HIGH VALUE RESEARCH 2025

Read the Fact Sheets:

High Value Research

1. Development of a Salt Spreader Controller Program Using Machine-Sensed Roadway Weather Parameters
2. Evaluating the Correlation Between Slip and Skid Resistance of Pavement Markings at Crosswalks
3. Implementing Roadway Context in Maine – Creating a Statewide Context Map and a Context-Sensitive Speed Limit Setting Tool
4. Precast Bridge Deck Panel Testing
5. Induction and Laser Ablation Coating Removal of Potentially Hazardous Bridge Coatings
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12. iTrain – Immersive Training of Department of Transportation Work Zone Inspectors using Virtual Reality
13. Intelligent Bridge Management (i-BM) Tool for Bridge and Culvert Deterioration Forecasting and Anomaly Detection based on Physics-Guided Deep Learning
14. Smart Data, Smarter Decisions: Maximizing Value in Transportation Data Investments
15. Approach Guardrail Transition Retrofit to Existing Buttresses and Bridge Rails
16. Investigating Implementation Potentials of Turbo Roundabouts in Nevada

Honorable Mention in the category of Safety, Security, and Emergencies

17. REAL-TIME TRAFFIC SIGNAL SYSTEM PERFORMANCE MEASUREMENT Phase III: System Integration, Intersection Deployment, and Control Center Dashboard Development
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19. Crash Data Analysis Tool (CDAT)
20. Counting Airport Operations Using Aircraft Transponder Signals and/or Aircraft Automatic Dependent Surveillance Broadcast Data
21. Utilizing Video Analytics with Connected Vehicles for Improved Safety
22. Connected and Automated Vehicles (CAVs) Attitudes and Perceptions
23. Anchorage Protected Bike Lane Pilot Study
24. Reduce Fatal & Serious Injury Crashes

Honorable Mention in the category of Maintenance, Management, and Prevention

25. Pavement Deterioration Models for Pavement Management
26. Innovative Techniques and Materials for Preventing Concrete Shrinkage Cracking
27. Developing a Cross Asset Allocation Mechanism
28. Development of Advanced Landslide Investigation Protocol Using Geophysical Methods for Mississippi
29. Electronic Water-Level Sensors for Monitoring Scour Critical Structures
30. Development of Test Procedures to Evaluate Moisture Susceptibility of Asphalt Mixtures Used in the State of Kansas, Phase I: Surface Free Energy of Binders
31. Repair Practices of Damaged Precast/Prestressed Concrete Girders

HIGH VALUE RESEARCH

massDOT
Massachusetts Department of Transportation

FACT SHEET

Development of a Salt Spreader Controller Program Using Machine-Sensed Roadway Weather Parameters

STUDY TIMELINE

April 2022 – July 2024

MassDOT CHAMPIONS

Mark Goldstein, Lead Statewide Snow & Ice Engineer

INVESTIGATORS

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Research and Technology Transfer

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FURTHER RESOURCES

https://www.mass.gov/doc/development-of-a-salt-spreader-controller-program-using-machine-sensed-roadway-weather-parameters-final-report/download

Brief Summary of the Research Project and Impact

Massachusetts treats more than 15,000 lane miles during winter. Delivering the deicing materials efficiently and effectively is critical to minimize the impacts of winter storms on road operations and reduce potential environmental impacts. Public agencies are actively searching for an optimized "formula" to minimize the utilization of the deicing material without affecting its effectiveness.

Implementation Status

Future efforts by MassDOT and municipalities will directly translate the outcome of this study to facilitate a successful implementation of the sensor-based spreader controller system in a more extensive fleet of winter operation vehicles. Based on the findings from this study, the developed solution will significantly reduce salt usage without degrading the performance of the treatment. The sensor-based system will cost-effectively apply to snow/ice remediation, treating the conditions with minimum operation intervention, leading to more environment friendly deployment and safer winter operation. The ultimate goal is to instrument the entire MassDOT winter operation fleet with a sensor-based system with real-time in-situ weather conditions and regional weather prediction, and to manage winter operations using an integrated coordination portal.

Potential Impacts and Benefits

The winter roadway deicing treatments sensibly includes a direct correlation between road weather and salt usage. Salt usage degrades road users' car frames, steel incorporated in bridges, and challenges ecosystems into compromise or in some cases, submission. Massachusetts has a growing list of chloride-impaired streams and water bodies, despite demonstrated achievements in using less salt. And, the costs of salt usage go far beyond the $75/ton price for salt. MassDOT was among the first entities to examine the efficacy of road-weather based salt applications. The direct benefit of this applied research is to leverage real-time roadway grip readings to inform road salt application rates on a salt spreader. The second phase of the study is currently underway to model and add the salt input necessary to address the precipitation expected to fall on the road.

HIGH VALUE RESEARCH

FACT SHEET

MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

Evaluating the Correlation Between Slip and Skid Resistance of Pavement Markings at Crosswalks

STUDY TIMELINE

04/2023 – 11/2024

AGENCY CONTACTS/CHAMPIONS

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Office of Materials Technology

INVESTIGATORS

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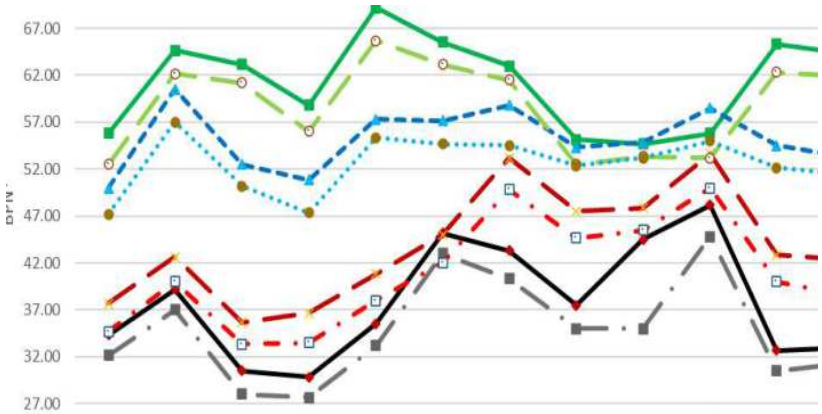
FURTHER RESOURCES

To view the complete report, click here.

Brief Summary of the Research Project and Impact

Pavement markings are crucial for ensuring the safe and efficient movement of vehicles, cyclists, and pedestrians at crosswalks. They provide essential guidance in lane navigation, road sharing, and safety compliance. With growing emphasis on safety in urban areas, crosswalk markings are becoming more prevalent. The primary objectives of this project were to (i) assess slip resistance for pedestrians, PSR, and skid friction for vehicles, TSR, on crosswalk areas where pavement markings are used, and (ii) relate vehicle pavement skid resistance to pedestrian slip resistance for a variety of conditions (wet versus dry, and/or icy conditions). The key findings of the study showed consistent performance across both PSR and TSR measurements in dry, wet, and icy conditions. While the statistical analysis confirmed the high repeatability of the BPT measurements, meaningful differences were observed between surface conditions (i.e., dry versus wet). All materials experienced reduced friction in wet and icy environments. Good relationships between lab and field data were established and related to the various surface conditions.



Implementation Status

The research findings allow the Maryland State Highway Administration to start the process of revising the British Pendulum Number (BPN) skid resistance specification requirement from 50 to 55 for pavement marking materials used in crosswalks and enhancing motorist and pedestrian safety.

Potential Impacts and Benefits

This investigation provided critical insights into the relationship between pedestrian slip resistance and vehicular skid resistance. The findings suggest that Maryland's current specifications, which focus on vehicle skid resistance, could be expanded to incorporate pedestrian slip resistance requirements for improved safety at crosswalks.

HIGH VALUE RESEARCH

FACT SHEET

MaineDOT

Implementing Roadway Context in Maine – Creating a Statewide Context Map and a Context-Sensitive Speed Limit Setting Tool

Brief Summary of the Research Project and Impact.

MaineDOT's project objectives were to bring travel speeds closer to speed limits, to improve safety for pedestrians and bicyclists, and to pursue a speed limit setting process which considered the surrounding environment. MaineDOT decided to implement a new, flexible speed limit setting process which considers roadway context. To assist practitioners and to promote consistent interpretation, MaineDOT also decided to create a statewide context map, using a data-driven approach to designate roads as Urban, Suburban, Village, Rural Town, or Rural.

MaineDOT developed this context map with internal staff based loosely on a methodology from a University of Kentucky research project. MaineDOT also developed a context-sensitive speed limit setting tool with internal staff. This tool is an adapted version of the tool developed in NCHRP Research Report 966 with significant changes to the user interface and the decision-making logic.

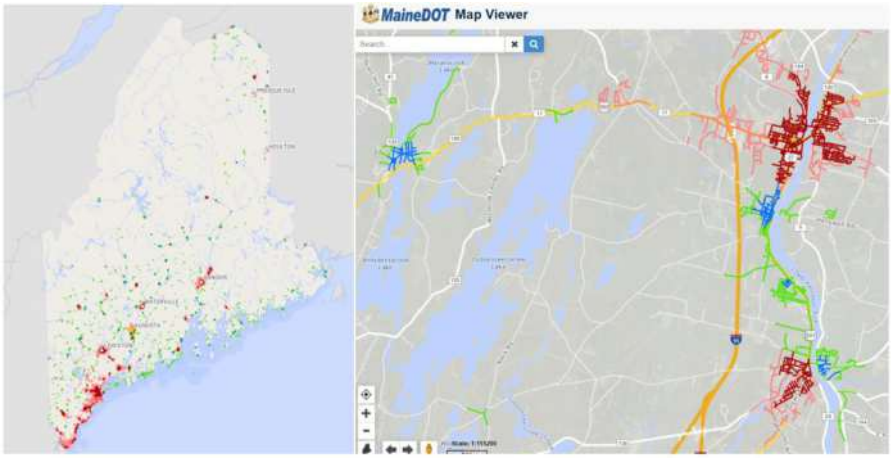


Figure 1- Images of the Context Map on MaineDOT's Public Map Viewer

Implementation Status

The context map has been fully implemented in MaineDOT's Public Map Viewer and context classification is now an official managed data set. The speed limit tool has also been fully implemented, and it is the official speed limit process for all Maine roads. The context map is also being used for project scoping as part of the new Complete Streets Policy. These tools are being used in conjunction with speed management strategies to calm traffic and improve safety where appropriate.

Potential Impacts and Benefits

These tools are being used to improve safety across the state, especially for active transportation users. This strategy helps implement strategies in the right places to maximize safety impact. The four "developed" contexts have 87% of Maine's pedestrian and bicycle crashes even though only 24% of Maine's VMT occurs on these roads.

STUDY TIMELINE

January 2023 – December 2024

MaineDOT CONTACTS/CHAMPIONS

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Dakota Hewlett, Active Transportation Planner

Steve Landry, State Traffic Engineer

INVESTIGATORS

Jeff Pulver, MaineDOT, PI

Brianna Spears, MaineDOT, Co-PI

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FURTHER RESOURCES

Link to project web page / StoryMap: 2024 Safety Initiatives

Link to context map on MaineDOT Public Map Viewer: https://www.maine.gov/mdot/mapviewer/?map=ezI4RENGQUNDLTQ2REQtMTFGMC1BMEYxLTAwNTA1NklzMUY5M30=

Link to speed limit video on MaineDOT YouTube: https://youtu.be/ScnlkvrCCK4?si=0meCmnTVBKDlKP76

HIGH VALUE RESEARCH

Pennsylvania Department of Transportation

FACT SHEET

Precast Bridge Deck Panel Testing

STUDY TIMELINE

08/01/2022 – 01/02/2025

AGENCY CONTACTS/CHAMPIONS

Stephen (Matt) McSweeney, Highway Administration Program Manager

INVESTIGATORS

David M. Mante, Ph.D., Lafayette College

For more information, please contact Matt McSweeney at smcsweeney@pa.gov

FURTHER RESOURCES

Final Report

Brief Summary of the Research Project and Impact.

Structural performance of the joints connecting precast concrete deck panels in bridge construction is an important area of study for precast bridge decks. Recognizing that these joints are vital to the overall integrity of precast bridge decks, the study focused on evaluating their flexural capacity under various conditions. Researchers conducted laboratory tests to compare different joint designs, paying particular attention to reinforcement configurations that align with regional practices such as the strategic placement of bottom reinforcing bars. The project also assessed alternative concrete materials for their compatibility and potential to enhance structural performance at the joints. By analyzing how different reinforcement details and materials behave under load, the study aimed to provide engineers with data-driven insights for optimizing joint design. Ultimately, the findings led to recommendations for revising PennDOT's standard joint detailing, with the goal of simplifying construction practices, reducing installation complexities, and improving the long-term performance and safety of bridge decks. These advances are expected to contribute to more efficient and cost-effective bridge construction and maintenance across Pennsylvania. A pilot project has been proposed to investigate the findings of this report.

