massDOT
Massachusetts Department of Transportation

Transportation Research Quarterly

Providing highlights of MassDOT's transportation research activities and other helpful information **2025 Q1**

Focus on Research

"Peer recognition and peer-to-peer communication are closely linked and reinforce each other in the work environment, helping to ensure a positive working relationship between peers."

Penny Smith – Freelance Blog

INSIDE THIS ISSUE

New Upcoming Projects

Advanced Technologies and Data Analytics for Safe, Smart, and Efficient Transportation (ASSET)

Budget: $604,334 Duration: 22 months

Massachusetts Department of Transportation's (MassDOT) research initiatives through an Interdepartmental Service Agreement (ISA) with the University of Massachusetts Lowell (UMass Lowell). Detailed scopes of work and budgets for individual tasks as fallows:

- Calibration of Safety Performance Functions for Urban and Suburban Arterial Intersections
- Artificial Intelligence (AI) for Sidewalk Detection
- AI for Multimodal Trip Counts

Evaluation and Mitigation Methods for the Prevention of Cement Concrete Deterioration due to Pyrrhotite Phase II

Budget: $204,889 Duration: 18 months.

The study will be performed by using the developed electro-chemical acceleration testing method complemented by visual observations, quantitative crack-length development, non-destructive evaluation test methods and microstructural analysis.

Uniform Speed Management

Budget: $150,000 Duration 28 months

This project seeks to identify key categories of information to be used as inputs in the design of a new user-friendly process to systemically identify current and predict future areas of speed concern. As well as Design a Speed Management Matrix Guide for MA municipalities as a reference 'pick list' of appropriate speed management countermeasures like the decision matrix guide provided in the FHWA's Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations.

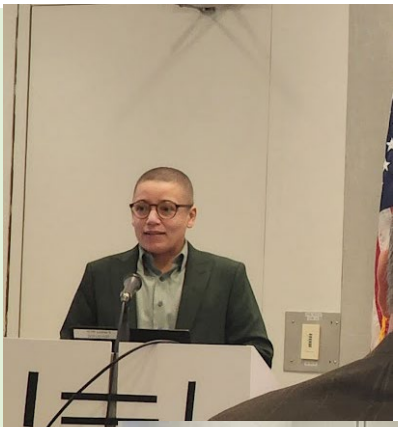
MassDOT Research Peer Exchange 2025

The MassDOT Research Program conducted a peer exchange with transportation research peers on March 12-13, 2025, at 10 Park Plaza. The peer exchange conducted in accordance with 23 CFR 420, which requires that agencies use a portion of State Planning and Research (SPR) Program funds to conduct periodic peer exchanges (every 5 years) to share and enhance their respective research program activities. MassDOT contracted the U.S. Department of Transportation's Volpe Center to facilitate the peer exchange.

This Research Peer Exchange brought together representatives from six other State DOTs, the FHWA Massachusetts Division, and the Transportation Research Board to identify innovative approaches and best practices in research solicitation, execution, implementation, and evaluation.

MassDOT Secretary and CEO, Monica Tibbits-Nutt gave the opening remarks on day one. MassDOT Highway Administrator Johnathan Gulliver and Chief Engineer Carrie Lavalle gave opening remarks on day two.

Participating state DOTs: Colorado, Kentucky, Maryland, New Jersey, Oregon, and Utah.



MassDOT Research Peer Exchange March 12-13, 2025

massDOT Massachusetts Department of Transportation

U.S. Department of Transportation Volpe Center

Ongoing Research Project Highlights

Cracks of Low-P Rapid Set Concrete in Deck Repairs: Analysis, Prevention, and Alternatives

