# MassDOT Research Annual Report FFY2025

## Research and Technology Transfer
## Office of Transportation Planning
## Massachusetts Department of Transportation

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## Executive Summary

The MassDOT Research Development and Technology Transfer (RD&T) Program supports MassDOT divisions across highway, rail and transit, aeronautics, the Registry of Motor Vehicles (RMV), and the Massachusetts Bay Transportation Authority (MBTA) by advancing applied research, data-driven decision-making and knowledge sharing. RD&T activities were funded through State Planning and Research (SPR) Part II funds from the Federal Highway Administration (FHWA), as authorized under Title 23, United States Code Section 505, and regulated by Title 23 of the Code of Federal Regulations (CFR), Part 420.

During Federal Fiscal Year 2025 (FFY 2025), the RD&T Program continued to support MassDOT's ability to plan, operate, and maintain a safe and reliable transportation system. The program focused on delivering actionable research, supporting innovation through technology transfer, and ensuring compliance and effective stewardship of SPR II funding. RD&T advanced transportation knowledge and agency practice by completing priority research projects, continuing multi-year studies, and facilitating opportunities for collaboration and peer learning across MassDOT and with external partners.

RD&T's work in FFY 2025 directly related to safety, multimodal access, system reliability and infrastructure performance. Research efforts addressed real-world challenges such as materials durability, asset condition assessment, driver safety, and the public health impacts of transportation access. Technology transfer activities ensured that research findings and emerging best practices were shared broadly and translated into practical use through peer exchanges, targeted training programs and conferences. Together, these efforts helped position MassDOT to make informed, data-driven decisions that benefit communities across the Commonwealth.

### 2025 At A Glance

- Delivered high-value, applied research. RD&T completed six research projects in FFY 2025, producing findings that informed materials performance, infrastructure condition assessment, and the relationship between transportation access and public health. These studies provided MassDOT with practical insights that can be applied to planning, design and maintenance decisions.
- Maintained momentum on critical multi-year studies. Seven research projects continued through FFY 2025, addressing topics such as driver behavior and safety, advanced material characterization, data analytics and innovative infrastructure repair techniques. Continued progress on these projects helped ensure continuity and alignment with long-term agency priorities.

- Strengthened knowledge exchange across MassDOT. RD&T hosted a MassDOT Research Peer Exchange that brought together external partners to share learned lessons, discuss emerging challenges and identify opportunities for collaboration.
- Expanded technology transfer and training. The program supported the MassDOT Innovation Conference and the Moving Together Conference, creating forums for sharing achievements, innovative practices and policy insights. RD&T also facilitated MassDOT highway division and Local Technical Assistance Program (LTAP) training courses, helping translate best practices into day-to-day operations.
- Demonstrated effective program management and stewardship. RD&T continued to manage the SPR II program in compliance with federal requirements, ensuring funds were aligned with statewide transportation priorities and used efficiently to support research and technology transfer activities.

**2026 Look Ahead**

In FFY 2026, the RD&T Program will continue to focus on research and technology transfer efforts that deliver clear value to MassDOT and the traveling public. Key priorities include completing ongoing research projects and initiating new studies that respond to emerging needs related to safety, resilience and system performance.

RD&T will place increased emphasis on implementation by working closely with project champions to ensure research findings are accessible, understandable and ready for use in practice. Technology transfer activities will continue to expand through conferences and targeted training courses, with a focus on reaching a broad audience across the agency and its partners.

The program will also continue to strengthen data-driven decision-making by supporting research that improves the use of data, analytics and performance measures. Through management of SPR II funds and continued collaboration with FHWA and stakeholders, RD&T will remain a key resource in helping MassDOT meet its mission and adapt to future transportation challenges across the Commonwealth.

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## 1. Why This Work Matters

MassDOT is facing a set of transportation challenges that are immediate, complex and interconnected. Much of the Commonwealth's infrastructure is aging and requires smarter, more cost-effective approaches to maintenance and repair. Climate impacts are placing new pressure on assets that were not designed for today's conditions. At the same time, the agency is navigating workforce capacity gaps and an increasing volume of data that can be difficult to translate into clear, timely decisions.

Research and innovation are critical tools for closing these gaps. Applied research helps MassDOT test new ideas, evaluate risks and understand what works before changes are made at scale. Innovation allows the agency to move faster and adapt proven practices to local conditions. Additionally, training ensures that new knowledge is not siloed, but instead reaches the engineers, planners, operators and municipal partners who need it to do their jobs safely and consistently.

## 2. 2025 in Brief

FFY 2025 provided a clear snapshot of how research and technology transfer supported MassDOT's mission.

### At a glance

- Projects delivered: 6 projects were completed
- Projects underway: 7 projects were started or continuing
- SPR II dollars invested: $7.1 million
- MassDOT and municipal staff trained: 4,103 participants
- Municipalities reached statewide: 212 communities