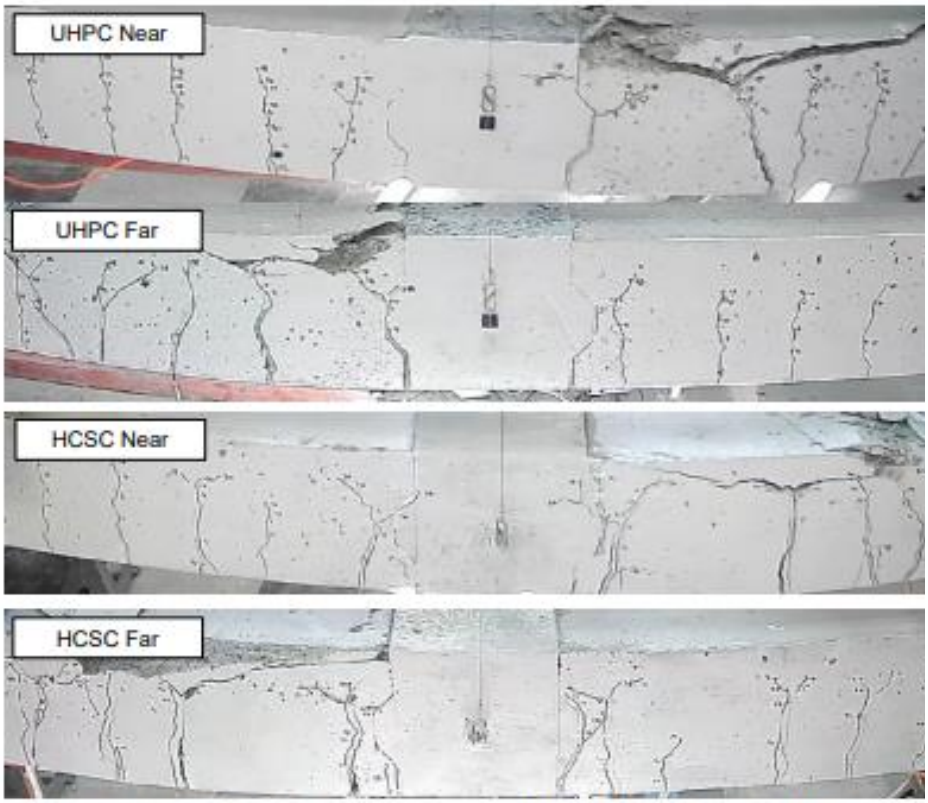

Figure 6-20: Elevation View of Cracking of D/D Panel Assemblages at Ultimate Flexural Capacity

Implementation Status

As a result of the experimental work, the research team proposed various revisions to current PennDOT design and construction standards that reflect proposed implementations. Specifically, joint details and geometries are proposed for longitudinal and transverse bridge deck panel joints with ultra-high performance concrete (UHPC). The use of various polymer concrete products is recommended for conditional use in various configurations of transverse joints only. Further research is recommended to evaluate the durability of various joint details under repeated service-level cyclic loading and to further explore the potential implementations of polymer concrete products in longitudinal closure pours.

Potential Impacts and Benefits

Enhancing bridge deck panel performance translates into safer, longer-lasting bridges with reduced maintenance costs, which is particularly vital for infrastructure in regions like Pennsylvania that face challenging environmental and traffic conditions. In addition to validating the structural aspects of the precast panels, the study supports more efficient construction practices by streamlining the design and installation processes, ultimately contributing to cost savings and improved reliability of the bridge deck system. It addresses a critical need in the field of bridge engineering by advancing our understanding of how to optimize critical structural joints for enhanced performance and durability. By incorporating these performance-based criteria into several of PennDOT's design standards, they can now ensure that new joints consistently meet required strength and longevity targets. Further evaluations into the durability of these deck panels are actively being discussed, and PennDOT has been working with states including New York, Virginia, and South Carolina who also have an interest in research related to precast panels.

HIGH VALUE RESEARCH

FACT SHEET

VDOT Virginia Department of Transportation

Induction and Laser Ablation Coating Removal of Potentially Hazardous Bridge Coatings

STUDY TIMELINE

May 2021 – September 2024

VDOT CONTACTS/CHAMPIONS

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Bryan Silvis, P.E., Bridge Maintenance Engineer

INVESTIGATORS

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Stephen Sharp, Ph.D., P.E., Virginia Transportation Research Council, Co-PI

Raquel Rickard, CIH, VDOT

Jim Fitz-Gerald, Ph.D., University of Virginia

Sean Agnew, Ph.D., University of Virginia

For more information, please contact Jason Provines at jason.provines@vdot.virginia.gov or Bryan Silvis at bryan.silvis@vdot.virginia.gov.

FURTHER RESOURCES

- VTRC Final Report: Evaluation of Combining Heat Induction and Laser Ablation for the Removal of Potentially Hazardous Bridge Coatings
- National Bridge Preservation Conference 2024 Presentation: Combining Heat Induction and Laser Ablation for the Removal of Potentially Hazardous Bridge Coatings
- VTRC Final Technical Assistance Report: Evaluation of the Mechanical and Metallurgical Properties of High Strength Bolts Subjected to Elevated Temperatures Due to Induction and Laser Ablation Coating Removal (available upon request)
- VTRC Final Report: Innovative Coating Removal Techniques for Coated Bridge Steel
- Journal Article: Assessing the Feasibility of Laser Ablation Coating Removal (LACR) on Legacy Bridge Steel: Coating Removal and Adhesion, and Effects on Mechanical Properties
- AASHTO AII: Laser Ablation Coating Removal

Brief Summary of the Research Project and Impact

Traditional abrasive blasting is effective for removing old coatings from steel bridges but requires large containment systems and extensive personal protective equipment (PPE) due to airborne blast media and hazardous waste. These challenges led VDOT to investigate innovative, alternative coating removal methods for smaller coating removal areas.

In 2019, VDOT completed an evaluation on laser ablation coating removal (LACR), which uses a laser to vaporize coatings before they are captured in an air emission control system. In 2024, VDOT completed another evaluation combining LACR with induction coating removal (ICR), which uses localized heat to de-bond coatings. The two methods were found to be complementary, with ICR efficiently removing bulk coatings and LACR removing the residual layers. Together, ICR and LACR removed coatings 10x faster than LACR alone.

Adhesion tests confirmed that zinc-based coatings applied to LACR-cleaned steel surfaces achieved acceptable adhesion. Importantly, both methods were shown to be environmentally friendly. With effective air emission control systems, LACR keeps hazardous air pollutants below OSHA limits, even for lead-based coatings, which minimizes the PPE requirements and eliminates the need for large containment systems.

This research earned selection as an AASHTO Innovation Initiative, highlighting its impact on bridge maintenance and preservation.

Implementation Status

VDOT has successfully implemented ICR and LACR into standard practice, using these methods for coating removal on two in-service steel bridges. These field demonstrations confirmed the effectiveness of ICR and LACR, illustrating faster coating removal rate and improved worker and environmental safety. These projects also showed that ICR and LACR can be best utilized in small areas of coating removal, such as in beam end repairs.

VDOT has developed a special provision for using ICR followed by LACR, with plans to incorporate it into the *2026 VDOT Road and Bridge Specifications*. This special provision requires surface temperatures, including those of beams, attachments, and bolted connections, be monitored with an infrared thermometer and remain below 400 °F. This temperature limit ensures effective coating removal while preventing any change to the mechanical properties of steel components or bolted connections.

VDOT also has an on-call contract in place to support future projects using ICR and LACR. Its primary purpose is to support VDOT work crews, enabling more efficient and effective repairs of steel beam ends. The contract has an approximate cost of $12,000 per bridge for coating removal of 100 ft^2 or less and re-coating, demonstrating the cost effectiveness of these two methods.

Potential Impacts and Benefits

VDOT's research on ICR and LACR has led to significant efficiency, safety, and cost benefits. When used together, ICR and LACR achieve coating removal rates 10x faster than LACR alone. Unlike traditional abrasive blasting, which requires large containment systems, these methods eliminate the need for costly containment and significantly reduce PPE requirements while still protecting workers and the environment. They also generate significantly less hazardous waste, lowering disposal costs and environmental impact.

By eliminating containment-driven project scopes, ICR and LACR make targeted maintenance possible, allowing coating removal and re-coating only where truly necessary. VDOT's on-call contract supports future ICR and LACR projects at approximately $12,000 per bridge, highlighting the cost effectiveness of these methods. VDOT plans to apply these methods to steel beam end repairs, including recoating, welded repairs, and repairs made using fiber-reinforced concrete such as ultra-high performance concrete (UHPC). With these innovative coating removal methods, VDOT can better allocate resources, reduce maintenance costs, and enhance safety and durability across its bridge inventory.

FACT SHEET

Transfer of Unmanned Aircraft Systems Technology to SCDOT for Enhanced Bridge Inspections

Brief Summary of the Research Project and Impact

Traditional bridge inspections require expensive equipment/vehicles and can put employees at risk when hazardous conditions are present. Unmanned aircraft systems, or drones, have been used by agencies across the nation for transportation related tasks. At SCDOT, they are most commonly used to enhance bridge inspections. While some SCDOT offices were already using these technologies, the agency had no standardized training, assessment or implementation plan for making this technology available statewide.

Clemson University's Center for Connected Multimodal Mobility (C2M2) and SCDOT partnered to improve the efficiency, safety and cost effectiveness of bridge inspections using the emerging technology. The research team first evaluated the effectiveness and potential benefits for drone inspections across South Carolina. SCDOT's main priority is improving the state's bridge inventory as many of our bridges are beginning to exceed their original lifespan. They found that using drones could expedite and supplement current bridge inspection processes.

Implementation Status

The C2M2 team developed an online training and assessment specific to SCDOT bridge inspections. Inspectors also attended a 2-day live "boot camp" to get hands-on experience with the technology. Attendees practiced pre-flight planning, execution, and finally the inspection itself. A Phase II of the project has been awarded to supplement the current implementation efforts and expand access across the state.

Potential Impacts and Benefits

SCDOT staff report easier access to hard-to-reach areas needing inspection and collecting much higher resolution images. Their inspections are more thorough and more accurate than before. The post-camp satisfaction survey reported that 92% of attendees would recommend the workshop and the new evaluation method to a colleague.

STUDY TIMELINE

March 2024- February 2025

SCDOT CONTACTS/CHAMPION

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Zach Follmer, IT Support Specialist

INVESTIGATORS

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Photo caption: Training attendees practice flights at the Unmanned Aircraft System's boot camp hosted at Clemson University. Attendees are now fully certified to perform drone bridge inspections.

FURTHER RESOURCES

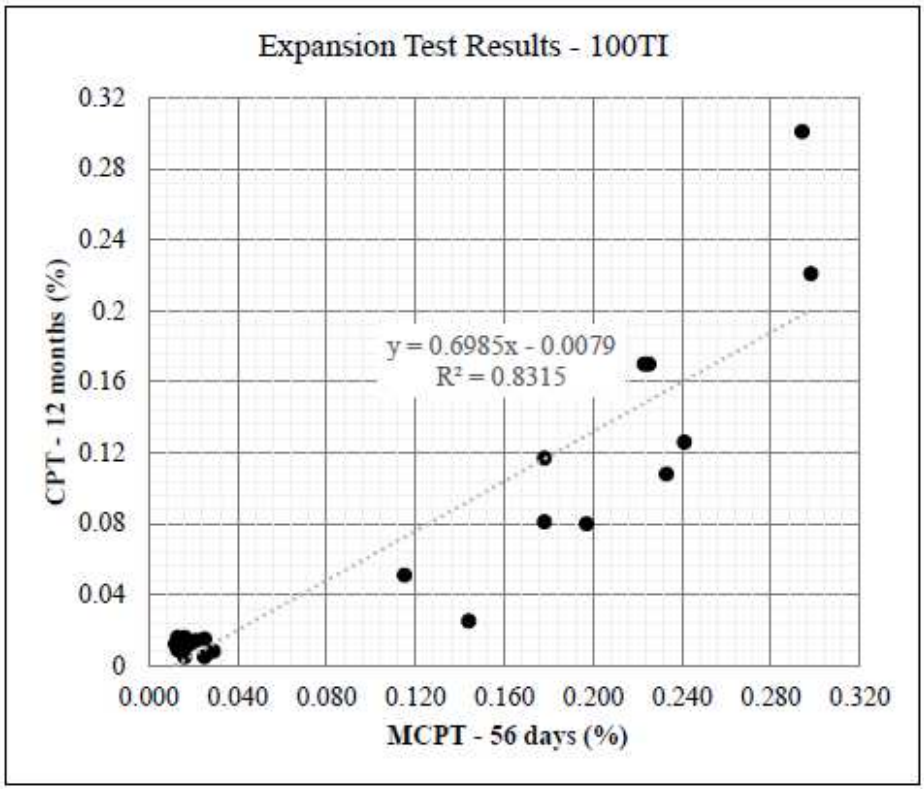
Final Report Link
Research Summary Link

FACT SHEET

Evaluation of the Miniature Concrete Prism Test (MCPT) for Use in LADOTD

Brief Summary of the Research Project and Impact.

Currently, there are two widely used testing methods to evaluate aggregates' alkali-silica reaction (ASR) potential: the concrete prism test (CPT) per ASTM C1293, and the accelerated mortar bar test (AMBT) per ASTM C1260. However, researchers have noticed that the AMBT method could produce false-positive and false-negative results, raising reliability concerns. The CPT method is a more reliable test method, but it takes one year to produce results for reactivity and two years to evaluate the effectiveness of the mitigation measures. This renders the test impractical for the routine assessment of aggregates' reactivity. In an effort to address the above limitations, the miniature concrete prism test (MCPT) was recently developed. A literature review showed that the MCPT method could produce reliable test results in 56 days in the published cases. In order to explore the suitability and feasibility of implementing the MCPT method for use in Louisiana Department of Transportation and Development (DOTD), this report presents a comparative study of the testing methods for the evaluation of aggregates' alkali-silica reactivity. The main impact is that after full adoption of the MCPT, aggregate acceptance procedures will move from a period of at least 1-year to a period of 90 days or less.