The occurrence of full-depth transverse cracks in Low-P rapid-set concrete highlights the need to investigate the cracking mechanisms in repaired bridge decks, as well as to develop prevention strategies and alternative materials.
The overall objective of this project is to analyze the correlations between cracks in Low-P rapid set concrete and factors including concrete mix design, construction practices, curing conditions, and the service environment/weather conditions of bridge decks. This analysis aims to deepen the understanding of cracking mechanisms and to develop strategies for preventing crack formation in this special concrete. The outcomes will guide the treatment of deck repair materials for MassDOT projects, ultimately enhancing the durability and longevity of repaired bridge decks. Anticipated outcomes include:
1. A comprehensive literature review.
2. Detailed data collected via laboratory tests per selected AASHTO and ASTM test methods.
3. A thorough understanding of the causes and mechanisms behind crack formation in young Low-P rapid set concrete.
4. Recommendation for preventing cracks in bridge decks repaired with Low-P concrete.
5. Development of high-performance alternative materials for bridge deck repair.

The objectives of this project will be achieved via the following methodologies and efforts:
1. Conduct a literature review on the current state and challenges of rapid-setting concrete, and compile testing standards and methods.
2. Investigate cement hydration kinetics, as well as phase and microstructure evolution.
4. Determine the early-age properties of Low-P binder and concrete, with a focus on their correlation with cracking mechanisms .
5. Identify the primary factors driving the formation of transverse cracks in Low-P concrete for bridge deck repairs through field inspections and laboratory testing.
6. Develop a rapid-setting UHPC (R-UHPC) that integrates exceptional mechanical properties and durability with rapid-setting and hardening characteristics suitable for emergent structural repairs.

Completed Research Project Highlights

Evaluation & Mitigation Methods for the Prevention of Cement Concrete Deterioration due to Pyrrhotite: Part I.

Aggregates containing reactive iron-sulfide minerals, such as pyrrhotite, incorporated into Portland cement concrete cause premature deterioration of the concrete. This process can start subtly in the form of interior hairline cracks and may take between 10 to 30 years. There is a need to establish a testing program which can accelerate the deterioration under controlled conditions in the laboratory. This will allow to perform and evaluate potential mitigation methods.

The primary goal of this study was to establish a foundational understanding of pyrrhotite- induced concrete deterioration and to lay the groundwork for a comprehensive research study. To achieve this goal, three key objectives were defined:

• Identify and evaluate pyrrhotite testing protocols by assessing total sulfur content, pyrrhotite concentration, expansion characteristics, and concrete performance.

• Initiate the study and testing of the effectiveness of mitigation strategies in Portland cement concrete by analyzing the impact of optimized mixture designs on deterioration progression.

• Develop a detailed scope of work for an extensive laboratory and field study to systematically evaluate mitigation methods and their long-term effectiveness in preventing deterioration.

Preliminary laboratory tests confirmed that electrochemical accelerated testing (EAT) on pyrrhotite-induce concrete samples effectively replicated deterioration patterns observed in the field, such as discoloration, pop-outs, and map cracking., while control specimens without pyrrhotite remained intact. Additionally, concrete with a lower water-cement ratio (0.4) exhibited greater resistance to deterioration, compared to specimens with a higher ratio (0.6).

The findings demonstrate the effectiveness of Electrochemical Accelerated Testing (EAT) in expediting and analyzing pyrrhotite-induced concrete deterioration, providing a reliable tool for early damage detection and risk assessment. These results underscore the need for refining testing methodologies to deepen the understanding of deterioration mechanisms and assess viable mitigation strategies. Future research will focus on comprehensive concrete parameter testing and the evaluation of chemical treatment methods to develop more resilient mix designs, ultimately mitigating pyrrhotite-induced concrete deterioration and extending the lifespan of affected structures.

A Look at Who We are – Team Highlights

Each MassDOT research project team is comprised of a Project Champion(s), a Principal Investigator(s) and a Project Manager. The Project Champion serves as the MassDOT technical representative, the Principal Investigator conducts research investigation and produces deliverables per project scope and schedule, and the Project Manager takes charge of the overall project administrative management and coordination. Highlighted below are the key members of "Evaluation & Mitigation Methods for the Prevention of Cement Concrete Deterioration due to Pyrrhotite" project team. This project was managed by project manager Austin Sanders from our research team.

Principal Investigator – Kay Willie Ph.D.