### FFY25 SPRII Funding Distribution

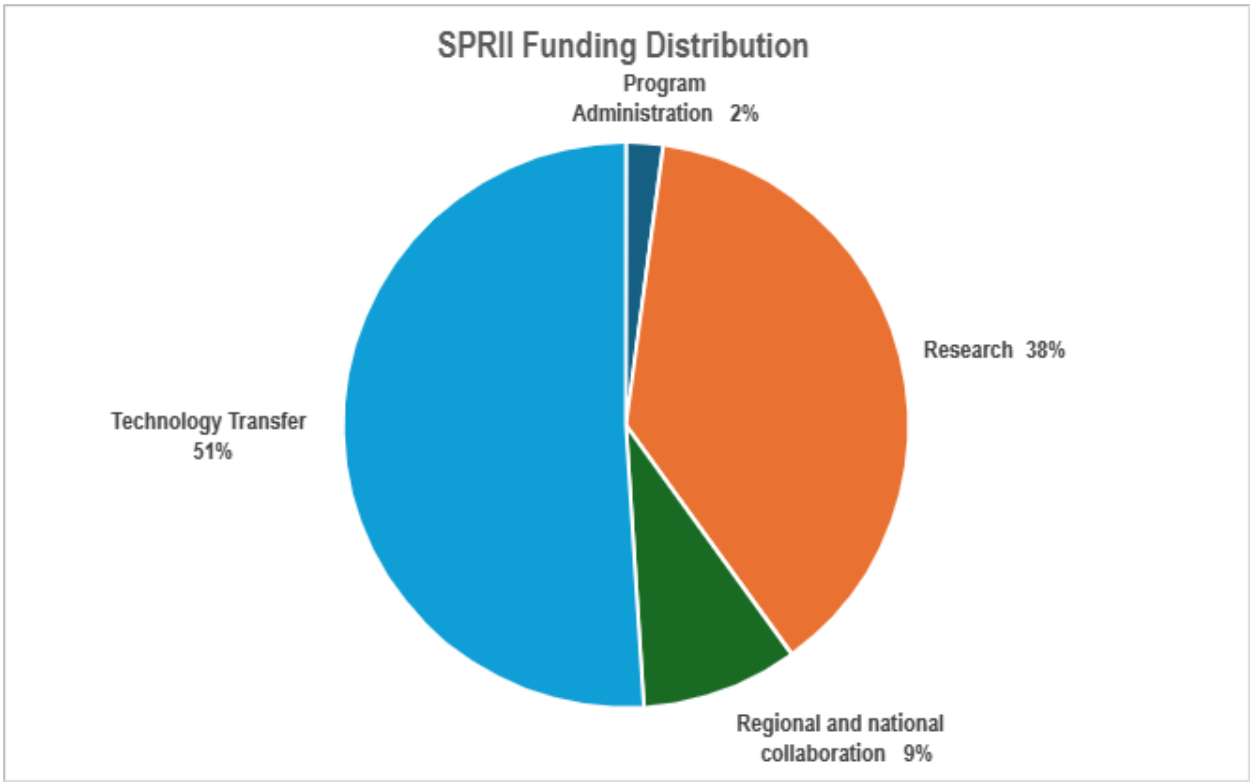
For Federal Fiscal Year 2025 (FFY25), SPRII funding is allocated to support research, technology deployment and collaboration initiatives that strengthen the Commonwealth's transportation system.

The largest share of funding, 51 percent, is dedicated to Technology Transfer. This investment supports knowledge sharing for practice, workforce training, and technical assistance.

Research activities receive 38 percent of FFY25 SPRII funding. These funds support studies, pilot projects, data analysis, and evaluations of emerging technologies that address transportation safety, resilience, equity, mobility and system performance. This category also includes $700,000 for outsourced consultants who supported project and contract management.

Regional and national collaboration accounts for nine percent of the allocation. Through partnerships with peer agencies, research consortia and national organizations, MassDOT leverages shared knowledge and resources to advance innovation and remain aligned with federal priorities and best practices.

The remaining two percent supports Program Administration, ensuring effective oversight, compliance, reporting and coordination of SPRII-funded activities.




**Headline Outcomes**

- Salt Spreader Phase II research project was awarded the high value research project by AASHTO Research Advisory Committee (RAC).
- First time a 3D printer has been used on an active bridge with traffic flowing.
- Pavement Marking research team utilized automated algorithms and methods to investigate pavement deterioration trends.

Across these efforts, MassDOT saw measurable improvement in how information was used to support planning, design and operations, particularly in safety, asset management and cross agency coordination.

## 3. What We Focused On

Rather than organizing work by funding source or program area, FFY 2025 research and technology transfer activities were aligned around strategic themes that reflect MassDOT's most pressing needs.

Safety and Speed Management

Why it matters now: Speed related crashes continue to drive severe injuries and fatalities. MassDOT needed better tools to understand risk and evaluate countermeasures.

How we responded: Research examined speed, behavior and roadway context, paired with training that supported consistent safety analysis across districts and municipalities.

Infrastructure Performance and Durability

Why it matters now: Aging assets and constrained budgets require longer lasting solutions and better timing of repairs.

How we responded: Studies focused on materials performance, asset assessment methods and repair strategies that extend service life.

Showcasing: In May 2025, the 3D Printing research team had the first field test of a 3D Printer using cold-spray on an active bridge. The test involved spraying high-velocity metal powder particles to coat sections of the beam. Repeated sprays create multiple layers, restoring thickness and other structural properties to the treated area.

Data, AI and Decision Support

Why it matters now: MassDOT manages vast amounts of data, but value depends on usability.

How we responded: Research tested analytics, dashboards and methods that reduce manual effort and improve clarity.

Climate, Energy and Sustainability

Why it matters now: Climate impacts are increasingly affecting system reliability and long-term costs.

How we responded: Research explored resilience considerations and sustainability focused approaches to investment.

Showcasing: The Salt Spreader research team developed hardware/software with an automated road surface classification (RSC) algorithm with the ultimate goal of saving a significant amount of salt. Efficient and effective material delivery is crucial to maximize material utilization and minimize the potential environmental impacts.

Multimodal Access

Why it matters now: Transportation access affects economic opportunity and public health.

How we responded: Research connected transportation data with public health and access indicators to inform planning.

Showcasing: The Public Health research team produced GIS map outputs that can be used by MassDOT to statewide planning and project prioritization or by local agencies and planning organizations to understand needs and justify investments.

Workforce Knowledge and Capability

Why it matters now: Workforce turnover and evolving standards require continuous learning.

How we responded: Training and peer exchange emphasized applied skills and shared understanding.

**4. What We Delivered**

In FFY25, The MassDOT RD&T Program completed a diverse portfolio of research projects that strengthen infrastructure performance, improve safety, support regulatory compliance, advance sustainability and promote equitable transportation planning. Together, these projects move research findings into practical application while positioning the agency for long-term system resilience and performance.

**Completed Projects**

Advancing Infrastructure Performance and Asset Management

Several projects focused on improving pavement and materials performance under Massachusetts conditions.