Implementation Status

STUDY TIMELINE

October 2019 – July 2024

LADOTD CONTACTS/CHAMPIONS

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Associate Director, Research

INVESTIGATORS

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FURTHER RESOURCES

https://www.ltrc.lsu.edu/pdf/2024/FR_700.pdf
https://www.ltrc.lsu.edu/pdf/2024/ts_700.pdf

The results of this project are currently being implemented and adopted by the Materials section of LADOTD. Specification changes have been drafted and are under review as well as ongoing testing of LADOTD's aggregate sources.

Potential Impacts and Benefits

The main benefit of this research project is the drastic reduction in time for the approval process for potential aggregate sources acceptance onto the Departmental Approved Materials List (AML) with regards to potential ASR reactivity. Current procedures require ASTM C1293 which is a 1-year long test method. By moving to the MCPT (AASHTO T380) test method, this 1-year long test is replaced with a test that takes 56-days to conduct. By switching to the MCPT, the Department can conduct the testing, review results, and make a decision on inclusion or exclusion of the aggregate source on the AML within 90-days of the request.

HIGH VALUE RESEARCH

FACT SHEET

Guidelines for Installing Pedestrian Treatments at Midblock Locations

STUDY TIMELINE

January 2019 – December 2020

AGENCY CONTACT/CHAMPION

Yujing "Tracey" Xie, P.E., District Four Traffic Safety Program Engineer,

INVESTIGATOR

Priyanka Alluri, PhD, PE, RSP_{2IB}

Florida International University, PI

Brief Summary of the Research Project and Impact.

Driving involves expectations about road users' actions, and design standards help make these actions predictable. However, pedestrians crossing midblock are at greater risk because drivers don't expect them, even though pedestrians often choose to cross there for convenience. In some cases, it makes sense to create marked and signalized midblock crossings to improve safety. This project investigated pedestrian safety for midblock crossings, focusing on crash-prone corridors and appropriate safety treatments. The project reviewed national, state, and local guidelines and identified factors influencing pedestrian crashes, including socioeconomic conditions, land use, roadway design, and infrastructure. The research team identified the top 20 pedestrian crash hotspots in the Florida Department of Transportation's (FDOT) District Four and compiled data on traffic, infrastructure, and population. Statistical analysis revealed numerous variables influencing pedestrian-vehicular crash risk potential, such as AADT, low-income populations, bus stop density, and nearby businesses. Conversely, factors like senior populations and overall population density were linked to fewer crashes. Using these insights and reviewed guidelines, the researchers developed Florida-specific guidelines for identifying corridors at risk and selecting suitable pedestrian safety treatments. These guidelines will help improve pedestrian safety on busy arterials and reduce crashes. As a result of this study, pedestrian median barriers were installed in District 4 at three locations (State Road 816 between NW 55th Ave. and NW 56 Ave., State Road 7 between Oakland Park Blvd. and NW 29th St., and State Road 7 between Broward Blvd. and NW Third Street) aimed at deterring pedestrians crossing at mid-block locations. The pedestrian median barriers were found to be effective in terms of reduction in mid-block crossings and pedestrian crashes. The results of the evaluation study have shown that guidelines in the research study could be utilized by local agencies throughout the State to improve pedestrian safety at midblock locations.

For more information, please contact Yujing "Tracey" Xie,
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FURTHER RESOURCES

https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-bdv29-977-49-rpt.pdf?sfvrsn=29334efe_2

https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-bdv29-977-49-sum.pdf?sfvrsn=95150d8f_4

Implementation Status

The implementation status is project implemented.

- SR 816 (Oakland Park Blvd.) between NW 55th Ave and NW 56th Ave - Installed between February 2017 and July 2017
- SR 7 (US 441) between Oakland Park Blvd. and NW 29th Street - Installed between July 2019 and May 2020
- SR 7 (US 441) between Broward Blvd. and NW 3rd Street - Installation from January 2024 to April 2024

Ongoing effort:
A safety study has been recommended to install a pedestrian channelization barrier along SR 7 between N. Hospital Dr and NW 6th Ct. An implementation strategy is in the works. Furthermore, the Development Design Standard Approval is one of the good resources for statewide pedestrian channelization barrier implementation. Please click the link below for more input. https://www.fdot.gov/design/standardplans/dev.shtm

Potential Impacts and Benefits

Pedestrian median barriers help improve safety by preventing people from jaywalking and encouraging pedestrians to cross at designated crossing locations. At the three locations where pedestrian median barriers are installed in FDOT District 4, we have seen a reduction in crashes. However, since these barriers were only installed recently, the data may not be statistically reliable. Nonetheless, based on professional judgement, pedestrian median barriers are considered to improve safety. We need more years of data and more locations to quantify the reduction in crashes that are statistically significant. The barriers will reduce not only crash frequency but also the crash severity; fewer fatal and serious injury crashes are expected to occur at the locations with barriers. Other benefits: In addition to the direct safety benefit in terms of reduced crash frequency and fatal and serious injury crashes, installing pedestrian median barriers along arterials reduces congestion and improves traveler comfort. The barriers do not have any operational cost and only have a minimum maintenance cost.

HIGH VALUE RESEARCH

FACT SHEET

Indiana Department of Transportation

Effectiveness of Contrast Markings on Roadways and Orange Markings in Work Zones

STUDY TIMELINE

July 2021 – September 2023

AGENCY CONTACTS/CHAMPIONS

Dave Boruff, Traffic Engineer

Joe Bruno, Traffic Engineer

INVESTIGATORS

Dr. Michael R. Williamson, Indiana State University/Kaskaskia Engineering, PI

Brief Summary of the Research Project and Impact.

Contrast pavement markings and orange colored pavement markings are believed to provide better delineation for motorists. While contrast pavement markings have been studied orange colored pavement markings are still considered experimental with past research projects having inconclusive results. An extensive literature review focused on work zone safety, pavement markings and driver behavior identified gaps in knowledge from previous research related to contrast and orange pavement markings, that helped to guide this research. The overall goal of this project was to reduce lane departure crashes on roadways, commonly resulting in severe types of crashes.

There were two research objectives for this project, quantifying the safety impacts of contrast pavement markings on light colored pavement and evaluating experimental orange pavement markings in work zones. The evaluation of the pavement markings followed a quantitative Highway Safety Manual (HSM) approach, prediction models were used to estimate the number of expected crashes and compared to the observed crashes at each test site to estimate the safety benefits, additionally comparison sites were used to control bias.

Implementation Status

Based on the findings of this project, the Indiana Design Manual is being revised to recommend expanded use of contrast markings. The revision has been drafted and is expected to go into effect in 2026. Since the project found that orange work zone markings have potential to improve safety and operations a follow up research as recommended is currently underway (SPR 4935). The goal of the second project is to confirm effectiveness and investigate design/pattern options, e.g. shadowing a standard color vs standalone. Orange markings have already been installed in several work zones for SPR 4935 and field work to verify the quality of the marking material (retroreflectivity, color) has been performed. The project is expected to conclude July 2027.

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FURTHER RESOURCES

Link to Final Report:
https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=3402&context=jtrp

Link to project web page:
https://www.in.gov/indot/about-indot/Blog/indot-tests-orange-pavement-markings/

Link to journal article:
https://docs.lib.purdue.edu/cgi/viewcontent.cgi?filename=0&article=3402&context=jtrp&type=additional
Etc.

Potential Impacts and Benefits

This research is part of the Federal Highway Administration's experimental process on orange pavement markings in work zones. The research has provided key insights into driver behavior in work zones with orange markings, public opinion of orange markings, and crash reductions linked to orange markings. Drivers were observed to center in their lane of travel at a higher rate than traditional stripped sections. The public opinion was positive overall with 82% of drivers preferring orange markings in work zones, and 81% of the drivers indicating orange markings made them more aware of the work zone. Driver's speeds were also found to be impacted; a sample of speeds found a 4-mph reduction in work zones with orange markings. Crash reductions were also identified, and a crash modification factor was developed showing a 74% reduction in lane departure crashes within the studied work zones. The study also evaluated contrast pavement markings on light colored sections of pavement identifying the safety impacts. The findings suggest that a reduction in lane departure crashes averaging 43% can be expected. The overall benefits of this project include decreased travel delays, economic savings due to crash reductions on roadways, and improved safety in work zones.

HIGH VALUE RESEARCH

FACT SHEET

Cost Effective Alternatives for Mitigating Debris and Environmental Impacts Around Bridge Piers

STUDY TIMELINE

July 2019 – December 2024

Ohio DOT CONTACTS/CHAMPIONS

Brandon Collett, Transportation Engineer

INVESTIGATORS

Jonathan Witter, The Ohio State University, PI

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research@dot.ohio.gov

FURTHER RESOURCES

Final Report SJN 135970.pdf
Final Fact Sheet SJN 135970.pdf

Brief Summary of the Research Project and Impact

Debris and scour mitigation techniques are often expensive, timely and can be very dangerous. This research addressed three key problems: 1) identifying safer, timely, and cost-effective solutions for removing accumulated debris from bridge piers, 2) designing and implementing countermeasures to prevent debris accumulation, and 3) finding technological solutions to enhance bridge inspection, scour detection, and mapping of river cross sections. The project evaluated various equipment solutions for debris removal, ultimately developing and testing a custom knuckleboom crane with grapple and saw attachments. Numerous methods and materials were also evaluated to develop strategies to mitigate debris accumulations and counteract scour. Three chevron vane structures were designed and implemented at SR 122 over the Great Miami River to better align river flow and direct debris away from piers. Additionally, a cross-vane structure was implemented at SR 52 over Ray's Run to address scour of the abutments. The research also explored remote, non-contact methods to aid in subsurface investigations for bridge inspection at sites with deep water where visual inspections and manual probing were ineffective.

Implementation Status

The knuckleboom crane with grapple and saw attachments was tested on 60 debris removal projects and 18 other projects (e.g. rip rap placement, etc.). Labor needs for small projects completed internally were reduced by 43% on average. Larger projects typically completed by contractors over many months could now be completed in weeks by Ohio DOT forces with ~80-90% reduction in cost. The equipment was able to reduce environmental permitting requirements and minimize road closures to a single lane and better maintain traffic. Worker safety and work quality were improved over previous methods. The knuckleboom has also been utilized in clean-up efforts from tornados. The chevron vane structures results in greatly reduced debris snagging on piers, but it was not

fully eliminated. Cross vane structures have shown that debris removal in conjunction with the mitigation measures are highly effective. The project remedied systemic degradation of the streambed and halted scour. The remote technologies provided valuable data for evaluating scour and establishing repeatable cross sections for change detection in subsequent bathymetric surveys. To facilitate technology transfer, multimedia educational materials were developed. Recently, the technologies are being used to help identify buried wells in lakes.

Potential Impacts and Benefits

The research suggests debris removal via the knuckleboom crane is highly effective. Results also indicate the approach is economical with return-on-investment in less than 1-year. Where debris is problematic, the equipment should be utilized broadly. Debris mitigation measures were effective; however, implementation is likely best at small sites due to complexity and costs associated with working in large rivers. Scour detection and bathymetric surveys can be completed effectively with sonar. A single unit likely meets statewide needs.

HIGH VALUE RESEARCH

DEPARTMENT OF TRANSPORTATION

FACT SHEET

Complete Streets Speed Impacts

STUDY TIMELINE
September 2023 – June 2024

MnDOT CONTACTS/CHAMPIONS
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INVESTIGATORS
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FURTHER RESOURCES
Final Report
Project Page
Crossroads Blog Post

Brief Summary of the Research Project and Impact.

To safeguard and accommodate all road users, MnDOT and local agencies have followed the Complete Streets approach when building and converting the state's roads. The approach uses site characteristics to create a safer, more accessible environment for all road users. New research demonstrates that roadway design features have a measurable impact on driving speeds. The development of speed reduction factors (SRFs) that estimate the impact of road features on speed reduction provides a data-driven approach to highway design.

Speed limits have conventionally been set based on vehicle interactions with road design and features. The Complete Streets approach emphasizes roadway conditions and speeds that prioritize access to all road users. Field data was needed to determine whether specific road features installed on Minnesota roads may cause changes in driving speeds. This information could provide guidance for future road design and speed limit targets.

The aim of this study was to examine the relationship between travel speeds and various design elements within the context of Complete Streets to develop SRFs. An initial review of existing research compared studies of various road features that have been deployed to improve performance and accessibility, such as medians, curbs, on-street parking, bicycle facilities and sidewalks.

Implementation Status

In the field, roadway segments were identified that emphasized certain road characteristics. Road corridors approaching smaller communities provided an opportunity to evaluate driver behavior as vehicles transitioned from higher speed limits on highways to lower speed limits on in-town roads. Also, locations with different roadway types and features allowed researchers to study multiple SRFs.

Nineteen roadway corridors were selected that included 16 different road characteristics, encompassing both rural and suburban communities.

Data analysis included statistical correlation between driving speeds and road features. Although posted speed limits remained a factor, the study design sought to account for the effect of other speed influencers.

Analysis of speed data from the 19 locations demonstrated measurable changes to traveling speeds when drivers encountered various design features. Although this study was not able to compare speeds before and after changes to design features during road conversions, collecting data across multiple sites allowed for statistical comparison and estimation of SRFs.

Single-lane roundabouts demonstrated the greatest reduction in average travel speed of 7 mph. Also noteworthy was the 3.1 mph reduction for raised medians. Depressed medians evidenced a 1.3 mph speed reduction. Other features with noteworthy speed decreases were on-street parking (1.7 mph), crosswalks (1.3 mph) and curbs with gutters (1 mph).

