WisDOT Research Program

# Annual 2024 Report

# Foreword

On behalf of the Wisconsin Department of Transportation (WisDOT), I am pleased to present the 2024 Research Program Annual Report. This report demonstrates the department's commitment to continuous improvement in the work we do to upgrade our transportation system and improve the quality of life in Wisconsin communities.

WisDOT's mission is to deliver a safe and efficient transportation system that meets the needs of everyone who travels in Wisconsin. The Research and Library Services Unit provides each of WisDOT's divisions the critical feedback needed to improve programs and processes and stay up to date on advancements in the transportation industry. Through meticulous project management and thorough analysis of research results, WisDOT gains new expertise and innovative ideas to enhance our daily work.

In 2024, WisDOT's award-winning $4.79 million research program funded 65 research projects and completed three Wisconsin Highway Research Program (WHRP) projects focused on construction materials. Two Policy Research projects provided public feedback on connected and automated vehicles and safety media campaigns. Research and library staff also completed three synthesis reports and 22 literature searches, responded to 592 information requests and delivered 567 resource items.

WisDOT research received special recognition in 2024 when the American Association of State Highway Transportation Officials (AASHTO) awarded the department a High Value Research designation for the WHRP project "Evaluating the Impact of Anti-Icing Solutions on Concrete Durability." The research provides guidance for best practices when using anti-icing solutions to increase the lifespan of concrete pavements and improve traction and safety conditions on Wisconsin's roads.

In addition to managing research projects, WisDOT's research team partners with colleagues in other states to learn best practices and find solutions to shared challenges. WisDOT hosted a joint peer exchange with the Illinois Department of Transportation. Research staff from eight Midwest states gathered in Madison in May 2024 to share ideas on workforce development, knowledge management, strategies to measure return on investment, and best practices on research project development, management, tracking and implementation.

Research projects are a critical step to spark innovation as we look to re-envision the future of our multimodal transportation system. I am proud of WisDOT's research team and our partners who are leading the way in providing valuable insight to expand our agency's knowledge and help us better serve the people of Wisconsin.

Kristina Boardman, Secretary
Wisconsin Department of Transportation

*This is a report of research and technology transfer activities carried out by the Wisconsin Department of Transportation through the Part B research portion of the State Planning and Research Program of the Federal Highway Administration, U.S. Department of Transportation. The report describes activities during Federal Fiscal Year 2024, covering October 1, 2023 through September 30, 2024.*

# Contents

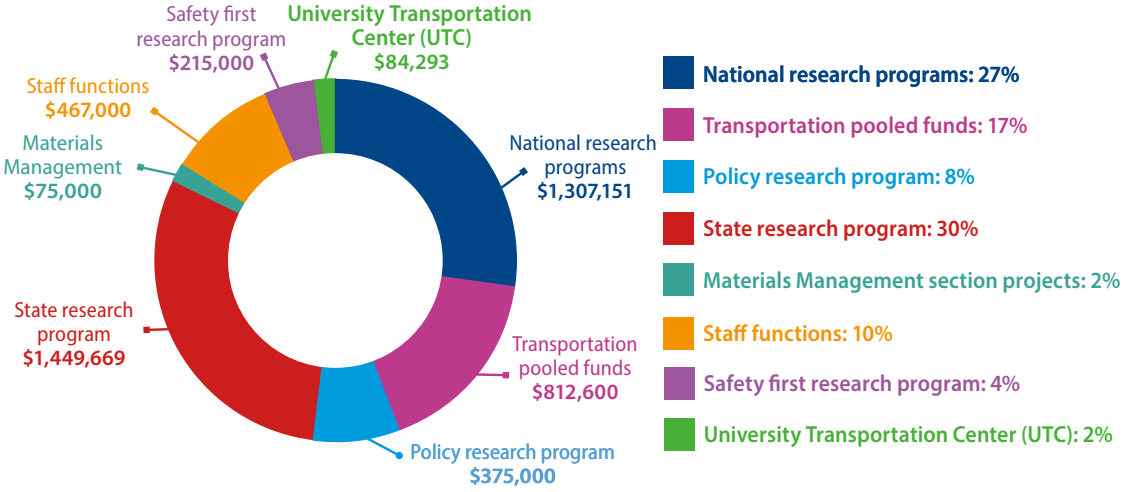


### Common acronyms used in this document

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| DBM | (WisDOT) Division of Business Management |
| DBSI | (WisDOT) Division of Budget and Strategic Initiatives |
| DMV | (WisDOT) Division of Motor Vehicles |
| DOT | U.S. Department of Transportation |
| DSP | (WisDOT) Division of State Patrol |
| DTIM | (WisDOT) Division of Transportation Investment Management |
| DTSD | (WisDOT) Division of Transportation System Development |
| EXEC | (WisDOT) Executive Offices |
| FFY | Federal Fiscal Year |
| IPIT | Institute for Physical Infrastructure and Transportation at University of Wisconsin – Milwaukee |
| FHWA | Federal Highway Administration |
| MMS | Materials Management Section |
| NCHRP | National Cooperative Highway Research Program |
| SPR | State Planning and Research Program |
| TPF | Transportation Pooled Fund |
| TRB | Transportation Research Board |
| TOPS | Traffic Operations and Safety Laboratory at University of Wisconsin - Madison |
| UW | University of Wisconsin |
| WHRP | Wisconsin Highway Research Program |
| WisDOT | Wisconsin Department of Transportation |

# Program Overview

*The Wisconsin Department of Transportation (WisDOT) managed a $4.79 million program for research and technology transfer services during federal fiscal year (FFY) 2024. The State Planning and Research Part B (SPR-B) federal program funded 87% ($4.18 million) of the program, while state funds covered the remaining 13% ($0.61 million).*




## National research

The department participates in national research initiatives through the Transportation Research Board (TRB), National Cooperative Highway Research Program (NCHRP) and American Association of State Highway Transportation Officials (AASHTO) Technical Services Program.

## Pooled fund research

The Transportation Pooled Fund (TPF) program allows federal, state and local agencies to combine resources to support transportation research studies of common interest. In FFY 2024, WisDOT participated in 45 TPFs. These projects include advances in safety and engineering methods and materials.

## Policy research program

The WisDOT Policy Research Program promotes and funds research that addresses planning, operations, safety, finance, economic impacts, environmental issues, emerging technology and other policy aspects of all transportation modes and agency operations.

## State research program

The Wisconsin Highway Research Program (WHRP), established in 1998 by WisDOT in collaboration with the University of Wisconsin–Madison, aims to better design, build, and reconstruct the state's transportation system. The four areas of focus include geotechnics, structures, and flexible and rigid pavements.

## Materials management projects

The research program funds WisDOT's Materials Management Section (MMS) internal projects, including the investigation and implementation of new materials and methods conducted at WisDOT's own MMS lab.

