massDOT
Massachusetts Department of Transportation

Transportation Research Quarterly

Providing highlights of MassDOT's transportation research activities and other helpful information **2022 Q4**

Continuous Improvement

Excellent firms don't believe in excellence – only in constant improvement and constant change.

– Tom Peters, Influential American writer on business management practices

Snow and Ice Program Aims to Further Improve Road Treatment Practices through Research

Massachusetts's average annual snowfall of 47.0 inches makes it snowier than most states in the United States. Snow and ice reduce pavement friction and vehicle maneuverability, causing slower speeds, reduced roadway capacity, and increased crash risk. It is estimated that nationwide, 24 percent of weather-related vehicle crashes occur on snowy, slushy or icy pavement and 15 percent happen during snowfall or sleet (source: FHWA Road Weather Management Program website).

INSIDE THIS ISSUE

MassDOT Highway Division works hard to keep the 16,000 lane-miles under its jurisdiction safe during storms. The Snow and Ice Program staff watch pavement temperature and precipitation types to choose the best way to treat the roads. Before a storm, a liquid salt brine solution is often applied to the road to prevent snow and ice from binding to the pavement and lowers the temperature at which water freezes. During and after a storm, the ice and snow are removed from the surface of the road and then additional deicing materials are applied to the road to keep the water on the road surface from freezing.

Following the adoption of various anti-icing practices and other efficiency measures, MassDOT has reduced its average annual statewide road salt usage by about 25% on a ton per lane mile basis in the past decade (adjusting for differences in winter weather severity). Presently, through MassDOT's SPRII Research support, Snow and Ice are working with UMass researchers and a USGS water scientist to investigate new ways to improve our anti-icing practices. The goal is to improve the precision of anti-icing and de-icing material applications and to reduce material costs and environmental impacts without compromising performance targets for roadway safety and levels of service.

Research Project Highlight

Field Study to Determine Salt Usage Efficiency and Transport to the Surrounding Environment on Two Pavement Types

MassDOT has concerns that certain pavement surface types might have been over treated during winter maintenance. This is because the Open Graded Friction Course (OGFC) pavement, has higher air void contents than standard dense-grade (DG) pavement (such as Hot Mix Asphalt) and thus allows quicker drainage of surface water, and often will appear visually “white” even after treatment. This could lead to a situation where the road is treated again when it is not necessary. Since OGFC pavement sections typically adjoin dense-graded (DG) pavement sections, the adjoining DG section is also often treated again when the OGFC section is treated again, leading to excessive treatment application. This study is to collect and analyze field data to determine winter maintenance treatment efficiency on both OGFC and DG pavement surfaces to ensure the right quantities of treatment are only applied where they are warranted. Excessive treatment leads to wasted materials and negative environmental impacts; while deficient treatment can result in roadway safety issues.

The project team, comprised of lead experts from Highway Sections (Snow and Ice Operation, Pavement and Environment) and researchers from UMass Dartmouth and USGS, set out to do the followings:

- Compare OGFC and DG pavement response to identical winter maintenance (salt) applications in terms of reflected physical parameters.
- Investigate the safety implications related to winter maintenance activities for both OGFC and DG pavement types.
- Evaluate whether either pavement type requires a greater or lower application rate and frequency to achieve desired results.

The project is a field study, so the field data collection will occur during winter weather events. Both pavement types are located successively on I-95 (Rt 128) Southbound in Needham, MA. Data will be collected with respect to each pavement type from: 1) existing weather stations, 2) invasive sensors (to be installed), 3) winter maintenance activities, 4) friction and surface condition testing, 5) crash data, and 6) photographs. With these data, and the known treatment application rate and frequency, the research team will attempt to develop a methodology that MassDOT can use to determine the appropriate treatment applications and frequency on these two pavement types.

Research Project Highlight

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

In recent years, MassDOT has adopted the "grip" indicator (produced by a third-party vendor software using winter weather condition forecast and road-side weather information sensors) to determine where road treatment is warranted. Most recently, mobile road weather information systems (RWISs) have been installed on field supervisors' vehicles to collect real-time road surface conditions. However, the data collected via the mobile RWIS, such as road surface temperature, grip level and surface state, is yet to be used timely and accurately to adjust the spreader controller to enable more precise salt application. This research project intends to close this gap by developing and validating an automated system that can automatically adjust the spreader controller based on the acquired mobile RWIS sensor data.

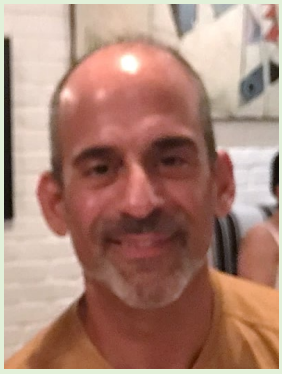
To achieve this, the research team, comprised of Highway Snow and Ice Operation staff, UMass Amherst researchers and UMass Transportation Center training specialist, aims to develop three sequential modules including 1) RWIS data acquisition module (an I/O library that will acquire, organize, transfer, and store the acquired data from the mobile RWIS sensor); 2) Treatment decision-making module (an automated decision-making algorithm for determining if roadway treatment will be withheld or delivered); and 3) Spreader control module and user interface (a controlling interface that can execute the decision).

The developed automated program will be calibrated through this research, and the performance of the program will be validated through tests on actual road surfaces. Tutorial and training materials on how to use the program will be delivered alongside with the program to facilitate the anticipated full deployment by MassDOT.

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 "Field Study to Determine Salt Usage Efficiency and Transport to the Surrounding Environment on Two Pavement Types" project team.