Potential Impacts and Benefits

Communities continue to express interest in slower, safer roads, and these results can help MnDOT and local agencies to better forecast impacts on speed when using Complete Streets principles to design roads for all users.

The demonstrated effect of roadway features on driving speeds provides an opportunity to use the data in designing standards for future road construction and conversion. Other roadway attributes not addressed in this study, such as transit lanes, bus stops, road curves and urban corridors, may also offer promising topics for speed research using a similar study methodology.

The project technical advisory panel found the results beneficial and determined that further study is warranted. This ultimately lead to the funding of a follow-up project, Speed Impacts on Complete Streets Elements, Phase II, which will look at factors including how driver speed selection varies when non-motorized users are present. Design factor effects on speed that will be investigated include:

- What is the impact on speed reduction based on length of median?
- What is the impact on speed based on street parking utilization?
- Comparing speed impacts between curb and gutter and parking lanes.

HIGH VALUE RESEARCH

FACT SHEET

iTrain – Immersive Training of Department of Transportation Work Zone Inspectors using Virtual Reality

STUDY TIMELINE

Aug 2021 – Sept 2024

MoDOT CONTACTS/CHAMPIONS

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Michael Todd, Training & Accountability Coordinator

INVESTIGATORS

Praveen Edara, Mizzou, PI

Zhu, Qing , Mizzou

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FURTHER RESOURCES

https://mospace.umsystem.edu/xmlui/handle/10355/104062

Brief Summary of the Research Project and Impact.

The iTrain project, in collaboration with the Missouri Department of Transportation (MoDOT), aimed to enhance work zone safety training of MoDOT staff through the development and implementation of Virtual Reality (VR) training modules. These modules were designed to provide immersive, realistic, and interactive scenarios to enhance knowledge retention, engagement, and practical skills application in work zone training courses.

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Implementation Status

The developed VR training modules were integrated into MoDOT's Advanced Work Zone Training and Flagger Training courses. For Advanced Work Zone Training, the modules focused on understanding typical applications and identifying deficiencies within work zones. For Flagger Training, the module emphasized hands-on practice of the 3-2-1 Cone Procedures. Both training programs incorporated measures of participants' actions and post-training surveys. Feedback from the surveys indicated high levels of training effectiveness and participant satisfaction of the realistic work zone representations and ease of VR use. Behavioral performance measures, not feasible with traditional training methods, showed that participants effectively performed flagger operations and identified work zone deficiencies

Potential Impacts and Benefits

The VR training modules developed through the iTrain project have proven to be effective tools for enhancing work zone safety training. The integration of advanced VR technology offers a promising approach to supplementing traditional methods and providing a more immersive, interactive, and effective training experience. The developed VR modules are intended for continued use in MoDOT training. The flexibility of VR training allows it to meet a variety of needs, staff backgrounds, and makes it suitable for different training purposes.

HIGH VALUE RESEARCH

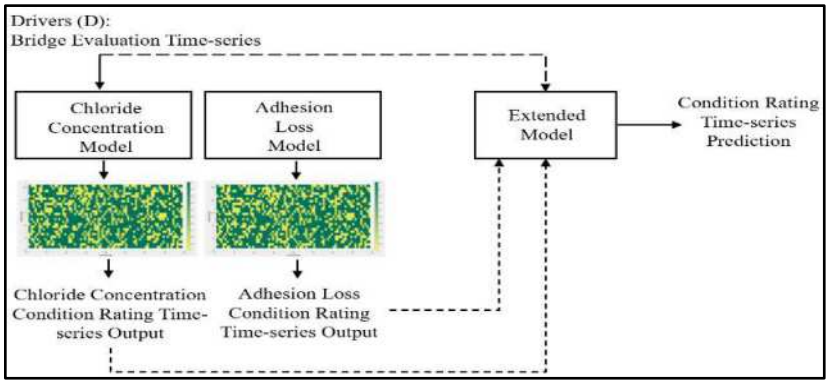
COLORADO
Department of Transportation

FACT SHEET

Intelligent Bridge Management (i-BM) Tool for Bridge and Culvert Deterioration Forecasting and Anomaly Detection based on Physics-Guided Deep Learning

Brief Summary of the Research Project and Impact

Two Colorado Department of Transportation (CDOT) research projects, studies R223.01 and its underpinning project R220.04, have led to the creation of an advanced software tool to guide bridge management. The Intelligent Bridge Management tool (i-BM) is a hybrid of a deep learning (DL) model, a form of machine learning, combined with a physics-based model enabling the advanced capability to perform in a more complex environment. Both models were developed using the large database of past bridge condition information. The tool provides two important products: (1) bridge deterioration forecasting used for planning decisions, and (2) bridge performance anomaly detection which can indicate potential premature bridge failures/accidents.



Example of Deep Learning module for effect of chloride on bridge deck & condition rating

Implementation Status

The i-BM tool complements the existing CDOT bridge management system and results in improved safety and reduced costs. Safety is improved because of early failure detection using anomaly analysis, and bridge maintenance costs are reduced because more accurate bridge deterioration forecasts lead to cost-effective and efficient bridge maintenance planning. The university research team is pursuing a patent and commercialization. They intend to further improve the technique and create a broadly available product. They also intend apply the hybrid-model method to other transportation asset management needs.

Potential Impacts and Benefits

The integration of the hybrid data-driven and physics-based deep learning model into CDOT's bridge management practices is optimizing the use of limited available resources to maintain our bridges and culverts. Use of the Intelligent Bridge Management (i-BM) tool provides several advantages and benefits: (1) a more precise forecast of bridge performance and future condition rating, both for individual bridges and for groups of similar bridges; (2) the identification – using clustering analysis – of bridges whose performance appears to be compromised by the use of specific materials or structural engineering choices; and (3) the prevention of accidents and failure of bridge components through early detection deterioration.

STUDY TIMELINE

January 2023 – December 2025

CDOT CONTACTS/CHAMPIONS

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Thien Tran, P.E., Research Project Manager

INVESTIGATORS

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Dr. Kevin Rens, University of Colorado, Denver

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FURTHER RESOURCES

Final Report
Research Brief
Presentation Slides

HIGH VALUE RESEARCH

FACT SHEET

Smart Data, Smarter Decisions: Maximizing Value in Transportation Data Investments

STUDY TIMELINE

January 2024 – December 2024

IDAHO TRANSPORTATION DEPARTMENT CONTACTS/CHAMPIONS

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FURTHER RESOURCES

https://apps.itd.idaho.gov/apps/research/Completed/RP307.pdf

Brief Summary of the Research Project and Impact.

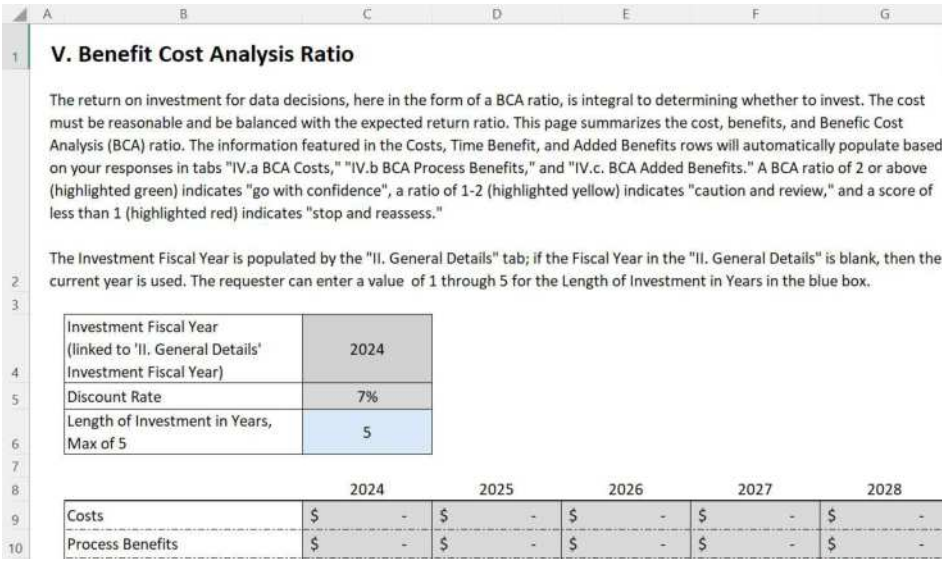
State DOTs increasingly rely on internal and third-party data to guide decision-making—but assessing the value of that data can be difficult. In response, ITD conducted a research project to develop clear, consistent tools for evaluating whether a data investment is worthwhile.

The project produced two practical tools:

- Data Purchase/Pilot Abstract Proposal (DPAP): A short-form tool for smaller data purchases or pilot projects, designed to help staff clearly define the purpose, cost, and expected benefit.
- Data Investment Needs and Evaluation (DINE): A detailed, spreadsheet-based tool for larger investments that facilitates in-depth review by multiple stakeholders.

To develop and refine these tools, the research team conducted a literature review, surveyed transportation professionals, and tested the tools using real-world datasets ITD had purchased or considered. This ensured the tools were tailored to ITD's needs.

With these tools, ITD now has a framework to support more transparent, informed, and cost-effective data investment decisions. The approach promotes collaboration across departments, improves documentation, and helps ensure that limited funds are directed toward high-value data that advances ITD's mission.



V. Benefit Cost Analysis Ratio

The return on investment for data decisions, here in the form of a BCA ratio, is integral to determining whether to invest. The cost must be reasonable and be balanced with the expected return ratio. This page summarizes the cost, benefits, and Benefic Cost Analysis (BCA) ratio. The information featured in the Costs, Time Benefit, and Added Benefits rows will automatically populate based on your responses in tabs "IV.a BCA Costs," "IV.b BCA Process Benefits," and "IV.c. BCA Added Benefits." A BCA ratio of 2 or above (highlighted green) indicates "go with confidence", a ratio of 1-2 (highlighted yellow) indicates "caution and review," and a score of less than 1 (highlighted red) indicates "stop and reassess."

The Investment Fiscal Year is populated by the "II. General Details" tab; if the Fiscal Year in the "II. General Details" is blank, then the current year is used. The requester can enter a value of 1 through 5 for the Length of Investment in Years in the blue box.

Investment Fiscal Year (linked to 'II. General Details' Investment Fiscal Year)	2024
Discount Rate	7%
Length of Investment in Years, Max of 5	5

	2024	2025	2026	2027	2028
Costs	$ -	$ -	$ -	$ -	$ -
Process Benefits	$ -	$ -	$ -	$ -	$ -

Implementation Status

While the tools developed in this research project have not yet been fully implemented throughout ITD, initial steps have been taken to support their future use. The High Street research team provided virtual training sessions to ITD staff, to introduce both the DPAP and DINE tools and to demonstrate how they can be applied to real-world data investment decisions. These sessions helped build awareness and laid the groundwork for agency-wide adoption. Internal coordination is underway to identify opportunities for piloting the tools within current and upcoming data collection and procurement efforts.

Potential Impacts and Benefits

By developing the DPAP and DINE tools, ITD now has an objective, structured approach to evaluating data purchases, ensuring that investments are cost-effective and support the agency's mission. These tools help ITD avoid common pitfalls such as duplicate purchases, underutilized data, and inadequate vetting of third-party vendors.

The financial implications are substantial. During testing, ITD identified opportunities to improve procurement efficiency and eliminate unnecessary costs, directly benefiting the state's transportation budget. The tools also enhance data governance and accountability, ensuring that all investments undergo rigorous review before approval.

This research provides a replicable model for other transportation agencies, demonstrating how structured data evaluation methods can maximize ROI, improve operational efficiency, and enhance public trust in transportation investments.

HIGH VALUE RESEARCH

FACT SHEET

NEBRASKA
Good Life. Great Journey.
DEPARTMENT OF TRANSPORTATION

Approach Guardrail Transition Retrofit to Existing Buttresses and Bridge Rails

STUDY TIMELINE

July 2021 to May 2024

AGENCY CONTACTS/CHAMPIONS

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Emilie Hudon, Bridge Engineer

INVESTIGATORS

Scott Rosenbaugh, Principal Investigator – University of Nebraska Lincoln

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FURTHER RESOURCES

Final report is available:
HERE

Brief Summary of the Research Project and Impact.

The Nebraska Department of Transportation (NDOT) frequently applies roadway overlays to the surface of bridges to extend the bridge's lifespan. To minimize repair costs, NDOT does not desire to replace or alter any bridge rails with adequate structural capacity and height. Bridge rails installed to NCHRP Report 350 or MASH standards are likely to remain in place, though their effective heights would be reduced by the overlay. This creates a problem of attaching new, 31-in. tall approach guardrail transitions (AGTs) to existing concrete bridge rails and buttressess (after an overlay) that were not designed for such connections and the resulting system may not be crashworthy to current safety standards. The objective of this project was to develop retrofit options for attachment of thrie-beam AGT systems to existing NDOT bridge railings and buttresses. The project began with a review of existing bridge railings and end buttresses used by NDOT to identify issues related to connection hardware alignment and crash safety performance. Retrofit options were then developed to address these issues while adhering to established design criteria. A new connector plate assembly was designed to facilitate the attachment of the thrie-beam terminal connector to these bridge railings and buttresses. Additionally, three retrofit concepts, including concrete fill, a steel assembly, and a curb, were considered to mitigate concerns related to vehicle snag below the thrie beam. These selected retrofit concepts were evaluated through a combination of structural analysis and computer simulated crash tests. All simulations of the AGT attached to these buttresses through these retrofit concepts met MASH TL-3 safety performance criteria.