## Staff functions

Efficient management of transportation knowledge and research findings contributes to continuous improvement. The Research and Library team conducts technology transfer activities and provides library services to coordinate dissemination of research recommendations to enhance operations within the department.

## Safety First research program

The Safety First Research Program funds projects to research, demonstrate or test new technology and innovative best practices to improve safety throughout the state's multimodal transportation system.

## University Transportation Center (UTC) support

UTC's are consortiums of colleges and universities focused on specific research topics. WisDOT partners with UTCs to involve students and instructors who explore cutting-edge ideas and focus on solutions-oriented research. WisDOT awards grants to UTCs to advance transportation research and develop the next generation of transportation professionals.

# Completed Wisconsin Highway Research Program Projects

The Wisconsin Highway Research Program aims to better design, build and reconstruct the state's transportation system. The following briefs showcase the research projects completed during this fiscal year.

# Balanced Mixture Design Pilot and Test Sections

## Objectives

- Assist in the experimental design and construction of pavement test sections for assessing the long-term field performance of BMD pavements and validate preliminary criteria
- Statistically analyze the variance of BMD test results from shadow projects

## Benefits

- Help establish criteria for asphalt mixture design approval and quality assurance
- Create recommendations for implementation of BMD as well as indicate where further research is needed

## Principal Investigator

Randy West
National Center for Asphalt Technology at Auburn University
westran@auburn.edu

## Project Manager

Tirupan Mandal
WisDOT
tirupan.mandal@dot.wi.gov

## Background

State highway agencies and the asphalt pavement industry have recognized the limitations of the Superpave mix design and the need for implementing balanced mix design (BMD) for improved asphalt mix design approval and quality assurance. The Wisconsin Department of Transportation (WisDOT) continues to make thoughtful steps toward the implementation of BMD tests and criteria for asphalt mixture design approval and quality assurance. This research project involved two important steps toward that goal: validation of BMD tests and criteria, and assessing the overall variability of the BMD test results in a mix production setting.

## Methodology

For the experiment, six test sections were recommended to establish correlations between BMD test results and field performance with a good balance between cost and experimental robustness. WisDOT selected State Project Number 1693-05-72, WIS 69 in Dane County, south of Verona, as the site for the BMD experiment. The designed cross-section of the reconstructed pavement is a 5-inch asphalt pavement consisting of a 2-inch upper layer and a 3-inch lower layer, and a 12-inch granular base constructed over 12-inches of select crushed material. The six experimental mixes were surface layers; the same medium-traffic (3 MT) mix containing a PG 58-28 S binder was used under each of the test sections. Falling Weight Deflectometer (FWD) testing was conducted, and the results were analyzed by the research team to assess the uniformity of the base and subgrade in the areas where the test sections were planned.


*WIS 69 prior to reconstruction*

Test section mixtures sampled during construction were tested using the Indirect Tensile Asphalt Cracking Test (IDEAL-CT) and Hamburg Wheel Tracking Tests (HWTT). The IDEAL-CT test was performed in

***"Outcomes from this project advanced implementation of BMD for WisDOT as well as provide valuable lessons learned on how to build test sections." – Tirupan Mandal, WisDOT***

accordance with ASTM D8225 after reheating the buckets of mixture samples for two hours to enable splitting samples to individual test portions, then aging the mixture samples at 135°C for six hours at a thickness of three-quarters to one inch, followed by Superpave Gyratory Compactor (SGC) compaction. Hamburg tests were performed in accordance with AASHTO T 324 on samples that were reheated then compacted to 7+/-0.5% air voids with an SGC.

To quantify the overall variability of asphalt mixture BMD tests, ten shadow projects were chosen from across Wisconsin to represent the state's diversity in aggregate type, binder grades, and mix types. The asphalt mixtures from the shadow projects were sampled during plant production while the contractor was sampling for regular quality control (QC) testing.

## Results

A few issues were encountered during construction of the test sections. Different granular base materials were placed and compacted in the area where the test sections were constructed. Analysis of FWD data from tests conducted throughout the area where the test sections were constructed was inconclusive, leaving uncertainty about the uniformity of the pavement structures which could impact field performance of the test sections and confound the desired lab-to-field correlations.

Another issue was from the lab-to-lab comparisons of the IDEAL-CT and HWTT for the mixtures sampled from the test sections. Despite the large lab-to-lab differences in the results, the ranking of the mixtures is similar. The range of resistance to rutting and cracking indicated should provide a suitable lab-to-field correlation.

## Recommendations for Implementation

Based on the results, the research team offers several recommendations for future research and implementation:

- WisDOT should closely monitor the rutting and cracking performance of the test sections with the state's Automated Road and Pavement Condition Survey vehicles to provide consistent measures of pavement condition over time.
- The lab-to-lab differences in rutting results from the test section mixtures should be further investigated to determine the possible causes – starting with a review of each lab's procedures for mix reheating, splitting, sample preparation and conditioning.
- Field performance of the shadow projects should be monitored as they may provide useful information about the ability of the BMD test parameters to indicate the resistance of the mixtures to rutting, cracking and moisture damage.
- A formal technician training program for the IDEAL-CT, HWTT and HT-IDT should be prepared and conducted. This will be critical as more pilot and shadow projects are conducted.

Interested in finding out more?
Final report is available at:
WisDOT Research website

This brief summarizes Project 0092-22-04
Balanced Mixture Design Pilot and Test Sections
Wisconsin Highway Research Program

Research Brief

Wisconsin Highway Research Program
Project 0092-22-05
May 2024

# Weight-Volume Relationships and Conversion Factors for Soils and Aggregates of Wisconsin

## Objectives

- Determine and update expansion and conversion factors for geomaterials used in large earthwork construction projects
- Conduct a comprehensive review of current practices among other state DOTs
- Develop an excel-based tool to accurately estimate the expansion and conversion factors of geomaterials between different states

## Benefits

- This research provides a comprehensive framework for precise earthwork calculations
- Insights from this work offer a thorough understanding of the behavior of geomaterials under different conditions

## Background

Earthwork construction involves the excavation, hauling, and placement (cut-haul-fill) of geomaterials including soils and aggregates. Geomaterials experience considerable volume changes during the cut-haul-fill cycle, including expansion from the “bank” state to the “loose” state after excavation and shrinkage from the “bank” state to the “compacted” state after construction.

Generalized or material-specific expansion and conversion factors can be used to estimate weight-volume relationships in each state, thereby providing a quantitative basis for more accurate earthwork design, bidding, and construction. This research aimed to develop accurate earthwork expansion and conversion factors for various geomaterials, thereby enhancing the accuracy of earthwork calculations for Wisconsin’s roadway construction.

