate an accurate prioritization of our asset types."

Dye's current project requires the firm to address geospatial data and associated technologies like geographic information systems, light detection and ranging (LiDAR), aerial photography and mapping. To meet that objective, Dye partnered with Wisconsin-based AeroMetric, Inc., an expert in the field. Croze emphasized the challenges associated with these technologies. AeroMetric's expertise in this area will ensure that the geospatial technology recommendations provided by this research are tailored to MDOT's needs.

The project is scheduled to be completed in January 2014, and Croze reports that the research is proceeding according to plan. "When the project reaches its conclusion," Croze says, "we expect to have a list of the assets that are suitable for remote monitoring and the framework for an implementation plan in Michigan."

Contact Tim Croze at crozet@michigan.gov to learn more about this project.

Developing Applications for Connected Vehicle Data



Connected vehicles use vehicle-mounted sensors, including adapted smartphones, to collect and transmit vehicle, atmospheric and location data for a variety of real-time, trended and historic applications.

Connected vehicles have the potential to improve safety, ease traffic congestion and save transportation departments money by using vehicle-based sensors to automate data collection. In Michigan, the Data Use Analysis and Processing (DUAP) project is working to make the potential offered by connected vehicle technology a reality.

The first phase of the project acquired data from multiple sensors within a number of connected vehicle fleets. This data was wirelessly transmitted to a central system for collection and processing. Researchers used these onboard sensors in vehicles to collect data, sort and aggregate multiple data types, synthesize performance measures for specific DOT applications, and develop a prototype Web site to display the data.

The second phase of the project, scheduled for completion in late 2014, will continue data collection and produce applications for this connected vehicle data. “We’re looking at how connected vehicle data can be applied across MDOT processes to meet our business needs,” says MDOT Connected Vehicle Technical Manager Collin Castle.

DUAP researchers are currently prioritizing those application concepts based on data availability, priority and benefit

analysis. Several particularly promising applications have been identified, including:

- **A pavement application** that would use vehicle accelerometer data to monitor pavement surface conditions. This application would report both “near-time” data, such as major cracks or potholes that need immediate attention, and longer-term trends in pavement conditions. “Currently, we use a profilometry van that drives the entire road network approximately every two years to collect pavement condition data,” Castle says. “Wouldn’t it be nice to capture that data more frequently to see trends rather than just a snapshot in time?”
- **A weather-responsive traveler information tool** that would use vehicle sensors to measure conditions like atmospheric temperature, antilock brake system activation, windshield wiper use and pavement surface condition (dry, wet, icy). This data would help MDOT identify localized areas that require winter maintenance action and weather-responsive traveler information on dynamic message signs and/or Mi Drive, MDOT’s traveler information Web site (www.michigan.gov/drive).

- **An incident/congestion location application** that would use global positioning system (GPS) data (location, speed and heading) from vehicles to identify where incidents or congestion are occurring, even in areas without Intelligent Transportation Systems instrumentation.

MDOT contracted with Mixon-Hill of Overland Park, Kansas, to undertake this project. Mixon-Hill also developed the data system for the Federal Highway Administration’s Clarus Initiative (www.its.dot.gov/clarus/), which aggregates data from environmental sensor stations nationwide. That project involved a similar type of large-scale data collection, user interface development and use of back-end data quality checking algorithms as are needed to make DUAP successful.

“One of the things that have allowed us to have a very positive collaboration is the constant communication,” says MDOT Operations/Maintenance Field Services Engineer Steve Cook. Mixon-Hill is a relatively small company, and its flexibility and fast response to MDOT’s requests have also contributed to the partnership’s success.

Once the application concepts have been prioritized, Mixon-Hill will begin developing the most valuable and feasible concepts. By mid-2014, the first applications should be ready for beta testing.

The applications that are ultimately developed will help MDOT become more efficient and effective, even as budgets remain tight. “We’re looking at how automatically collected probe data will align with, support and enhance current data, which are generally manually collected,” Cook says. “It will help us become better, faster, cheaper, safer and smarter.”

For more information on MDOT’s Connected Vehicle Program, see www.michigan.gov/cv or contact Collin Castle at castlecc@michigan.gov.

Developing Best Practices for Emergency Rerouting

MDOT recently developed guidance for dealing with road closures due to unplanned events such as traffic crashes or floods. Such closures require emergency rerouting, or the channeling of traffic to alternative routes. Managed on a regional basis, emergency rerouting can be a significant logistical challenge requiring advance planning for route selection, deployment of signs and coordination with other agencies.

Developed by consulting firm Kimley-Horn, MDOT's *Best Practices for Emergency Rerouting* provides guidance for MDOT regions in the process of developing or updating their emergency rerouting plans. It includes best practices from other states, guidance on evaluating the effectiveness of emergency rerouting, and sign recommendations. These signs are placed along emergency detour routes, and must be designed to be intuitive and easily comprehended by motorists. Since each region currently develops its own plans, the manual could help increase

consistency statewide.