Implementation Status

The information provided by this research is being implemented into NDOT's Roadway Special Plan. The retrofit provided in this research will allow for time and money savings, as well as increase the safety of construction workers and the public by reducing construction time. This research allows the use of a connection plate at the existing concrete buttresses to connect to the guardrail. Previously, the concrete buttresses had to be completely removed and reconstructed to allow for the connection to the guardrail when an asphalt overlay was placed on the bridge. In fact, the development of cost-effective retrofit options was confirmed by attaching a new, 31-in. tall AGTs to existing NDOT bridge rail and parapet designs. This research has a cost saving estimate of $600,000 in the 2026 fiscal year alone, with similar estimates savings in other upcoming fiscal years.

Potential Impacts and Benefits

The retrofit provided in this research will allow for time and money savings, as well as increase the safety of construction workers and the public by reducing construction time. The cost saving estimate of $600,000 in the 2026 fiscal year alone, with similar estimates savings in other upcoming fiscal years.

HIGH VALUE RESEARCH

FACT SHEET

Investigating Implementation Potentials of Turbo Roundabouts in Nevada

STUDY TIMELINE

August 2021 – March 2024

NDOT CONTACTS/CHAMPIONS

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INVESTIGATORS

Kakan Dey, West Virginia University Research Corporation, PI

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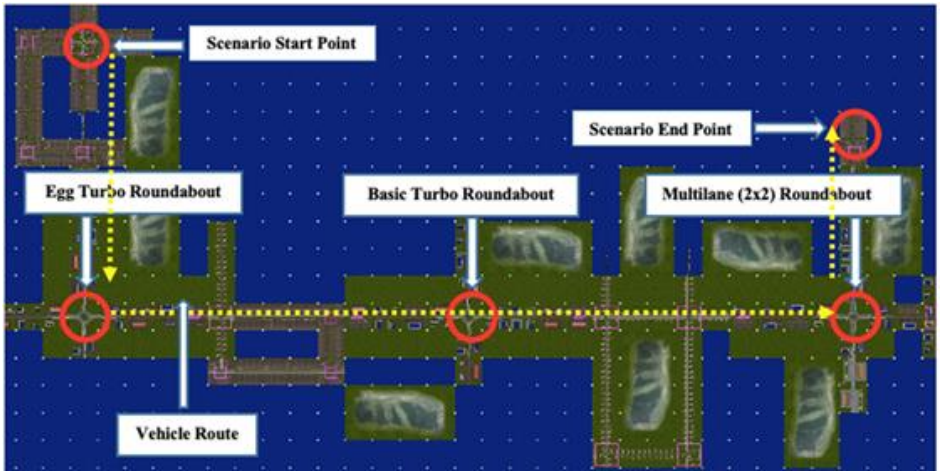
FURTHER RESOURCES

Link to final report

Brief Summary of the Research Project and Impact.

The "turbo roundabout" offers promise to improve operations and reduce the limitations of multi-lane roundabouts by utilizing unique geometric design features that effectively guide drivers within the roundabout and limit lane changes and the associated lane-change-related weaving conflicts and crashes. Whereas turbo roundabouts were first designed and implemented in the Netherlands and widely used in European countries, they remain a relatively novel concept in the US. The primary goal of this project was to investigate the feasibility of novel turbo roundabout designs as an intersection treatment in Nevada. This project performed operational and safety evaluation by conducting two-fold comprehensive investigations: microsimulation-based studies and driving simulator experiments. The extensive microsimulation-based evaluation considered larger US designed vehicles and assessed safety and operational performance, while the driving simulator-based experiments examined human factors to gain insights into driver behavior in navigating turbo roundabouts. More specifically, this project demonstrated the safety and operational benefits of turbo roundabouts over traditional two-lane and single-lane roundabouts. The findings indicated that the egg turbo and basic turbo roundabouts are the most suitable intersection controls for traffic volumes up to 2,800 passenger cars per hour and 3,300 passenger cars per hour, respectively.



Driving path for simulation scenario

Implementation Status

NDOT is incorporating the findings from this project into the ongoing Two-Stage Intersection Control Evaluation (ICE) methodology. The study findings and tool allow for understanding of what Turbo Roundabouts are, where they fit within the hierarchy of roundabouts for volume and footprint, and utilizing the tool to quickly compare single lane, turbo, and two-lane roundabouts for existing and future year conditions without the need for complex analysis tools. This allows practitioners to quickly screen viable options, reducing the number of alternatives required in the more complex Stage Two evaluations.

Potential Impacts and Benefits

This project presents definitive operational and safety performance measures for two commonly adopted turbo roundabout designs compared to traditional intersection control types that can be used by design engineers in Nevada and other states in the United States. This project compared driver behavior in navigating turbo roundabouts with traditional single-lane and two-lane roundabouts to facilitate the adoption of this emerging intersection control type. An Intersection Control Evaluation tool was developed to assist the Nevada DOT in comparing the performance of turbo roundabouts with stop-controlled and single-lane and two-lane roundabouts. The Nevada DOT has integrated the ICE tool developed from this research work to assist intersection design engineers in promoting turbo roundabouts in addition to other conventional intersection control types. As documented in this project, the significant benefits of turbo roundabouts over other intersection types are: (1) Turbo roundabouts reduce the risk of traffic crashes compared to traditional single-lane and two-lane roundabouts. For example, a basic turbo roundabout reduces the risk of traffic crashes by 18-30% compared to a traditional two-lane roundabout. (2) Turbo roundabouts substantially reduce the severity of crashes. This study found that the injury crash risk at a turbo roundabout is 80% and 70% lower than at traditional multi-lane and single-lane roundabouts.

HIGH VALUE RESEARCH

FACT SHEET

REAL-TIME TRAFFIC SIGNAL SYSTEM PERFORMANCE MEASUREMENT Phase III: System Integration, Intersection Deployment, and Control Center Dashboard Development

STUDY TIMELINE

December 2022 – June 2024

AGENCY CONTACTS/CHAMPIONS

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Research Project Manager

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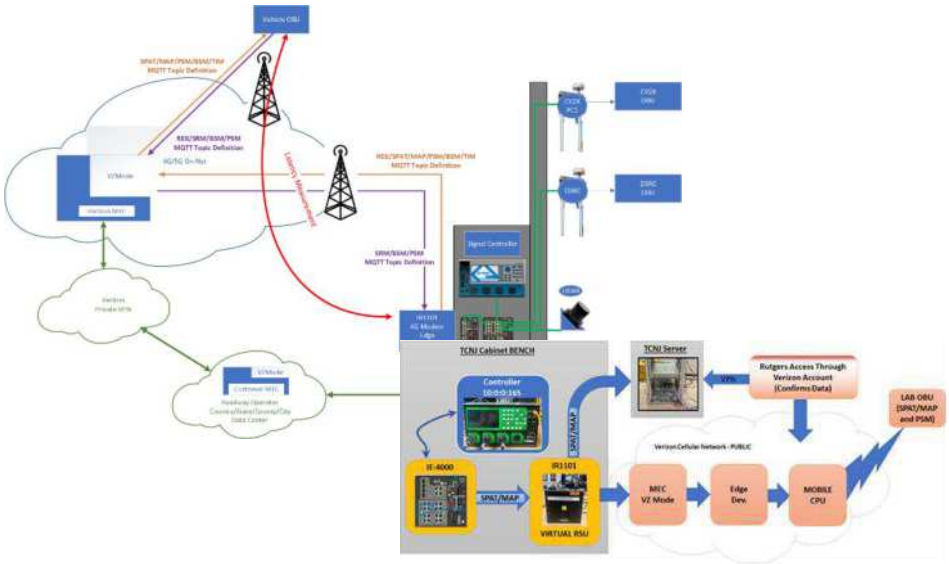
FURTHER RESOURCES

https://www.njdottechtransfer.net/2018/01/01/research-project/?pdb=72

Brief Summary of the Research Project and Impact.

The project demonstrated a scalable, cost-effective ATSPM approach to improving arterial signal operations and safety through advanced sensing and communication technologies. The enhanced ATSPM platform has been deployed across 72 intersections using SCATS and Autoscope systems. C-V2X technologies via virtual RSUs over cellular networks for real-time messaging and pedestrian safety has been piloted at a closure testing intersection. Deployment conditions of LiDAR and CCTV sensors were evaluated for traffic detection, and a web-based dashboard was developed for visualizing and assessing ATSPM and C-V2X data.



Implementation Status

The ATSPM platform was deployed at 72 intersections across four corridors using SCATS and Autoscope systems. SCATS and Autoscope data archiving was implemented through scheduled scripts and GUI automation, with thousands of files processed and efforts underway to enable full automation. A pilot deployment of virtual RSU C-V2X technology was completed at the NJDOT Bordentown Training Center, integrating LiDAR sensors, edge computing, and cabinet-to-pole infrastructure. SPaT messages were successfully retrieved and validated at the TCNJ lab, confirming effective C-V2X and ATSPM integration.

Potential Impacts and Benefits

The enhanced ATSPM platform leverages SCATS and Autoscope data, avoiding on-site sensor installation and controller reconfiguration, saving a total of $2.52 million materialized ATSPM deployment cost. The pilot of virtual RSUs enables C-V2X functionality via geo-fencing and cellular messaging without physical RSUs, supporting scalable deployment with ATSPM system that allow potential savings at the rate of $8,000-10,000 per vehicle. The pedestrian-in-crosswalk warning system is validated in lab and testbed settings, shows strong potential of better reducing pedestrian crashes at intersections.

HIGH VALUE RESEARCH

Pennsylvania Department of Transportation

FACT SHEET

Flood Mitigation Solutions

STUDY TIMELINE

07/01/2021 – 09/01/2022

AGENCY CONTACTS/CHAMPIONS

Richard Heineman, Roadway Programs Manager

INVESTIGATORS

Virginia Smith Ph.D., Villanova University

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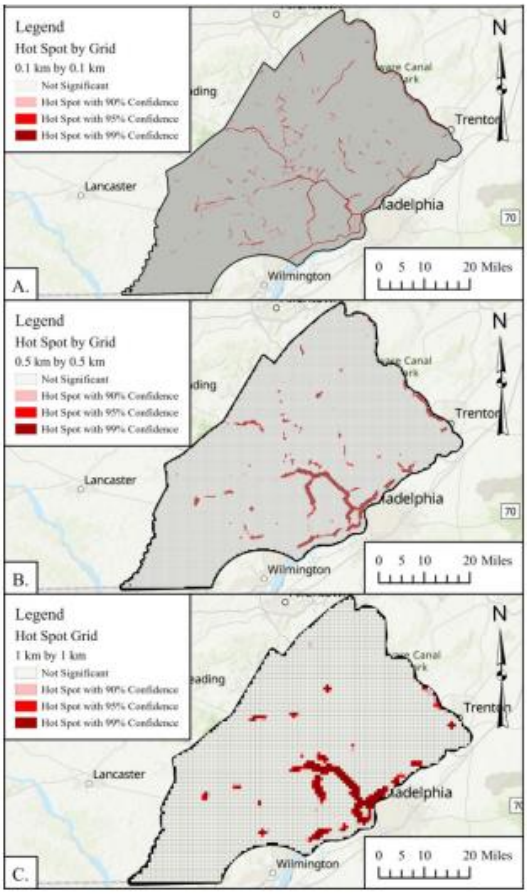
FURTHER RESOURCES

Final Report

Brief Summary of the Research Project and Impact.

Expanding watershed development is increasing demands on roadways and worsening flooding. This research study applied technological advancements like LiDAR and near IR cameras, and harnesses data analysis to identify actions that lead to greater resiliency in response to stormwater inundation of roadways. The report addresses key research questions related to identifying repeat inundation points, efficient methods for identifying inundated areas, the system impact of flood inundation on safety and operation, and effective mitigation measures. Tasks included identifying risk variables for flood inundation, reviewing techniques to deploy LiDAR, near IR, using drones to identify flood inundation, assessing impacts of inundation in terms of safety, network flow, and infrastructure sustainability. The outcomes included creating a baseline of analysis techniques, conducting spatial analysis to identify flood risk hotspots, and performing multiple regression analysis to predict bridge closures due to flooding.



Hot Spots of potential flood impacted roadways

Implementation Status

Implementation of this study is still in its early stages as widespread adoption throughout the Districts will require significant investment. Using advanced monitoring technologies such as flood prediction models and early warning systems can improve response strategies around the state and educating the Districts on these benefits has been key in initial implementation. A pilot project to create a working model for Engineering District 8-0 in Harrisburg and utilizing the hotspots generated is being discussed as the first step to widespread adoption. Along with this additional confirmation of costs compared to benefits, official PennDOT publication updates and additional funding for staff and equipment are likely hurdles for full statewide implementation of these solutions.

Potential Impacts and Benefits

This research provided PennDOT with data-driven insights and tools to enhance roadway resilience, improve safety, and ensure the long-term sustainability of their infrastructure in the face of increasing flood risks.

