AID-PT

Accelerated Implementation & Deployment of Pavement Technologies

ANNUAL REPORT 2020 2021

U.S. Department of Transportation
Federal Highway Administration

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Cover photos: Crews install overlays in Maine (top right) and Colorado (bottom left). Source: Shreenath Rao, ARA, Inc.

Front cover images source: FHWA

Success through Adversity

Every adversity is an opportunity to excel a little more. Staff and stakeholders who supported the Federal Highway Administration's (FHWA) Accelerated Implementation and Deployment of Pavement Technologies (AID-PT) program in FY21 proved this notion.

The AID-PT program advances the latest and best practices and technologies for constructing and maintaining high-quality, long-lasting pavements. It is vital in supporting FHWA's mission to improve connectivity, mobility, and accessibility on the Nation's highways. The program, which typically features onsite field demonstrations and hands-on training, was faced with pandemic-related travel restrictions during 2021. However, AID-PT staff and participants found new, and in some instances improved, ways to fulfill program initiatives.

As we reflect on our progress, I want to highlight how FHWA and its stakeholders showed ingenuity in challenging times. Their work delivered critical insights, experience, and practices to the pavement community through meaningful and cost-effective strategies that ranged from preparation and delivery of virtual training courses, workshops, and demonstrations to videos and equipment loan programs.

The AID-PT initiatives highlighted in this annual report exemplify how embracing adversity can lead to success. During the past year, the program's accomplishments included the following:

- Virtual visits to 12 States to discuss reclaimed asphalt pavement implementation, balance mix design and quality assurance stewardship reviews.
- Working with 13 States to create the Demonstration to Advance New Pavement Technologies pooled fund.
- Hosting virtual peer exchanges to help agencies progress toward more resilient pavements.
- Finalizing a pavement preservation strategic plan and drafting a pavement management roadmap.
- Collaborating with 28 States to advance targeted overlay pavement solutions as part of FHWA's Every Day Counts round six initiative.
- Collecting effective practices identified by States participating in the performance engineered mixtures pooled fund study.
- Deploying dielectric profiling systems as part of the AID-PT equipment loan program.
- Developing test protocols to assess pavement macrotexture.

In these ways, we're enabling stakeholders to manage the Nation's pavement assets more effectively and improve the condition of the roadway network. I'm honored to share these highlights from our ongoing activities, and I look forward to further successes as together we continue to develop and deploy innovation on the Nation's roadways.

Hari Kalla

Hari Kalla
FHWA Associate Administrator for Infrastructure

About the Program

Congress established the Accelerated Implementation and Deployment of Pavement Technologies (AID-PT) program in 2012 under the Moving Ahead for Progress in the 21st Century Act (Pub. L. 112-141). The program's purpose is to document, demonstrate, and deploy innovative pavement technologies—including their applications, performance, and benefits.

In 2015, Congress continued the program in the Fixing America's Surface Transportation (FAST) Act (Pub. L. 114-94), with funding available through fiscal year 2020. FHWA is leveraging Federal investments through relationships with State transportation agencies and others to maximize the impact of the program, effectively amplifying benefits to the traveling public.

The AID-PT program focuses on promoting, implementing, and deploying proven technologies and demonstrated practices. Specifically, the program encourages highway agencies to adopt and implement new technologies proven to save money, enhance safety, improve performance and quality, increase efficiency, reduce delay, and enhance road user satisfaction. This annual report documents FHWA's approach to achieve the six overarching goals Congress set for the program (see page 3). The FAST Act Section 6003 requires "a report on the cost and benefits from deployment of new technology and innovations that substantially and directly resulted from the program." This report highlights examples of how technologies promoted through the AID-PT program have produced anticipated long-term improvements in cost savings, project delivery time, congestion relief, enhanced safety, and pavement performance.

The Program highlights showcased on the following pages offer a snapshot of the exciting work FHWA and its stakeholders are doing to accelerate implementation and deployment of innovative pavement technologies and practices.

FHWA is engaged in a variety of efforts to improve training materials and deliver information to help highway agencies design and construct asphalt and concrete pavements more effectively. These efforts range from focused technology transfer activities featuring webinars and on-demand YouTube videos to documents on asphalt and concrete pavement technologies. In addition, efforts range from stakeholder-based initiatives to promote the overall sustainability of pavement systems to field demonstration and construction projects supported by the agency's mobile technology centers.

The AID-PT program is an example of FHWA operating under a shared vision with its stakeholders to implement and deploy needed products and technologies. With strong stakeholder support, the program is providing benefits ranging from shorter project delivery times and less congestion to cost savings and fewer roadway fatalities.

Source: DepositPhotos.com

AID-PT Program Goals

AID-PT GOALS [Title 23,United States Code, Section 503(c)(3)]	***SELECTED FHWA EFFORTS***											
	Demonstration Pooled Fund Study	Pavement Preservation	Resilience	LCA Pave Tool	Virtual Technology Deployment	Mobile Pavement Technology Centers	Targeted Overlay Pavement Solutions	Balanced Mix Design	Performance Engineered Mixtures	Dielectric Profiling Systems	Macrotexture	Pavement Management Roadmap
1. The deployment of new, cost-effective designs, materials, recycled materials, and practices to extend the pavement life and performance and to improve user satisfaction.	●	●	●	●	●	●	●	●	●			●
2. The reduction of initial costs and lifecycle costs of pavements, including the costs of new construction, replacement, maintenance, and rehabilitation.	●	●	●	●		●	●	●	●			
3. The deployment of accelerated construction techniques to increase safety and reduce construction time and traffic disruption and congestion.	●				●	●				●		
4. The deployment of engineering design criteria and specifications for new and efficient practices, products, and materials for use in highway pavements.	●	●	●	●	●	●	●	●	●		●	
5. The deployment of new nondestructive and real-time pavement evaluation technologies and construction techniques.	●				●	●		●		●	●	●
6. Effective technology transfer and information dissemination to accelerate implementation of new technologies and to improve life, performance, cost-effectiveness, safety, and user satisfaction.	●	●	●	●	●	●	●	●	●	●	●	●
See page	4	6	10	14	18	20	24	28	32	34	37	40

FHWA and States Pool Resources to Demonstrate and Advance New Technologies

The FHWA is leading a pooled fund study aimed at accelerating the delivery of safe, smooth, and durable pavements and ensuring a favorable return on highway funding investment. The Demonstration to Advance New Pavement Technologies pooled fund will leverage Federal investments with State collaboration to support and showcase the implementation of innovative pavement technologies, products, and processes by State departments of transportation (DOTs).

Traffic navigates a freshly snow-plowed highway in Flagstaff, Arizona.
Source: ADOT

Topics of Interest

The pooled fund will serve as a mechanism to deploy and showcase pavement technologies and resources to address the following topics:

- Development of programs for balanced mix design for asphalt and performance engineered mixtures for concrete.
- Implementation of strategic pavement preservation programs.
- Integration of sustainability and resiliency into decision-making processes, technical frameworks, education efforts, and stakeholder engagement.

Other project topics may be considered with approval from the Pooled Fund Technical Advisory Committee.

The FHWA anticipates contributing $2 million annually for a period of 5 years (fiscal years 2021–2025) subject to availability of funds. The FHWA contribution will provide up to $250,000, and up to 100 hours of technical assistance, resources for developing case study reports and videos for each selected demonstration project, a website for related publications, and peer exchanges for showcasing lessons learned from projects. Participating State DOTs contribute $10,000 annually, submit and administer projects, collaborate actively with other States and FHWA to advance initiatives, and develop reports documenting project outcomes.

State Projects

Source: DepositPhotos.com

Thirteen States have committed to the pooled fund, and the following three projects from participating DOTs have already been selected to receive funding.

The Wisconsin DOT (WisDOT) will conduct a long-term field evaluation of balanced mix design (BMD) test sections and determination of performance testing variability during production. WisDOT is implementing BMD concepts into construction specifications and will use pooled fund resources to help fulfill its local research obligations and improve and expand the project. WisDOT has also requested technical guidance for contract special provision development, support for test section sensor installation, and consultant help for material sampling.

So far, WisDOT has evaluated available performance test methods, begun collecting BMD data for current mixture designs, and established preliminary thresholds for quality acceptance. More research is needed before full implementation to validate performance test selection in the field and to better understand performance test variables during production. The WisDOT local research program has hired contractors to implement BMD test sections and conduct production-style testing on WisDOT projects.

The Colorado DOT (CDOT) project will benchmark transportation sector materials' greenhouse gas (GHG) emissions. This will include operational and embodied carbon to identify strategies for reducing CDOT's carbon footprint. To determine what strategies may help CDOT reach these goals, the agency will first catalog and build a database of Colorado-specific materials and their carbon footprint, then establish a benchmark.

This project will develop a methodology for collecting, reviewing, and cataloging GHG emissions through environmental product declarations for various construction materials used on CDOT projects, with a focus on concrete, asphalt, and steel. The project will also include stakeholder engagement, development and implementation of specifications for eligible materials, development of product category rules, development of a materials catalog, and policy development.

The Arizona DOT (ADOT) project will develop long-term climate model data in connection with future heat and precipitation to the year 2100. It will also quantify pavement impacts on those future climate projections with a focus on binder grades, freeze-thaw, and the State DOT surface treatment toolbox. ADOT anticipates this effort will measurably advance FHWA and State DOT state of the practice and tool evaluation as it relates to linking climate models, climate data, pavement, materials, and sustainability and resilience for weather and natural hazard risks.

The pooled fund States believe other States can see benefits from participating as well. "We recommend going through the pooled fund process as it is one of the key FHWA/State DOT tools where we can conduct progressive agency applied research," said ADOT Program Manager Steven Olmsted, National Environmental Policy Act Assignment Manager, ADOT. "We have also had great success participating in the Transportation Systems Management and Operations Road Weather pooled fund." CDOT State Materials Engineer Craig Wieden adds, "CDOT believes there is a lot of value in participating in these types of projects. We are excited to be part of this one and are looking forward to working with FHWA on our project."