Dr. Kay Wille is a Professor and Interim Director of the School of Civil and Environmental Engineering at the University of Connecticut. He is a nationally recognized expert in advanced cementitious materials, with a research focus on ultra-high-performance concrete (UHPC), and sustainable concrete technologies. He leads the Advanced Cementitious Materials and Composites (ACMC) Laboratory at UConn. Dr. Wille has been playing a pivotal role in investigating the issue of crumbling concrete foundations in Connecticut caused by pyrrhotite-induced deterioration since 2015. He has been leading four major research projects on this issue in collaboration with the National Institute of Standards and Technology (NIST) since 2020.

Principal Investigator – Maria Chrysochoou Ph.D.

Dr. Marisa Chrysochoou is Dean and Ketcham Professor of Engineering at the University of Missouri. Prior to this role, she served as Professor and Department Head in the Department of Civil and Environmental Engineering at the University of Connecticut. An expert in environmental geochemistry and spectroscopy, Dr. Chrysochoou has published on ettringite-induced expansion in cementitious materials and has contributed to characterization of construction materials through advanced spectroscopic methods. She played a central role in pyrrhotite research at UConn, serving as Co-PI on three major federally funded projects in collaboration with NIST.

Co-Principal Investigator– James Mahoney

James Mahoney serves as the Associate Program Director at the Connecticut Transportation Institute (CTI) and is the Executive Program Director of the Connecticut Advanced Pavement Lab (CAP Lab) at the University of Connecticut. He has extensive experience in pavement design, materials testing, and field evaluation of transportation infrastructure. Mahoney has served as Co-PI on all four major federally supported research projects on pyrrhotite-induced concrete deterioration, playing a critical role in developing and implementing field sampling protocols and overseeing the statewide field testing and specimen retrieval program.

Project Champion – Jason Robertson

Jason Robertson is the Director of Research and Materials for the Massachusetts Department of Transportation. Jason joined the department in 2018, after 14 years of materials consulting across 14 states along the east coast. Jason obtained his Bachelor of Science degree in Civil Engineering from Bluefield State College in West Virginia. With a passion for strict adherence to quality, Jason has worked on several large multimillion-dollar and even billion-dollar projects such as, Encore Casino, Green Line Extension, Amtrak Rail Redevelopment from Hartford to New Haven, Lowes Corporation HQ, and various multistory buildings and public facilities.

Project Champion – Richard Mulcahy

With a B.S. in Civil Engineering from Northeastern University, a Professional Engineer (P.E.) Civil License, and over 14 years of engineering experience, Richard brings a wide range of skills, expertise, certifications, awards, and hundreds of professional connections to the table. With a passion for cement concrete and related materials, his research interests include cementitious materials, alternative materials for use in concrete, low carbon concrete, concrete mix design optimization, concrete durability, ultra-high performance concrete, fiber reinforced concrete, alkali silica reaction, iron sulfide reaction, and concrete workmanship best practices.

News and Events

Transportation Review Board Annual Meeting 2025

Thousands of transportation administrators, practitioners, policy makers, and researchers who came to DC and participated in the 104th TRB Annual Meeting January 5–9, 2025.The full 2025 program, Presentations and Abstracts: Details about the program, including abstracts of all papers, are available via the **Online Program**.

TRB

(TRB) Annual Meeting ***held January 5–9, 2025 Washington D.C.***

massDOT Innovation Webinar Series

Developing Massachusetts-Specific Trip Generation Models for Land Use Projects – March 26, 20025
This research aims to develop Massachusetts-specific trip generation models for high-priority land uses using location-based services (LBS) data. The proposed approach based on LBS data can significantly reduce the efforts and time needed to collect trip generation data for model fitting, making it possible to frequently update trip generation models and develop more sophisticated models to capture temporal changes in trip generations.
Click here for the webinar recording

Climate Resilience of Transportation Infrastructure: Challenges and Opportunities- February 20, 2025
For this study, the researchers conducted a survey of Massachusetts municipalities to shed light on the challenges and opportunities to strengthen the climate resilience of transportation infrastructure. Already affected by severe climate impacts, municipalities have started planning and developing numerous types of resilience strategies including planning, engineering and nature-based solutions.
Click here for the webinar recording