- Based on the outcomes of this research, PennDOT was able to update their PennDOT Drainage Manual (Publication 584) to update flood mitigation options and there is additional work being done to coordinate with a District to further implement the geospatial solutions and provide further updates to Pub 584.
- Cost-benefit analyses will be required to determine which specific technology is most beneficial to implement in specific locations, but the underlying processes and methods to use these prediction methods have been established by this project

HIGH VALUE RESEARCH

TEAM KENTUCKY
TRANSPORTATION CABINET

FACT SHEET

Crash Data Analysis Tool (CDAT)

STUDY TIMELINE

July 2017-June 2018; July 2020-June 2021

Kentucky Transportation Cabinet CONTACTS/CHAMPIONS

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INVESTIGATORS

Eric Green, PhD, Kentucky Transportation Center, PI

Paul Ross, Kentucky Transportation Center

Megan White, Kentucky Transportation Center

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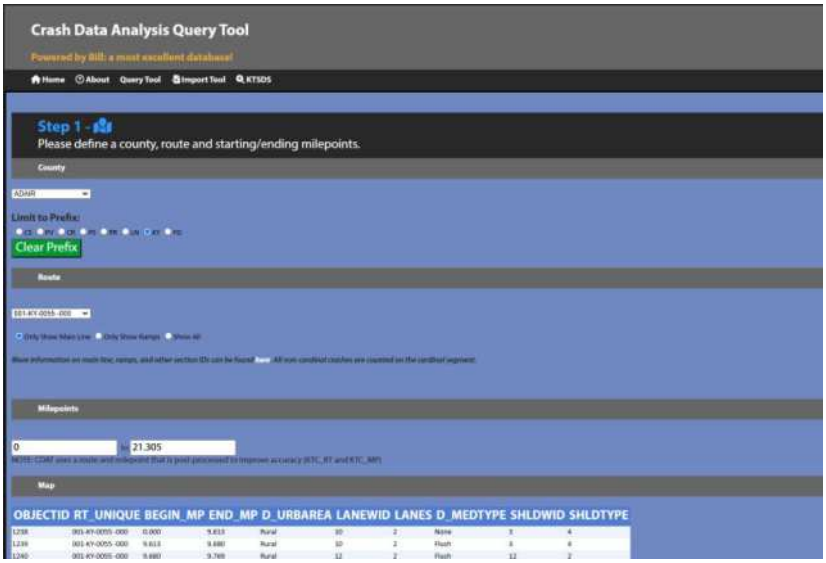
FURTHER RESOURCES

Link to final report
Link to final report 2.0
Link to project web page
Link to training video

Brief Summary of the Research Project and Impact.

Kentucky State Police provides a feature-rich crash access tool for public and private (secure) access called "KYOPS". This secure portal is sufficient for tabulation and rudimentary analysis; however, advanced crash analysis can require significant data post-processing. The Transportation Cabinet monitors lane departure, cable crossover, and other specific crash types routinely. These crash types are based on complex algorithms using several crash and roadway characteristics, and they are stored as crash flags that are easy to query against but absent from KYOPS. Many of these flags are research-backed and new flags are being created, often based on Highway Safety Manual (HSM) guidance. A tool was needed to leverage these flags for high quality safety analysis.



Implementation Status

This project resulted in a live, web-based tool to access crash and roadway data, a mapping interface, functionality for intersection analysis, and several training videos and user's guide for CDAT. Use of the tool has been tracked via logging on the server. The tool has nearly 300 active users and has been accessed over 3200 times since 2022. Use of the tool greatly enhances the way KTC, KYTC, and consultants access and analyze crash data. Moreover, this tool ensures consistency of crash analysis in Kentucky because all users employ the same crash codes to identify specific emphasis areas.

Potential Impacts and Benefits

We've taken a process that would have required complex algorithms, detailed knowledge of crash data, and merging multiple databases (all things that would require robust computing) and turned it into a web application that can be supported on a mobile device. We've enhanced CDAT with advanced mapping powered by ESRI's ArcGIS mapping tool, added separate intersection and segment analysis, and worked with KYTC to ensure that this tool is integrated with the Continuous Highway Analysis Framework (CHAF).

By making this a web-based tool, we've allowed users to bypass the complex equipment needed for housing and querying large data. Computational load is handled server-side, making this tool available to anyone with a modern web browser. The built-in logic for safety analysis relies on industry standard techniques, saving users time. Output includes charts, graphs, and maps which aid in faster report-making. CDAT also offers a segmentation score so an analyst can catch mistakes related to major changes in roadway geometry and refine parameters for a more robust analysis.

HIGH VALUE RESEARCH

FACT SHEET

Counting Airport Operations Using Aircraft Transponder Signals and/or Aircraft Automatic Dependent Surveillance Broadcast Data

STUDY TIMELINE

June 2021 – February 2024

AGENCY CONTACT/CHAMPION

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INVESTIGATOR

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FURTHER RESOURCES

https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-bed32-977-02-rpt.pdf?sfvrsn=5ef0a247_1

https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-bed32-977-02-sum.pdf?sfvrsn=159103f5_3

Brief Summary of the Research Project and Impact.

Airports without air traffic control towers often struggle with accurate data on daily and annual aircraft operations, affecting planning, funding, and safety decisions. Many non-towered airports in Florida currently lack reliable counting methods, leading to inaccuracies that can impact infrastructure investments.

This project aimed to improve aircraft operation counting at these airports by evaluating new technologies. The research focused on the effectiveness of Automatic Dependent Surveillance Broadcast Data (ADS-B) technology, combined with RADAR and cameras, to enhance accuracy.

Field tests were conducted at DeLand Municipal and Ormond Beach Municipal Airports, using ADS-B receivers, RADAR, and human spotters to validate data accuracy. The study recommended combining the use of these hybrid systems for better data, which will improve airport planning, funding allocation, and safety at non-towered airports.

The findings would update the Florida Department of Transportation's (FDOT) 2018 report on non-towered airport operations and lead to Statewide implementation of aircraft transponders.

Implementation Status

The implementation status is project implemented.

- The installation of the device has been installed at 94 out of 95 airports.

Ongoing effort:

The remaining airport is in the process of installation, which will bring the implementation rate to 100%.

Potential Impacts and Benefits

Time Savings: Provides instant aircraft operations data.

	Qualitative: • Identified pros and cons of current state-of-the-art measurement. technologies and/or techniques to identify the type and number of operations at non-towered airports. • The findings from this study add to those of previous study – BDV22-977-02. • The new test method induces minimal disturbance prior to testing which produces high quality data for design. • High quality permeability data was collected throughout the state. • Provides a better understanding of the permeability ranges we can expect to encounter within each FDOT district. Quantitative: Estimated cost for deploying alternative technologies/systems for monitoring utilization of non-towered airport. Operational Costs: Estimated 196,000 Annually.

HIGH VALUE RESEARCH

FACT SHEET

MDOT Michigan Department of Transportation

Utilizing Video Analytics with Connected Vehicles for Improved Safety

STUDY TIMELINE
February 2021 – January 2024

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www.Michigan.gov/MDOTResearch

FURTHER RESOURCES
Final Report
Project Spotlight
Website

Brief Summary of the Research Project and Impact.

An emerging technology that analyzes video information offers a possible solution for transportation agencies to monitor roadway locations that are at increased risk for collisions. Supplementing collision data already collected, these newer tools may also identify near-miss incidents, thereby increasing the amount and type of data available for agencies to use. The Michigan Department of Transportation (MDOT) evaluated these video analytics solutions to understand their current capabilities and then tested them in the field. Study results confirmed the potential value of video analytics to proactively address safety risks and provided guidelines for future assessment and use. To ensure people's safety and mobility on Michigan's roadways, MDOT continually evaluates new technologies for eliminating unsafe roadway conditions. MDOT currently analyzes incidents after the fact but is not able to capture real-time data or immediately notify drivers of road conditions. Moreover, lacking real-time information, MDOT cannot respond as quickly to mitigate road hazards. Newer video analytics tools may be able to collect and analyze real-time information while also pushing safety notifications to road users via connected vehicle (CV) technology and dynamic message signs (DMSs). Researchers undertook a multistep analysis to evaluate whether the current state of these technologies can support MDOT's safety priorities.

Implementation Status

Study results confirm the availability of video analytics tools that may be developed further to address MDOT's safety and mobility goals. The vendor partnerships created through this research reveal a willingness on the part of technology developers to understand MDOT's needs. The goal is stronger integration between real-time identification of road incidents and broader communication channels. It includes the ability to better assess where resources are needed for mitigation and the capability to deliver real-time updates through a more fully connected system of road users and transportation professionals. The outcomes and guidance recommendations can benefit future researchers as they explore additional uses for video analytics.

Potential Impacts and Benefits

The market analysis identified 14 video analytics vendors. Designed for traffic analysis, the systems and tools recognize hazardous roadway conditions, including near-miss events, and also provide data to traffic management centers to address incidents and determine road performance improvement. However, the study did not allow for the testing of real-time notifications to road users or for the integration with other connected communication technology, such as CV. But through the collaborative research partnership, the technology vendors received useful feedback about requirements that would further MDOT's safety goals.

The pilot demonstration required adjustments to the original methodology due to the available field equipment, so all six participating vendors received the same recorded video footage of the intersection to analyze. From this footage, they provided their data detecting different incidents of the use cases that they had been asked to identify. Analysis indicated the equipment's ability to detect certain incidents, its accuracy and the number of missed incidents. The variability among vendors results prompted the development of recommendations for future investigations, such as uniform guidance for study metrics and careful placement of equipment based on vendor input.

FACT SHEET

Connected and Automated Vehicles (CAVs) Attitudes and Perceptions

STUDY TIMELINE

December 2022 – February 2024

WisDOT CONTACTS/CHAMPIONS

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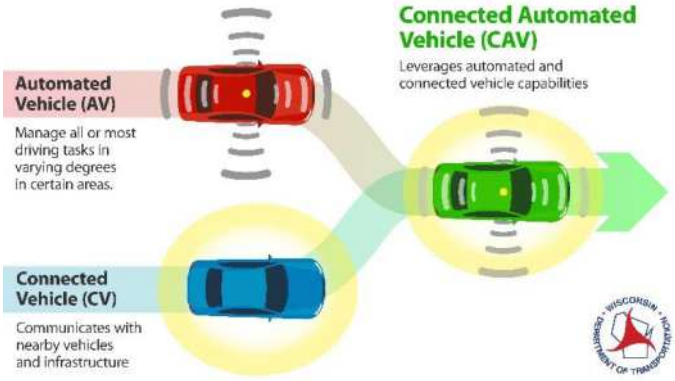
FURTHER RESOURCES

Research Brief

Final Report

Brief Summary of the Research Project and Impact.

With the imminent adoption of CAV technologies, WisDOT is invested in exploring these emerging technologies to make roadways safer and more efficient. Since CAV technology is still developing, market penetration is low and the general population's exposure is minimal. Most knowledge about public attitudes on CAVs have stemmed from national surveys and small-scale pilots. Despite the variety of methods deployed in the U.S. to study CAVs, little is known about Wisconsin-specific attitudes towards them. This work presents the results of a detailed study of the Wisconsin public's understanding of CAVs through a large-scale (N=915) survey. The results include acceptance of early testing; perceived benefits, drawbacks, and barriers to CAV implementation; and the implications for potential WisDOT action. Results indicate that Wisconsinites were willing to share the road with vehicles with advanced driver-assistance systems, moderately comfortable with connected vehicle technologies, and not comfortable with automated vehicle systems. Results for willingness to use CAVs saw the same order of technology preference as comfort sharing the road. An exploratory factor analysis and latent class cluster analysis were conducted and yielded six factors and five latent clusters which were used to create profiles of the Wisconsin population and document their attitudes and attributes.



Implementation Status

The results of the survey were used in informing future research and policy objectives of WisDOT's CAV initiatives. From this study, future research was suggested on conducting pilot programs with a limited geographic scope as well as continuing to explore the limitations that Wisconsinites see as acceptable use of CAV technology and initiatives.

Potential Impacts and Benefits

This research establishes a baseline of Wisconsinites' attitudes and perceptions of automated vehicle technology to be measured against as technology and applications advance. The survey conducted breaks down respondents' attitudes based on factors including acceptance, benefits, regulation, concerns and education. Being able to see where the public's potential misunderstanding or hesitancy lies can help stakeholders implementing these technologies see where more resources are needed.

HIGH VALUE RESEARCH

FACT SHEET

Anchorage Protected Bike Lane Pilot Study

STUDY TIMELINE

June 2023 – December 2024

ALASKA DOT&PF CONTACTS/CHAMPIONS

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FURTHER RESOURCES

Download Final Report

View Final Presentation

Brief Summary of the Research Project and Impact.

In 2023, Alaska DOT\&PF and the Municipality of Anchorage launched a two-phase pilot study to evaluate protected bike lanes (PBLs)—on-street bikeways separated from traffic by barriers like flex-posts or curbs. Phase 1 introduced Anchorage's first PBL in a residential area, using temporary materials to test design and installation. The results showed enhanced cyclist and pedestrian comfort and safety, along with a calming effect on traffic.

Phase 2 expanded to a downtown commercial corridor, testing a higher-quality, two-way PBL with upgraded materials and signage. While this phase did not show the same traffic calming, it significantly increased cyclist usage—up to 130 riders per weekday—and demonstrated that temporary installations can be effective for summer use. Public outreach and traffic analysis revealed minimal impact on vehicle flow, common concerns from businesses, and strong community interest. The study suggests future focus on low-speed, low-volume streets to better connect cyclists to destinations and greenbelt paths. There is also continued interest in exploring winter-proof materials and long-term corridor planning for permanent PBLs.

Implementation Status

The project team has identified the following areas that need further investigation before full deployment in Alaska:

- Testing the functionality and winter maintenance of different, more-robust PBL vertical elements for year-round installation.
- Testing the long-term effects of different PBL vertical elements on traffic speed.
- Evaluating public perception of reallocating and right-sizing road space for other uses like snow storage.
- Establishing street typologies that identify the most meaningful routes for future PBLs with tradeoffs for vehicle mobility and freight.

