massDOT
Massachusetts Department of Transportation

Transportation Research Quarterly

Providing highlights of MassDOT's transportation research activities and other helpful information **Fall 2021**

Focused on Research

The goal of MassDOT Research Program is to provide systematic knowledge and scientific evidence to facilitate changes in the real world. This is best achieved through stakeholder engagement throughout the lifecycle of a project. We emphasize the crucial role of MassDOT and MBTA project champions in identifying our agency's research needs, defining project objectives and deliverables, and implementing the results. This issue highlights the real changes resulting from three recently completed projects: piloting higher reclaimed asphalt pavement content in pavement projects, standardizing the use of compost blankets for better erosion control, and incorporating data-based health factors into transportation project prioritization process.

Lily Oliver, Manager of Research, Office of Transportation Planning

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FFY2022 FUNDED MassDOT Research Projects

In the Commonwealth's effort to be a national leader in transportation research and practice, MassDOT holds an annual research problem statement solicitation process. This year we received 33 submissions from MassDOT Divisions, Shared Services offices, and the MBTA. Fourteen of these submissions were selected for funding in FY22, based on Division senior leaders' priority rankings and FHWA's advice on SPRII funding eligibility.

Division Origin	Project Title
Highway Bridge & Structure	Development of Improved Inspection Techniques – Using LiDAR for Deteriorated Steel Beam Ends
Highway Bridge & Structure	Feasibility Study of 3D Printing Applications for Bridge Elements in MA
Highway Bridge & Structure	Post-Fire Damage Inspection of Concrete Structures Phase III – Field Verification Phase
Highway Landscape	Complete Streets v.2: Respecting the Roots
Highway Operation	Field Study to Determine Salt Usage Efficiency on Two Pavement Types
Highway Operation	Using Grip Sensors to Control a Salt Spreader's Application Rate
Highway Pavement	Implementing the AASHTO Mechanistic-Empirical Pavement Design Guide Phase III – Lab Experiment and Field Data Collection
Highway Traffic & Safety	Effectiveness of Two-stage Turn Queue Boxes in Massachusetts: A Comparison with Single-stage Bike Boxes
Highway Traffic & Safety	Evaluating the Safety Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts: Approach Level Analysis
Highway Traffic & Safety	Smart Work Zone Control and Performance Evaluation Based on Trajectory Data
MBTA Accessibility	Accessibility-Focused Customer Technology User Research
MBTA Capital Planning	Building Information Model for Transit Infrastructure: A Feasibility and Gap Assessment with Current Practices and Systems at the MBTA
Planning Freight Planning	Methods to Identify Problematic Carriers and Prevent Infrastructure Damage
Rail & Transit Capital Planning	Data-Drive Approaches for Transit Capital Planning

For the next step, the Research Section will work with each new project champion to refine the project statement and begin the process for identifying and selecting a principal investigator.

Research Impacts

Characterization of Reclaimed Asphalt Pavement (RAP) for Hot-Mix Asphalt (HMA) Surface Courses in Massachusetts

State transportation agencies are working with the asphalt paving industry to optimize the use of reclaimed asphalt pavement (RAP) in asphalt mixtures and to design asphalt mixtures so they have balanced performance against pavement distresses. Using RAP significantly reduces the need for new aggregates, the amount of energy needed to quarry, process, and haul them, and the cost of an asphalt mixture. FHWA encourages the use of recycled highway materials like RAP to "the maximum extent possible with equal or improved performance." MassDOT wanted to ascertain if the amount of RAP currently specified in our surface courses (15% by dry weight) is valid and if RAP content could be increased without degrading performance.

The properties of various RAP stockpiles vary significantly so the optimum RAP content depends on the stockpile. Many current specifications group all RAP together while disregarding significant differences in stockpiles. There are often several available sources for the asphalt binder used as well, each of which meet the required performance grade but may not have the exact same properties. Thus, the optimum RAP content may also depend on the source of the virgin asphalt binder even for a specified performance grade. The research aimed to determine if the MassDOT specification, allowing up to 15% RAP without accounting for RAP source or virgin binder source.