Research on asphalt binder source variability confirmed that materials meeting the same Performance Grade specification can perform differently in the field and identified practical rheological indicators to better predict cracking resistance. A related pavement design initiative localized national mechanistic-empirical design tools to Massachusetts traffic, climate and material conditions, improving confidence in pavement life predictions and long-term return on investment.

Additional materials research evaluated recycled ground-glass pozzolan as a supplementary cementitious material in concrete. Findings show that recycled glass can reduce lifecycle carbon emissions while maintaining performance, supporting MassDOT's sustainability goals and diversifying material supply options.

Winter maintenance performance was also examined through a field study comparing Open Graded Friction Course and dense-graded pavements. While data collection was limited by mild winters, results showed no evidence that OGFC sections required additional salt treatment or froze faster than adjacent pavement types, helping inform future maintenance decision-making.

Improving Safety and Regulatory Compliance Through Innovation
A major safety-focused project advanced the use of mobile LiDAR for statewide pavement marking inventory and retroreflectivity assessment. The research demonstrated that automated LiDAR-based methods can reliably detect and classify markings, estimate retroreflectivity condition and support quality assurance for new installations. The work lays the foundation for standardized operating procedures and a unified marking database to help MassDOT meet updated federal retroreflectivity requirements under the MUTCD while improving efficiency and repeatability compared to manual inspections.

Integrating Equity and Public Health into Transportation Planning
The Measuring Access to Improve Public Health – Phase II project expanded multimodal accessibility metrics and linked them to health outcomes such as chronic disease prevalence. Using spatial modeling and high-resolution mapping, the research quantified disparities in access to essential destinations including healthcare, education, parks and food. The resulting tools and datasets support more equitable, health-informed transportation investment decisions and provide a framework for integrating access metrics into planning dashboards and prioritization processes.

Across disciplines, FFY25 research projects share common themes:

- Grounding national models and specifications in Massachusetts-specific data
- Strengthening compliance with federal requirements
- Supporting sustainability and carbon reduction goals
- Improving safety and asset performance
- Embedding health considerations into planning decisions
- Delivering practical tools, guidance and data systems that MassDOT can implement

Collectively, these completed projects enhance MassDOT's ability to make data-driven, performance-based decisions that improve the reliability, safety and long-term value of the Commonwealth's transportation system. See details in Appendix A.

**Continued and New Projects**

In FFY25, MassDOT advanced a forward-looking research portfolio that strengthens winter operations, improves infrastructure durability, enhances safety performance, supports equitable mobility and integrates emerging technologies into transportation practice. These continued and new projects build on prior work while addressing evolving operational, environmental and policy challenges across the Commonwealth.

Improving Winter Operations and Environmental Stewardship
MassDOT continues to refine winter maintenance strategies through Phase 2 of the Salt Spreader Controller Program, which integrates machine-sensed roadway weather data, mobile and stationary RWIS inputs and weather forecasting into advanced control algorithms. By applying deep learning models and validating them across multiple plow

trucks, the project aims to improve salt application precision, reduce material waste and minimize environmental impacts without compromising roadway safety.

Advancing Safety Through Data, Speed Management and Education

Several projects focus on strengthening roadway safety using advanced analytics and practical implementation tools:

- The Advanced Technologies and Data Analytics for Safe, Smart and Efficient Transportation (ASSET) project recalibrates Highway Safety Manual safety performance functions for Massachusetts conditions and leverages artificial intelligence to automate pedestrian and multimodal counts, extract sidewalk data and improve multimodal trip projections tied to land use.
- The Uniform Speed Management project synthesizes the best national practices to create structured guidance for identifying areas of speed concern and implementing appropriate countermeasures at both the state and municipal levels.
- The Driver's Education Effectiveness study evaluates how training programs, particularly those focused on advanced driver assistance systems (ADAS), influence safety outcomes for newly licensed drivers.
- Ongoing speed regulation editing support improves the accuracy and completeness of regulatory speed data across MassDOT's roadway network.

Together, these projects enhance MassDOT's ability to use data-driven, systemic approaches to improve roadway safety and mobility.

Enhancing Infrastructure Durability and Performance

Several continued research efforts address long-term infrastructure reliability:

- Research on Low-P rapid set concrete examines cracking mechanisms in bridge deck repairs and develops strategies to improve durability and service life.
- Phase III development of 3D-printed lattice-based bridge bearings moves toward prototype manufacturing and load testing, exploring innovative materials and cost-effective solutions for next-generation bridge components.
- The Pyrrhotite Phase II study evaluates mitigation strategies to prevent concrete deterioration caused by reactive minerals, strengthening material specifications and long-term asset protection.

These projects reflect MassDOT's focus on preventing premature deterioration, improving lifecycle performance and supporting resilient infrastructure investments.

Supporting Accessibility and Community Mobility

The Environmental Scan of Community Transit Needs Among Older Adults assesses transportation barriers facing Massachusetts' aging population. Through analysis and stakeholder engagement, the project will generate actionable recommendations to enhance transit programs and improve mobility options for older adults and people with disabilities. This work supports equitable access to essential services and aligns with broader demographic and public health considerations.

The FFY25 continued and new research portfolio demonstrates MassDOT's commitment to:

- Integrating artificial intelligence and advanced analytics into operations and planning
- Strengthening safety through systemic, data-informed strategies
- Improving winter maintenance efficiency and reducing environmental impacts
- Enhancing infrastructure durability through materials innovation
- Supporting equitable mobility for vulnerable populations
- Translating research into implementable tools, guidance and policy improvements

Collectively, these projects position MassDOT to operate more efficiently, invest more strategically and deliver a safer, more resilient transportation system for the Commonwealth.

**5. From Research to Action**

MassDOT's research program is designed not only to generate knowledge, but to translate findings into operational improvements. In FFY25, research-to-implementation efforts continued to demonstrate measurable value to the agency.