## Methodology

Researchers focused on understanding existing practices of earthwork calculations through a review of state DOTs’ methodologies via survey. Following this, the team collected and analyzed soils and aggregates, including recycled and large-sized aggregate materials. Lab tests were conducted to determine key properties and characteristics of these materials. Field tests were conducted to measure in-situ density and moisture conditions in different material states (e.g., bank, loose, compacted). The findings from these were used to develop an excel-based tool designed to accurately estimate conversion and expansion factors for various geomaterials based on their index properties.

*In-place density and moisture content test by nuclear density gauge (NDG) in Dane County (left) and St. Croix County (right)*

### Principal Investigator

Bora Cetin, PhD.
Michigan State University
cetinbor@msu.edu

### Project Manager

Andrew Zimmer
WisDOT
andrew.zimmer@dot.wi.gov

***"The Weight-Volume Relationships and Conversion Factors for Soils and Aggregates of Wisconsin study will greatly assist WisDOT engineers more accurately estimate earthwork volumes, which will reduce costly change orders during construction." – Andrew Zimmer, WisDOT***

## Results

Survey results from 26 state DOTs were obtained to understand existing practices of earthwork calculations and show that only about 31% of the DOTs surveyed provide specific expansion factor equations for commonly used soils. Less than half of the DOTs consistently align their design expansion factors with post-construction data. For aggregates, the survey results were less conclusive, with only about 23% of DOTs providing conversion factors, and a notable lack of consistent data alignment between design factors and post-construction results.

These findings reveal that practice for applying earthwork factors substantially relies on personnel experience and a wide variety of methodologies, thus highlighting the need for a more systematic approach. To address this, the research team conducted a comprehensive field and laboratory testing on 29 aggregates and 14 natural soil types collected across Wisconsin. Test results were used to develop a suite of expansion and conversion factors for natural soils and aggregates in various states of compaction (bank, loose, compacted). Expansion factors for natural soils from the compacted to bank state show considerable variation, with factors for sands ranging from 1% to 15%, silts at 12%, and clays between (-5)% to 9%. Results for aggregates show a range of conversion and expansion factors between 1.50 to 1.98 and 27% to 60%, respectively. There are notable variations in factors across different material types, in particular with over consolidated clays.

## Recommendations for Implementation

The research emphasizes the need for region-specific expansion factors, especially for consolidated clays, to accurately reflect their unique expansion rates. Future studies should examine the densification effects of heavy machinery during clearing and grubbing operations. Moreover, expanding the database to encompass a wider range of soil types and aggregates is essential for refining predictive models.

For field applications, particularly with large-sized aggregates, it's important to extensively utilize the study's developed methods. This includes employing the developed *In-Place Density Measurement by Water Replacement Method* in the field and the *Alternative Compaction Method* for large-sized aggregates in the laboratory. The potential for using *3D Lidar Scanning on dump trucks* to enhance loose density measurement accuracy is highlighted, although this requires meticulous coordination with contractors and quarries to minimize operational disruptions.

In addition, future research should consider employing unit weight measurements at various excavation depths, which could lead to the development of a modification factor for improved accuracy in expansion factors. Furthermore, it is recommended that the proposed expansion factors be adopted for aggregates.

Interested in finding out more?
Final report is available at:
WisDOT Research website

This brief summarizes Project 0092-22-05
Weight-Volume Relationships and Conversion Factors for Soils and Aggregates of Wisconsin
Wisconsin Highway Research Program

Research Brief

Wisconsin Highway Research Program
Project 0092-23-05
April 2024

# Underwater Concrete Pours and Non-Segregating Concrete

## Objectives

- Examine best practices for the placement of concrete underwater and in deep drilled shafts
- Evaluate current guidance and specifications for improvements based on best practices

## Benefits

- Enhances existing WisDOT policies, standards and specifications regarding underwater concrete placement or repair for bridge substructures
- Minimize environmental impact while ensuring the concrete's quality and structural integrity

**Principal Investigator**
Behrouz Shafei
Iowa State University
sjafei@iastate.edu

**Project Manager**
James Luebke
WisDOT
james.luebke@dot.wi.gov

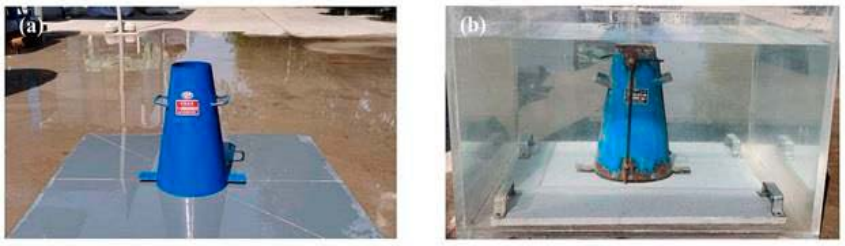
## Background

Underwater concrete (UWC) placement in bridge substructures often raises concerns regarding concrete quality, primarily due to the potential for aggregate segregation, especially in deep drilled shafts. Such issues are not only challenging to identify but also include substantial repair costs. The overarching goal of this project was to critically evaluate and recommend enhancements to existing WisDOT policies, standards, and specifications regarding underwater concrete placement or repair for bridge substructures and the prevention of aggregate segregation during concrete placement in deep drilled shafts.

## Methodology

Relevant research studies and the practices of other departments of transportation (DOTs) and the construction industry, especially agencies and companies operating in marine settings, were explored. The research team examined numerous materials and construction-related factors involved in pouring concrete underwater or in deep drilled shafts, including parameters such as concrete mix designs and placement techniques.

Additionally, a nationwide survey was distributed to key personnel in 50 state DOTs to better understand current practices and trends, the difficulties faced by various DOTs, solutions to these challenges, and potential directions for the future.




*Mock-up test assessing UWC flowability: (a) Slump flow test in the air and (b) Underwater slump flow test.*

## Results

The extensive research comprising a literature review, database analysis, and survey of practices, combined with input from various DOTs and experienced contractors who work in UWC and drilled shafts, has led to significant insights into UWC and drilled shaft construction. In underwater concrete placement, there is a consensus among numerous state guidelines regarding the initiation of the process.

***"Underwater concrete pours are a critical technique for constructing bridge substructures. This research explores methods to mitigate associated risks and enhance concrete quality for these underwater structures." – James Luebke, WisDOT***

It is generally agreed that concrete placement should only commence when the tremie or the designated placement apparatus has been accurately positioned at the correct base or shaft elevation. This precise positioning is essential to ensure a consistent and controlled flow of concrete, which is critical to achieving the desired structural integrity and durability. Adhering to this protocol mitigates the risks of premature washout and potential contamination of the concrete, thus laying a solid foundation for the subsequent phases of construction. The compiled guidelines from surveyed states show a consistent focus on quality assurance, equipment standards and placement conditions.

## Recommendations for Implementation

As specifications are refined across all 50 state DOTs, the goal is to delve deeper into the specifics of materials, mix designs, and placement techniques. This will enhance the methods of direct underwater concrete casting, advancing practice with the accumulated wisdom of experience and the fresh perspective of innovation.