Thirteen RAP stockpiles were sampled and tested to determine and compare their properties, indicating that not all stockpiles were the same and should not be treated as such. New binders were also sampled with results indicating that some binders have less capacity to accommodate RAP. Three methods were analyzed to specify RAP in a mixture using the properties of both the RAP and new binders. The analyses indicated that a range of 3-45% RAP may be used in a typical mixture depending on the combination of binders selected. Under the current MassDOT specification (15% RAP) the acceptable RAP percentage was underestimated in 71% of cases, demonstrating that one RAP percentage cannot be specified as the properties of RAP and new asphalt binder vary by source.

The research recommended the following changes to MassDOT's specifications: (1) measure RAP binder and virgin binder properties for all mixtures; (2) utilize blending equations to calculate or directly measure the properties of blended binders in the mixture to ensure they meets specifications; and (3) use mixture performance testing to ensure adequate mixture performance. MassDOT is currently working to utilize these results and refine them in an implementable framework. The introduction of robust RAP binder testing protocol can be challenging but the sustainability goals of the industry necessitate increased usage of RAP and the use of higher RAP percentages requires a comprehensive understanding of its properties.

MassDOT is proceeding with a series of higher RAP demonstration projects using 25-30% RAP to assess the constructability, quality, and properties of higher RAP mixtures. These demonstrations will help set guidelines for the design and construction of higher RAP mixtures and present an opportunity to examine the influence of RAP from start to finish in a closely monitored real world experiment. This data is vital to justify any specification changes for limiting or increasing RAP use and any potential increase in RAP sampling and testing requirements. Upon completion, MassDOT anticipates updating its material and construction specifications to utilize RAP in a more sustainable fashion and lessen the use of non-renewable resources.

Reclaimed Asphalt Pavement Research Team Highlights

The Characterization of RAP for HMA Surface Courses in Massachusetts project was submitted by MassDOT to the AASHTO High Value Research as a High Value Research Project for the 2021 cycle and was selected by peer agencies as a Sweet Sixteen winner, calling attention to the sixteen most valuable transportation research projects nationwide as voted on by representatives from each State taking part in AASHTOs Research Advisory Committee.
A video presentation given by the research team at the 2021 RAC Conference can be found here.

Principal Investigator – Dr. Walaa Mogawer

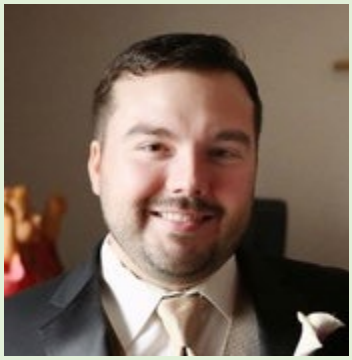
Dr. Walaa Mogawer is a Professor of Civil Engineering and the Director of the Highway Sustainability Research Center at the University of Massachusetts Dartmouth. He has over 32 years of research and practical experience with all aspects of asphalt pavements including pavement materials, design, preservation, and management. His current research efforts include balanced mixture design of pavements, increased environmental stewardship in pavements through increased use of recycled materials and innovative technologies, high performance thin lifts, pavement asset management, and improving the resiliency of roads against extreme weather events like flooding and rising sea levels.

Dr. Mogawer is a member of the Association of Asphalt Pavement Technologists (AAPT) and Transportation Research Board Committee AKM 10 “Production and Use of Asphalt.” Dr. Mogawer is a fellow of ASCE and a registered professional engineer in Massachusetts and Rhode Island.