- Measuring the economic impact of bicycle trips and PBLs specifically.
- Measuring change in public perception related to PBLs over time.
- The accuracy of self-identified bicyclist user profiles for understanding the types of facilities cyclists are comfortable using and their willingness to ride. Determine whether bicyclist user profiles are appropriate benchmarks for use in future studies.

Potential Impacts and Benefits

This project serves as the first test of Protected Bike Lanes (PBLs) in Anchorage and Alaska. Therefore, the project itself is both innovative and unique. The outcomes of this pilot study will inform future Department and City policy for both quick builds and protected bike lanes. This pilot study tested, demonstrated, and refined methods and materials for implementing PBLs in Anchorage. These findings can be applied to cities across Alaska as well as nationally for communities with similar traffic demands and climate. Refining the methods now helps ensure cost-effective implementation of permanent PBLs in the future. A temporary demonstration of PBLs also helps bicyclists, drivers, and other residents in Anchorage begin learning how to safely and effectively interact with these facilities, setting them up for success when similar facilities are built in the future. Temporary installations are naturally a low-cost option to trial new infrastructure initiatives in the community vs. leaping to permanent infrastructure changes. This demonstration included public outreach to educate local businesses and other stakeholders on the advantages of PBLs, setting the stage for future public discourse on other proposed PBL facilities.

HIGH VALUE RESEARCH

FACT SHEET

SD DOT

STUDY TIMELINE

September 2022 – September 2024

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FURTHER RESOURCES

https://rosap.ntl.bts.gov/view/dot/78896

Reduce Fatal & Serious Injury Crashes

Brief Summary of the Research Project and Impact.

The South Dakota Department of Transportation explored implementation of a zero-fatality transportation safety initiative. A literature review of national strategies and relevant policies from neighboring states was conducted for the purpose of developing an initiative implementation plan aligned with South Dakota's safety goals, unique landscape, demographics, and challenges. Interviews were conducted with South Dakota's peer states to further enrich the findings, allowing stakeholders to take advantage of lessons learned and avoid potential pitfalls. A review of South Dakota state standards and policies as well as interviews with state and local agencies identified gaps to further derive recommendations for a comprehensive implementation plan that features agency-specific recommendations and impact evaluation indicators. The resulting implementation plan provided by the project serves as a guiding document for a zero fatality transportation safety initiative to drive a future of vital safety projects, increase awareness and education, coordinate and inspire stakeholders, and build a transportation safety movement that will save lives, prevent injury, and reduce costs.

Implementation Status

Implementation is in progress. A detailed implementation plan was developed, and multiple state agencies are involved with the implementation process.

Potential Impacts and Benefits

Guided Safety Improvements

- The Operations and Implementation Plan will serve as a roadmap for safer transportation infrastructure.
- Provides evaluation techniques and metrics for continuous improvement.

Cost Savings

- Reduces direct costs to state and local agencies by preventing fatal and serious injury crashes.
- Avoids emergency responses, traffic management costs, and infrastructure repairs.

	• Enables efficient use of safety budgets and minimizes emergency funding reallocations. Increased Revenue Potential • Improves travel time reliability and mobility by reducing crash-related disruptions. • Allows freed-up funds to be used for other statewide transportation priorities. Improved Safety Outcomes • Identifies high-risk crash locations and patterns. • Prioritizes limited funding toward the most impactful safety improvements. • Uses established methods to measure before-and-after safety performance. Extended Facility Life • Reduces premature reconstruction needs by maintaining safety without major capital investments. • Minimizes damage to infrastructure, extending the lifespan of assets like guardrails, signals, and signage. Improved Project Effectiveness • Integrates safety improvements into design standards and project scopes from the beginning. • Ensures systematic identification and resolution of safety issues. • Tracks effectiveness through comparative crash data analysis over time. Support for Broader Safety Efforts • Enhances traveler behavior change.

HIGH VALUE RESEARCH

FACT SHEET

VERMONT
AGENCY OF TRANSPORTATION
RESEARCH PROGRAM

Pavement Deterioration Models for Pavement Management

STUDY TIMELINE

April 2023 – August 2024

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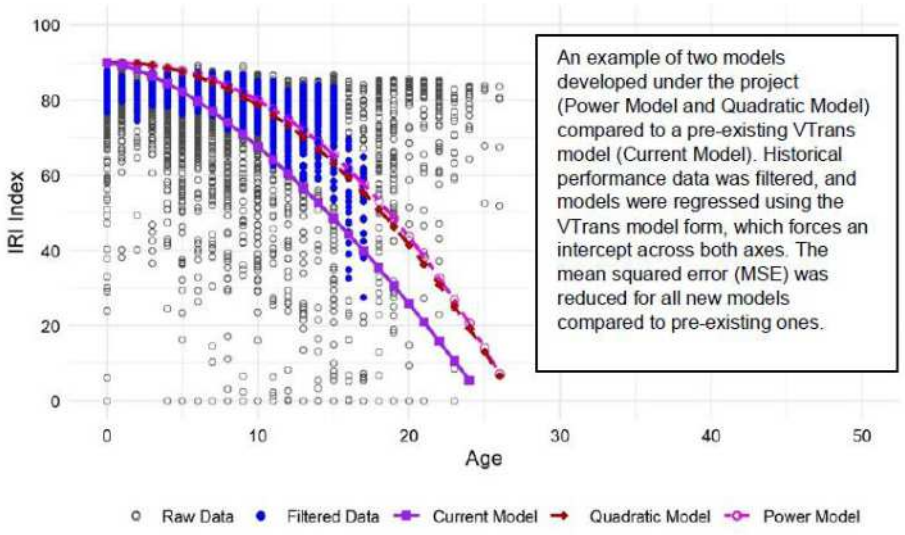
FURTHER RESOURCES

2024 Final Report
Project Web Page
2024 VT AOT Symposium Web Page

Brief Summary of the Research Project and Impact

The Vermont Agency of Transportation (VT AOT) manages 3,100 miles of paved public roads. In 2004, VT AOT began using pavement performance models based on past data about road conditions and types of paving treatments. Since then, they added two newer treatments—bonded wearing course and thin overlay—but didn't yet have models to predict how these would perform over time. Federal standards now require states to track road conditions using specific measures like rutting, cracking, and smoothness on major highways. VT AOT already had models for smoothness and rutting, but not for cracking based on the new standards. This project reviewed historical pavement condition and maintenance history data. VT AOT then updated its existing models and created new ones for the newer treatments and the cracking measure. These improved models will help the Agency better understand how roads age and make more accurate predictions about future pavement conditions, leading to smarter paving decisions.



An example of two models developed under the project (Power Model and Quadratic Model) compared to a pre-existing VTrans model (Current Model). Historical performance data was filtered, and models were regressed using the VTrans model form, which forces an intercept across both axes. The mean squared error (MSE) was reduced for all new models compared to pre-existing ones.

Implementation Status

VT AOT Pavement Management Engineers were excited to use the new research-based models right away in our Pavement Management System. These models help VT AOT choose the right pavement treatment based on the current roadway conditions. Because the models were developed using Vermont-specific data - such as weather, paving materials, and pavement performance - they give a clearer idea of how long each treatment should last. This allows VT AOT to make smarter, more cost-effective decisions about maintaining and resurfacing roads. Although this was a small research project, it has a big impact on how VT AOT manages the $100 million spent each year on Vermont's pavements.

Potential Impacts and Benefits

Vermont aims to get the most out of its Pavement Management System (PMS) to make smart use of limited funding and keep roads in the best possible condition. The new and updated pavement deterioration models will make PMS predictions more accurate, helping the state better estimate funding needs. Because Vermont faces tough weather - long winters, cold temperatures, and frequent freeze-thaw cycles - it's important to use models based on local conditions. These Vermont-specific models will help the state plan road resurfacing and maintenance more effectively. With better tools to predict how roads age over time, the state can meet long-term road quality goals at a lower cost. This frees up funding for other important transportation needs like bridges, safety improvements, and expanding road capacity. The project is expected to improve confidence in future road projects and make long-term investment planning more reliable.

HIGH VALUE RESEARCH

FACT SHEET

Innovative Techniques and Materials for Preventing Concrete Shrinkage Cracking

STUDY TIMELINE

June 2019 – Nov 2022

AGENCY CONTACTS/CHAMPIONS

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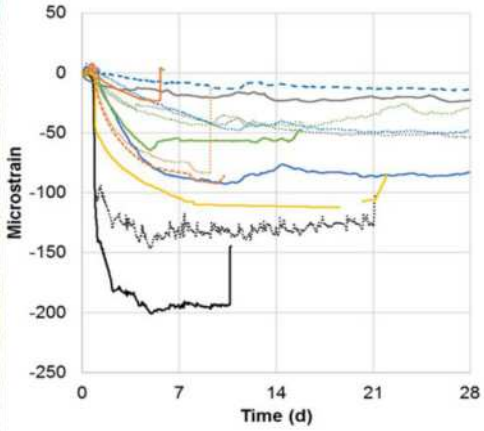
FURTHER RESOURCES

https://www.njdottechtransfer.net/2018/01/01/research-project/?pdb=31

Brief Summary of the Research Project and Impact.

Modern concrete in transportation offers rapid strength gain, low permeability, and high durability. However, the high cementitious content, low water-to-cementitious ratio, and use of admixtures make them prone to shrinkage cracking—especially at early ages. This issue is widely reported across the U.S., including in New Jersey, particularly on bridge decks. While national research has explored the mitigation of shrinkage cracks, there have been limited studies focusing on the specific conditions in New Jersey. This study investigated shrinkage cracking in New Jersey's infrastructure concrete by identifying key shrinkage types—chemical, autogenous, and drying—and evaluating the effectiveness of recent innovations, including shrinkage-reducing admixtures, internal curing, shrinkage-compensating materials, coatings, and fibers. The project quantified shrinkage levels and assessed the impact of mitigation strategies on these processes. Ultimately, the research results provide New Jersey engineers with the insight needed to improve both concrete mix proportioning and construction practices, thereby reducing shrinkage cracking in infrastructure concrete.



Implementation Status

The study found that fifteen high-performance concrete mixtures exhibited cracking potentials ranging from moderate-low to high. Autogenous shrinkage increased with higher fine aggregate content or reduced coarse aggregate volume, whereas drying shrinkage increased with more Portland cement and binder and fewer aggregates. Admixtures and additives affected shrinkage behaviors differently. Shrinkage-Reducing Admixture (SRA) significantly lowered both shrinkage and cracking potential, while Shrinkage-Compensating Admixture (SCA) reduced drying shrinkage only at the maximum dosage and had a minimal effect on autogenous shrinkage. Surface coating (EN) slightly reduced both types of shrinkage, whereas

lithium silicate (LS) reduced autogenous shrinkage only. Internal curing using lightweight aggregate (LWA) and the inclusion of fibers both reduced autogenous shrinkage and the risk of cracking but did not affect drying shrinkage. None of the additives, including SRA, SCA, LS, EN, or fibers, compromised concrete strength or elastic modulus. Among them, SRA proved more effective than SCA in reducing shrinkage under field conditions.

Potential Impacts and Benefits

Cracks weaken concrete, allowing water and harmful chemicals to infiltrate structures, thereby accelerating concrete deterioration and promoting corrosion. Shrinkage also causes concrete slabs to curl and warp, which affects the girder-to-deck composite action, ultimately decreasing the load-carrying capacity of bridges.

The study enhances the longevity and performance of transportation infrastructure by reducing concrete shrinkage and cracking potential, as well as limiting the ingress of water and other deleterious substances into the concrete. Innovative techniques and materials for preventing shrinkage were studied in New Jersey materials and conditions.

The cost of improving the durability of concrete infrastructure is difficult to quantify. Its impact is long-term. However, according to the International Concrete Repair Institute, the annual cost to repair, rehabilitate, strengthen, and protect concrete structures in the United States is estimated to be between $18 and $21 billion per year. The annual direct cost estimate for corrosion of bridges in the United States is $8.3 billion. The indirect costs to users, such as traffic delays and lost productivity, were estimated to be as high as 10 times that of direct corrosion costs. This work is part of the effort to reduce this cost.

HIGH VALUE RESEARCH

FACT SHEET

TEAM KENTUCKY TRANSPORTATION CABINET

Developing a Cross Asset Allocation Mechanism

STUDY TIMELINE

July 2022- June 2025

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FURTHER RESOURCES

https://uknowledge.uky.edu/ktc_researchreports/1810/

Brief Summary of the Research Project and Impact.

The Kentucky Transportation Cabinet (KYTC) uses various tools and methods—such as the Enhanced Bridge Prioritization Index, Enhanced Pavement Prioritization Index, and SHIFT—to compare proposed projects within programs and asset classes. However, these tools do not easily allow comparisons of individual projects' contributions to overall performance goals. Therefore, KYTC needs a robust mechanism to evaluate projects across its capital, safety, and asset management programs. After reviewing frameworks from academic literature and other states, this report recommends KYTC adopt the asset sustainability ratio (ASR) to compare bridge and pavement projects. The ASR measures the amount of work completed relative to what is needed to maintain the network in its current condition. An ASR of 1 indicates steady preservation; values below 1 show deterioration. Achieving an ASR of 1 depends on project types—replacement projects require more funding than preservation treatments. Researchers analyzed various bridge project portfolios to estimate budget needs ranging from $383 million to $673 million—significantly higher than the current budget of $189 million. While numerous funding scenarios exist, only a manageable number should be considered to keep decision making practical. Further development is required to implement ASR for capital and safety programs.