Based on the results, the research team provided several recommendations related to the mix proportions, as well as fresh and hardened properties of underwater concrete including:

- Grade A should be used for structural concrete, which contains a minimum cement content of 565 lb/yd$^3$. For specific applications, such as underwater concrete, an engineer-approved mix design with a potentially higher cementitious materials content is permissible.
- WisDOT specifies that the oven-dry weight of fine aggregates shall constitute up to 45% of the total oven-dry weight of aggregates in concrete mixtures, which aligns well with the recommended ranges. However, increasing the ratio to at least 50% can be considered for underwater concrete and drilled shaft applications.
- For structural concrete mixtures, WisDOT specifies the maximum size of aggregate to be 1 inch. WisDOT also recommends that well-graded coarse aggregates should conform to the ASTM C33 gradation requirements for size number 67 aggregates.

Interested in finding out more?
Final report is available at:
WisDOT Research website

This brief summarizes Project 0092-23-05
Underwater Concrete Pours and Non-Segregating Concrete
Wisconsin Highway Research Program

# Completed Policy Research Program Projects

The Policy Research Program promotes and funds research that addresses planning, operations, safety, finance, economic impacts, environmental issues, emerging technology and other policy aspects of all transportation modes and agency operations.

# Connected and Automated Vehicles Attitudes and Perceptions

## Objective

- Assess public attitudes and perceptions of connected and automated vehicle technology

## Benefits

- Establish a baseline of Wisconsinites' attitudes and perceptions of automated vehicle technology to be measured against as technology and applications advance
- Break down respondents' attitudes based on factors including acceptance, benefits, regulation, concerns and education

## Principal Investigator

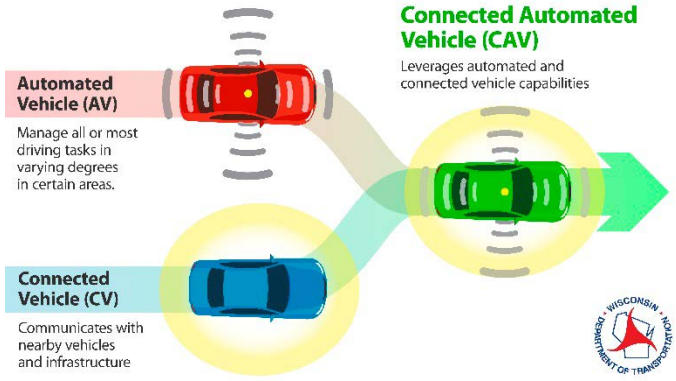
David Noyce
University of Wisconsin - Madison
noyce@engr.wisc.edu

## Project Manager

Brad Basten
WisDOT
brad.basten@dot.wi.gov

## Background

With the increasing adoption of Connected and Automated Vehicle (CAV) technologies, WisDOT is invested in exploring and implementing these emerging transportation technologies to make roadways safer and more efficient. Most knowledge about the public's attitudes toward CAVs have stemmed from national surveys and small-scale pilots. Despite the variety of methods and surveys deployed in the U.S. to study CAVs, currently 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 survey.




*The difference between automated and connected vehicles*

## Methodology

The research team first reviewed the substantial literature on public surveys of automated vehicle (AV) technologies and considerably less work focused on public attitudes of connected vehicle (CV) technologies. The primary data collection method used in this study was a 184-item survey in paper and online modes. The survey was organized by screening questions, travel behavior, attitudes on CAV, attitudes on interventions, attitudes on technology and demographics.

Out of the original 2,800 survey invitations sent, 672 (24%) returned a valid response. After the review of initial responses, an additional 1,500 surveys were mailed to newly identified households to improve the power of the study. Out of the additional 1,500 survey invitations sent, 243 (16.2%) returned a valid response. Out of the total 4,300 invitations sent, 915 (21.3%) Wisconsinites returned a valid response. An exploratory factor analysis and latent class cluster analysis were conducted and yielded six factors and five latent clusters. These factors and clusters were used to create profiles of the Wisconsin population and document their attitudes and attributes.

***"Knowing what information the public and other transportation stakeholders need is crucial for everyone in preparing for connected vehicle and automated vehicle technologies and realizing the benefits those systems can offer."***

***-Brad Basten, WisDOT***

## Results

Once data cleaning and weighting was performed, the research team analyzed overall weighted population distributions and descriptive statistics. The team noted higher than expected experience with new CAV technologies considering that these technologies are relatively rare in the U.S. and especially Wisconsin. Results indicate that Wisconsinites were generally willing to share the road with vehicles equipped with advanced driver-assistance systems (ADAS). They were also moderately comfortable with CV technologies, and not comfortable with AV systems. Results for willingness to use CAVs saw the same levels of technology preference as comfort sharing the road.

## Recommendations for Implementation

Based on the results of the survey, there are several implications for WisDOT to consider for future research.

- Having an operator in the driver's seat is currently a requirement in Wisconsin. Future AV use cases may wish to remove this operator when it is safe and legal to do so. However, this study indicates keeping the operator in place results in a significantly larger portion of Wisconsinites willing to use AV applications.
- Any future pilot programs would be deployed in a relatively small geographic scope. Further refinements of subarea population attitudes would be needed before any implementation to determine the best location.
- Future programs should consider which data elements Wisconsinites are willing to share. When asked about their willingness to share data for a CV application that could increase their safety, Wisconsinites were generally more willing to share short-term sensor data (i.e., wiper, headlight, braking, traction, and onboard diagnostics), make/model, and mileage information than more sensitive information like vehicle ownership, trajectories, trip location, and speed.
- There may be some confusion over the term "connected vehicle". Some respondents may have assumed that vehicles with in-vehicle infotainment systems with Bluetooth or WIFI are connected vehicle technologies. While this is not necessarily incorrect, these more widely used technologies do not have the real-time communication benefits of full-fledged CV technologies this study was hoping to analyze.

Interested in finding out more?
Final report is available at:
WisDOT Research website

This brief summarizes Project 0092-23-11
Connected and Automated Vehicles Attitudes and Perceptions
Wisconsin Highway Research Program

Research Brief

Policy Research Program
Project 0092-23-12
February 2024

# Highway Safety Media Campaign Awareness

## Objectives

- Assess and improve upon the effectiveness of Wisconsin's traffic safety media campaigns
- Measure attitudes and perceptions regarding traffic safety messaging
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## Benefits

- Development of a safety communications plan based on survey results
- Compile real-time data and feedback from Wisconsin drivers

**Principal Investigator**
Katie Womack
Texas A&M Transportation Institute
k-womack@tti.tamu.

**Project Manager**
Michael Schwendau
WisDOT
michael.schwendau@dot.wi.gov

## Background

The vision of the Wisconsin Department of Transportation's Bureau of Transportation Safety is zero fatalities on Wisconsin roads. To achieve this, WisDOT and its safety partners have established high-visibility law enforcement efforts and public outreach including multiple statewide safety campaigns. WisDOT commissioned a study to assess the state's current safety media campaign communications by garnering feedback from the public with the goal of creating a more effective and strategic traffic safety communication plan.