Tree Protection for Street Corridor Development in Massachusetts– January 30, 2025
MassDOT is seeking a cohesive collection of best-practice standards to ensure that urban forest health and preservation remains a priority in these upcoming transportation improvement projects. The information gathered during this project, including a survey and discussion with an expert panel, will be used to create a comprehensive guide that will be an overview of current best practices to inform planting and tree protection management techniques during project construction and foster thriving urban forests for all.
Click here for the webinar recording

Research Resources

In Progress MassDOT Research

	Start Date
Development of Improved Inspection Techniques Using LIDAR for Deteriorated Steel Beam Ends	March 2022
Smart Work Zone Safety Control and Performance Evaluation	April 2022
Tree Preservation and Planting for Complete Streets Development	April 2022
Field Study to Determine Salt Usage Efficiency on Two Pavement Types	August 2022
Implementing AASHTO Mechanistic-Empirical Pavement Design Guide Phase III	November 2022
Effect of Asphalt Binder Source on Asphalt Mixture Performance	February 2023
A Pavement marking Inventory and Retroreflectivity Condition Assessment Method Phase II	March 2023
Speed Management and Emergency Response – A Synthesis Study	April 2023
Evaluating the Effectiveness of Drivers' Education Modules on Safety	April 2023
Fare Payment Compliance on MBTA Buses and Light Rail	May 2023
Measuring Food Access to Improve Public Health Phase II	September 2023
Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete	September 2023
Cracks of Low-P Rapid Set Concrete in Deck Repairs: Analysis, Prevention, and Alternatives	December 2024
MassDOT Speed Regulation Editing Support	January 2025
Environmental Scan of Community Transit Needs Among Older Adults in Massachusetts	February 2025

Recently Completed MassDOT Research

	Completion Date
Optimizing MassDOT's High Performance Asphalt Overlay Mixtures	May 2023
Massachusetts Depth to Bedrock	May 2023
Multisource Data Fusion for Traffic Incident Detection	May 2023
Measuring Food Access To Improve Public Health Phase I	July 2023
Post-Fire Damage Inspection of Concrete Structures (Phase II) – Experimental Phase	February 2023
Building Information Model for Transit Infrastructure: Feasibility and Gap Analysis	August 2023
Implementing AASHTO Mechanist-Empirical Pavement Design Guide Phase II	September2023
Developing Massachusetts-Specific Trip Generation Models for Land Use Projects	September 2023
Revised Load Rating Procedures for Prestressed Concrete Beams	November 2023
Ultra-High-Performance Concrete Reinforced with Multi-scale Hybrid Fibers	December 2023
Artificial Intelligence Framework for Midblock Crosswalk Detection Across Massachusetts	February 2024
Using Traffic Signals to Reduce Speeding Opportunities	February 2024
LIMMS Development Planning	July 2024
Development of a Salt Spreader Controller Program	July 2024
3D Printing Applications for Bridge Element Repair	August 2024
Data-Driven Approaches for Transit Capital Planning	August 2024
Cross-Modal Assessment of Sustainable Transportation Networks	August 2024
Evaluating Safety Impacts of Two-stage Bike Boxes	August 2024
Evaluation & Mitigation Methods for the Prevention of Cement Concrete Deterioration due to Pyrrhotite	September 2024
Accessible Bus Stop Design in the Presence of Bike Lanes	September 2024
Post-Fire Inspection of Concrete Structure Phase III- In-Situ Experiments	December 2024
Methods to Identify Problematic Carriers and Prevent Infrastructure Damage	December 2024

Additional Resources

Transportation Research and Information Database (TRID) is a comprehensive bibliographic database containing more than 1.2 million records of transportation research.

Research in Progress (RiP) Database contains information on more than 13,000 current or recently completed federally-funded transportation research projects.

AASHTO Publications include the most accepted technical guides, specifications, and manuals of the industry.

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