massDOT
Massachusetts Department of Transportation

Transportation Research Quarterly

Providing highlights of MassDOT's transportation research activities and other helpful information **2024 Q3**

Focus on Research

"Construction is a matter of optimism; it's a matter of facing the future with confidence."
— Cesar Pelli, Architect

INSIDE THIS ISSUE

Using Research Findings at MassDOT (Project Champion Survey Results)

MassDOT is committed to tracking the implementation and impacts of research. To help with this goal, the MassDOT Research Section sent a Project Completion Survey to the MassDOT Project Champions (PCs) and Principal Investigators (PI), and Project Managers (PM) for research projects completed during FFY23, and a follow-up survey to the PCs and PIs for research projects completed in FFY22.

Survey responses from MassDOT Project Champions (PCs) demonstrate a range of potential implementation efforts. In the most successful cases, research findings and results are being, or have already been, incorporated into the agency's Standard Operating Procedures (SOPs) and technical specifications, and/or have facilitated a phased approach to long-term implementation. For example, it is anticipated that the results from the Construction and Materials Best Practices for Concrete Sidewalks project (Phase I and II) will inform MassDOT's Standard Specifications for sidewalks and will guide the construction of future sidewalks on roadways within MassDOT's jurisdiction and other roadways constructed in the Commonwealth as well. Similarly, with bridge maintenance and safety, the results from earlier studies such as Improved Load Rating Procedures for Deteriorated Steel Beam Ends (2021) and Development of Load Rating Procedures for Deteriorated Steel Beam Ends (2019) have led to changes in the MassDOT Bridge Manual. The results from the FFY23 project Revised Load Rating Procedures for Deteriorated Prestressed Concrete Beams may lead to further updates to the MassDOT Bridge Manual.

One common theme in PC responses to the survey questions on technology transfer and implementation was that the research results had been shared with other MassDOT personnel who may play a crucial role in MassDOT using the findings and implementing recommendations.

Annual MassDOT Moving Together Conference 2024

Annual MassDOT Innovation Conference

Some of the topics at this year's conference will include:

- MassTrails
- Transit Connectivity
- Bicycle Counts
- Systemwide Accessibility
- Climate Resiliency
- Safe Streets/Smart Trips High School Video Contest
- Site Visits

Research Team will moderate the following panels:

Session 3C: Using Technology to Improve Bicycle and Pedestrian Counts - Room C

How do we know when and where people are cycling and walking? Through automated technology, counting stations are providing a wealth of new data to help plan expanded, better bike-ped infrastructure.

Panelists:
Ian Adams, MassDOT
Julia Campbell, City of Boston
David Nolan, Cape Cod Commission
Moderator: Anil Gurcan, MassDOT

Session 3E: Spotlight on Vulnerable Road Users: Agency-wide Cross-cutting Initiatives - Grand Ballroom

This session will highlight ongoing and upcoming initiatives including the impacts of bike lanes on bus stop accessibility, findings from the Commonwealth's Direct Vision Study, as well as an overview on the recently released Safety Action Planning Primer for Massachusetts Communities.