## Methodology

In July 2023 an online survey with 45 questions was sent to a statewide sample of Wisconsin residents yielding over 1,500 responses. After an analysis of survey results showing descriptive-level findings, a communication plan was developed for testing in the field with seven focus groups in five different locations in the state. The communication plan included general recommendations for development of overarching goals for traffic safety communication and media objectives for attaining these goals.

A focus group discussion guide was also developed that included topics and questions from the online survey. Prompts helped explore thinking behind responses. PowerPoint visuals were used to present material, and participants were asked to engage in polling exercises to measure their feedback on existing media campaigns.

## Results

The statewide survey and series of focus group discussions revealed that the typical Wisconsinite is keenly aware of traffic safety issues in the state. High percentages of survey respondents and most focus group participants are familiar with major traffic safety campaigns and their messages. They favor strong and consistent enforcement of traffic laws intended to curb the most dangerous behaviors behind the wheel. They support proven countermeasures and welcome more public information and education, including effective media campaigns.

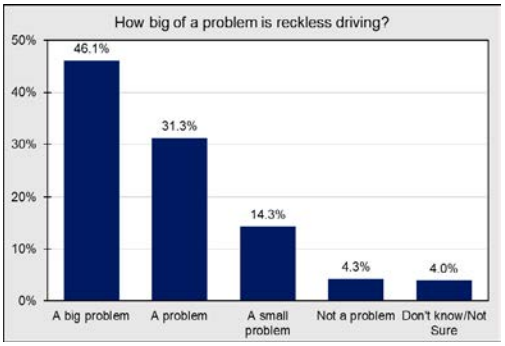
## Recommendations for Implementation

Results from the survey and focus groups led the research team to create a series of program goals and media objectives. Researchers also identified specific audiences at a higher risk of reckless behavior that safety campaigns should target, as well as a schedule for coordinating the release of campaigns to coincide with holidays and times of higher road use. The program goals include:

- **Reduce distracted driving:** Decrease instances of texting while driving and promote distraction-free behavior.

*"The Bureau of Transportation Safety will be implementing many of the recommendations in this report and apply what we learned in the survey to gauge the media's impact on driver behavior and establish ways to keep current with data trends and public feedback." – Michael Schwendau, WisDOT*

- **Address impaired driving:** Decrease instances of driving under the influence through awareness and education. This was one of the top issues discussed in focus groups.
- **Promote responsible driving:** Reduce speeding and reckless driving on local roads through awareness and enforcement.
- **Improve compliance with traffic laws among specific groups:** Increase compliance with specific traffic laws. Results from the survey show teens and young adults ages 18-21 self-report use of seat belts less than any other age group. 91% of Hispanic drivers and 92% of Black drivers self-report no seat belt use.




Over 91% of respondents agree that reckless driving is a problem in Wisconsin.

Media objectives include:

- **Create more effective and strategic communication initiatives for traffic safety messages in Wisconsin:** 61% of survey respondents agree that more traffic safety campaigns are needed in Wisconsin. 67% agree that they are more likely to be influenced by crash victim stories than a safety reminder.
- **Increase campaign recognition:** Heighten awareness of traffic safety media campaigns and achieve a pre-set percentage increase in campaign recognition over the next year.
- **Behavioral change:** Achieve a pre-set percent reduction in distracted driving, speeding and drinking and driving incidents within the target audience.

Interested in finding out more?
Final report is available at:
WisDOT Research website

This brief summarizes Project 0092-23-12
Highway Safety Media Campaign Awareness and Attitudes

Policy Research Program

# Completed Materials Management Projects

Materials Management projects are an important research and technology transfer activity for WisDOT. These projects ensure the department is collecting reliable data, revising specifications and updating methodologies on the materials used to build and maintain Wisconsin's transportation system.

# Final Report

Materials Management Section Project
Project 0092-22-51
September 2024

# Field Friction Testing

## Objectives

- Evaluate the performance of surface treatments used for enhancing the friction properties

## Benefits

- Identify the best practice for enhanced surface friction
- Define service life of different friction surface treatments

***"This research and its results help support safety measures that reduce the number of fatalities in Wisconsin. The installation of high friction surface treatments aid in the reduction of run-off-the-road crashes." – Peter Kemp, WisDOT***


WisDOT Project Contact
Peter Kemp
peter.kemp@dot.wi.gov


Interested in finding out more?
Final report is available at:
WisDOT Research website

## Background

Friction is a critical characteristic of a pavement that affects how vehicles interact with the roadway. In the areas of high run-off-the-road crashes increased friction has been employed as a crash reduction strategy. Friction testing was first conducted on various friction treatments in 2014 for the Wisconsin Department of Transportation. Since then, skid numbers have been measured for these treatments.

## Methodology

The research used a locked-wheel skid friction tester manufactured by International Cybernetics Corporation that meets all specifications set forth in ASTM E-274, Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire. Tests were conducted using an ASTM E-501 ribbed testing tire in the left wheel path. The testing interval for the project was set at 0.05 miles when site length was sufficient to collect at regular, automated intervals. In locations where the site length was not long enough to collect adequate data, testing was manually activated by the field personnel as often as possible to maximize data collection. Data collected at each test point include SN40R, test speed, linear distance, GPS coordinates, ambient air temperature, and surface temperature. The target test speed for all locations was 40 mph. However, due to geometric limitations, some data was collected at speeds below 40 mph and corrected in post-processing.

## Results

A final report included test results on high friction surface treatment (HFST) encompassing site average friction number (SN40R). The reported SN40R data, the friction measure of locked wheel applied at 40 mph on pavement, supports HFST as a superior non-skid surface. Consistent friction values are documented from year to year in a range associated with high skid resistance for the anticipated service.

## Recommendations for Implementation

Adoption of high friction surface treatment as a safety improvement in high occurrence areas of wet weather run-off-the-road crashes.


This report summarizes Project 0092-22-51
Field Friction Testing
Materials Management Section Project

# Final Report

Materials Management Section Project
Project 0092-23-52
September 2023

# WisDOT Evaluation and Transition of Bentley, Inc., OpenGround Geotechnical Database Management Software for Integration with Civil 3-D

## Objectives

- Test and develop Bentley,Inc., OpenGround® cloud-based software package for use as WISDOT's geotechnical data management platform.

## Benefits

- Expand and improve WISDOT's geotechnical data management capabilities by transitioning to Bentley's OpenGround software platform.