Interested States can participate by going to solicitation 1542 on the [Transportation Pooled Fund Program website](#).

Developing a Strategic Approach to Pavement Preservation

Microsurfacing being placed on State Route 3010 in Pennsylvania. ***Microsurfacing*** is a pavement preservation treatment to extend life of pavements that are showing signs of aging. Source: Shreenath Rao, ARA, Inc.

With an expansion of the Nation's roadway system and increases in traffic volume during the last 50 years, FHWA, highway agencies, and industry are working to make the system run smoother and last longer.

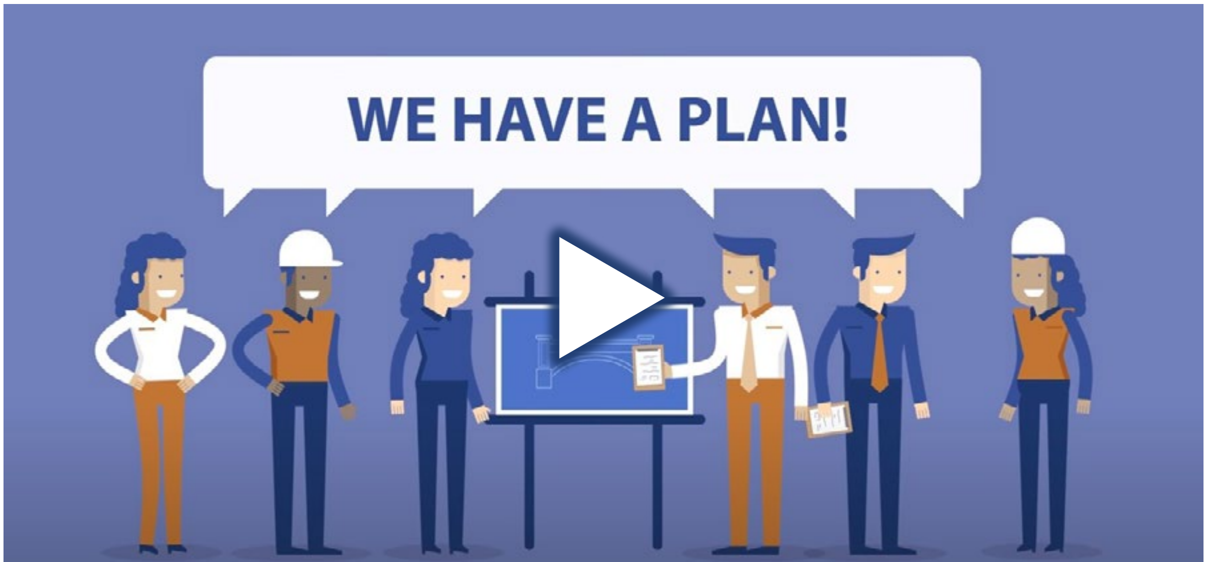
"By proactively preserving our existing highways, we can reduce costly, time-consuming rehabilitation and reconstruction and the associated traffic disruptions," said FHWA Construction Engineer Antonio Nieves. "With timely preservation, we can provide the traveling public with improved mobility, reduced congestion, and safer, smoother, longer-lasting pavements. This is the true goal of pavement preservation."

While FHWA has supported several pavement preservation initiatives dating back to the 1990s, the agency took key steps over the past year to formalize a preservation program. FHWA is working on related materials to build on the strategic plan.

The FHWA program's primary objective is to help State and local agencies strategically consider and implement pavement preservation programs in a data-driven and systematic manner to optimize pavement performance, maximize the use of available funding, and incorporate effective stakeholder engagement. Achieving this objective is expected to create significantly lower annual expenditures per mile of roadway for highway agencies.

Planning for Preservation

The FHWA Pavement Preservation Strategic Plan shares the agency's role in the effective implementation of pavement preservation. It includes three main strategies.



Ohio DOT was able to reallocate $300 million to priority projects over 6 years thanks to its strategic preservation program. Learn more in this ***Ohio DOT video***. Source: Ohio DOT

Strategy 1. Explore and disseminate fundamentals of pavement preservation.

To address inconsistency in quantifying benefits, particularly when evaluating entire networks and when considering long-term impacts, FHWA conducted a benchmarking study that includes a survey* of State agenices. Fifty State departments of transportation (DOTs) responded to questions about their programs, including funding, scheduling, construction, and performance monitoring. The FHWA intends to use the responses to develop metrics to measure preservation effectiveness in reducing costs, maintaining conditions, and sustaining roads and highways. Project objectives also include conducting a gap analysis. Identified gaps in knowledge and experience suggest opportunities for FHWA to provide information, improvements, and support.

In conjunction with the benchmarking study, FHWA conducted a market assessment to evaluate the current state of pavement preservation practice across the country. This effort included one-on-one interviews with several FHWA personnel, State agencies, metropolitan planning organizations, industry organizations, and contractors. Questions included, "What are the challenges and barriers?" and "What is needed to help stakeholders gain support of pavement preservation and implement successful programs?"

FHWA is using results from the benchmarking study and market assessment are being used to create a communication plan to increase fundamental understanding of pavement preservation among a variety of audiences. This could lead to potentially increased adoption and implementation of pavement preservation activities as agency standard operating procedures. The communication plan may help FHWA accomplish the following:

- Help highway agencies expand their knowledge of pavement preservation materials and technologies.
- Demonstrate the positive impacts that can result from using preservation treatments.
- Improve understanding and expertise in implementing pavement preservation programs as related to pavement management or other strategic processes.
- Foster collaboration and cooperation among stakeholders.

** OMB Control Number 2125-0628.*

Strategy 2. Encourage effective pavement preservation programs.

The FHWA Pavement Preservation Strategic Plan includes three steps to fulfill strategy 2. First, develop and deploy pavement preservation tools directed toward implementation. Second, integrate pavement preservation with the existing performance management, pavement management, and asset management activities. Third, undertake an effort to maximize industry and other resources to support effective pavement preservation programs.

Strategy 3. Facilitate strategic pavement preservation research and implementation efforts.

The Pavement Preservation Research Roadmap identifies potential topics for research in the areas of selection, design, and installation of pavement preservation products on road and highway pavements. The FHWA and stakeholders anticipate using the Research Roadmap to identify research projects to address the needs and focus on linking the findings to implementation efforts.

FHWA's role in pavement preservation as outlined in its strategic plan:

Provide leadership (including training and technology transfer) toward effective application of pavement preservation within an overall pavement management process.

Demonstrate the economic, social, and environmental benefits derived from proper implementation of a data-driven preservation program.

Conduct and sponsor research to address pertinent pavement preservation questions and needs of national significance.

Stakeholder Input

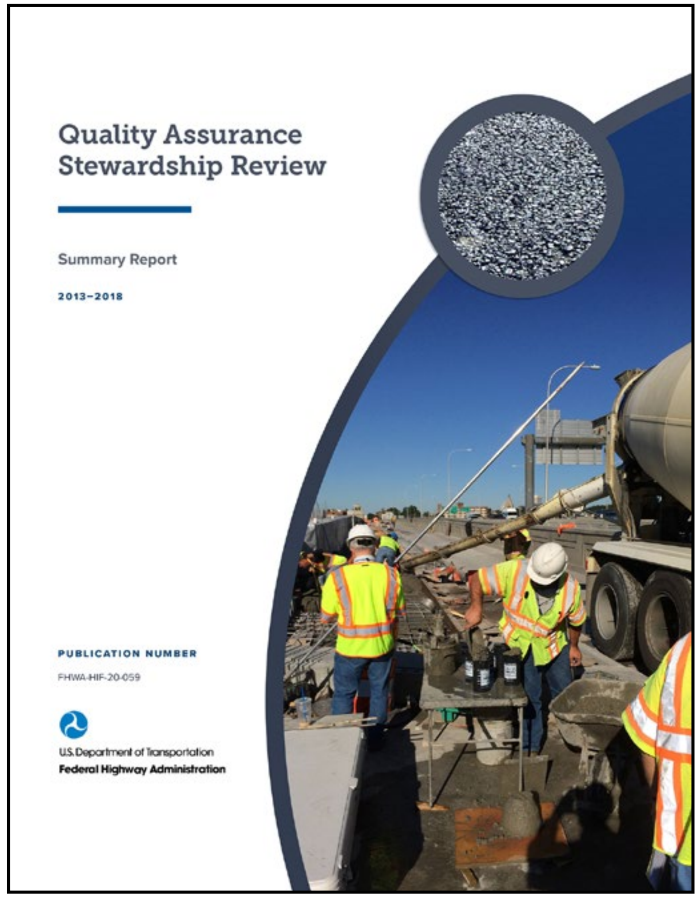
The FHWA solicits input from its stakeholders through the Pavement Preservation Technical Feedback Group, which includes members of State DOTs, local public agencies, industry, academia, contractors, and consultants. Improved coordination within the FHWA pavement preservation program will yield comprehensive resources to help State DOTs and other highway owners implement effective pavement preservation strategic programs.

The FHWA is raising awareness of proven preservation strategies by exploring current practices, disseminating information to increase understanding, encouraging effective programs, and facilitating strategic research and implementation efforts.

This *video highlights New Jersey DOT's Pavement Preservation Program* and the tools used to extend pavement life for State highways in good and fair condition. Source: NJDOT

AID-PT *SHORT TAKE*

New Report Highlights Quality Assurance Stewardship Review Findings



The FHWA has released the latest Quality Assurance Stewardship Review Summary Report, which summarizes the findings of 27 State department of transportation (DOT) quality assurance (QA) program reviews completed from 2013 to 2018. QA stewardship reviews are important because a considerable amount of Federal-aid construction dollars is used on pavement and material activities. This creates a signficant risk to the Federal-aid program if a DOT's QA program does not meet Federal requirements.