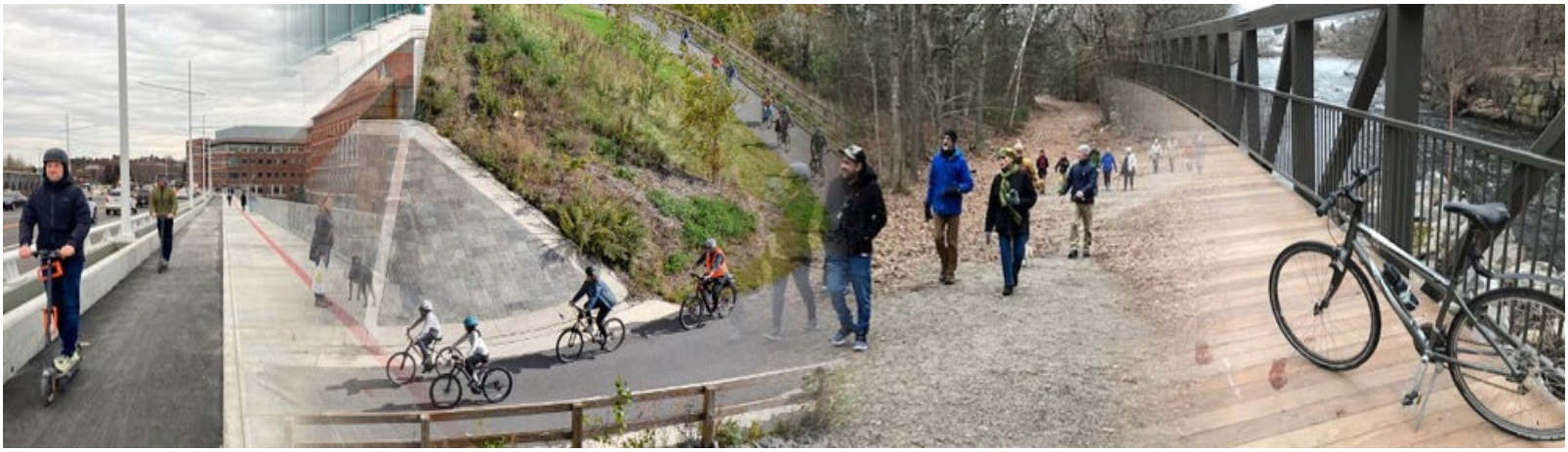
Panelists:
Bonnie Polin and Michelle Deng, MassDOT
Martha Koch, MassDOT Office of Performance Management and Innovation, and Kathryn Quigley, MBTA
Kris Carter, Chief Innovation Officer, MassDOT
Moderator: Austin Sanders, MassDOT

Session 2B: Cutting-Edge Research to Improve Mobility and Safety - Room B

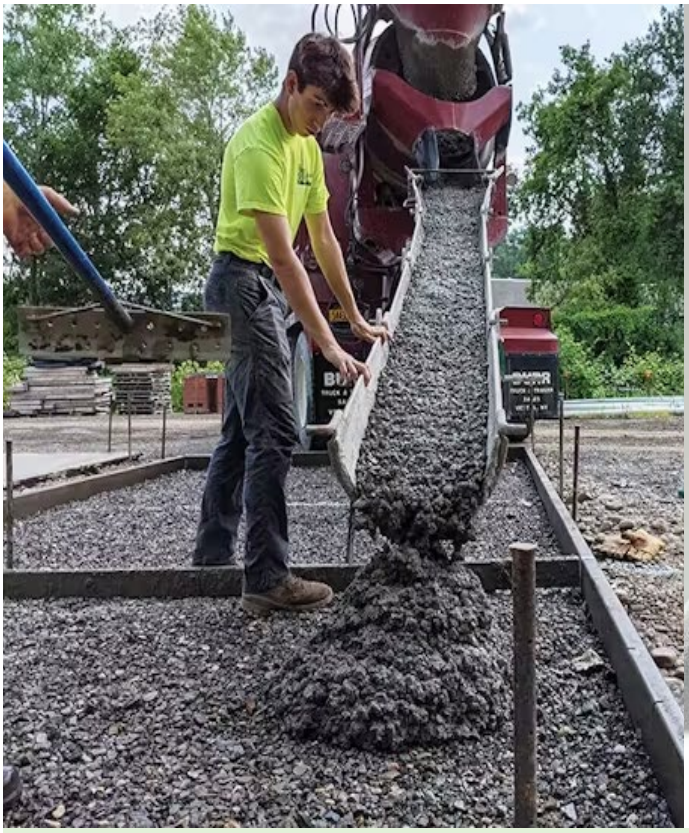
Catch up on the latest in cutting-edge statewide research: development of an Artificial Intelligence framework to detect crosswalk locations across the state as well as their type classification and location category; MIT's City Form Lab's approaches for understanding, modeling and operationalizing pedestrian mobility in cities; and how to meet accessibility needs and provide high-quality customer experience for transit riders, while simultaneously providing space for safe cycling along bus corridors.