***"Open Ground has the potential to be WISDOT's future geotechnical data management software platform and provides for substantial improvement over our current gINT software package."* – Dan Reid, BTS Geotechnical Engineering Unit**

## WisDOT Project Contact

Dan Reid
Daniel.reid@dot.wi.gov

Interested in finding out more?
Final report is available at:
WisDOT Research website

## Background

WisDOT Bureau of Technical Services (BTS) Materials Management Section's (MMS) current geotechnical data management software package, gINT, is nearing the end of its useful life cycle and is being discontinued by Bentley, Inc. in 2026. There are also compatibility issues between gINT and Civil-3D, the current WisDOT Bureau of Structures (BOS) design software package. These issues have required BTS to seek out and evaluate a better solution for geotechnical data management that is compatible with Civil 3-D.

## Methodology

One-year licenses for OpenGround (OG) i3 Cloud Service Subscription, OG Manager, OG Integrator, OG Collector were purchased and evaluated. The software and cloud service were tested to assess functionality within the WisDOT IT environment, compatibility with importing historical gINT files/data, user interface/ease of use, field data collection and integration of OG software with Civil 3-D(WisDOT's software design package).

## Results

The evaluation and testing of the OG platform indicated there were many issues with this platform that proved to be problematic. These issues included a complicated and difficult user interface (particularly with boring log template design, and with creating and generating fences and cross-sections), inability to easily import historical gINT data, and difficult integration with Civil 3-D. Discussions with Bentley staff indicated that other software add-ons and unanticipated additional consulting time/costs with Bentley and/or other vendors would be required to overcome these issues.

## Recommendations for Implementation

Based on the testing and evaluation results, adoption and use of the OpenGround software platform as WisDOT's geotechnical database management platform is not recommended.

This report summarizes Project 0092-23-52
WisDOT Evaluation and Transition to Bentley, Inc., OpenGround Geotechnical Database Management Software for Integration with Civil 3-D
Materials Management Section Project.

# Technology Transfer and Library Activities

*The WisDOT Research and Library Services provides information services for WisDOT staff and stakeholders and supports implementation of research results. Through services including synthesis reports and literature searches, we connect WisDOT employees with the most up-to-date research and industry trends.*

## AASHTO Research Advisory Committee Region 3 Peer Exchange

In May 2024, WisDOT jointly hosted a peer exchange with the Illinois Department of Transportation focusing on experiences, practices and ideas that can be used in effective administration and management of DOT research programs. Research staff from Illinois, Iowa, Kansas, Michigan, Minnesota, Missouri, Ohio and Wisconsin gathered in Madison for the 2.5-day event. The focus areas of the peer exchange included workforce development, knowledge management, research project development, research project management and tracking, as well as implementation and strategies to measure return on investment.

## WisDOT Library Services

Library staff handled 592 information requests and delivered 567 digital items (books, reports, periodicals and articles)..

## Synthesis Reports

A synthesis report is an evaluation of other state transportation agencies' policies and procedures made by comparing, contrasting, and combining information gathered from agencies' websites or through electronic surveys. Three synthesis reports were completed in FFY 2024 on topics, including: federal apportionment authority, technical career paths for DOT employees, and traffic data.

## Literature Searches

A literature search is a systematic and thorough search of all types of published literature to identify a breadth of quality references relevant to a specific topic. Customers apply the collected information to decision making for funding and crafting research efforts and for general policy improvement. WisDOT completed 22 literature searches in FFY 2024. Topics included: roadside oral fluids testing, connected and automated vehicle education, pavement buckling, and non-driver transportation behavior.

# Completed WHRP Research Projects

| PROGRAM | PROJECT ID | PERFORMING ORGANIZATION | PRINCIPAL INVESTIGATOR | PROJECT BUDGET | WISDOT PROJECT MANAGER | PROJECT TITLE | IMPLEMENTATION METHOD | COMPLETION DATE |
|---|---|---|---|---|---|---|---|---|
| WHRP – Rigid | 0092-22-04 | National Center for Asphalt Technology at Auburn University | Randy West | $250,000 | Tirupan Mandal | Balanced Mixture Design (BMD) Pilot and Field Test Sections | Assess long-term field performance of BMD pavements | 08/2024 |
| WHRP – Geotech | 0092-22-05 | Michigan State University | Bora Cetin | $125,000 | Andrew Zimmer | Weight-Volume Relationships and Conversion Factors for Soils and Aggregates of Wisconsin | Develop a model | 03/2024 |
| WHRP – Structure | 0092-23-05 | Iowa State University | Behrouz Shafei | $75,000 | James Luebke | Underwater Concrete Pours and Non-Segregating Concrete | Revise a specification, new product implementation | 04/2024 |

# Ongoing WHRP Research Projects

| PROGRAM | PROJECT ID | PERFORMING ORGANIZATION | PRINCIPAL INVESTIGATOR | PROJECT BUDGET | WISDOT PROJECT MANAGER | PROJECT TITLE | ANTICIPATED IMPLEMENTATION STATUS |
|---|---|---|---|---|---|---|---|
| WHRP – Rigid Pavement | 0092-22-02 | Applied Research Associates, Inc. | Shreenath Rao | $130,000 | Sinan Coban, Peter Kemp | Field Investigation of Dowel and Tie Bar Placement | Revise a specification |
| WHRP – Rigid Pavement | 0092-22-03 | University of Missouri – Kansas City | John Kevern | $170,000 | Tirupan Mandal | Timely and Uniform Application of Curing Materials | Revise a specification, New product Implementation |
| WHRP - Geotech | 0092-22-06 | Iowa State University | Alice Alipour | $200,000 | Dave Staab | Wind-Load Structures | Develop a model, Revise a specification |
| WHRP – Rigid Pavement | 0092-23-01 | Rutgers, The State University of New Jersey | Thomas Bennert | $175,000 | Erik Lyngdal | Benchmarking Delta Tc (ΔTc) for Wisconsin Materials | Revise a specification |
| WHRP - Structure | 0092-23-02 | University of Virginia | Zhen Liu | $227,617 | David Staab | Seasonal Weight Restriction Decision Making based on Monitoring of Frost Susceptibility of Pavement Structures | Develop a model, develop a web-based decision support tool |
| WHRP – Rigid Pavement | 0092-23-03 | American Engineering Testing, Inc. | Jussara Tanesi | $199,779 | Tirupan Mandal | Chemistry and Performance of Supplementary Cementitious Materials (SCMs) for Wisconsin Concrete Pavement | New design method or guidance |
| WHRP – Geotech | 0092-23-04 | AECOM Technical Services, Inc. | Brady Seston | $129,462 | Philip Meinel | Bridge Deck Thermography Verification and Policy | Revise a specification |
| WHRP – Flexible Pavement | 0092-24-01 | Iowa State University | Christopher Williams | $249,980 | Casey Wierzchowski | Design Requirements for High-Traffic Asphalt Mixes to Ensure Pavement Performance | New product implementation, Revise a specification |
| WHRP – Geotech | 0092-24-02 | Geocomp, Inc. | W. Allen Marr | $228,286 | Steve Doocy | Investigation of MSE Wall Corrosion in Wisconsin | New product implementation, Revise a specification |
| WHRP – Rigid Pavement | 0092-24-03 | Marquette University | Jaime Hernandez | $129,999 | Tirupan Mandal | Proactive Prevention of Pavement Buckling | Develop a model, Revise a specification |
| WHRP – Rigid Pavement | 0092-24-04 | American Engineering Testing, Inc. | Jussara Tanesi | $198,999 | Tirupan Mandal | Alternative Conditioning Method to Calculate Formation Factor for Wisconsin Concrete Pavement | New product implementation, Revise a specification |
| WHRP - Structure | 0092-24-05 | Wiss, Janney, Elstner, Associates, Inc. | John Lawler | $199,860 | Andrew Smith | Vertical Overhead Concrete Patches | Revise a specification |
| WHRP - Structure | 0092-24-06 | Applied Research Associates, Inc. | Jerry DiMaggio | $159,994 | Ruth Coisman | State of Practice for Specifying and Repairing Mechanically Stabilized Earth Walls | New product implementation, Revise a specification |