One project in particular, Optimizing of MassDOT's High Performance Asphalt Overlay (HPOL) Mixtures, has advanced from study to active implementation, directly benefiting MassDOT operations. This work was recognized by the AASHTO Research Advisory Committee (RAC) as a High-Value Research (HVR) project, acknowledging demonstrated progress in applying research results in practice.

While this recognition reflects successful implementation, MassDOT recognizes that not all research findings can be adopted immediately. In many cases, implementation requires additional field validation, policy alignment, specification updates, funding coordination, or follow-up research to address remaining technical questions. These implementation needs have been documented to guide next steps and future research priorities. By tracking both immediate outcomes and longer-term integration pathways, MassDOT ensures that research investments continue to deliver practical value, strengthen decision-making and support continuous improvement across the transportation system.

**6. Technology Transfer**

FFY25 demonstrated a strong emphasis on expanding the real-world impact of training delivered through MassDOT's Research and Technology Transfer program. The focus was not simply on hosting events, but on ensuring technologies were translated into practical workshops, webinars, and technical sessions that improved safety, consistency and day-to-day operations across the Commonwealth.

<u>Who Was Trained and Why It Mattered</u>

Training reached municipal public works staff, engineers, planners, consultants and internal MassDOT personnel through the Massachusetts Local Technical Assistance Program (LTAP), branded as Baystate Roads and through MassDOT Training Services (MTS) for Highway Division staff.

Municipal participation remains critical. Cities and towns manage a large share of the roadway network and rely on clear, applied guidance to maintain safe and compliant infrastructure. In FFY25, 2,460 personnel from 212 Massachusetts communities participated in LTAP training across 217 in-person and virtual events. These sessions provided access to technical expertise and updated best practices, strengthening local decision-making and improving roadway safety statewide.

For MassDOT staff, MTS training reinforced standards and ensured best practices were implemented consistently across divisions. In FFY25, 1,643 participants attended 130 MTS training events, supporting alignment across Highway operations.

How Training Supported Safety, Compliance and Consistency

Courses aligned with current safety standards, asset management practices and federal and state requirements. By sharing standardized methods statewide, the program improved compliance and reduced inconsistencies in how roads and infrastructure are maintained and evaluated.

Topics with the Strongest Demand

The highest-demand topics focused on practical application:

- Roadway and work zone safety
- Asset management and condition assessment
- Pavement and materials practices
- Data collection and performance measurement
- Emerging technologies and inspection tools

Participants were most engaged when sessions provided clear, step-by-step guidance they could apply immediately in their work.

The program increasingly emphasizes real-world application over theory, ensuring research investments lead to measurable operational improvements. By reinforcing evolving standards and introducing new tools in a structured way, training helped maintain consistency across municipalities and MassDOT divisions. In short, FFY25 technology transfer efforts strengthened the connection between research and practice, ensuring knowledge was not only shared but actively used to improve transportation safety and performance statewide.

**7. Sharing What We Learn**

The RD&T program continued to prioritize collaboration and knowledge sharing in FFY25 to strengthen the impact of its transportation research program.

On March 12–13, 2025, the RD&T program hosted a transportation research peer exchange in Boston with representatives from six State DOTs: Colorado, Kentucky, Maryland, New Jersey, Oregon and Utah. A representative from the Transportation Research Board (TRB) also participated. The peer exchange focused on four core elements of the research lifecycle:

- Research project selection
- Research project management and execution
- Project implementation
- Project evaluation

These discussions allowed agencies to share lessons learned, compare processes and identify practical strategies to improve research efficiency and impact. Each day concluded with forward-looking sessions where DOT peers highlighted emerging research areas and innovation priorities, including:

- Advanced air mobility (AAM)
- Artificial intelligence (AI)
- Methods to improve state and local coordination
- Remote construction monitoring

The exchange provided a clear roadmap for strengthening research governance, accelerating implementation and ensuring research investments translate into measurable improvements for agencies and the communities they serve.

Beyond the peer exchange, the RD&T program facilitated webinar presentations throughout FFY25 featuring project champions and research partners. These sessions extended the reach of completed and ongoing studies to a broader, often national audience, reinforcing transparency and shared learning.

University research partners, federal agencies and regional collaborators continued to play a critical role in delivering results. These partnerships provided technical depth, independent analysis and opportunities for coordination that strengthened research quality and expanded its practical relevance.

**8. What's Next**

The lessons learned in 2025 will directly inform where MassDOT focuses resources in the coming year and how research and training continue to support a safer, more reliable transportation system.

Looking ahead, MassDOT is preparing for emerging challenges related to climate resilience, safety outcomes, infrastructure durability and workforce capacity. In FFY26, there will be a deliberate shift from exploration to execution. Compared to prior years, the emphasis of RD&T program will move beyond generating findings toward implementation, decision support and practical application.

More projects will be framed around clear operational questions and greater attention will be placed on translating results into tools, guidance and training that can be used immediately in the field. Technology transfer will continue to play a central role in ensuring consistency across districts and municipalities.

Overall, the FFY26 SPRII funding distribution will maintain a balanced approach: investing in forward-looking research while strengthening implementation pathways, reinforcing collaboration and ensuring research delivers measurable value to MassDOT operations and the public.

## Appendix A: FFY25 Completed Projects

### A Pavement Marking Inventory and Retroreflectivity Condition Assessment Method Using Mobile LiDAR – Phase II

The Problem

MassDOT must comply with updated Federal requirements in the *Manual on Uniform Traffic Control Devices* (MUTCD) that set minimum retroreflectivity standards for pavement markings to ensure visibility, especially at night and in poor weather. Conventional visual inspections are labor-intensive, subjective and inconsistent, making it difficult to reliably assess pavement marking conditions across the state. Without an efficient and accurate way to inventory markings and measure retroreflectivity, MassDOT risks non-compliance with federal regulations and uncertainty in maintenance planning and safety assurance.