Panelists:
Eleni Christofa, University of Massachusetts Amherst
Andres Sevtsuk, Massachusetts Institute of Technology
Yuanchang Xie, UMass Lowell
Moderator: Nicholas Zavolas, MassDOT

October 23, 2024
Sheraton Boston Hotel
39 Dalton Street
Boston, MA • 7:45 am - 4:30 pm



Ongoing Research Project Highlights



Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete

In the context of climate change, there is an increasing need for the development of sustainable and low-carbon concrete. Recycling waste glass as a pozzolan in concrete is promising, however there are knowledge gaps in cement hydration, mix design, quality, and long-term durability of cement concrete.
The overall research objective of this project is to evaluate the viability of recycled ground-glass pozzolan (RGGP) as a suitable replacement for hydraulic cement and alternative to traditional supplementary cementitious materials (SCM), to decrease the carbon footprint and increase the quality and long-term durability of concrete used in MassDOT projects. Anticipated outcomes and deliverables include:

- A literature review and understanding of the current state and existing knowledge gaps.
- A comprehensive understanding of the pozzolanic reactivity of RGGP.
- Insights into the hydration behavior of Portland cement containing RGGP.
- Development of RGGP cement concrete mix design formulations.
- Evolutions of physical, mechanical, and durability properties of RGGP-based concrete.
- Structural performance evaluation of RGGP-based concrete through mock-up tests.
- Specification and recommended application of RGGP and RGGP concrete.

Methodology:
-Characterization and Enhancement of Pozzolanic Reactivity of RGGP. To characterize the reactivity of RGGP, chemical and mineral compositions, amorphousness, activation energy and reaction kinetics between RGGP and calcium hydroxide will be studied.
-Hydration of Cement. Thermodynamic simulation, cement hydration kinetics, the evolutions of hydration products, and microstructure will be studied.
-Concrete Mix Design and Property Evaluation. Five concrete mix formulations will be developed followed by evolutions of fresh, hardened, and durability properties.
-Mock-up Tests. The structural performance of RGGP concrete will be determined on reinforced concrete beams and panels.
Expected completion date of this project is May 2025.

Completed Research Project Highlights

Feasibility of 3D Printing Applications for Highway Infrastructure Construction and Maintenance.

In recent years there has been a significantly increased interest in additive manufacturing (also frequently referred to as 3D Printing), a design platform largely unexplored within infrastructure projects. This project built on a previous and explores further the feasibility of 3D printing applications for highway construction and maintenance in the Commonwealth of Massachusetts.

The research effort focused on the following objectives:

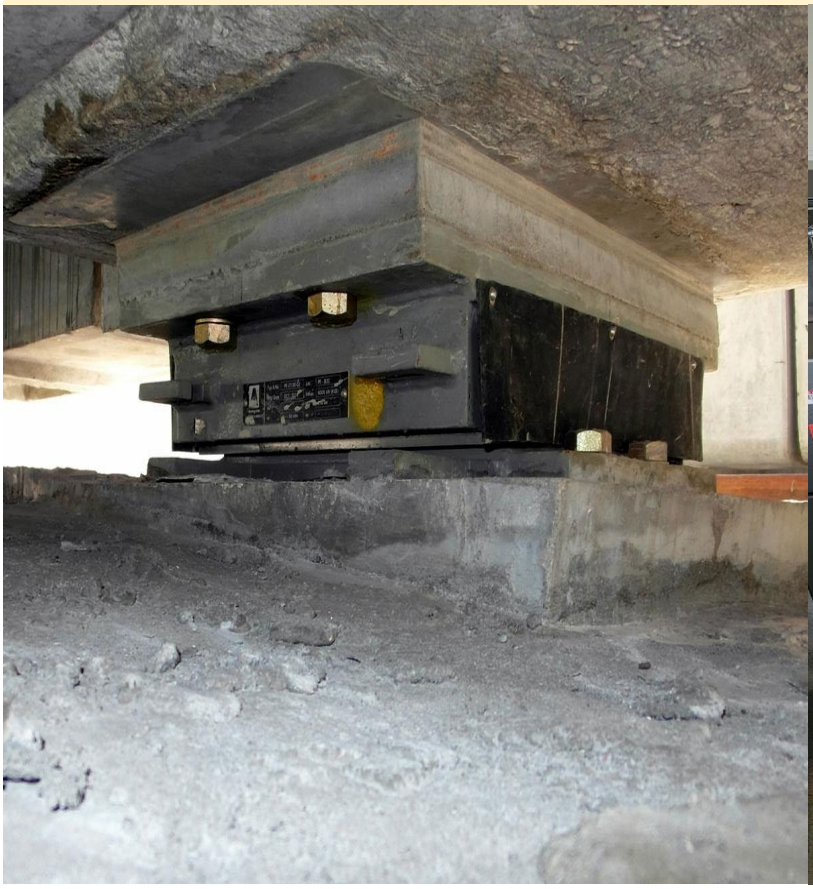
1. Explore the feasibility of additive repair technologies for real corroded steel beams ends.
2. Perform research on the key factors related to the different repair technologies and equipment investigated that can impact the success of an attempted repair.