# Completed Policy and Safety First Research Projects

| PROGRAM | PROJECT ID | PERFORMING ORGANIZATION | PRINCIPAL INVESTIGATOR | PROJECT BUDGET | WISDOT PROJECT MANAGER | PROJECT TITLE | IMPLEMENTATION METHOD | COMPLETION DATE |
|---|---|---|---|---|---|---|---|---|
| Policy | 0092-23-11 | University of Wisconsin-Madison | Andrea Bill | $74,995 | Brad Basten | Connected and Automated Vehicles Attitudes and Perceptions | New design method or guidance, Recommend future studies, Inform policy | 02/2024 |
| Policy | 0092-23-12 | Texas A&M Transportation Institute | Katie Womack | $124,087 | Michael Schwendau | Highway Safety Media Campaign Awareness and Attitudes | New design method or guidance, Recommend future studies, Inform policy | 01/2024 |

# Ongoing Policy and Safety First Research Projects

| PROGRAM | PROJECT ID | PERFORMING ORGANIZATION | PRINCIPAL INVESTIGATOR | END DATE PROJECT BUDGET | WISDOT PROJECT MANAGER | PROJECT TITLE | ANTICIPATED IMPLEMENTATION STATUS |
|---|---|---|---|---|---|---|---|
| Policy | 0092-24-10 | University of Wisconsin-Milwaukee | Xiao Qin | 2/2025 $90,000 | Ethan Severson | Wisconsin Non-Driver Transportation Behavior Study | New design method or guidance, Recommend future studies, Inform policy |
| Safety First | 0092-24-11 | Pennsylvania State University | S. Ilgin Guler | 7/2025 $120,000 | Maryne Taute | Engineering Countermeasures to Mitigate Reckless Driving Behavior | Develop a model, New design method or guidance, Revise a specification, Inform policy |
| Safety First | 0092-24-12 | University of Wisconsin-Milwaukee | Xiao Qin | 7/2025 $95,000 | Maryne Taute | Countermeasures To Improve Pedestrian Visibility to Tall Vehicles | Develop a model, New design method or guidance, Inform policy |
| Policy | 0092-24-14 | University of Wisconsin-Madison | Sikai Chen | 7/2025 $95,000 | Johanna Schmidt | Artificial Intelligence in Transportation | New product implementation, Recommend future studies, Inform policy |
| Policy | 0092-24-16 | University of Wisconsin-Milwaukee | Romila Singh | 7/2025 $95,000 | David Hunt | Maintaining Knowledge and Investing in Talent for Next-Generation Transportation Engineering | New design method or guidance, Inform policy |
| Policy | 0092-24-17 | Montana State University | Marcel P. Huijser | 7/2025 $95,000 | Jennifer Gibson | Wildlife Crossing Hotspot Analysis | Develop a model, New design method or guidance, Revise a specification |

# Pooled Fund Participation

| TPF # | PROJECT TITLE | FFY 2024 FUNDING AMOUNT | WISDOT TECHNICAL REPRESENTATIVE | LEAD AGENCY/ STATE |
|---|---|---|---|---|
| TPF-5(255) | Highway Safety Manual Implementation | N/A | Kevin Scopoline | FHWA |
| TPF-5(305) | Regional and National Implementation and Coordination of ME Design | N/A | Mumtahin Hasnat | FHWA |
| TPF-5(317) | Evaluation of Low-Cost Safety Improvements | N/A | Kevin Scopoline | FHWA |
| TPF-5(326) | Develop and Support Transportation Performance Management Capacity Development Needs for State DOTs | N/A | Dan Lamm | Rhode Island |
| TPF-5(347) | Development of Maintenance Decision Support System | $30,000 | Mike Adams | South Dakota |
| TPF-5(368) | Performance Engineered Concrete Paving Mixtures | N/A | James Parry | Iowa |
| TPF-5(370) | Fostering Innovation in Pedestrian and Bicycle Transportation Pooled Fund | N/A | Christopher Squires | FHWA |
| TPF-5(372) | Building Information Modeling (BIM) for Bridges and Structures | N/A | Josh Dietsche | Iowa |
| TPF-5(375) | National Partnership to Determine the Life Extending Benefit Curves of Pavement Preservation Techniques (MnROAD/NCAT Joint Study Phase 2) | $50,000 | Haluk Sinan Coban | Minnesota |
| TPF-5(382) | Drivers Failing to Yield at Multi-Lane Roundabout Exits | N/A | Rebecca Szymkowski | FHWA |
| TPF-5(385) | Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDDs) | N/A | Jhuma Saha | Virginia |
| TPF-5(388) | Developing Implementation Strategies for Risk Based Inspection (RBI) | N/A | Steve Doocy | Missouri |
| TPF-5(389) | Connected Vehicle Pooled Fund Study | N/A | David Karnes | Virginia |
| TPF-5(395) | Traffic Disruption-Free Bridge Inspection Initiative with Robotic Systems | N/A | David Bohnsack | Missouri |
| TPF-5(399) | Improve Pavement Surface Distress and Transverse Profile Data Collection and Analysis, Phase 2 | $20,000 | Andrew Schilling | FHWA |
| TPF-5(430) | Midwest Roadside Safety Pooled Fund Program | $74,000 | Erik Emerson | Nebraska |
| TPF-5(435) | Aurora Program (Weather Monitoring/ Forecasting in Highway Operations) | N/A | Mike Adams | Iowa |
| TPF-5(437) | Technology Transfer Concrete Consortium (FY20-FY24) | $8,000 | Tirupan Mandal | Iowa |
| TPF-5(438) | Smart Work Zone Deployment Initiative (FY20-FY24) | N/A | Erin Schwark | Iowa |
| TPF-5(441) | No Boundaries Transportation Maintenance Innovations | $10,000 | Rebecca Szymkowski | Colorado |
| TPF-5(442) | Transportation Research and Connectivity | N/A | John Cherney | Oklahoma |
| TPF-5(443) | Continuous Asphalt Mixture Compaction Assessment using Density Profiling System (DPS) | N/A | Erik Lyngdal | Minnesota |