Why It Matters

- Safety**:** Pavement markings are a key traffic control device; degraded or non-reflective markings reduce nighttime visibility and increase crash risk.
- Efficiency & cost: Traditional condition assessments are slow and labor-intensive, limiting how often assessments can be made and potentially delaying needed maintenance.
- Regulatory compliance: Meeting MUTCD retroreflectivity standards is required for continued federal funding; inconsistent measurement methods could jeopardize compliance.

Who is Affected

MassDOT maintenance and traffic engineers, pavement marking crews, roadway users (drivers and cyclists) and regulatory/oversight partners (FHWA).

What We Did

This project extended Phase 1 research on mobile LiDAR-based pavement marking detection by integrating broader marking types and conditions and by advancing methods to assess retroreflectivity condition and completeness using collected LiDAR, imagery and supporting data.

- Analysis & modeling: Automated extraction and classification of pavement markings from mobile LiDAR.
- Field data collection: Expanded data collection across multiple roadway test sections with a variety of marking materials and configurations.
- Tool development: Methods for assessing in-service marking condition and new marking installation quality assurance (QA/QC), with outputs feeding into a unified database and draft standard operating procedures (SOPs).

*Type of work:* Analysis and modeling, data collection, assessing quality assurance

What We Found

- LiDAR use works: Mobile LiDAR can consistently detect and classify pavement markings across multiple materials (thermoplastic, epoxy, polyurea, tape) and configurations (wet performance, skip lines, RPMs).
- Retroreflectivity assessment feasible: LiDAR-derived data can be reliably processed to estimate marking retroreflectivity across large roadway networks.
- QA/QC for new installations: Retroreflectivity changes within the first 6 months after installation can be tracked to support improved installation quality checks.
- Standardization potential: The expanded dataset and processing approach support development of a draft SOP for routine in-service retroreflectivity assessment to meet MUTCD requirements.
- Toward unified management: A statewide pavement marking database that integrates inventory and condition data is feasible and supports long-term asset management.

What This Delivers

- Automated LiDAR-based inventory and condition assessment tools for pavement markings that scale beyond manual inspection.
- Draft SOPs for routine in-service retroreflectivity assessment and QA/QC of new marking installations.
- A unified, state-wide marking condition database to inform maintenance planning and compliance reporting.
- Improved data quality and repeatability compared to manual visual inspections. Enabling more frequent and reliable condition tracking.

How MassDOT Is Using This

MassDOT is using project outputs to:

- Pilot automated retroreflectivity measurement methods within maintenance and traffic units.
- Inform development of internal guidelines and SOPs for systematic marking condition assessment.
- Support planning for compliance with upcoming MUTCD retroreflectivity mandates through improved inventory and tracking.

Additional tool refinement and operational deployment are ongoing before full implementation.

Key Takeaway

Mobile LiDAR-based inventory and retroreflectivity assessment provides MassDOT with an efficient, repeatable way to meet federal retroreflectivity requirements and improve roadway marking condition management.

Learn More

Final Report

https://www.mass.gov/doc/a-pavement-marking-inventory-and-retroreflectivity-condition-assessment-method-using-mobile-lidar-phase-2-final-report/download

**Effect of Asphalt Binder Source on Asphalt Mixture Performance**

The Problem

MassDOT relies on standardized Performance Grade (PG) asphalt binders to produce hot-mix asphalt, but recent experience and preliminary research showed that mixtures meeting the same PG specification can still perform differently in the field. One key reason is variability in asphalt binder source and formulation often arising when contractors switch suppliers, or when binders are modified with different additives to meet the same grade. These variations can influence how mixtures resist cracking and other forms of distress, even though they technically comply with PG grade requirements. Before this project, MassDOT lacked reliable, practical indicators to predict whether asphalt binders from different sources would result in consistent, long-lasting pavement performance, creating uncertainty in mix design, quality control and specification compliance.

Why It Matters

- Performance risk: Variability in binder quality can compromise asphalt mixture durability leading to premature cracking, reduced life and added maintenance.
- Cost and reliability: Inconsistent binder performance can increase life-cycle costs and diminish pavement reliability for travelers.
- Spec compliance and confidence: MassDOT engineers need tools that go beyond PG grade to ensure that real-world production binders match design expectations.

Who is Affected

MassDOT materials engineers and lab staff, asphalt producers and contractors and road users dependent on durable pavement surfaces.

What We Did

MassDOT funded research to evaluate how asphalt binder source and formulation affect mixture performance, particularly resistance to intermediate-temperature cracking. The work involved laboratory testing of binders from multiple sources, identification of key rheological parameters that correlate with performance differences and development of a simplified testing approach that can be applied in MassDOT labs and production settings.

MassDOT transitioned from prescriptive volumetric mix design to a performance- and cost-based framework to improve long-term durability and return on investment (ROI). Through implementation of Balanced Mix Design (BMD) mixtures were required to demonstrate rutting and cracking resistance. Using AASHTOWare Pavement ME Design and FHWA RealCost, the research showed that ROI depends not simply on RAP percentage, but on RAP binder grade, blending behavior and source properties. This mechanistic approach supported validation of 25–30% RAP surface mixtures on high-volume interstates, confirming high RAP mixtures can remain performance-balanced when

properly characterized and controlled. MassDOT also evaluated innovative overlays (ARGG, HiMA, SMA) by combining laboratory testing, mechanistic predictions and life-cycle cost analysis to quantify added service life and ROI. The M-E Phase 3 calibration improved Massachusetts-specific performance predictions.

What We Found

- Source matters: Binders that meet the same PG specification can perform very differently in asphalt mixtures, especially regarding resistance to cracking.
- No single test is enough: No single rheological test parameter consistently identified poor binders on its own.
- Combined indicators work: The Glover-Rowe parameter (G-R) and the phase angle at a specific modulus ($\delta_{10}$MPa) together reliably distinguish lower-quality binders linked to poor mixture cracking performance.
- Validated correlation: Mixtures made with poorly ranked binders showed low cracking tolerance index values, confirming that these parameters meaningfully predict performance
- Simplified testing possible: Researchers developed a streamlined method using dynamic shear rheometer (DSR) tests that reduces time and complexity while still capturing key performance indicators.