However, the manual is not intended to require specific processes. "This is not a one-size-fits-all approach," says MDOT Traffic Incident Management Engineer Angie Kremer. "Michigan's regions are diverse. This manual simply provides the information that allows regions to develop emergency rerouting plans tailored to their needs."

To develop the manual, researchers conducted a literature review, a survey of states and interviews with selected states to document practices for developing emergency rerouting plans. They also got feedback from Michigan stakeholders during a series of workshops and a conference call.

"Kimley-Horn went above and beyond the call of duty in the work they did to develop this manual," says Kremer. "And they're still helping us, even though the project has been closed out."

That help includes co-presenting with MDOT about the project at the 2013



For a permanent sign designating an emergency route, researchers recommended a green background with an orange emergency route panel.

National Rural ITS Conference in St. Cloud, Minnesota. Kimley-Horn also is assisting MDOT with obtaining FHWA approval for the use of new signs.

Ultimately, the new manual will help Michigan's transportation system move people and commerce in the safest and most efficient way during an unplanned incident. "We wanted to make sure that our emergency rerouting plans were designed in the best possible way for the traveling public," Kremer says. "By incorporating the best practices of other states, we succeeded in doing this."

Contact Angie Kremer at kremera@michigan.gov or see report RC-1581 online to learn more about this project.

Increasing Awareness of Michigan's Quick Clearance Law

MDOT is reaching out to motorists to increase their awareness of a state law designed to minimize the negative effects of roadway incidents. This "quick clearance" law, passed by the Michigan Legislature in 2010, requires motorists who have been in a crash to move their vehicles to the side of the road if there are no injuries and the vehicles are drivable.

Motorists traditionally have been taught to leave their vehicles in place after a crash occurs to make it easier for police to investigate incidents. However, this practice can lead to traffic backups, along with secondary crashes as other drivers encounter unexpectedly blocked lanes.

As part of an initial outreach effort to increase driver awareness of the quick clearance law, MDOT and the Michigan State Police adopted the message, "If you

can steer it, clear it!" However, anecdotal evidence indicated that after several years, many drivers remained unaware of the law.

A recent MDOT research project conducted by consulting firm Cambridge Systematics took steps to address this problem by evaluating drivers' awareness of the quick clearance law and identifying low-cost communications strategies for increasing it.

"This project helped us identify the kinds of drivers who may not be aware of the quick clearance law and provided us with the materials for a comprehensive campaign to reach drivers statewide," says MDOT Traffic Incident Management Engineer Angie Kremer.

Researchers reviewed how other states publicize quick clearance laws and



MDOT will educate drivers about Michigan's quick clearance law using campaign materials that feature the character Captain ClearIt with the message, "If you can steer it, clear it!"

surveyed 800 Michigan drivers. Results showed that while most drivers move their vehicles to the side of the road after a crash, only 13 percent were aware that they are legally required to do so.

Increasing Awareness of Michigan's Quick Clearance Law

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Based on these results, researchers recommended using a combination of traditional communication methods (such as television advertising) and social media (such as Facebook) to reach drivers in multiple demographic groups. They also developed sample campaign materials, including a superhero character named Captain ClearIt, to increase public recognition of the campaign's messages.

Using the recommendations and

materials developed in this project, MDOT is implementing a targeted public education campaign with the goal of increasing awareness of the law from the 13 percent baseline established in this study to 50 percent by the end of 2016. This goal was established by the Michigan Traffic Incident Management Action Team, which Kremer co-chairs, and supports a new emphasis on traffic incident management in Michigan's

2013-2016 Strategic Highway Safety Plan. A proposed Phase 2 of the research project would conduct another survey to evaluate the effectiveness of this targeted outreach campaign in reaching the 50 percent goal.

"Improving driver compliance with the quick clearance law would allow Michigan residents to experience the law's full safety and mobility benefits," Kremer says.

Contact Angie Kremer at kremera@michigan.gov or see report RC-1583 online to learn more about this project.

Improving Overload Permit Analysis for MDOT and Local Agencies

To help protect infrastructure and public safety, Michigan places limits on the weights of vehicles using its roads and bridges. Operators of trucks carrying loads that exceed these weight limits must apply for and receive overload permits before crossing state bridges. Since 2002, MDOT has issued an average of 6,000 bridge overload permits a year.

MDOT saw an opportunity to review its permit review methodology and update its permitting software so that it could be integrated with other software packages available to local agencies. Researchers from Pennsylvania-based consulting firm Michael Baker Corp. carried out the project, examining the existing software systems and recommending process improvements and implementation approaches. The department selected a software solution that provides a faster, more comprehensive and more flexible permit review process.