Project Champion – Edmund Naras

Edmund Naras is the Pavement Management Engineer at the Highway Division. He obtained his B.S. in Civil Engineering from Wentworth Institute of Technology and a JD from UMass- School of Law in Dartmouth. Ed has been with MassDOT for 32 years, 31 of which have been in the Pavement Section and one year as a litigator in the General Counsel’s office. He is a strong advocate for the increased use of Recycled Asphalt Pavement (RAP) and other recycling initiatives such as the use of ground tire rubber in asphalt, pavement reclamation and in-place pavement recycling. MassDOT is among the nation’s leaders of Warm Mix Asphalt technologies, first using this technology on Interstate highway pavements in 2005.

Project Champion – Mark Brum



Mark Brum is the Materials Quality Systems Engineer in the Quality Assurance Unit at Highway Division Research & Materials Lab. Mark has worked at MassDOT for over 13 years and worked as a materials engineer at a construction company for 3.5 years He has a Master’s degree in Civil and Environmental Engineering from the University of Massachusetts Dartmouth where his focus was on pavement materials. He is a Registered Professional Engineer and a member of the American Society of Civil Engineers and Association of Asphalt Paving Technologists.

Research Impacts (Continued)

Compost Blankets for Erosion Control and Vegetation Establishment

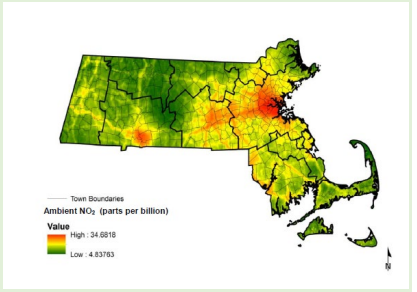
Principal Investigators: Dr. Jack Ahern, UMass Amherst
Project Champions: George Batchelor & Stephanie Smoot, MassDOT Highway
Project Manager: Nicholas Zavolas, MassDOT OTP

This research examined how and whether blanket applications of compost over bare soil can improve slope stabilization and whether such applications can aid in the establishment of native grasses and forbs, particularly for sloping roadside conditions. Research included a literature review and interviews with transportation engineers and compost and seeding professionals, and the evaluation of five MassDOT construction projects where compost blankets had been applied.

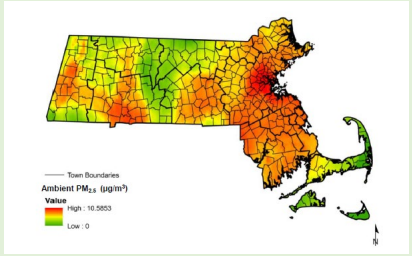
Overall, the research found compost blankets to be highly effective at reducing erosion on slopes. The site evaluations, conducted 2-3 years after the application of compost and seed, found that erosion was limited to locations where concentrated flow occurred. Establishment of the native grasses and forbs seeded as part of the compost application was determined to be generally successful. This report resulted in standards changes around site preparation, particle size distribution of compost material, depth of compost with regard to slope steepness, specific cover crops to be included in the seed mix, recommended seeding dates, monitoring during seeding establishment, and mowing guidelines to improve establishment after seeding.

Public Health Assessment for Transportation Projects

Principal Investigators: Dr. Eleni Christofa- UMass Amherst, Dr. Krystal Pollitt- Yale University, Ms. Karin Valentin Goins & Dr. Stephanie Lemon- UMass Medical School
Project Champions: Derek Krevat, MassDOT OTP- MPO Activities



Transportation projects can affect health through multiple pathways and there is a need to incorporate health considerations in transportation decision making. This project assessed the state-of-practice on incorporating health in transportation decision making primarily through project prioritization processes and proposed health-related criteria the MassDOT highway project prioritization scoresheet.



Information was obtained through review of publications and interviews with state DOTs, Departments of Public Health (DPH) and MPOs. General health assessment methods and tools used in practice, as well as prioritization processes, performance measures, models, and datasets utilized to assess health-related criteria were investigated. This information guided the development of eight new criteria related to air quality, accessibility, equity, physical activity, and safety that are recommended for incorporation in the MassDOT highway project scoring process. The research also identified existing collaborations between DOTs and DPHs as well as research needs and challenges related to incorporating health in transportation decision making.