The FHWA created its QA Stewardship Review Program in 2003 to evaluate State QA programs and assess compliance with Federal requirements such as Title 23, Code of Federal Regulations, Part 637, Subpart B. This governs QA procedures for Federal-aid highway projects on the National Highway System. The program also captures and shares practices, assesses and reduces risks, and provides recommendations to improve material quality and program efficiency.

"Some States have really good processes, and they are being implemented in the field, so QA is a strength for them," said FHWA QA Program Manager Jeff Withee. "Other States have good policies that are documented, but not everyone is consistently following them due to staff turnover, training, or other issues."

Since the creation of the program, FHWA has completed materials QA stewardship reviews for all 50 State DOTs, Puerto Rico and the District of Columbia. FHWA conducts weeklong reviews at four to five DOTs each year. Travel restrictions in calendar year 2020 limited the team to two reviews, but FHWA switched to a virtual format and completed four in 2021.

The new report includes the following trends:

- Most DOTs' QA programs are meeting Federal regulations (23 CFR 637.205, 23 CFR 637.207, and 23 CFR 637.209).
- The use of contractor test results in the acceptance decision without adequate verification sampling and testing is a recurring issue, most notably for pavement smoothness.
- Test sample security is an issue. DOTs should maintain control of verification samples to have confidence that the sample represents the material used to construct the Federal-aid project.
- Some DOTs use random sampling inconsistently, do not maintain consistent procedures, or use biased procedures.
- DOTs should update process documents as they make improvements to their QA programs.

Progress Toward More Resilient Pavements

A road collapses in New York due to flooding.
Source: Dan D'Angelo, ARA, Inc.

Extreme weather events, increasing temperatures, and changing sea levels can threaten investments in transportation infrastructure. Transportation agencies are preparing for changing conditions by planning, designing, and constructing resilient pavement systems. The FHWA supports transportation agencies in their efforts to withstand, respond to, and recover rapidly from disruptions.

The FHWA's national efforts toward more resilient pavements began with a documented commitment and policies. The agency issued Order 5520: Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events in December 2014 to establish FHWA policy and responsibilities. The order sets FHWA's approach to addressing these risks. It also serves to implement relevant provisions of transportation law and comply with executive orders.

The FHWA is working with State and local agencies to include climate change vulnerability and risk in transportation decision-making at both the system level (planning, asset management, operations, maintenance) and the project level (environmental processes, preliminary engineering, design, construction) in the following ways:

- Hosting webinars to explain adaptation strategies.
- Hosting peer exchanges to share information.
- Developing a National Highway Institute course to help pavement engineers and other disciplines address climate resilience in project development.
- Conducting research to look at impacts of sea level rise.

Adaptation Strategies

In March 2021, FHWA conducted a webinar to help agencies progress toward more resilient pavements. Participants learned three steps for adapting and incorporating resilience into their pavement systems and projects. "First, we want agencies to monitor trends, note changes, and decide whether they are important," said FHWA Highway Research Engineer Amir Golalipour. "Next, evaluate the vulnerability. Is the trend risky or not? Finally, plan and design infrastructure to meet future conditions."

Step 1: Monitor Trends

Most climate change impacts are projected to occur over a long period of time (e.g., increases in average annual temperature of 4 degrees over 40 years, slow changes in precipitation patterns, and sea level rise of 0.8 to 6.5 feet over nearly 100 years).[1] While research shows climate change is slow on the scale of the typical 20- to 40-year pavement life cycle, some changes are already impacting pavements. Low-lying coastal roads are experiencing daily flooding at high tide, permafrost thaw has caused damage to pavements in Alaska, and extreme summer heat events have caused rutting.

Key changes will likely focus on how to modify current design and maintenance practices rather than how to respond to potential impacts. A first step is to identify and monitor key pavement performance parameters and search for developing trends.

Agencies should monitor key pavement performance indicators and climate metrics (e.g., freeze-thaw cycles, average temperatures, temperature extremes) on an annual basis. They should monitor the distresses that typically trigger rehabilitation efforts and their frequency of occurrence in relation to traffic levels, then incorporate summary statistics annually in pavement management system reports. While such monitoring and annual reporting is not required under FHWA regulations, it provides a useful means of identifying trends in pavement performance as they begin to occur.

Step 2: Evaluate Vulnerability

The next recommended step not required by regulation is to identify if an asset is vulnerable to identified stressors or threats, then prioritize segments to ensure connectivity and mobility for the system. This can be done using available land elevation data, such as from light detection and ranging (LiDAR) and geographic information system (GIS) software. The FHWA has also developed a Vulnerability Assessment Scoring Tool and adaptation framework to help agencies in the evaluation process. The spreadsheet guides users through conducting a quantitative, indicator-based vulnerability screening so agencies can assess how individual components of their transportation system may be vulnerable to climate stressors.

Step 3: Plan and Design for Future Conditions

Finally, agencies should step through the Adaptation Decision-Making Assessment Process. This 11-step framework helps decision makers determine which project alternative makes the most sense in terms of life-cycle cost, resilience, and regulatory requirements. It can be used to assess existing projects or design new ones. While the assessment process is not required, it is a useful tool.

The Delaware Department of Transportation (DOT) created a Transportation Resiliency and Sustainability Division in 2021 to focus on these strategies.

"Delaware is the lowest-lying State in the country, so sea level rise has a tremendous impact on our infrastructure," said Delaware DOT Director of Transportation Resiliency and Sustainability James Pappas. "We are collecting data associated with flooding, roadway elevations, and frequently flooded roadways to identify critical needs. We have also studied critical corridor roadway elevations to determine future elevation requirements."

Peer Exchanges

A structured approach to resilience by transportation agencies is beginning to take shape. In the last quarter of 2020, FHWA hosted two, 2-day peer exchanges with 3 to 4 hours of content per day. The purpose was to identify strategies and barriers for designing, constructing, and maintaining more resilient pavement systems.

1 U.S. Global Change Research Program, https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf

“We hosted the peer exchanges because we want to facilitate discussion on problems that exist—we don’t want to create problems DOTs don’t have,” said Golalipour. “We want to hear from them and identify the gaps and future needs, and then we can act upon their needs.”

Participants focused much of their feedback on flooding and inundation and, to a lesser degree, temperature change. Some agencies are beginning to track flooding data to identify locations where pavements are adversely impacted by inundation and rising water tables. Representatives from 15 State DOTs voiced concerns about flooding.

Participants agreed that areas with a high risk of inundation should be avoided when constructing a new roadway or reconstructing an existing roadway. If alternative routes are unavailable, or the alignment of an existing roadway cannot be changed, the risk of inundation should be accommodated in the pavement section by one or more of the following:

- Raising the road elevation.
- Protecting against erosion.
- Stabilizing subgrade soil and base.
- Using stiffer and thicker surface layers.
- Improving pavement drainage.
- Developing reopening protocol.

Increasing temperatures were of less concern. However, North Carolina DOT has experienced shoving and tearing of asphalt pavement ramps, possibly due to higher temperatures, and participants from Iowa and Texas have seen blowups in concrete pavements during hot weather.

Peer exchange participants also voiced concerns about limitations with the current pavement design methodologies. These concerns fell into two broad categories: the inability of the methodologies to adequately consider the impact of pavement inundation and the inability to use past climatic data to predict future climatic conditions.

“My engagement and exposure to resiliency prior to the peer exchange was very limited,” said Virginia DOT Assistant State Materials Engineer Affan Habib. “It was a big eye-opener to see some DOTs are already very active working on resiliency issues. We need to continue coordination and information exchange to avoid duplication of efforts.”

The FHWA is using information from the peer exchanges to create a resilience research roadmap. This document includes a plan for addressing knowledge gaps and discusses critical, resilience-related issues facing transportation agencies.

Sea Level Rise Research

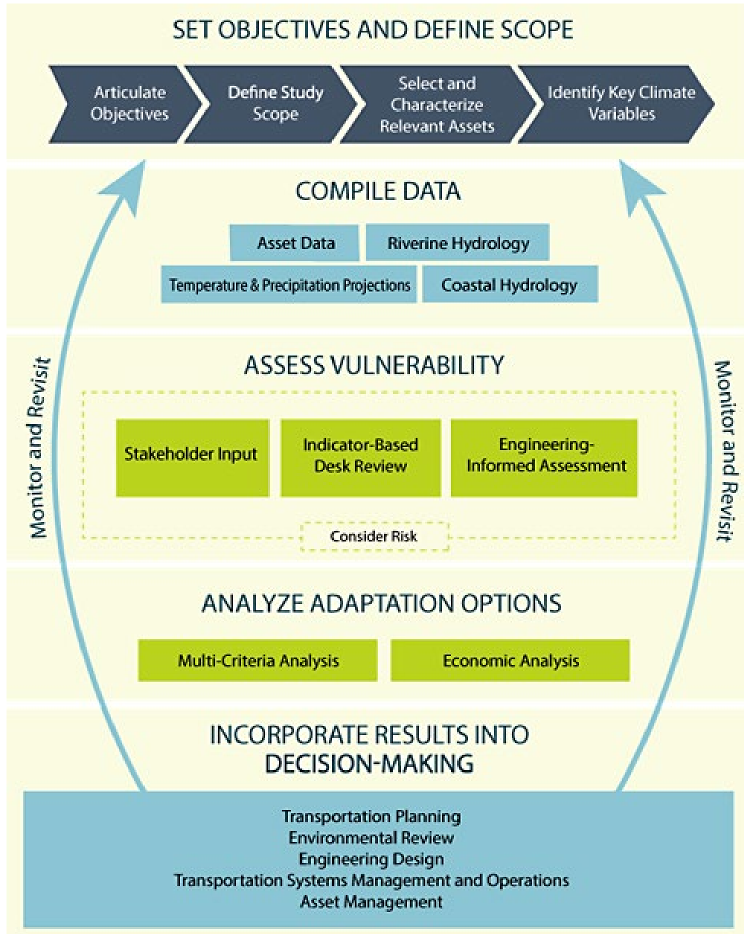
The National Oceanic and Atmospheric Administration’s National Centers for Coastal Ocean Science (NCCOS) and FHWA collaborated to facilitate informed adaptation planning and coastal management decisions. The multidisciplinary research program may result in integrated models and tools capable of evaluating vulnerability and resilience options under multiple sea level rise, inundation, and management scenarios. The research may provide transportation agencies with a methodology to estimate the extent, timing, frequency, and costs of future coastal roadway flooding and assess the effectiveness of nature-based solutions.