Heavily loaded trucks must obtain an overload permit to cross state bridges. Permits are issued by MDOT for state-owned bridges and by local agencies for bridges in their jurisdictions.

In issuing permits, MDOT uses software called BridgeOV to determine whether a given vehicle is compatible with the load rating for a particular bridge. This software places vehicles into overload classes by modeling their effects on bridges of various lengths and comparing these effects to those of 20 standard overload vehicle configurations. To receive a permit for a particular bridge, a vehicle's load effect on that bridge must be lower than the effects of all 20 configurations.

Traditionally, determining bridge load ratings has required a separate software application. For this purpose, MDOT and local agencies typically use AASHTOWare Bridge Rating (formerly called Virtis), a comprehensive bridge analysis software program developed by the American Association of State Highway and Transportation Officials (AASHTO) and licensed by a majority of states. Bridges are given a rating based on whether they can carry all legal loads and, if so, classified based on the maximum overload that they can carry. Bridge Rating accommodates both the older Load Factor rating method and newer Load and Resistance Factor rating method, and considers a wide variety of bridge types.

However, Bridge Rating cannot model all types of bridges in the MDOT inventory, and MDOT is still working to complete the software's database. Also,

not all local agencies use the program. Consequently, MDOT recognized the need to refine BridgeOV so that it can either be integrated with Bridge Rating to refine permit analysis, or function independently of it for use by local agencies without access to Bridge Rating.

"It was critical to create a piece of software capable of working with Bridge Rating as well as independently of it," says MDOT Bridge Load Rating Program Manager Brad Wagner. "Making software that meets the needs of local agencies will help bolster MDOT's efforts to standardize the overload permitting process across Michigan."

The updated BridgeOV software makes permit analysis more robust by taking into account shear (loading stress at or near a bridge span's supports) and span length data for an improved pass/fail analysis. When integrating the software with Bridge Rating, users can get a more accurate representation of each bridge. The resulting permit review process will offer more flexibility for both MDOT and local agencies, whether they use the Bridge Rating software or not.

MDOT is in the process of incorporating the new BridgeOV software into its permitting software. The department also is continuing to update its Bridge Rating database to include almost all of its approximately 5,000 bridges.

For more about this project, contact Brad Wagner at wagnerb@michigan.gov or see report RC-1589 online.

Study Confirms the Safety Benefits of Michigan Roundabouts

Roundabouts' benefits as intersection treatments are well known. They're prized for their ability to control speeds, reduce congestion and enhance safety compared with traditional intersections. Across the country, roundabouts' impact has been positive, and national research studies have quantified their safety and operational benefits.

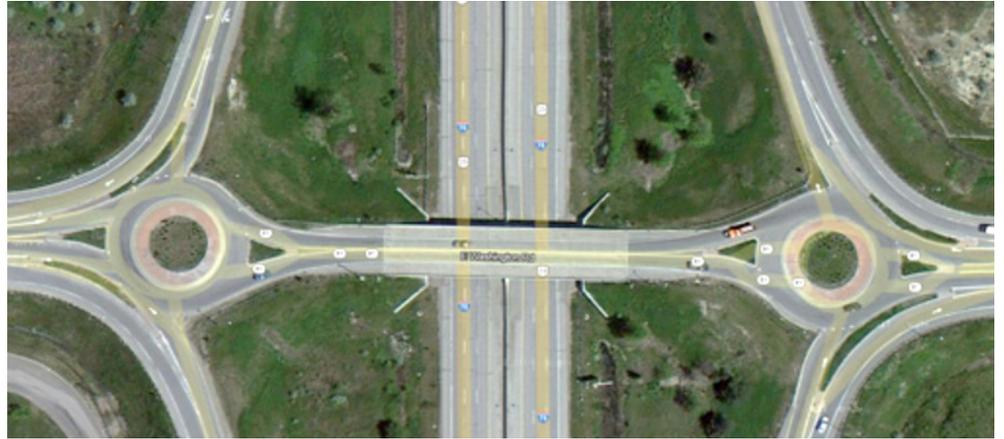
To make the most effective decisions about roundabout design and placement in Michigan, MDOT needed specifics on how well roundabouts have performed here. The department initiated a research project to assess the safety impacts of converting conventional intersections to roundabouts, determine how roundabouts affect traffic operations and examine the economic impacts of roundabout conversions.

The results confirmed the effectiveness of MDOT's past approaches and provided quantifiable details about benefits, says MDOT Safety Analysis Engineer Dean Kanitz, who served as project manager for the study.

"As designers and engineers put together a plan for an intersection, this analysis will help them understand the safety and operational aspects of roundabouts and the expected return on investment," Kanitz says. "This study adds a new dimension to our existing guidance."