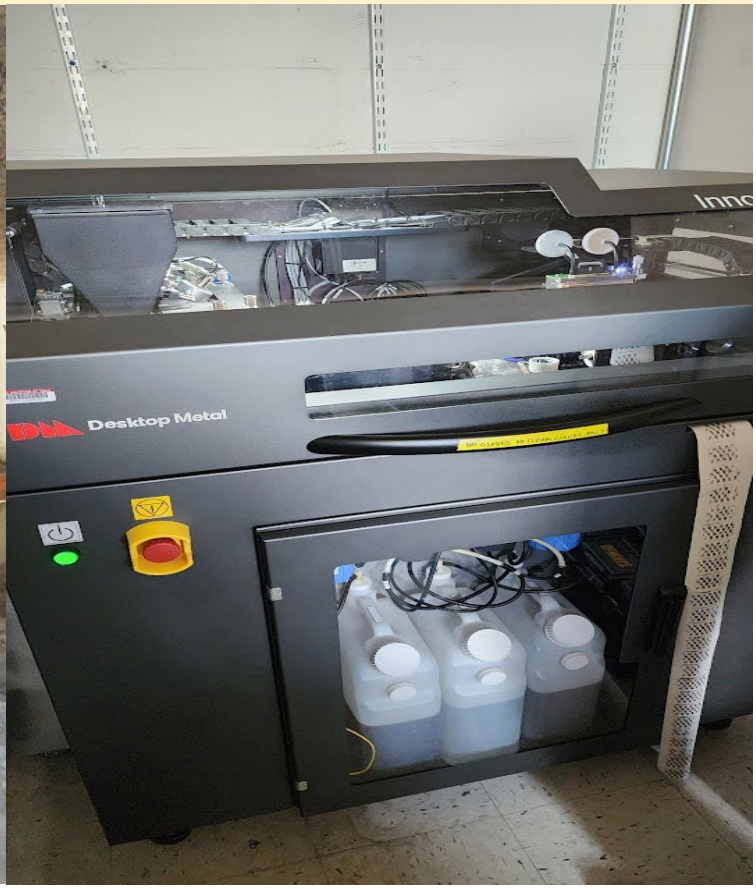
The work shows the steps for obtaining results using different additive manufacturing technologies. Several additive manufacturing technologies were studied and applied, and their mechanical properties were carefully tested. To determine the mechanical properties, both tensile- and compression tests have been performed in the lab. The results are used to then carefully examine the potential of the additive manufacturing technologies.

Additive manufacturing (AM) technologies are showing great potential for future use to repair steel corroded bridge beams. A key finding is the swift and precise deposition possibilities that cold-spray can offer in practice. Furthermore, great results are obtained in compression and further research need to be performed to improve the tensile properties.

The research team encourages MassDOT to distribute the knowledge described in the report among the employees to widen the options for future possibilities of structural repair. A new rehabilitation and repair protocol should be developed as a next step and then on-site applications should be explored to showcase the new additive repair solution. Additive manufacturing technologies has the potential to change how the corroded beam end issues can be addressed in the future.

Next steps in this research effort will focus on additive repair of deteriorated steel bridges.





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 "Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete" project team. This project is managed by project manager Austin Sanders from our research team.

Principal Investigator –Jianqiang Wei Ph.D.

Dr. Jianqiang Wei is an Assistant Professor in the Department of Civil and Environmental Engineering at the University of Massachusetts Lowell. He is a material scientist with a research focus on sustainable cementitious materials, durable concrete, and novel composites for next-generation civil infrastructure. Dr. Wei is leading an active research group to solve critical long-standing challenges in civil engineering and transportation infrastructure via innovations in materials and manufacturing technologies, including the development of ultra-high performance concrete, low-carbon cement, low-energy cement production, carbon-storing binders, upcycling solid wastes into low-carbon concrete, self-healing cement composites, concrete deterioration analysis and mitigation, service-life extension of structures, cement chemistry, and additive manufacturing (3D printing) of functional and carbon-sink concrete.