“NCCOS is excited to partner with FHWA to support science projects that help coastal communities more holistically consider ecological, human, and transportation needs as they make decisions on how to manage their risk to flooding,” said NCCOS Competitive Research Program Director Dave Kidwell.

A study in Alabama and New Hampshire will explore the causal linkages between coastal hazards and pavement damage. The goal is to identify primary coastal processes that cause pavement deterioration and assess whether natural approaches can stop the damage. This study aims to develop a toolkit DOTs can use to assess a roadway's vulnerability to flooding and to quantitatively compare conventional and nature-based adaptation alternatives to increase infrastructure longevity.

A second project will feature Alabama State Route 180, a coastal roadway often impacted by severe coastal storms and high groundwater tables. The project aims to address the effects of sea level rise on surface transportation infrastructure and the ability of natural and nature-based features to mitigate the effects while simultaneously enhancing the local ecosystem and communities. The NCCOS and FHWA plan to fund more projects in 2022 if funds are available.

Transportation agencies should consider resilience in planning, designs, and operations; use and disseminate FHWA resilience resources; and continue to conduct research. "If we don't begin incorporating resilience into our infrastructure designs and decision-making, the future of our mobility, safety, and the economy may be at risk," said Golalipour.



Vulnerability Assessment and Adaptation Framework. Source: FHWA

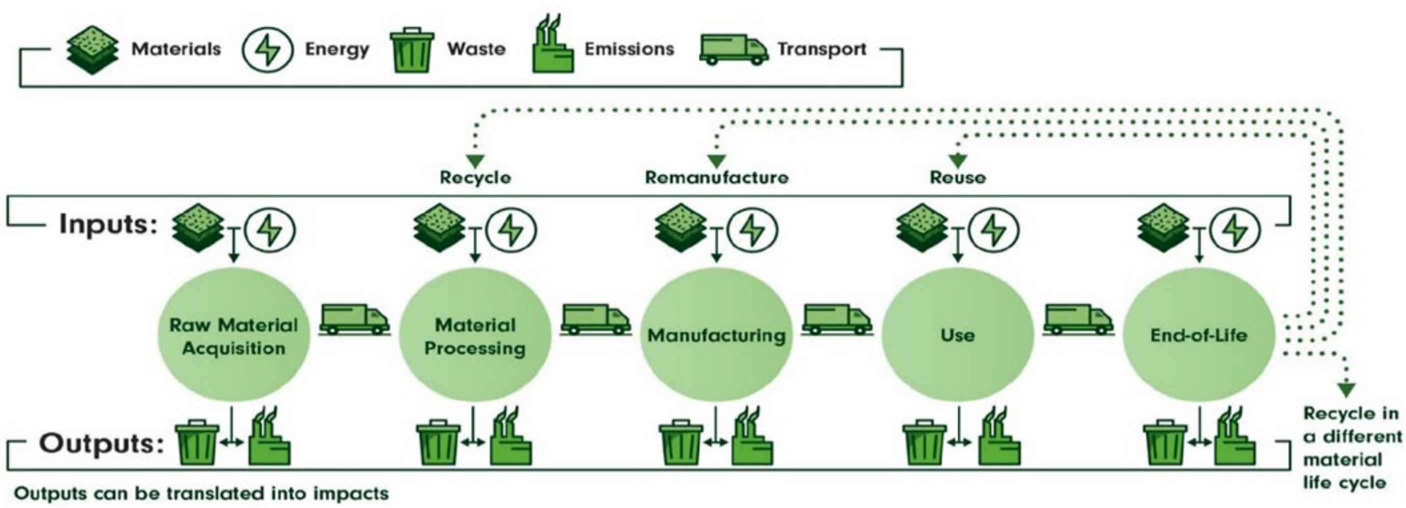
ASPHALT PAVEMENT INDICATORS	CONCRETE PAVEMENT INDICATORS
Rutting of asphalt surface	Blowups (*JPCP)
Low-temperature (transverse) cracking	Slab cracking
Block cracking	Punch-outs (*CRCP)
Raveling	Joint spalling
Fatigue cracking and potholes	Freeze-thaw durability
Rutting of subgrade and unbound base	Faulting, pumping, and corner breaks
Stripping	Slab warping
	Punch-outs (*CRCP)

New Tool Helps Measure Pavement Infrastructure's Embodied Carbon

Identifying effective measures to reduce greenhouse gas (GHG) emissions across industry sectors has become a priority in the 21st century. According to the U.S. Environmental Protection Agency, the transportation sector is cited as having the highest GHG emissions. Moreover, these estimates typically do not include emissions associated with pavement infrastructure throughout its life cycle, often referred to as embodied carbon. One way State departments of transportation (DOTs) can reduce embodied emissions is by controlling pavement design, material and construction specifications, and pavement management. To achieve savings, DOTs can first establish GHG emissions levels for baseline practices and "green" technologies using data-driven metrics and a scientific approach.

Life cycle assessment (LCA) is one method to quantify potential environmental impacts of products and processes through all stages of a pavement's life. Since its initial development in the 1990s, LCA has been implemented across industries and other Federal agencies to inform decisions. While not required under FHWA regulations, LCA is a reliable and scientifically sound method to measure environmental footprint, including GHG emissions.

"LCA is a unique lens through which to view emissions and environmental impacts," said FHWA Pavement Design and Performance Team Leader LaToya Johnson. "Typically, when someone hears emissions in a transportation context, they think of operational emissions through fossil fuel use. That's only one part of one phase of a road's life cycle. Embodied carbon represents the emissions associated with the raw material manufacturing all the way up to the roadway's end of life. Unlike vehicle operational GHG emissions, there is no chance to decrease these emissions with updates in efficiency after the infrastructure project is completed. Therefore, quantifying and reducing embodied emissions during the design and engineering phases of projects is an important step to reach net-zero emissions."



System inputs and outputs of pavement life cycle considered during LCA. Source: FHWA

A Solution

The FHWA Sustainable Pavements Program (SPP), with engagement from stakeholders, developed a spreadsheet-based LCA benchmarking tool known as LCA Pave. Using this tool, agencies can assess and quantify environmental impacts of their pavement material and design decisions on a project level. LCA Pave allows users to evaluate environmental impacts of pavement materials, structures and treatments, and mix designs. Users also can compare material sources and hauling alternatives; evaluate life-cycle strategies for maintenance, preservation, and rehabilitation; and compare pavement end-of-life strategies (recycling versus reuse versus landfill).

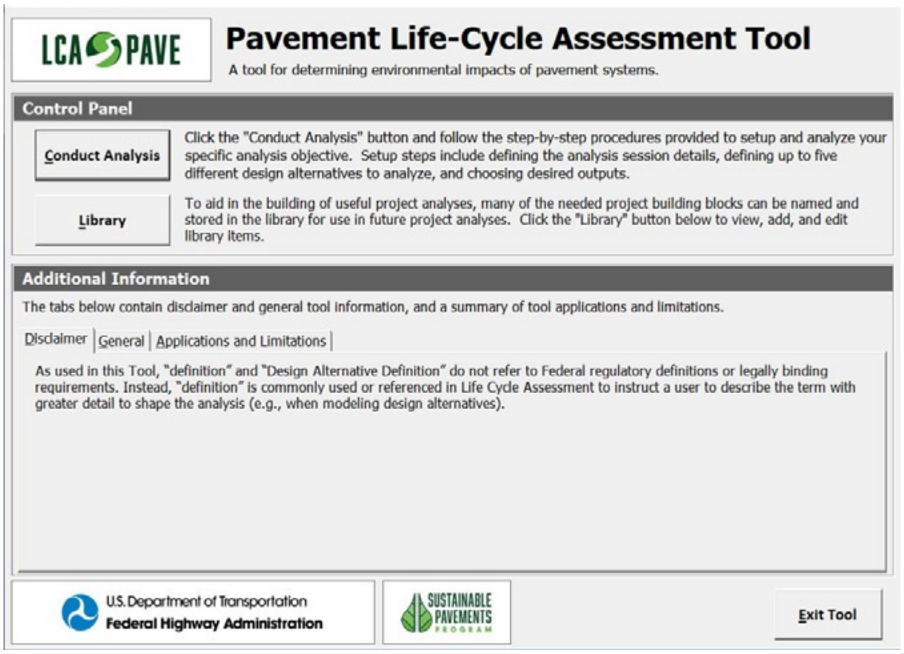
Embodied carbon represents the emissions associated with the pavement life cycle, including raw material manufacturing. Source: Lehigh Cement

LCA Pave uses publicly available data. Public background data sets are important for transparency and comparability, and can reduce the costs of conducting LCAs. Users can also add, store, update, and use data stored in the tool's library.