| TPF # | PROJECT TITLE | FFY 2024 FUNDING AMOUNT | WISDOT TECHNICAL REPRESENTATIVE | LEAD AGENCY/ STATE |
|---|---|---|---|---|
| TPF-5(447) | Traffic Control Device (TCD) Consortium (3) | $10,000 | Ryan Mayer | FHWA |
| TPF-5(448) | Integrating Construction Practices and Weather into Freeze Thaw Specifications | N/A | Tirupan Mandal | Oklahoma |
| TPF-5(458) | Traffic Analysis, Modeling, and Simulation | $20,000 | Vicki Haskell | FHWA |
| TPF-5(460) | Flood-Frequency Analysis in the Midwest: Addressing Potential Nonstationary Annual Peak-Flow Records | $55,600 | Steve Neary | Nebraska |
| TPF-5(465) | Consortium for Asphalt Pavement Research and Implementation (CAPRI) | $20,000 | Daniel Kopacz | Alabama |
| TPF-5(466) | National Road Research Alliance (NRRA) - Phase II | $150,000 | Barry Paye | Minnesota |
| TPF-5(467) | Research Project Tracking System | N/A | Evelyn Bromberg | Kentucky |
| TPF-5(478) | Demonstration to Advance New Pavement Technologies Pooled Fund | $10,000 | Erik Lyngdal | FHWA |
| TPF-5(479) | Clear Roads Winter Highway Operations Phase 3 Pooled Fund | N/A | Emil Juni | Minnesota |
| TPF-5(480) | Building Information Modeling (BIM) for Infrastructure | N/A | Steve Popke | Iowa |
| TPF-5(486) | Steel Bridge Research, Inspection, Training and Education Engineering Center (SBRITE) | $30,000 | Jason Lahm | Indiana |
| TPF-5(487) | Transportation Management Centers Pooled Fund Study Phase 2 | $50,000 | Randall Hoyt | FHWA |
| TPF-5(490) | Enterprise- Phase 3 (Phase 2 Continuation) | $30,000 | Elizabeth Lloyd-Weis | Michigan |
| TPF-5(492) | Biennial Asset Management Conference and Training on Implementation Strategies | $24,000 | Cheryl Simon | Iowa |
| TPF-5(508) | Concrete Bridge Engineering Institute | $30,000 | Aaron Bonk | Texas |
| TPF-5(514) | Work Zone Analytics | $30,000 | Erin Schwark | Indiana |
| TPF-5(516) | Highway Safety Manual 2nd Edition (HSM2) Implementation | $16,000 | Kevin Scopoline | FHWA |
| TPF-5(517) | Performance Centered Concrete Construction | $25,000 | Tirupan Mandal | Iowa |
| TPF-5(518) | Implementation of Structural Data from Traffic Speed Deflection Devices | $55,000 | Haluk Sinan Coban | Virginia |
| TPF-5(520) | Improving Traffic Detection Through New Innovative i-LST Technology Demonstration Pilot | $15,000 | Russell Lewis | FHWA |
| TPF-5(522) | National Partnership to Improve the Quality of Preventative Maintenance Treatment Construction & Data Collection Practices | $50,000 | Haluk Sinan Coban | Minnesota |
| TPF-5(523) | Building Information Modeling (BIM) for Bridges and Structures (Phase II) | $20,000 | Josh Dietsche | Iowa |
| TPF-5(532) | MAASTO Connected Automated Vehicle (CAV) Steering Committee | $30,000 | Brad Basten | Michigan |

# Research Program Committees

## Wisconsin Highway Research Program (WHRP)

### WHRP Steering Committee

**Ethan Severson, Chair**
WisDOT, DBSI, Bureau of Performance Improvement Research and Strategic Initiatives

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**Tim Rank**
WisDOT, DTSD Regional Representative

**Amr El Ragaby**
Academic Representative, UW-Platteville

**Debbie Schwerman**
Wisconsin Asphalt Pavement Association

**Jackie Spoor**
Wisconsin Concrete Pavement Association

### WHRP Technical Oversight Committee chairs

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WisDOT, DTSD, Bureau of Technical Services

#### GEOTECHNICS

**David Staab**
WisDOT, DTSD, Bureau of Technical Services

#### RIGID PAVEMENTS

**Tirupan Mandal**
WisDOT, DTSD, Bureau of Technical Services

#### STRUCTURES

**James Luebke**
WisDOT, DTSD, Bureau of Structures

#### TECHNICAL SUPPORT

**Dante Fratta**
Principal Investigator, University of Wisconsin - Madison

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**Maryne Taute**
WisDOT, DBSI, Bureau of Performance Improvement, Research and Strategic Initiatives

## Safety First Work Group

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WisDOT, DBSI, Bureau of Performance Improvement and Strategic Initiatives

**Katie Bartelt**
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**Ryan Chaffee**
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WisDOT, DTIM, Administrator's Office

**Leah Fix**
WisDOT, DMV, Bureau of Driver Services

**Jennifer Fedie**
WisDOT, Executive Offices, Office of Public Affairs

**Matthew Gast**
WisDOT, DTIM, Bureau of State Highway Programs

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WisDOT, DBSI, Administrator's Office

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WisDOT, DTSD, Bureau of Traffic Operations

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WisDOT, DTSD, Northeast Region

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WisDOT, DTIM, Bureau of Aeronautics

**Matthew Rohrbeck**
WisDOT, DBM, Administrator's Office

**Ethan Severson**
WisDOT, DBSI, Bureau of Performance Improvement and Strategic Initiatives

**Kris Sommers**
WisDOT, DTIM, Bureau of Transit, Local Roads, Railroads and Harbors

## Research and Library Unit Staff

**Shari Krueger**
WisDOT, DBSI, Supervisor

**Ethan Severson**
WisDOT, DBSI, Performance, Research and Library Section Chief

**John Cherney**
WisDOT, DBSI, Librarian

**Joy Loomis**
WisDOT, DBSI, Budget and Research Implementation Coordinator

**Penny Yanke**
WisDOT, DBSI, Contracts Specialist

**Evelyn Bromberg**
WisDOT, DBSI, National Programs Coordinator

**Carter Angelo**
WisDOT, DBSI, Research Communications Coordinator


# WisDOT Research Program

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research@dot.wi.gov