		Bridges	Pavements	Total
Budget Need for ASR = 1.0 ($M)		$443	$507	$950
Current Funding Level	Anticipated Annual Spending ($M)	$189	$501	$690
	Shortfall	$254	$6	$260
	ASR% Met	43%	99%	73%
Equalize ASR %	Proposed Annual Spending ($M)	$322	$368	$690
	Shortfall	$121	$139	$260
	ASR% Met	73%	73%	73%
Transition to Comparable ASR%	Proposed Annual Spending ($M)	$255	$435	$690
	Shortfall	$188	$72	$260
	ASR% Met	58%	86%	73%

Implementation Status

As part of KYTC's performance management efforts—particularly in determining investments—the agency sought to develop a way to compare the impact of projects across its capital, safety, and asset management programs. This research focused on asset management, specifically bridges and pavements. As a result, KYTC now has a mechanism to compare resource allocations within its asset management program, enabling more informed investment decisions.

Potential Impacts and Benefits

To mitigate difficulties associated with conceptualizing how safety and capital programs fit within a cross-asset allocation framework, researchers focused on asset management, including pavements and bridges. After testing multiple approaches, researchers concluded that the asset sustainability ratio (ASR) is a robust approach to measure the amount of work completed by a particular program (i.e., bridges or pavements) and the amount of work required to maintain the network in its current condition. KYTC already has a robust ASR for pavements; this project focused on the development of a similar, yet novel approach for bridges, known hereafter as the Bridge Sustainability Ratio or BSR. KTC used data provided by a KYTC subject-matter expert to estimate the additional service life that could be expected from different types of bridge projects which underpinned the expected ASR calculations for various scenarios and was then applied to current budget numbers. Using this approach, decisionmakers will know the impact of resource allocation choices and how to maximize available funding to improve bridge and pavement conditions.

HIGH VALUE RESEARCH

FACT SHEET

Development of Advanced Landslide Investigation Protocol Using Geophysical Methods for Mississippi

STUDY TIMELINE

July 2020 – July 2023

MDOT CONTACTS/CHAMPIONS

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FURTHER RESOURCES

https://mdot.ms.gov/documents/Research/Reports/Interim%20&%20Final/SS316%20Final%20Report.pdf

Brief Summary of the Research Project and Impact.

Jackson State University used LiDAR drones, electrical resistivity and wave-based-testing, as well as continued use of inclinometers from State Study 286, to investigate movement of highway slopes and embankments. These methods can help MDOT identify failed areas, determine their depth, and evaluate moisture content. Movement can be measured over time using the baselines provided in this study. In addition, Vetiver grass was planted on one slope. Its deep root systems help absorb moisture, anchor the slope, and can be installed by MDOT maintenance forces quickly, easily, and cheaply.

Implementation Status

MDOT's Geotechnical and Maintenance Engineers have implemented the use of sensors and Vetiver grass planting and plan to do so on more slopes. A subsequent study is underway in which JSU is creating cheaper and easier-to-use sensors and data loggers and formulate a geotechnical asset management (GAM) decision support framework.

Potential Impacts and Benefits

These new methods will reduce and save MDOT money versus costly soil borings and give us consistent monitoring of these slopes in our highly plastic clays and increasingly extreme precipitation events.

HIGH VALUE RESEARCH

FACT SHEET

MDOT Michigan Department of Transportation

Electronic Water-Level Sensors for Monitoring Scour Critical Structures

STUDY TIMELINE

April 2021 – June 2024

MDOT CONTACT

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INVESTIGATORS

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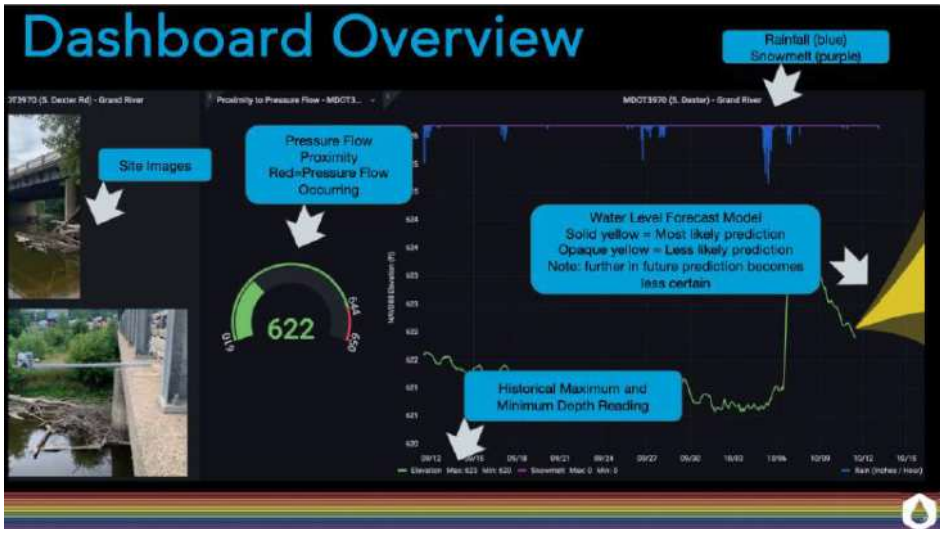
FURTHER RESOURCES

Final Report
Project Spotlight
Website

Brief Summary of the Research Project and Impact.

This research project is aimed at developing and deploying a cost-effective water level sensor network for monitoring scour critical bridges in Michigan. The project involved a comprehensive review of existing water level monitoring technologies, followed by the selection and pilot deployment of Open-Storm sensors on over 30 bridges across the state. Real-time water level data was collected and transmitted, and system performance was continuously monitored. The results demonstrated that the sensors provided valuable real-time information, enhancing bridge inspection efficiency and decision-making. Positive feedback from bridge engineers highlighted the benefits of the technology in improving situational awareness and resource allocation. The report concludes with recommendations for scaling the technology statewide and integrating it with predictive models and other data sources to further enhance bridge scour management practices.



Implementation Status

Based on the study's success, researchers recommended scaling up for deployment across the state. Expanding MDOT's existing High Flow system and integrating new water-level sensing data or creating a stand-alone system to communicate the water-level data, would require the agency to coordinate with state information technology specialists to ensure appropriate Internet security requirements and other protocols are built into the collection, transmission and visualization of the data.

Potential Impacts and Benefits

The hydrologic sensor network and data system custom, low-power, embedded computer sensor nodes operated efficiently and reliably. Users had two methods to access the data and incorporate it into bridge inspector workflows. First, the research team integrated the sensor data with MDOT's High Flow system. Additionally, team members created separate web-based dashboards, housed at the University of Michigan's Digital Water Lab, which displayed water-level data from the scour bridge-monitoring systems for each district and enabled researchers to track user feedback and refine visualization. MDOT staff used both data visualization systems throughout the project.

	The availability of real-time data received positive feedback from bridge engineers and inspectors, who reported enhanced situational awareness and decision-making capabilities. The real-time water-level sensing system could improve the efficiency of bridge inspections to monitor scour by reducing unnecessary site visits. A five-minute training video describes the real-time water-level monitoring system and provides historical data and forecasts for supporting bridge inspections.

HIGH VALUE RESEARCH

FACT SHEET

Kansas Department of Transportation

Development of Test Procedures to Evaluate Moisture Susceptibility of Asphalt Mixtures Used in the State of Kansas, Phase I: Surface Free Energy of Binders

STUDY TIMELINE

8/1/2018 – 10/1/2024

AGENCY CONTACTS/CHAMPIONS

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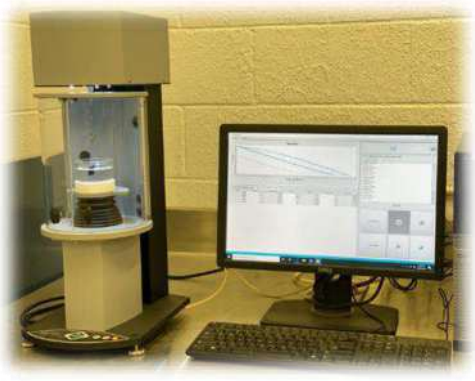
FURTHER RESOURCES

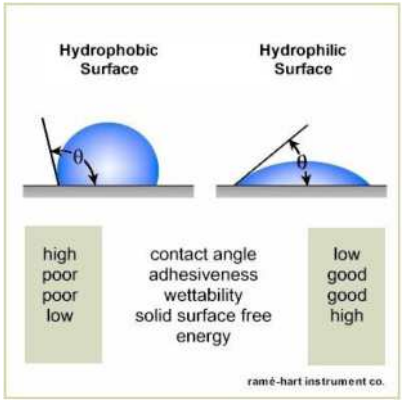
Final Report:
https://dmsweb.ksdot.gov/AppNetProd/docpop/docpop.aspx?clienttype=html&docid=12235093

Technical Summary:
https://dmsweb.ksdot.gov/AppNetProd/docpop/docpop.aspx?clienttype=html&docid=12235094

Project Summary

The material property related to the moisture sensitivity of asphalt mixtures is the surface free energy (SFE) of the asphalt binder and the aggregate. SFEs of these materials can be used to quantitatively determine the interfacial adhesive bond strength between these two materials and the tendency of water to displace this bond based on fundamental principles of thermodynamics. Surface energy of solids can usually only be measured indirectly by measuring the work of adhesion between the solid and probe liquids with known surface energy components and solving the system of equations for the unknown components of the solid. This project evaluated asphalt surface energy to calculate moisture susceptibility of various asphalt-aggregate combinations. Surface energies of these materials can be used to calculate the energy ratio (ER) of asphalt binder-aggregate combinations to identify moisture resistance levels. A higher value of work of adhesion indicates that more work is required to break the adhesive bond between the asphalt binder and the aggregate, implying improved resistance to moisture damage. In this study, the Wilhelmy plate device was used to establish a standardized test method to routinely measure the surface energies of asphalt binders and aggregates and to begin creating a database of binder SFEs.





(Left) The Wilhelmy plate device consists of a thin glass plate, a probe liquid, and a tensiometer. A plate coated with asphalt binder is lowered into the liquid; surface tension and contact angle of the liquid on the plate are measured. (Right) Illustration of contact angle for hydrophobic vs. hydrophilic liquid on the surface of a solid. Binder and aggregate combinations that are hydrophobic while bonding well to each other are desired.

Implementation Status

This research has paved the way for a follow up project, currently under way, to continue development of a database of asphalt binders and their surface free energy components, while concurrently evaluating an alternative test method, the Sessile drop method using a contact angle goniometer. This will provide additional data and help to determine which test and equipment can most accurately and efficiently determine the surface free energy components of asphalt binders. Subsequently, future efforts will be made to build a database of aggregate surface energies.

Potential Impacts and Benefits

Results of this research could provide more fundamental lab tests and characterization methods to determine moisture susceptibility of asphalt mixtures as an alternative to the current practice of performing mechanical tests on moisture conditioned specimens that require extended testing times and can be unreliable due to poor correlation with field performance, have substantial variability in test results and lack repeatability, and are unable to address specific failure mechanisms and their underlying root causes.

HIGH VALUE RESEARCH

FACT SHEET

NEBRASKA Good Life. Great Journey. DEPARTMENT OF TRANSPORTATION

Repair Practices of Damaged Precast/Prestressed Concrete Girders

STUDY TIMELINE
July 2018 – March 2020

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FURTHER RESOURCES
Final report is available:
HERE

Brief Summary of the Research Project and Impact.

Bridge girders are constantly subjected to various types of damage during their service life. There is currently limited knowledge or guidelines provided by the NDOT Bridge Office Policies and Procedures (BOPP) regarding the assessment and repair procedures of damaged precast/prestressed concrete girders. This report aimed to develop a comprehensive repair manual for precast/prestressed concrete girders subjected to damage caused by over-height vehicular collision and damage located at the girder ends. Over-height vehicular collision damage typically occurs at the middle portion of the exterior girders and the primary concerns are focused on flexural deficiencies. Girder end damage can occur due to corrosion of prestressing strands or reinforcement, malfunctioning joints, or during deck/abutment replacement; where the primary concerns are focused on shear deficiencies. When damage occurs, the decision-making process regarding whether to repair, rehabilitate, or replace the girder is typically challenging. A literature review on the classification of damage and a proposed damage classification are presented for each damage type. Repair methods and procedures for each damage class are then presented for each damage type. Previous repair cases done by NDOT are documented and their performance is evaluated by visual inspection records. Ultimate limit state structural calculations are presented in the form of design examples to calculate the flexure or shear strength of the undamaged and damaged girder according to AASHTO LRFD. The ultimate flexure or shear strength of a strengthened girder using FRP wrapping is also presented according to ACI 440.2R-17 as a design example. Suggested material properties are presented for each repair method according to previous research work and previous NDOT repair cases.

Implementation Status

Bridge has adopted this research in the NDOT Bridge Design Manual in Chapter 7 Repair and Preservation. Section 7.4.4.2 – Prestressed Concrete Girder Repairs refers to this report when introducing repair practices. This research has been a standard policy since November 2024.

Potential Impacts and Benefits

1. Provide repair alternatives and a methodology for selecting concrete girder repair that enables NDOT and contractor to make timely and cost-effective repair decisions.
2. Repair damaged bridge girders minimizes the need for full replacement, which are time consuming, traffic disruptive, and cost friendly.