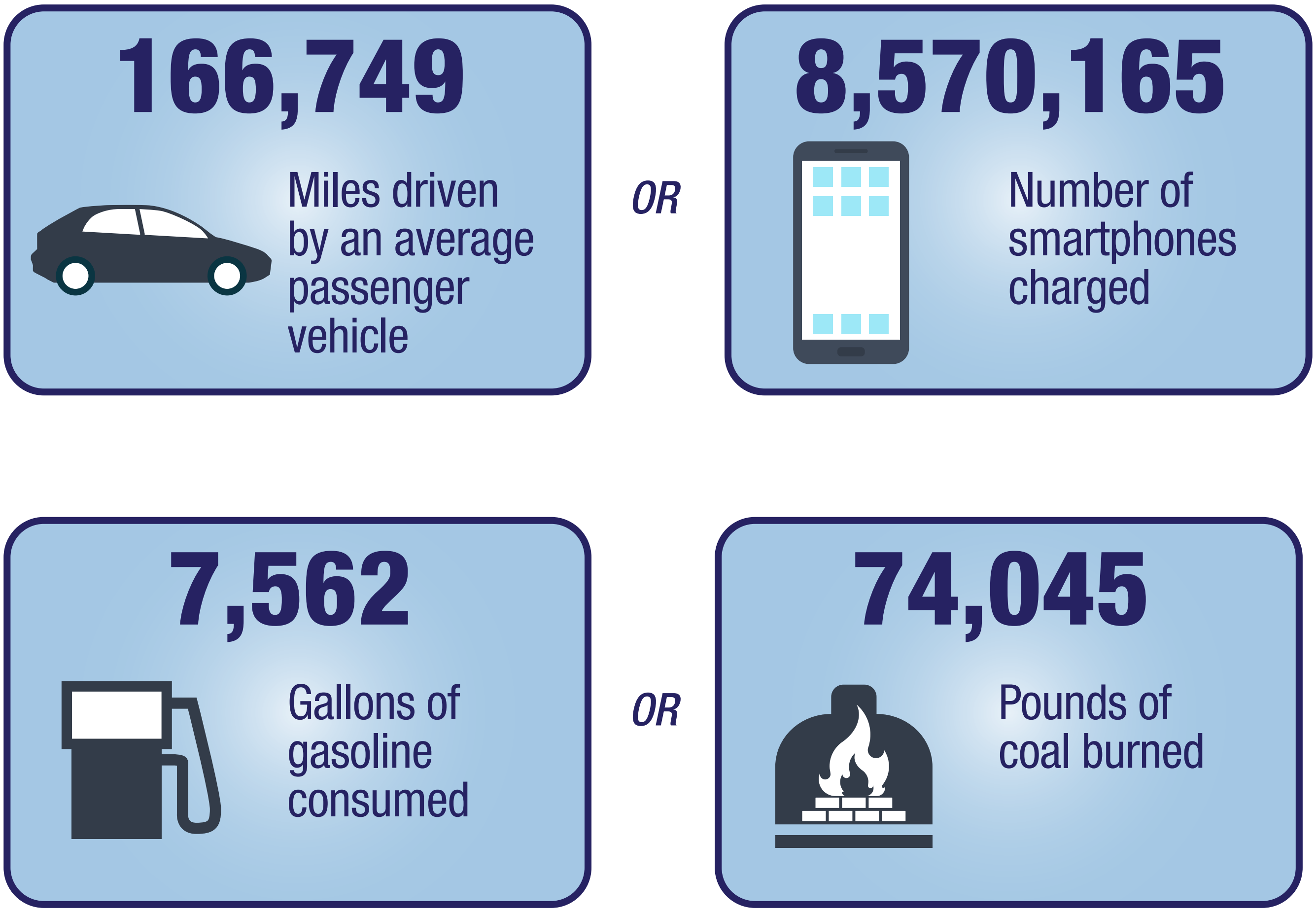
LCA Pave incorporates environmental product declarations for pavement materials and mix. LCA Pave is also one of the first tools designed specifically for use on pavement projects.

The Delaware and Minnesota DOTs helped evaluate the tool's effectiveness. "Other tools only allow for broad-based discussions," said Minnesota DOT Pavement Engineer Curt Turgeon. "LCA Pave gives us detailed environmental impact information we can consider throughout the project design process to optimize impact levels and compare options."

"The tool allows agencies to plan, design, construct, and maintain pavements by looking at the long-term impacts and benefits from an environmental perspective," said Delaware DOT Deputy Director of Operations and Support Jim Pappas. "Furthermore, various scenarios can be performed in the planning stages to maximize the benefits of the pavement selection."



This is an introductory screen of FHWA's LCA Pave Tool. Source: FHWA



Based on FHWA's 2020 study with Iowa DOT, this graphic represents the equivalent amount of greenhouse gas emissions saved on a lane mile of pavement when using a lower-cement content mixture on two shoulders. Source: FHWA

Life Cycle Assessment in Action

The FHWA Mobile Concrete Technology Center (MCTC) and SPP recently collaborated on a study to quantify environmental impacts for concrete paving projects and compare the achieved emission savings when business-as-usual mixtures are modified with reduced cement/cementitious content. The MCTC and the SPP worked with Iowa DOT to perform a LCA for concrete mixtures for two commonly used mixtures and another mixture with lower cement content.

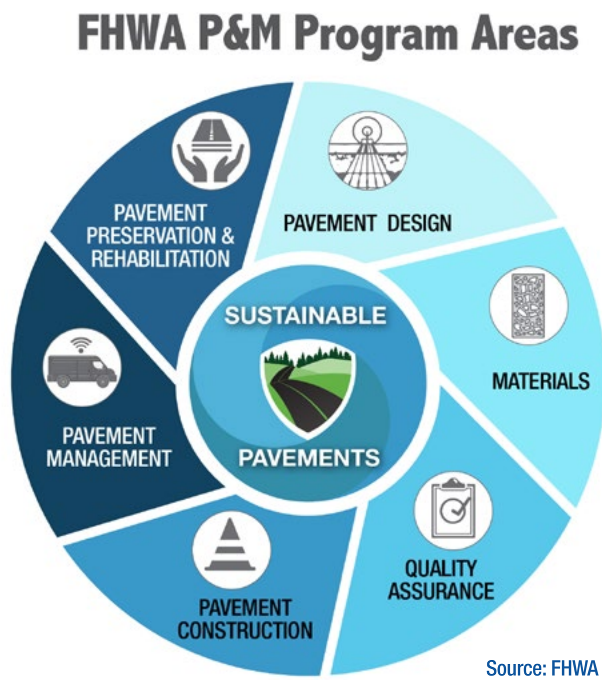
Initial results from the study showed that reducing cement content through optimizing mixture designs results in a lower environmental footprint. The savings relative to Iowa DOT's common mixtures ranged from 7 to 14 percent in all impacts. An estimated 12.4 tons per mile of CO2 emissions can be saved using optimized mixtures.

As the study continues, the team will analyze multiple MCTC projects and develop a procedure and inputs so LCA can be conducted and streamlined for every project. The team will also develop LCA Pave modules that align with MCTC needs to ease the process.

New Pavement and Material Program Areas

The FHWA's Pavement and Materials Program provides leadership and technologies for the delivery and management of safe, durable, cost-effective, and sustainable pavements. Recently, the Program updated its core areas to better reflect the stages of the pavement life cycle and align with current stakeholder needs and focus areas. The program now supports the following seven core areas:

1. **Pavement design focuses on designing pavements in a safe and sustainable way to meet current and future traffic.**
2. **Materials focuses on using materials in properly designed pavement mixtures to achieve cost-effective, durable, and sustainable roadways.**
3. **Quality assurance ensures the quality of materials produced for highway projects meets specifications and provides durable, long-life infrastructure.**
4. **Pavement construction focuses on technical guidance, assistance, research, and leveraging Federal funds to reduce project life cycle costs; enhance the use of sustainable products; mitigate risks; optimize operations; enhance safety of the work force; and other field construction performance factors.**
5. **Pavement management establishes data-driven strategy improvements for pavement management system models to fiscally plan infrastructure investments.**
6. **Pavement rehabilitation and preservation emphasizes extending pavement life, enhancing safety, resilience, improving functional performance, and contributing to increased user satisfaction.**
7. **Sustainable pavements balances economic, social, and environmental life cycle impacts in the design, construction, and maintenance of pavements.**



Source: FHWA

Within these program areas, technical experts from FHWA Headquarters, its Resource Center, the Turner-Fairbank Highway Research Center, Office of Federal Lands, and division offices work collaboratively to:

- Improve existing technologies.
- Develop practices and tools that improve pavement longevity, safety, and sustainability.
- Build strong research and deployment-focused relationships.
- Delivery technologies and tools to address stakeholder needs.

Technology Takes on New Role in Tech Deployment

Source: DepositPhotos.com

Sometimes getting the job done involves creativity and ingenuity—especially when facing travel restrictions.

Implementation visits are an important way the FHWA AID-PT staff supports State departments of transportation (DOTs). During these visits, States showcase best practices and lessons learned. Over the last year, a team led by Senior Asphalt Engineer Tim Aschenbrener conducted reclaimed asphalt pavement implementation virtual site visits in six States: Florida, Nebraska, New Jersey, South Carolina, Washington, and Wisconsin.

Cooperation among DOTs and FHWA division offices was key to making the virtual visits effective. “Our team had to be very clear with our plan—what we wanted to see and what we wanted to do,” said Aschenbrener. “Then we worked with the States to figure out a way to make it happen. States really stepped up. They did whatever was necessary to make the visits work—installing apps on phones, using cameras on computers, even wheeling computers around on carts to tour facilities. The FHWA teams used whichever video conferencing solution the States preferred to make the process as seamless as possible.”

During the Florida visit, the team conducted phone interviews, used video conferencing to demonstrate a vehicle simulator, and toured contractor plants across multiple parts of the State virtually. “During the first hour we were ‘visiting’ an asphalt plant in Jacksonville, and immediately following that tour, we jumped down to Miami virtually to tour another plant,” said Aschenbrener. “In reality the plants are more than 5 hours apart, so technology certainly had its advantages.”

During virtual site visits in Nebraska and South Carolina, contractors used a series of short, pre-recorded videos to conduct a tour of their plants and labs and narrated as the team watched the videos virtually.