The project involved using a data-driven approach to evaluating safety performance—a new standard evaluation procedure detailed in the AASHTO Highway Safety Manual (HSM), published in 2010. The HSM guides practitioners in quantitatively assessing the impact of infrastructure decisions on safety and incorporating that analysis into the project planning and development process.

Consulting firm Opus International put together the needed expertise. "At the time the project began, knowledge of the HSM was still growing, and use and application of it was still growing,"



On-site observers found that the many trucks using this interchange at I-75 and M-81 in Saginaw County are able to maneuver through the roundabouts with relative ease. (Source: Google.)

Kanitz says. "The statistical practices involved were fairly specific. Opus was able to illustrate that they could deliver on that spectrum."

To conduct the safety performance analysis, Opus selected 58 roundabouts built across the state between 2001 and 2009. The sites included new construction as well as locations where an existing signaled or stop-controlled intersection was converted to a roundabout. For comparison, the researchers selected reference sites with characteristics that were similar to the roundabout sites but that still operated as conventional intersections.

Using data from the Michigan State Police crash database, traffic counts and other sources, researchers conducted a simple before-and-after study and a more rigorous statistical analysis to assess the safety of the roundabout conversions. They also assessed the roundabouts' cost-effectiveness, taking crash, construction and delay costs into account.

The results were very positive. All types of roundabout conversions led to a decrease in injury crashes, and the economic benefits were clear as well. Researchers estimated the benefit from reduced road user delays at more than \$500,000 per year for a single-lane roundabout, with greater benefits for larger roundabouts. They cal-

culated a return on investment of less than two years for all sizes of roundabouts, attributing this relatively quick return to the large reduction in crashes at many of the intersections and the benefits associated with reduced congestion.

"The study results reinforced what we were already doing," Kanitz says. "And the project quantified the impacts of single-lane roundabouts compared with two lanes and three lanes, which is valuable information that we didn't have before."

Armed with this analysis and researchers' recommendations for modifications to its roundabout design guidance, MDOT can prioritize funding for roundabouts, apply the most appropriate design elements and quantify the benefits of roundabouts for Michigan communities considering them as an effective alternative to conventional intersections. Kanitz noted that other states, such as Wisconsin, have applied the research results as well.

"This study will help MDOT make decisions on roundabouts in the future," Kanitz says. "As we continue to apply the HSM's performance-based approaches, we're customizing and refining our practices based on research like this."

For more information, see report RC-1566 online or contact Dean Kanitz at kanitzd@michigan.gov.

Evaluating the Impact of Passing Relief Lanes

Designed to give motorists a safe opportunity to pass slower traffic, passing relief lanes have been a fixture on rural two-lane roads in Michigan since the 1980s. In the right locations, passing lanes can improve the traffic flow and prevent crashes caused by unsafe passing maneuvers, especially where passing sight distance is limited.

To evaluate the effectiveness of the state's passing lanes, MDOT partnered with Opus International Consultants, which has an office in West Bloomfield, to analyze safety and traffic impacts and recommend guidance for future installations in Michigan. Completed in 2011, the research is part of the department's ongoing effort to incorporate practices from the AASHTO Highway Safety Manual into its planning and design processes.

Researchers used data from the Michigan State Police crash database to estimate crash incidence at the sites before and after the passing lanes were installed. Although they were only able to perform a limited statistical analysis, the results indicated that passing lanes are effective in reducing injury crashes. In addition, traffic flowed freely during the observation periods, and the speed study indicated that drivers were not behaving recklessly or excessively and unsafely exceeding posted speed limits.

The research provided insight into the impact of passing relief lanes in Michigan, and will help MDOT identify the most appropriate design and location for future installations. "This research provided us with an updated understanding of passing lanes' safety impacts and performance," Kanitz says.

MDOT was pleased with the Opus team's work.

"Opus was a newer company in Michigan and in North America, but we were familiar with their past work elsewhere," Kanitz says. "They had a team with the knowledge and expertise that we needed, and they provided a streamlined approach to the study analysis. They were very professional."

For more information, see report RC-1565 online or contact Dean Kanitz at kanitzd@michigan.gov.

Call for Research Ideas (FY 2015-17 Research Biennium)

Research Administration is soliciting research project ideas aimed at improving the way MDOT plans, builds, operates and maintains Michigan's transportation system. RA looks to partners both inside and outside MDOT to help identify key information needs and opportunities for innovation that can be addressed through research. To submit an idea for the FY 2015-17 research cycle:

- Review the MDOT Research Priorities for 2015/2016/2017 at www.michigan.gov/mdotresearch. Research Priorities are a guide to what research topics MDOT may be interested in further developing into a research project.
- Complete a Research Idea Form with a proposed research idea. The Research Idea Form can be obtained by requesting the form from Portia VanPelt at vanpeltp@michigan.gov or at 517-636-0033. Send the form by December 13, 2013, to mdot-research@michigan.gov.

Research Administration

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