What This Delivers

- Practical performance indicators: Two rheological parameters (G-R and $\delta_{10}$MPa) that meaningfully predict binder quality related to cracking resistance.
- Simplified test method: A faster, implementable approach for MassDOT labs to assess binder quality without full master curve construction.
- Framework for specification refinement: A basis for updating binder evaluation and mix design procedures to ensure consistency across sources.

How MassDOT Is Using This

The findings are being used to support internal discussions on refining asphalt binder testing and mix design protocols, including how MassDOT might update its specifications and quality assurance practices to incorporate performance-linked rheological parameters. While not yet fully adopted in specifications, the research lays the groundwork for more consistent, performance-based binder evaluation.

Key Takeaway

Asphalt binder source and formulation influence mixture performance even when PG specs are met; incorporating targeted rheological indicators into testing helps MassDOT better predict and ensure consistent pavement performance.

Learn More

Final Report

https://www.mass.gov/doc/effect-of-asphalt-binder-source-on-asphalt-mixture-performance-final-report/download

Summary
https://www.mass.gov/doc/effect-of-asphalt-binder-source-on-asphalt-mixture-performance-research-summary/download

**Improving Long-Term Pavement Performance and Return on Investment in Massachusetts**

The Problem
MassDOT designs and maintains pavements under some of the most demanding conditions in the country—heavy truck traffic, freeze-thaw cycles and aging infrastructure. But pavement design decisions were largely based on national defaults and legacy methods that don't fully reflect how Massachusetts pavements perform over time. Without design tools calibrated to local conditions, MassDOT faced uncertainty about how long pavements would last, when they would fail and which design choices truly deliver the best long-term value. This made it harder to confidently compare alternatives, optimize investments, and justify decisions tied to cost, performance and maintenance timing.

Why It Matters
- Cost & reliability: Better design decisions reduce premature failures and lower long-term maintenance costs.
- System performance: Longer-lasting pavements mean smoother rides, fewer work zones and more reliable roads.
- Decision-making: MassDOT engineers need tools that reflect Massachusetts' conditions, not national averages.

Who is Affected
MassDOT engineers and planners, municipalities, contractors, and ultimately drivers and freight operators statewide.

What We Did
MassDOT implemented and localized a modern pavement design framework that predicts how pavements perform over time. The project analyzed real pavement performance data and aligned national design models with Massachusetts traffic, materials and climate conditions to support better long-term investment decisions.

What We Found
- National pavement design models do not accurately predict pavement performance in Massachusetts without local adjustment.

- Calibrating models to Massachusetts conditions significantly improve confidence in predicted pavement life and distress.
- Design choices that look similar upfront can have very different long-term costs and performance outcomes.
- Using locally calibrated tools supports earlier, more cost-effective preservation instead of costly reconstruction.
- ROI improves when pavement decisions are based on lifecycle performance rather than short-term cost alone.

What This Delivers

- Massachusetts-specific pavement design calibration factors
- Guidance for using mechanistic-empirical pavement design in MassDOT practice
- A framework for comparing pavement alternatives based on long-term performance and return on investment
- Reusable approach that can be applied to future pavement designs and updates

How MassDOT Is Using This

The results are being used to support pavement design decisions and refine internal guidance, helping engineers better evaluate design alternatives based on expected performance and lifecycle cost rather than default assumptions.

Key Takeaway

By aligning pavement design tools with real Massachusetts conditions, MassDOT can invest smarter in building roads that last longer, cost less to maintain and perform better for the public.

Learn More

Final Report

https://www.mass.gov/doc/improving-the-long-term-condition-of-pavements-in-massachusetts-and-determining-return-on-investment-implementing-the-aashto-final-report/download

**Measuring Access to Improve Public Health – Phase II**

The Problem

MassDOT and its public health partners recognized that traditional transportation planning metrics don't fully capture how access to essential destinations such as healthcare, education, parks and basic services affects public health outcomes across communities in Massachusetts. Prior metrics often focused narrowly on travel times or roadway capacity without integrating multimodal accessibility or how access disparities correlate with chronic health conditions. Without improved measures of access that reflect walking, biking, transit and driving conditions in real-world environments, MassDOT lacked reliable

tools to identify transportation-related barriers to health, prioritize investments equitably, or assess how improvements in mobility could support public health goals.

Why It Matters

- Public health outcomes: Better access to destinations like clinics and parks is linked to reduced chronic disease rates and better overall community health.
- Equitable planning: Vulnerable populations (low-income, zero-vehicle households) experience disproportionate access limitations that correlate with poorer health outcomes.
- Policy integration: Transportation decisions that do not account for access equity may unintentionally widen health disparities or miss opportunities to promote active travel modes.

Who is Affected

Underserved communities, public health agencies, metropolitan planning organizations and local governments.

What We Did

This project expanded on Phase I work to develop quantitative access metrics that link transportation accessibility to public health outcomes. It used statewide, multimodal data and spatial analysis tools (including Conveyal and Replica) to generate high-resolution maps of access to key destinations (healthcare, higher education, parks, food, etc.). The study integrated demographic and health data to analyze how access disparities correlate with outcomes such as diabetes and heart disease and developed approaches to embed these metrics in planning tools and dashboards.

*Type of work:* Analysis, spatial modeling, metric development

What We Found

- Multimodal access varies by destination: Access by walking, biking, transit and driving each contributes differently to predict public health outcomes, depending on the destination type.
- Unequal access correlates with health disparities: Limited access among low-income and zero-vehicle households is strongly associated with poorer chronic health outcomes.
- Spatial tools enhance insight: High-resolution accessibility maps provide a clearer picture of where transportation barriers exist across the Commonwealth.
- Integrated modeling informs policy: Geographic random forest models that combine accessibility and demographic variables help quantify how different access modes relate to health measures.
- Implementation resources prepared: The project developed step-by-step directions and resources to replicate the analyses, supporting further use by planners and analysts.