Aschenbrener’s team had similar success providing implementation support for balanced mix design in California, Illinois, Louisiana, Maine, New Jersey, Texas, and Virginia.

To adapt the full-day schedules into a virtual setting, visits were condensed into multiple sessions over several days to avoid "video conference fatigue." In-person site visits typically concluded with a closeout meeting, but this was adapted and scheduled to occur 1 to 2 weeks after the virtual visit.

"By visiting sites virtually, we were able to get about 90 percent of the information we needed to obtain during an in-person visit," said Aschenbrener. "The number of locations and people our teams interacted with over the past year was only possible due to the virtual nature of the visits."

Another AID-PT group, led by FHWA Quality Assurance Program Manager Jeff Withee, operated virtually to conduct quality assurance (QA) stewardship reviews. An important adaptation Withee's team made to the QA stewardship review process was additional coordination with FHWA division offices involved in the reviews. This ensured States had support to follow up and take appropriate action when high-risk items were identified.

One element of the virtual visits the teams noted was diminished as compared to in-person visits was the presence of "side bar conversations."

Both teams agree—conducting closeout meetings virtually is beneficial. "Scheduling closeout meetings 1 to 2 weeks after the visit gives FHWA additional time to discuss findings and recommendations and gives the State DOT time to look over the material to prepare to discuss findings and recommendations and formulate questions," said Withee. "With the in-person visit format, this type of lead time isn't feasible. Meeting virtually also gives the State the opportunity to schedule appropriate staff for the closeout meeting, which allows for a more robust discussion."

Virtual kickoff and closeout meetings also allowed for additional participation from both FHWA and the State DOTs. DOT personnel who would not typically be able to travel to a stewardship review participated in the discussions. It allowed DOT central office personnel to call in and gain more insight into work conducted in the DOT regional offices.

"Overall, even though the in-person experience can't be fully replicated virtually, we are getting positive feedback from the division offices and State DOTs," said Withee. "We are still able to add value by helping agencies identify risks in their QA programs and leaving them with suggestions regarding where they can improve and help get the best return on investment for the taxpayer."

FHWA's implementation support for balanced mix design included a virtual tour of Texas DOT facilities. Source: FHWA

Mobile Pavement Technology Centers Add New Meaning to "Mobile"

The year 2020 presented unprecedented challenges to some FHWA programs. Mobile Pavement Technology Center (MPTC) staff, who previously relied on face-to-face visits to deliver new pavement technologies to departments of transportation (DOTs), local agencies, and industry, had to think creatively. Faced with travel restrictions, MPTC teams developed solutions to ensure continued program success.

In past years, the Mobile Asphalt Technology Center (MATC) and the Mobile Concrete Technology Center (MCTC) spent 2 to 3 weeks at five or six agency projects a year. On site, time is devoted to demonstrating test methods and equipment, performing laboratory tests of field-produced mixtures, providing in-person support and equipment training, and reviewing specifications. In addition to on-site testing, other activities include a kickoff meeting, open house, and tour of the center.

"When we first faced travel restrictions, there was a high degree of uncertainty; but now looking back, I think there are pieces of our virtual strategy that will be big, positive additions to the program," said FHWA Senior Concrete Engineer Mike Praul. "It forced us to come up with a lot of creative ideas. We missed the face-to-face contact, but considering the circumstances, I could not be more pleased with what our teams achieved."

Mobile Pavement Technology Center Activities in 2020

- **Conducted live training.**
- **Produced how-to videos.**
- **Hosted virtual conference tours.**
- **Loaned equipment.**
- **Provided technical assistance/ data analysis.**
- **Reviewed specifications.**
- **Produced technical publications.**

Building New Skillsets

The teams adapted by adding video capability. They purchased, installed, and learned how to operate cameras to broadcast trainings, walkthroughs, and live question and answer sessions.

"When I was studying civil engineering 35 years ago, I never thought the thing I'd be worried about the most would be getting the right camera angle," said Praul.

In spring 2020, the MCTC conducted a pilot session internally with FHWA's Federal Lands Highway Division staff. This proved that virtual support was feasible, but the staff would need to learn lighting techniques, camera angles, and how to capture hands-on demonstrations in a way that allows virtual participants to easily see what is happening. The challenge was quickly overcome.

Virtual Site Visits

The MATC conducted virtual site visits and ensured participants received the same level of attention as they would during on-site visits. The MATC team conducted demonstrations including balanced mix design testing and how to pour and saw specimens. In addition to demonstrating laboratory equipment, the MATC team also demonstrated field equipment virtually. States even shipped asphalt mixes from projects to the MATC team so they could perform asphalt testing and simulate as much of the on-site process as possible.

Agencies received web-based closeout presentations to talk through the results virtually. The MATC conducted virtual visits with Florida, Rhode Island, Maine, Vermont, North Dakota, Montana, and California and provided virtual follow-up support to South Carolina and Vermont.

Unlike asphalt mixes, shipping fresh concrete to the MCTC for testing was not viable. Instead, the team created virtual training sessions called "Live from the MCTC." These virtual events allowed agencies, contractors, and consulting firms to get more information via a customized virtual experience. MCTC staff explained the benefits of the tests and how to conduct and implement them into a program.

Equipment Loan Program

One program that continued with little impact was the MPTC equipment loan program, which includes both [asphalt]() and [concrete]() equipment. Loans range from weeks to months. Agencies and contractors can borrow equipment, free of charge, to evaluate and determine if it meets their needs before making a purchase. Rather than receive in-person training, States were trained virtually.

South Carolina DOT (SCDOT) borrowed a dielectric profiling system (DPS) and received several 2- to 3-hour virtual training sessions to learn how to assemble, set up, use, calibrate, and collect data using the unit.

"We appreciate the use of this machine to make future decisions about how we plan to possibly implement the DPS into our paving operations," said SCDOT Asphalt Materials Manager Cliff Selkinghaus. "The virtual sessions were interactive and informative."

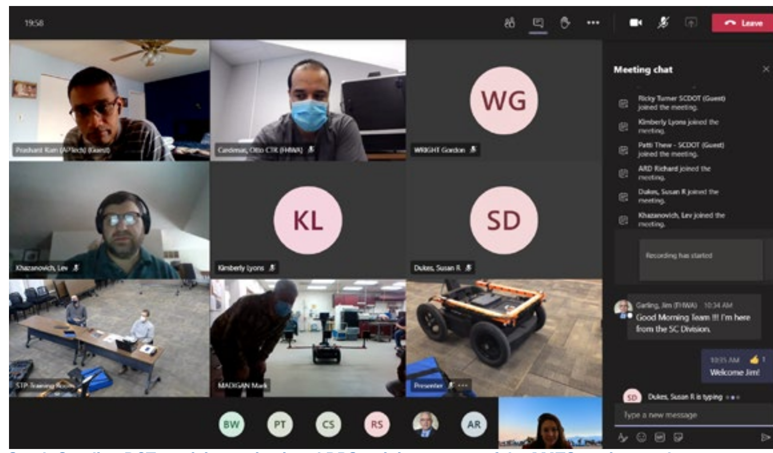
Virtual Technician Training

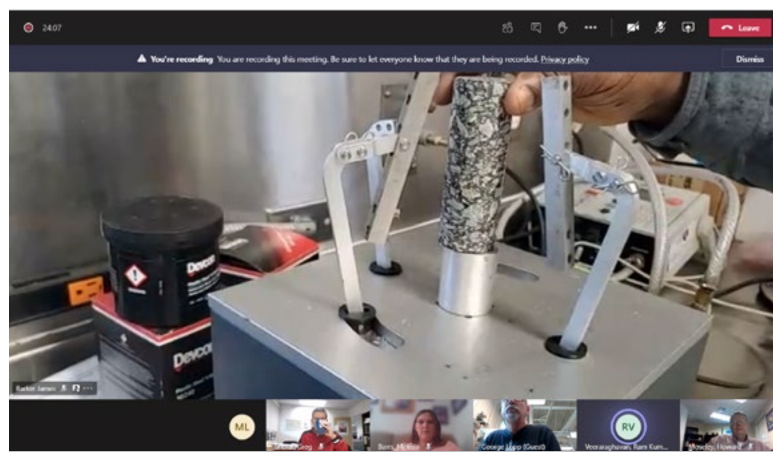
Early on, the teams identified a virtual need they were uniquely positioned to meet. Most existing online videos on pavement and materials testing are aimed at the engineering audience rather than technicians. High-quality how-to videos on conducting and using tests and technologies the MPTC teams demonstrate were not available.

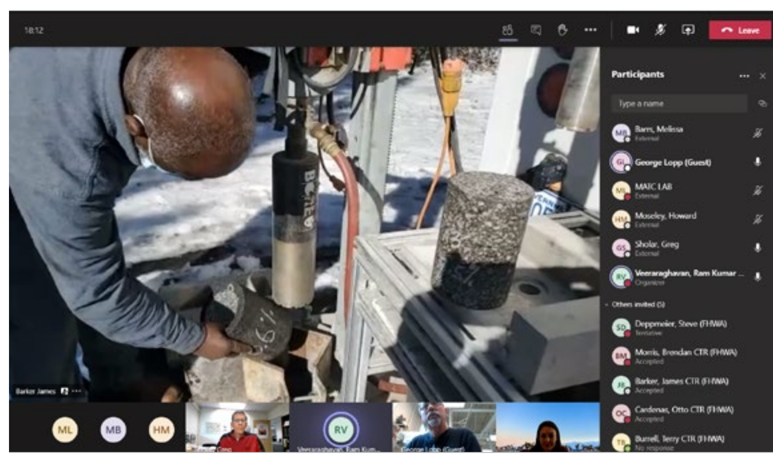
To address this need, the MPTC teams are producing a series of YouTube training videos aimed at the technician level. The 5- to 10-minute videos include training for technologies and techniques such as the [Super Air Meter](), [Calorimeter](), and more. Online, technician-focused videos allow the teams to reach a broad audience, including many groups they may not ordinarily contact.