Principal Investigator – Sergio Breña Ph.D.

Sergio F. Breña is a Professor and Department Head at the University of Massachusetts Amherst. He has over 26 years of experience in laboratory and field-testing of structures and structural systems. Additionally, he has over six years of structural design experience in projects involving seismic rehabilitation of existing buildings and structural design of underground structures and tunnel liners, among others. His research interests include design and behavior of reinforced and prestressed concrete structures, use of fiber-reinforced materials in civil infrastructure applications, field performance of bridges, structural testing of bridge and building structural components, and sustainability and performance of concrete in infrastructure applications. He is a Fellow of the American Concrete Institute (ACI) and the Precast/prestressed Concrete Institute (PCI).

Principal Investigator – Kara D. Peterman Ph.D.

Professor Peterman is an associate professor and undergraduate program director in the Civil and Environmental Engineering department at University of Massachusetts, Amherst. Her expertise is in experimental and analytical behavior of cold-formed and hot-rolled steel structures; Full-scale experimentation; Seismic behavior of cold-formed steel structures; Creating and implementing sustainable design methods; Multi-hazard design. Professor Peterman earned her Ph.D. in civil engineering from John Hopkins University.

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.

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.

News and Events

GIS Day
November 20, 2024

The Massachusetts Department of Transportation (MassDOT) Office of Transportation Planning (OTP) GIS and Research team is happy to announce our first annual GIS Day!
This event is an opportunity for members of the geospatial data and analysis community to come together and celebrate the wide array of innovative projects currently underway.
We will be celebrating GIS Day in an interactive conference-style format. Participating organizations and MassDOT departments will be encouraged to prepare tables where they can showcase emerging GIS tools in their respective areas of expertise.

The Massachusetts Transportation Building
Conference Rooms 1,2,3
10 Park Plaza
Boston, Massachusetts 02116

geoDOT

massDOT Innovation Webinar Series

Smart Work Zone Control and Performance Evaluation Based on Trajectory Data – December 12, 2024
This research utilizes ultrahigh-definition radar and thermal camera sensors to capture detailed driver behavior data. Specifically, the radar sensors provide individual vehicle speed profiles along the segment prior to a work zone, allowing us to study how drivers adjust speeds in response to various control strategies.
Click here to register

Cross-Modal Impact Assessment for Sustainable Transportation Networks – November 14, 2024
This study aims to develop a Holistic Impact Measurement (HIM) methodology incorporating economic, environmental, and social factors of sustainability for different transportation modes. The focus of the project compares the overall sustainability of a travel choice from point A to point B with a current snapshot of Massachusetts transportation infrastructure.
Click here to register

What You Can't See: The Commonwealth of Massachusetts Direct Vision Study Findings – October 9, 2024
This webinar will walk attendees through the co-creation of the vehicle vision rating system called Direct vision. Webinar will share the findings from the 60 vehicles measured, including common medium- and heavy-duty trucks, as well as some new market entrants.
Click here for the webinar slides.

massDOT Massachusetts Department of Transportation
U.S. Department of Transportation Federal Highway Administration
TRB Transportation Research Board of the National Academies
AASHTO

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
Post-Fire Inspection of Concrete Structure Phase III- In-Situ Experiments	April 2022
Methods to Identify Problematic Carriers and Prevent Infrastructure Damage	June 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
Accessible Bus Stop Design in the Presence of Bike Lanes	March 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
Evaluation & Mitigation Methods for the Prevention of Cement Concrete Deterioration due to Pyrrhotite	April 2024

Recently Completed MassDOT Research

	Completion Date
Uncovering the Root Causes for Truck Rollover at Highway Ramps	March 2023
Safety Impacts of Yellow Flashing Permissive Left-Turn Indications – Approach Analysis	March 2023
Using Mycofiltration Treatment for Stormwater Management	March 2023
Construction and Material Best Practices for Concrete Sidewalk Phase II – Hot Placement	March 2023
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

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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