What This Delivers

- Standardized access metrics linked to public health outcomes that integrate walking, biking, transit and driving.
- Data products and maps showing where access shortfalls occur statewide.
- Analytic tools and methods for repeating accessibility evaluations with available spatial software.
- Documentation and guidance to help embed these metrics into decision-making dashboards or scoring frameworks.
- Foundations for equity-centered planning that can support transportation investment decisions tied to health outcomes.

How MassDOT Is Using This

The access metrics and analytical framework are being integrated into planning discussions and tools that support transportation investment decisions across MassDOT and partner agencies. This includes exploring how to incorporate health-related access criteria into project prioritization processes and dashboards used by planners, metropolitan planning organizations and local governments.

The methods and data are also being used to support short-term funding allocation decisions and long-term strategic planning that emphasize equitable access to essential destinations.

Key Takeaway

By quantifying multimodal access to essential destinations and linking it to health outcomes, this project provides MassDOT with actionable metrics to support more equitable, health-informed transportation planning across Massachusetts.

Learn More

Final Report

https://www.mass.gov/doc/measuring-access-to-improve-public-health-phase-ii-final-report/download

Summary

https://www.mass.gov/doc/measuring-access-to-improve-public-health-phase-ii-summary/download

**Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete and Comparison with Other Alternative Constituent Materials**

The Problem

MassDOT's concrete infrastructure relies heavily on Portland cement, a material with a high carbon footprint and subject to supply variability of traditional supplementary cementitious materials (SCMs) like fly ash and slag. At the same time, millions of tons of

post-consumer glass are landfilled annually despite having chemical characteristics that could make it a viable cement replacement. Before this project, there was limited clarity on how recycled ground glass performs compared with conventional SCMs in cement concrete, and how to design concrete mixes that reliably meet performance and durability requirements while reducing environmental impact.

Why It Matters

- Environmental impact: Cement production is a major source of greenhouse gas emissions; increasing the use of low-carbon SCMs directly reduces the carbon footprint of concrete.
- Material sustainability: Traditional SCM sources like fly ash are declining due to changes in energy production, creating supply risks.
- Waste reduction: Utilizing waste glass helps divert large volumes of recyclable material from landfills.

Who is Affected

MassDOT materials engineers, concrete producers and suppliers, construction contractors and communities interested in sustainable infrastructure.

What We Did

This research evaluated recycled ground-glass pozzolan (RGGP) as a supplementary cementitious material in concrete and to compare its performance with other alternative constituent materials. The project synthesized laboratory results, mix design studies and comparative assessments to determine RGGP's suitability for use in MassDOT concrete applications.

*Type of work:* Analysis, material comparison, mix design evaluation

What We Found

- Recycled glass can function as a pozzolan: Ground glass exhibits pozzolanic activity when processed to fine powder, making it a viable partial replacement for Portland cement.
- Sustainable benefits: Replacing cement with RGGP reduces lifecycle carbon emissions of concrete compared to conventional mixes.
- Comparison with other SCMs: RGGP performs comparably to or better than some traditional SCMs (e.g., fly ash) in certain properties, though variability exists and mix design must be optimized.
- Design guidance needed: Knowledge gaps remain around hydration behavior, long-term quality and how RGGP interacts with concrete mixtures across conditions.
- Potential for broader use: With appropriate processing, RGGP could help meet sustainability goals and reduce reliance on diminishing SCM supplies.

What This Delivers

- A comparative assessment of RGGP against alternative constituent materials for concrete.
- Foundational evidence that recycled ground glass is a promising SCM candidate, with a framework for further evaluation and specification development.
- Guidance for future mix design testing and implementation decisions emphasizing environmental performance.

How MassDOT Is Using This
The project's findings are being used to inform internal discussions on sustainable concrete mix strategies, including how alternative materials such as RGGP could be integrated into future specifications. Additional study and field demonstrations remain necessary before full implementation.

Key Takeaway
Using recycled ground-glass pozzolan as a supplementary cementitious material could reduce the environmental impact of MassDOT concrete while maintaining performance, supporting sustainable infrastructure investment.

Learn More
Final Report
https://www.mass.gov/doc/recycled-ground-glass-pozzolan-rggp-for-use-in-cement-concrete-and-comparison-with-other-alternative-constituent-materials-final-report/download

Summary
https://www.mass.gov/doc/recycled-ground-glass-pozzolan-rggp-for-use-in-cement-concrete-and-comparison-with-other-alternative-constituent-materials-research-summary/download

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

The Problem
MassDOT has concerns that certain pavement surface types are being overtreated during winter maintenance. This is because one specific type of pavement surface Open Graded Friction Course (OGFC) will appear visually "white" even after treatment. This could lead to a situation where the road is treated again when it is not necessary. OGFC pavement sections typically adjoin dense-graded (DG) pavement sections. Thus, when the OGFC section is treated, the adjoining DG section is also typically treated leading to excessive treatment application.

The purpose of this study was to compile data in the field to justify winter maintenance treatment efficiency on OGFC and DG pavement surfaces to ensure that the application is not deficient or excessive. Salt deficiency would result in safety concerns.

What We Did

Data analysis was conducted on existing weather stations, invasive sensors, installed in each pavement type (OFGC & DG), winter maintenance activities, friction and surface condition testing, crash data and photographs. With this data, and the known treatment application rate and frequency, the research team attempted to develop a methodology that MassDOT can use to determine if the treatment applications and frequency are correct, deficient, or excessive.

This Salt Usage study addressed environmental durability from deicing practices. Together, these efforts established a comprehensive performance-based framework that enhances durability and fiscal stewardship across the Commonwealth.