"We have top-level technicians with expertise we can effectively leverage to develop a set of test demonstration videos," said Praul. "This will continue to serve a purpose once the teams are back to conducting in-person visits."

FHWA MATC has five DPS units available through its equipment loan program. Source: FHWA

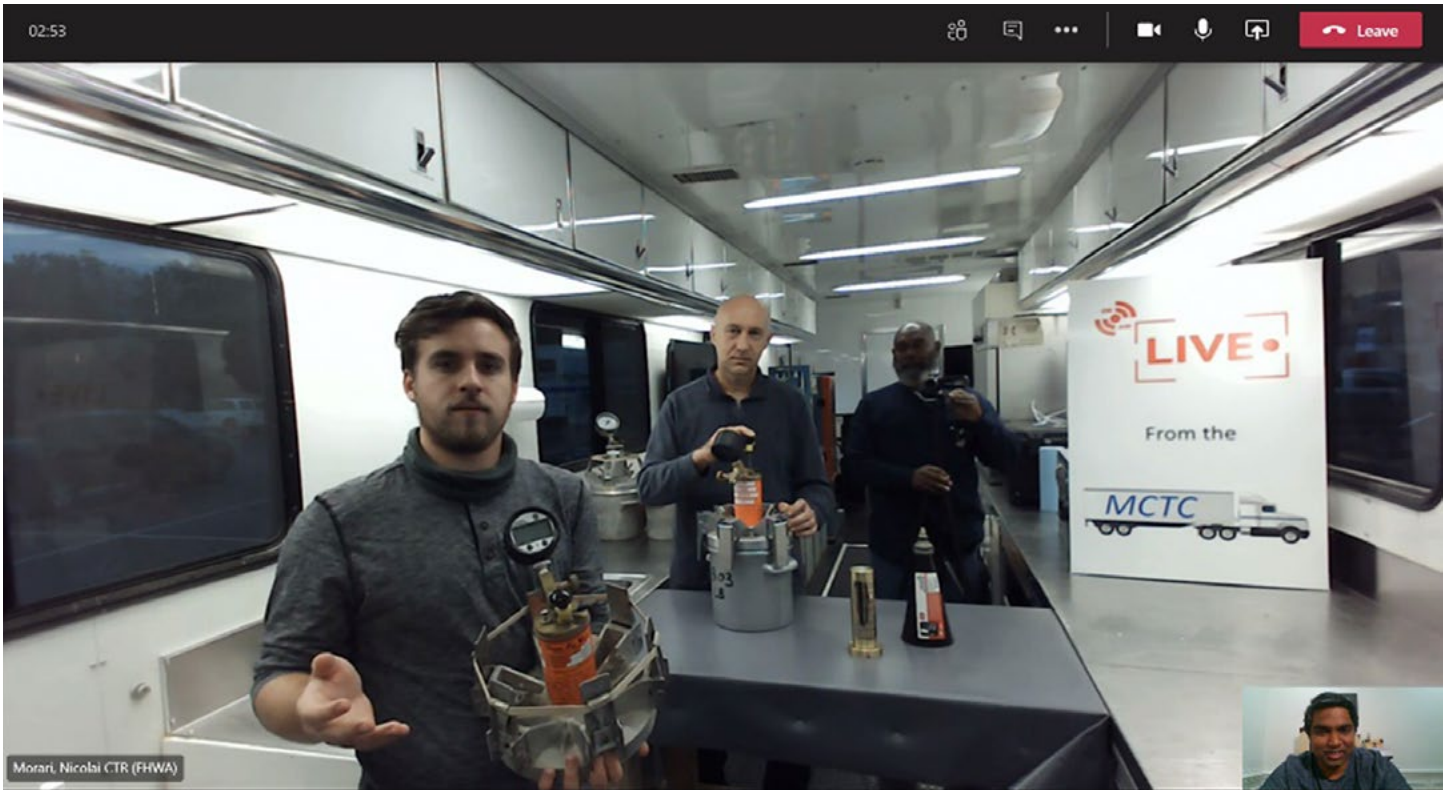

South Carolina DOT participates in virtual DPS training as part of the MATC equipment loan program.


Florida DOT participates in specimen fabrication training during an MATC virtual site visit.


Florida DOT participates in specimen fabrication training during an MATC virtual site visit.

Virtual Conference Tours

In 2020, rather than set up in a convention center parking lot for conference and open house appearances, the trailers were staged in the Turner-Fairbank Highway Research Center parking lot. Standing next to the trailers and tables of equipment, the teams gave program overviews and discussed various technologies with virtual audiences joining from around the country.



The MCTC team demonstrates equipment during a "Live From the MCTC" session. Source: FHWA

Looking Ahead

The MPTC teams believe blending their new virtual tools into the proven on-site visit model will be a natural progression, particularly in larger States where visiting an on-site center may not be possible for everyone within that State.

"Looking ahead, we would like to have daily check-ins, where each day at a designated time, interested stakeholders can peek into the laboratory," said FHWA Senior Asphalt Pavement Engineer Leslie Myers McCarthy. "During this time, we will turn on the cameras and any State stakeholder—DOTs, contractors, local agencies, universities, or consultants—can tune in to see the tests or activities going on."

The team is also considering options for viewing field tests on-demand.

"I think of it as an opportunity to reach new stakeholders," said Myers McCarthy. "We couldn't reach many stakeholders in the past, whether due to travel, availability, or time. A daily virtual outreach opportunity while we are on-site really expands our reach to a new group that traditionally may not be visiting our lab."

AID-PT *SHORT TAKE*

Stakeholders Offer Input on Pavement Foundation Research

The FHWA held a virtual peer exchange in June to obtain input and perspectives from pavement and geotechnical engineers nationwide regarding pavement foundation policies, practices, and experiences. The meeting was also an opportunity to assess the extent to which specific foundation failure modes are recognized as problems and devise a plan for future outreach to support FHWA pavement foundation research. Fourteen States, two pavement industry groups, four universities, and three consulting firms participated.

Stable, uniform, durable, and drainable foundations are critical to long-term pavement performance. Foundation design is important, but its benefits may not show up in pavement mechanistic-empirical design analysis. This is because the procedure is response-based—it uses calculation of stresses, strains, and deflections at key locations throughout the pavement system. Thus, pavement design analysis is determined governed by the stiffness of the pavement surface layers.

The FHWA has identified two key issues related to pavement foundations—foundation uniformity and performance over time. Uniformity involves ensuring what is assumed in pavement design is achieved during construction. Intelligent compaction technology is one useful tool for this purpose. Performance over time is a more difficult issue to address. The most important function of a pavement is to retain its integrity throughout its life. However, due to the presence of water and the migration or erosion of fines, the condition of the foundation layers can change. Under the influence of repeated heavy loads, the layers can de-compact or become deformed, resulting in weaker and non-uniform support conditions and deterioration of the pavement surface layers. Justifying the need for specific design features is difficult since the benefits cannot be quantified in design analysis. It is preferred that pavement foundations be designed as permanent structures.

Several State departments of transportation (DOTs) shared pavement foundation practices and experiences during the peer exchange, including the following:

- Minnesota DOT presented opportunities to eliminate unsafe field testing, move toward a performance-based approach for foundation design, and improve long-term foundation and pavement performance.
- Missouri DOT (MoDOT) presented information about the rock fill base used in the southern part of the State. It consists of large aggregates that are daylighted to the slopes, capped with finer aggregate, and placed to a depth of 18 to 24 inches. MoDOT said the base is easily constructed, provides additional structure, and has low maintenance requirements. In the northern part of the State, a conventional crushed stone base is used.
- Oregon DOT indicated that most subgrade failures occur in urban pavement sections, where thin bases, poor draining, and/or significant traffic increases are factors. The agency has observed that a solid, uniform, and well-drained base significantly helps the service life of concrete pavements.
- Texas DOT experienced distresses in rigid pavements caused by deficient foundations, not deficient slab thickness. Agency resources to aid foundation design include State maps that show expansive soil and sulfate concentration locations, guidelines for soils and base materials in pavement structures and flexible base selection, and nondestructive testing tools.
- Georgia DOT (GDOT) presented its base types and subgrade treatments and the guidelines for their usage. GDOT mostly uses graded aggregate base because it is readily available. In the southern part of the State and along the coast, GDOT uses other base types including Florida lime rock, soil cement, and asphalt concrete.

Overall, the virtual peer exchange format allowed for sharing information between stakeholders with a goal of improving pavement foundations and enhancing the service life of pavement structures. As a follow-up, FHWA plans to host a stakeholder workshop to discuss what can be done to improve foundation design practices.

Creating a Top-Notch Pavement Network with TOPS

FHWA's Every Day Counts (EDC) targeted overlay pavement solutions (TOPS) initiative kicked off in January 2021 and has earned a strong following. Twenty-eight States chose to participate in the EDC effort, with 26 interested in learning more about asphalt overlays, 15 focused on concrete, and 13 participating in both.

TOPS features new and improved overlays for both asphalt and concrete pavements that enable agencies to provide long-life performance under a wide range of traffic, environmental, and existing pavement conditions. Overlays are widely used, but not always targeted to high-priority or high-maintenance locations such as primary or interstate pavements, intersections, bus lanes, ramps, and curves where the standard fix is not performing well.

TOPS

Targeted Overlay Pavement Solutions

Why TOPS?

More than 30 percent of urban roads and 14 percent of rural roads are in poor condition according to the U.S. Department of Transportation's 2015 Conditions & Performance Report. The report estimates that America needs $836 billion to fix highways and bridges. By enhancing overlay performance in priority locations, State and local highway agencies can help ensure safer, longer-lasting roadways.