Project Champion – Mark Goldstein



Mark Goldstein received his Bachelor of Arts degree from Brown University in the area of Business Economics and his Master of Science degree in Environmental Science and Engineering from the Colorado School of Mines. He has been with MassDOT for over a decade and worked in Highway Division Environmental Services before joining Operations and Maintenance as the Snow & Ice Program Coordinator. He now serves as the Statewide Snow & Ice Engineer and enjoys utilizing the latest strategies and technologies to increase operational efficiency, while reducing normalized salt usage in MassDOT's Snow & Ice Program. Mark is the project champion for both projects highlighted in this issue.

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.

Principal Investigator – Kirk Smith

Kirk Smith is a Supervisory Physical Scientist for the United States Geological Survey New England Water Science Center. Kirk received a B.S. in Environmental Management and a Minor in Wildlife and Fisheries Science from the Pennsylvania State University. He holds two U.S. Government Patents for the development of an automated self-calibrating water quality monitoring sensor-housing assembly and an automated groundwater monitoring system and method. Kirk has conducted numerous studies in the field of stormwater and urban hydrology and specializes in the design and construction of integrated turnkey water-quality monitoring and sampling systems for the study of time-variable water-quality contaminant sources in surface water and groundwater.

Research Section Staff – Michael Flanary

Mike Flanary is a transportation planner with the Research Section at the Office of Transportation Planning. He joined MassDOT in September 2019 after graduating from Tufts University with a Master's in Urban and Environmental Policy and Planning. Prior to working at MassDOT, Mike worked at Tufts University and had internships with Conservation Law Foundation, the Martha's Vineyard Commission, and the City of Cambridge, MA. He is an avid cyclist and greatly enjoys riding his e-bike around Boston. You may contact him at Michael.Flanary@dot.state.ma.us.

Snow & Ice Training and Resources

Technical Training

The AASHTO TC3 has a seven-course training series, **Anti-icing/Road Weather Information System (RWIS)**, which introduces learners to effective use of anti-icing techniques in winter road maintenance using road weather information system technology. The courses are:

- Introduction to Anti-icing and Winter Maintenance
- Anti-icing Practice
- Computer Access to Road Weather Information
- Weather and Roadway Monitoring
- Weather Basics
- Winter Road Maintenance Management
- Winter Roadway Hazards and the Principles of Overcoming Them

You can view **all of these courses here**; or check out the entire **Maintenance category of courses here**. Since MassDOT subscribes to the TC3 services, all our employees can access the TC3 Web Based Training free of charge, if you create an AASHTO account using your MassDOT email address.

No time to conduct a literature search yourself? TRB Library Snap Searches can help

Snap Searches are designed for the busy professionals and researchers who would like to quickly get up to speed on complex research topics. They provide a succinct summary of current activities at TRB on a given topic. Follow the link below for the TRB snap search results for "Winter Operations and Maintenance."

TRB Snap Search: Winter Operations and Maintenance

TPF-5(479) Clear Roads Phase III

Pooling resources and expertise jointly with thirty-six other state DOTs, MassDOT has been a long-term partner of the Transportation Pooled Fund project titled "Clear Roads Winter Highway Operations." This TPF project focuses on real world testing of winter maintenance materials, methods, and equipment. The current phase addresses both operational and management research needs by investigating the most effective tools and practices for clearing snow and ice and for managing program resources, budgets, and performance measures. It will also provide expanded support for implementation and technology transfer through the development of user manuals, training modules, peer exchanges, and quick turnaround syntheses of the most effective state practices from around the country.

MassDOT Research Resources

In Progress MassDOT Research

	Start Date
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 Phase I	May 2021
Revised Load Rating Procedures for Prestressed Concrete Beams	May 2021
Post-Fire Damage Inspection of Concrete Structures (Phase II) – Experimental Phase	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
Mycofiltration Design and Treatment Option	August 2021
Ultra High-Performance Concrete Reenforced with Multi-scale Hybrid Fibers	August 2021
Safety Impacts of Yellow Flashing Permissive Left-Turn Indications – Approach Analysis	October 2021
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
Development of a Salt Spreader Controller Program	April 2022
Post-Fire Inspection of Concrete Structure Phase III- In-Situ Experiments	April 2022
Building Information Model for Transit Infrastructure: Feasibility and Gap Analysis	May 2022
Methods to Identify Problematic Carriers	June 2022
3D Printing Applications for Bridge Element Repair	June 2022
Evaluating Safety Impacts of Two-stage Bike Boxes	August 2022
Field Study to Determine Salt Usage Efficiency and Transport to the Surrounding Environment on Two Pavement Types	August 2022

Recently Completed MassDOT Research

	Completion Date
Implementing AASHTO Mechanist-Empirical Pavement Design Guide Phase II	September 2022
Understanding the Asset Management Systems Utilized by Municipalities in Massachusetts	September 2022
Use of UAS for Surface Transportation Emergency Response	July 2022
A Pavement Marking Inventory and Retroreflectivity Assessment Method Using Mobile LiDAR	June 2022
3D Printing Application for Transportation Infrastructure and Maintenance	May 2022
Automated Guardrail Inventory and Condition Assessment	May 2022
Development of Comprehensive Inspection Protocols for Deteriorated Steel Beam End	March 2022
Impact of Advanced Driver Assistance System on Road Safety	March 2022
Detecting Subsurface Voids using UAS Infrared Thermal Imaging	February 2022
Best Practices for Cost Recovery	October 2021
Exploring Short-Sea Shipping as an Alternative to Non-Bulk Freight Trucking in Southeastern MA	September 2021
Improving Load Rating Procedures for Steel Beam Ends with Deteriorated Stiffeners	September 2021
Effectiveness of Bike Boxes in Massachusetts	September 2021

Additional Resources

Transportation Research and Information Database (TRID) is a comprehensive bibliographic database containing more than 1.3 million records of transportation research.

Research in Progress (RiP) Database contains information on more than 12,000 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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