What We Found

- The internet-based survey showed that only 12.5% of respondents currently place OGFC in their state. The reasons noted for opting not to use OGFC included snow and ice concerns, durability issues, project failures, cost and poor performance issues.
- Survey respondents indicated that they noticed increased damage to OGFC surfaces as compared to DG surfaces due to normal plowing operation, although frequency of plowing was not increased for OGFC as compared to DG surfaces.
- Field instrumentation data combined with winter maintenance treatment (salt) application data indicated that the OGFC and DG pavement types responded similarly to the winter maintenance in terms of pavement temperature and friction (based on both invasive and non-contact sensors).
- The safety implications related to winter maintenance activities for both OGFC and DG pavement types could not be investigated due to incomplete crash data and limited direct friction measurements.
- The invasive and non-contact sensors did not indicate a friction reduction for either pavement type, they performed similarly based on the data collected.
- No evidence was found that OGFC pavement type froze faster than the DG which challenges assumptions about OGFC's vulnerability during winter events.
- The combined analysis of all the anticipated data could not be completed as limited data was collected. The winters of 2023-2024 and 2024-2025 were less harsh than historically anticipated for the region, thus yielding limited data to analyze.

What This Delivers

Generally, the data collected indicated both pavement types perform similarly when the same winter maintenance treatment is applied.

How MassDOT Is Using This

Requires additional study before implementation. More crashes, direct friction measurements and stronger winter storms.

Key Takeaway

MassDOT has concerns that certain pavement surface types are being overtreated during winter maintenance and this project found no evidence that this was the case. The anticipated analysis couldn't be completed as the winters were less harsh than historically expected for the region.

Learn More

Final Report

https://www.mass.gov/doc/field-study-to-determine-salt-usage-efficiency-and-transport-to-the-surrounding-environment-on-two-pavement-types-final-report/download

Summary

https://www.mass.gov/doc/field-study-to-determine-salt-usage-efficiency-and-transport-to-the-surrounding-environment-on-two-pavement-types-research-summary/download

**Appendix B: FFY25 Continued and New Projects**

| Project | Objective | FFY25 |
|---|---|---|
| Development of a Salt Spreader Controller Program Using Machine-Sensed Roadway Weather Parameters (Phase 2) | Clearing roadways during winter seasons, it is critical to deliver the materials efficiently and effectively so that the impacts of winter storms are minimized while the utilization of the materials is maximized to reduce potential environmental impacts. The objective of this study is twofold: 1) to develop an improved RSC algorithm by incorporating additional critical road condition categories (e.g., black ice and packed snow) and employing a more complex deep learning architecture; 2) to develop a new SRP model by incorporating the real-time mobile RWIS information from the instrumented truck, the regional stationary RWIS information and the climate and weather forecasting information. The algorithm and model developed will be validated on multiple snowplowing trucks. More information | $43,171.00 |
| Advanced Technologies and Data Analytics for Safe, Smart, and Efficient Transportation (ASSET) | Project objectives: Recalibrate the SPFs in Chapter 16.6.4 of the HSM2, along with the associated parameters, for the twelve types of urban intersections in Massachusetts using the most recent data. Develop and refine methodologies that can effectively and reliably extract sidewalk data from aerial imagery. Leverage artificial intelligence (AI) to automate the counting of pedestrians, active transit modes (such as bicycles and e-scooters), and site trips generated by new developments. By using real-time AI models that process video and sensor<br>data, this task also aims to develop algorithms to estimate multimodal trip projections associated with multiple ITE land use codes or Massachusetts-specific land use codes, considering the existing or | $99,557.00 |

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| | planned infrastructure design, congestion management and mobility strategies. More information | |
| 3D-Printed Lattice-Based Structures for Next Generation Bridge Bearings and Bridge Isolation Bearings (Phase III) | The current project will develop a prototype bearing system using concepts from architected lattice materials and aspire to manufacture and test the 3D printing bearing systems. The objectives of the proposed research include computational and experimental work to develop a new architected material bridge bearing product and test it for vertical, transverse and other load conditions. In addition, the proposed research will aim to develop recommendations regarding the technoeconomic decision-making process (including cost models) informing how to apply the new prototype and identify the technical capabilities to achieve a cost-effective solution that can be implemented in the field. More information | $130,390.65 |
| MassDOT Speed Regulation Editing Support | Throughout this effort, speed regulations gaps along the conflated Traffic Messaging Channel (TMC) segment network will be checked out from a web map, reviewed and edited in a Roads and Highways Event Editor Application while cross-referencing the speed regulation statute documents associated with the roadways described. | $90,405.00 |
| Cracks of Low-P Rapid Set Concrete in Deck Repairs: Analysis, Prevention, and Alternatives | 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. | $100,000.00 |

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| | More information | |
| Environmental Scan of Community Transit Needs Among Older Adults in Massachusetts | This project aims to support MassDOT in advancing its community transit programs by systematically identifying and addressing the needs of older adults. Through detailed analysis and stakeholder engagement, the project will provide actionable recommendations for improving transit options and enhancing the quality of life for Massachusetts's aging population. Outputs and deliverables include:<br>A report documenting existing transportation needs of older adults in MA. This will illustrate nuanced differences in transportation needs for different populations of older people and people with disabilities.<br>More information | $82,500.00 |
| Evaluation and Mitigation Methods for the Prevention of Cement Concrete Deterioration due to Pyrrhotite Phase II | The project will investigate the effectiveness of concrete mix design mitigation methods on the evolution of deterioration of cement concrete containing pyrrhotite reactive minerals. | $125,442.00 |
| Uniform Speed Management | This scope of work will synthesize existing speed management research and guidance resources to aid MassDOT and municipalities with the application and implementation of speed management countermeasures. The project will assist MassDOT in the development of Methods to Systemically Identify *Areas of Speed Concern,* Matrix Guide of Appropriate Speed Management Countermeasures and Process Guidance "How to Implement Speed Management Interventions". | $161,285.65 |
| Evaluating the Effectiveness of Driver's Education Modules on Safety | The objective of this research is to better understand the effectiveness of education and training as well as how education and training can improve use of ADAS. The research will examine the role of the driver education framework for novice driver training and will evaluate the efficacy of ADAS-centric training for new drivers.<br>More information | $202,644.63 |