Research Resources

In Progress MassDOT Research

	Start Date
Improving Load Rating Procedures for Steel Beam Ends with Deteriorated Stiffeners	June 2019
Development of Comprehensive Inspection Protocols for Deteriorated Steel Beam End	February 2020
Effectiveness of Bike Boxes in Massachusetts	March 2020
A Pavement Marking Inventory and Condition Assessment Method Using Mobile Lidar	March 2020
Understanding the Asset Management Systems Utilized by Municipalities in Massachusetts	April 2020
Energy Consumption, Cost and Emissions of MBTA Rapid Transit Vehicles	May 2020
Exploring Short-Sea Shipping as an Alternative to Non-Bulk Freight Trucking in Southeastern, MA	May 2020
Impact of Advanced Driver Assistance System on Road Safety	June 2020
3D Printing Application for Transportation Infrastructure and Maintenance	June 2020
Detecting Subsurface Voids using UAS Infrared Thermal Imaging	November 2020
Automated Guardrail Inventory and Condition Assessment	January 2021
Best Practices for Cost Recovery	February 2021
A UAS Network for Transportation Emergency Response	March 2021
Discover the Root Causes for Truck Rollover at Highway Ramps	March 2021
Massachusetts Depth to Bedrock	March 2021
Massachusetts-Specific Trip Generation Rates	March 2021
Multisource Data Fusion for Traffic Incident Detection	April 2021
Accessibility to Public Health	May 2021
Post-Fire Damage Inspection of Concrete Structures (Phase II)	May 2021
Revised Load Rating Procedures for Prestressed Concrete Beams	May 2021
Post-Fire Damage Inspection of Concrete Structures (Phase II) – Lab Experiment	June 2021
Using Traffic Signals to Reduce Speeding Opportunities	July 2021
Optimizing MassDOT's High Performance Asphalt Overlay Mixtures	July 2021
Construction and Material Best Practices for Concrete Sidewalk Phase II – Hot Placement*	July 2021
Implementing AASHTO Mechanist-Empirical Pavement Design Guide Phase II*	July 2021
Mycofiltration Design and Treatment Option*	August 2021
Ultra-High Performance Concrete Reenforced with Multi-scale Hybrid Fibers*	August 2021

Recently Completed MassDOT Research

	Completion Date
Flexible Transit Services in Rural Areas	August 2021
Future of Commonwealth's Curb	June 2021
Implementing the AASHTO Mechanistic-Empirical Pavement Design Guide (Phase I)	June 2021
Translating Data Generated by the Transit App into Insights on Transportation Use	May 2021
Post-fire Damage Inspection of Concrete Structure (Phase I)	April 2021
Construction and Materials Best Practices for Concrete Sidewalks (Phase I)	March 2021
Impacts of Flashing Yellow Permissive Left-Turn Indications in Massachusetts	March 2021
Characterization of Reclaimed Asphalt Pavement for HMA Surface Courses in Massachusetts	August 2020
Compost Blankets for Erosion Control and Vegetation Establishment	May 2020
Public Health Assessment for Transportation Projects	March 2020
Applications of Unmanned Aerial Systems in Surface Transportation	December 2019
Commuter Bus Demand, Incentives for Modal Shift, and Impact on GHG Emissions (Part II)	December 2019
Estimating Future Changes in 100-year Floods on the Connecticut and Merrimack Rivers	November 2019
Improving Pedestrian Infrastructure Inventory in Massachusetts Using Mobile LiDAR	September 2019
Risk Factors for Older Pedestrian Injuries and Fatalities in MA	August 2019
Optimizing ADA Paratransit Operations with Taxi and Ride Share Programs	May 2019

Contact Us

Email Research & Technology Transfer Section for General Questions

Email Research Section Manager **Hongyan (Lily) Oliver**

Research Project Managers

Email **Drew Pflaumer** Email **Michael Flanary** Email **Nicholas Zavolas** Email **Patrick McMahon**

Note: * The 508-compliant research-in-Progress cut sheets will be posted soon.