Targeted overlays can extend pavement life 15 to 50 years depending on the materials used. They also increase load-carrying capacity and improve safety, mobility, and user satisfaction in a cost-effective and sustainable manner.

Asphalt overlay

Source: National Asphalt Pavement Association

Concrete overlay

Source: American Concrete Pavement Association

Innovations in Overlays

The TOPS team is promoting eight asphalt overlays and four types of concrete overlays that can offer many benefits to stakeholders. These overlays may reduce maintenance, maximize previous investments, and reduce user delays (fewer work zones) due to extended service life of pavement structures. In addition, some TOPS products may increase skid resistance, improve resiliency in flood-prone areas, reduce splash and spray, and reduce noise.

OVERLAY INNOVATIONS ADVANCED BY TOPS

Asphalt

- Asphalt rubber gap-graded
- Crack attenuating mix
- Enhanced friction overlay
- Highly modified asphalt
- High-performance thin overlay
- Open-graded friction course
- Stone matrix asphalt
- Ultra-thin bonded wearing course

Concrete

Concrete on Asphalt

- Bonded on Asphalt
- Unbonded on Asphalt

Concrete on Concrete

- Bonded on Concrete
- Unbonded on Concrete

Success Stories

The New Jersey Department of Transportation (DOT) uses binder-rich intermediate course*, which is similar to crack attenuating mix, as well as highly modified asphalt and stone matrix asphalt. The agency's efforts in the past decade have paid off.

"Targeted overlay pavement solutions have made a significant difference in New Jersey's asphalt pavements," said Robert Blight, New Jersey DOT Pavement Design and Technology Unit supervising engineer. "We've increased our good pavements by nearly 30 percent. Our goal is to create a balanced, cost-effective approach of preservation, resurfacing, rehabilitation, and reconstruction that best optimizes allocated funding to create the best possible roadway network condition."

The Colorado DOT has approximately 1,000 lane-miles of concrete overlays on existing asphalt pavements. The concrete overlay can be either a bonded system that acts with the underlying asphalt or an unbonded system that is paved on top of the existing asphalt to carry ever-increasing volumes of traffic.

"We've had great success with concrete overlays in Colorado for more than two decades," said Angela James Folkestad, American Concrete Pavement Association Colorado/Wyoming Chapter executive director. "They are faster and far more economical to deploy than reconstruction. The reduced frequency and duration of work zones means safer roadways for both workers and users."

**Course is the terminology used to denote the material of the pavement layer.*

Crews pave a concrete overlay of an existing asphalt-surfaced pavement on C-470 in Colorado. Source: ARA, Inc.

EDC-6 TOPS Resources

The TOPS team continues to develop case studies, how-to documents, webinars, workshops and more. Resources are posted on the FHWA Office of Preconstruction, Construction and Pavements TOPS web page. EDC-6 continues through 2022.

Asphalt overlay mixtures have advanced significantly with the use of stone matrix asphalt, polymer-modified asphalt, and other materials and agents that reduce rutting, increase cracking resistance, and extend pavement life.
Source: ARA, Inc.

WHAT IS EDC?

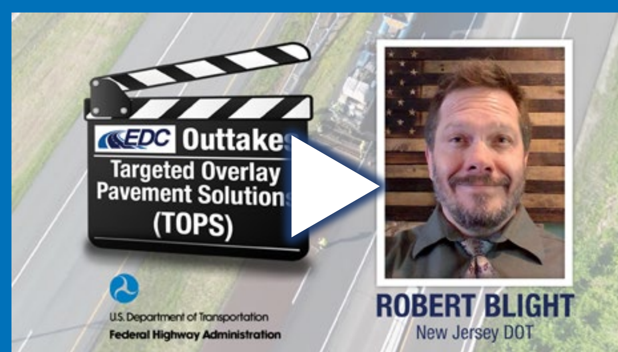
Since 2009, FHWA's EDC program has identified and deployed many proven but underused transportation innovations to make our transportation system adaptable, sustainable, equitable and safer for all. Proven innovations promoted through EDC facilitate greater efficiency at the State, Local and Tribal levels, saving time, money and resources to ensure our infrastructure is built better, faster, and smarter.

FHWA works with State transportation departments, local governments, tribes, private industry and other stakeholders to identify a new collection of innovations to champion every two years that merit accelerated deployment.

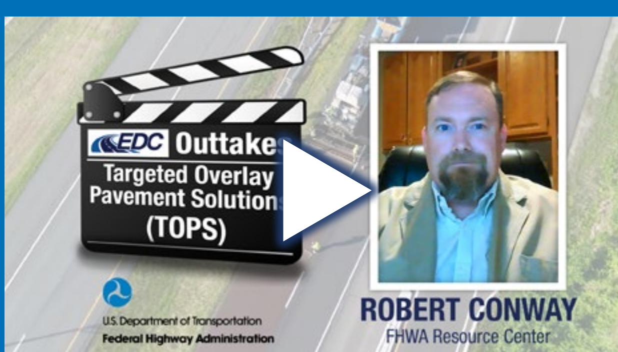
Throughout the deployment cycle, specifications, noteworthy practices, lessons learned, and relevant data are shared through case studies, webinars, and demonstration projects. The result facilitates rapid technology transfer and accelerated deployment of innovation across the Nation.

Hear more about EDC-6 targeted overlay pavement solutions in these short video sound bites:

Asphalt



Concrete



Eight Tasks toward Implementing Balanced Mix Design

Highway agencies are continuously striving to improve asphalt pavement performance by considering new ways to address durability issues, rutting, and cracking. Some are now integrating balanced mix design (BMD) into their asphalt pavement programs to address the shortcomings of common design and construction methods based solely on volumetric properties.

BMD uses performance tests on appropriately conditioned specimens to address multiple modes of distresses, taking into consideration mixture aging, traffic, climate, and location within the pavement structure. It may offer benefits such as improved rutting and cracking resistance and a better way to assess mixture quality. BMD also opens the door to using new, innovative, and more sustainable materials.

While BMD is not a new concept, specifications for its use were developed only recently. Draft specifications were developed in 2018 under the National Cooperative Highway Research Program's Project 20-07/Task 406: Development of a Framework for Balanced Mixture Design. These were published in 2020 as provisional American Association of State Highway and Transportation Officials (AASHTO) PP 105-20, Standard Practice for Balanced Design of Asphalt Mixtures, and AASHTO MP 46-20, Standard Specification for Balanced Mix Design. These are voluntary specifications; their use is not required by Federal statute or regulation.

Potential Balanced Mix Design Benefits:

- Improves mixture quality.
- Increases cost-effectiveness.
- Meets specifications with performance tests.
- Improves overall pavement network.
- Incorporates recycled materials.
- Creates long-life asphalt pavements.

In 2020, FHWA held virtual site visits and conducted interviews with State departments of transportation (DOTs) in California, Illinois, Louisiana, Maine, New Jersey, Texas, and Virginia, as well as some of their suppliers and contractors. The virtual site visits also included video tours of many of the laboratories.

"These States have valuable experiences and lessons learned that can help other States incorporate BMD into their asphalt pavement programs," said FHWA Senior Asphalt Engineer Tim Aschenbrener. "We learned that there are many different approaches to implementing BMD, so we looked for commonalities among their practices."

Hamburg Wheel Tracking Device (HWTD) photo from the Illinois DOT virtual visit. Source: FHWA

Each FHWA division office and State DOT received a case study report outlining the observations and the practices identified following each virtual site visit. Key findings from the visits were also summarized into the following eight BMD implementation steps:

1. **Understand the "why" and benefits of BMD.**

   Stakeholders should understand why a new approach to asphalt mixture design and acceptance is recommended and the potential benefits. This may help secure management support and commitment from both the DOT and industry to invest in developing a BMD program.

2. **Plan.**

   Strategic planning is an important step to creating a new program. Internal State agency offices such as materials, pavement design, construction, and pavement management can work together and maintain constant communication. Some States form task forces with stakeholders from within the agency, industry, and academia. Also, as part of the planning phase, States could identify issues with current asphalt mixtures and pavement performance and assess how BMD may be able to resolve them. Setting goals and a timeline for implementing the various BMD tasks is part of this step.

3. **Select performance tests.**

   Several key factors can be used by States in selecting a performance test, including their experience with a test and where they are in their implementation process. States can conduct specific studies to establish new performance tests or modify existing ones. Generally, the first step is a review and assessment of the validity and applicability of past studies on relating test results to field pavement performance. Some States conduct additional field validation of performance tests to build confidence in the results and the tests' ability to relate to field pavement performance under State-specific conditions.

4. **Conduct performance testing.**

   This task includes acquiring test equipment, managing resources, and providing training. State DOTs and contractors need equipment to conduct the selected performance tests, including equipment for sample preparation, aging/conditioning, and fabrication. This involves purchasing new equipment or modifying existing equipment, depending on the selected performance tests. Some equipment, such as the jig set for fatigue testing in the asphalt mixture performance tester, can be borrowed from the Mobile Asphalt Technology Center (MATC) through FHWA's equipment loan program.

5. **Establish baseline data.**

   Baseline data is useful in developing performance test criteria for specifications. The baseline data helps support the test criteria initially established during performance test field validation. Some States base test criteria on whether the material tested is from the asphalt mixture design and/or acceptance. Efforts to establish baseline data include the following:

   - Leveraging previous experiences with performance testing of asphalt mixtures.
   - Benchmarking existing asphalt mixture designs using the selected performance tests.
   - Conducting test projects using contractors around the State over a 3-year period.
   - Conducting shadow projects by identifying an existing project that is using conventional acceptance tests and obtaining additional samples during the project for performance testing.

BMD Implementation (cont.)

6. **Develop specifications.**

   Criteria are established for the performance tests using field validation experiments, variability studies, and baseline data. States develop preliminary acceptance criteria to use in the development of specifications prior to constructing pilot projects. Asphalt mixture acceptance examples include:

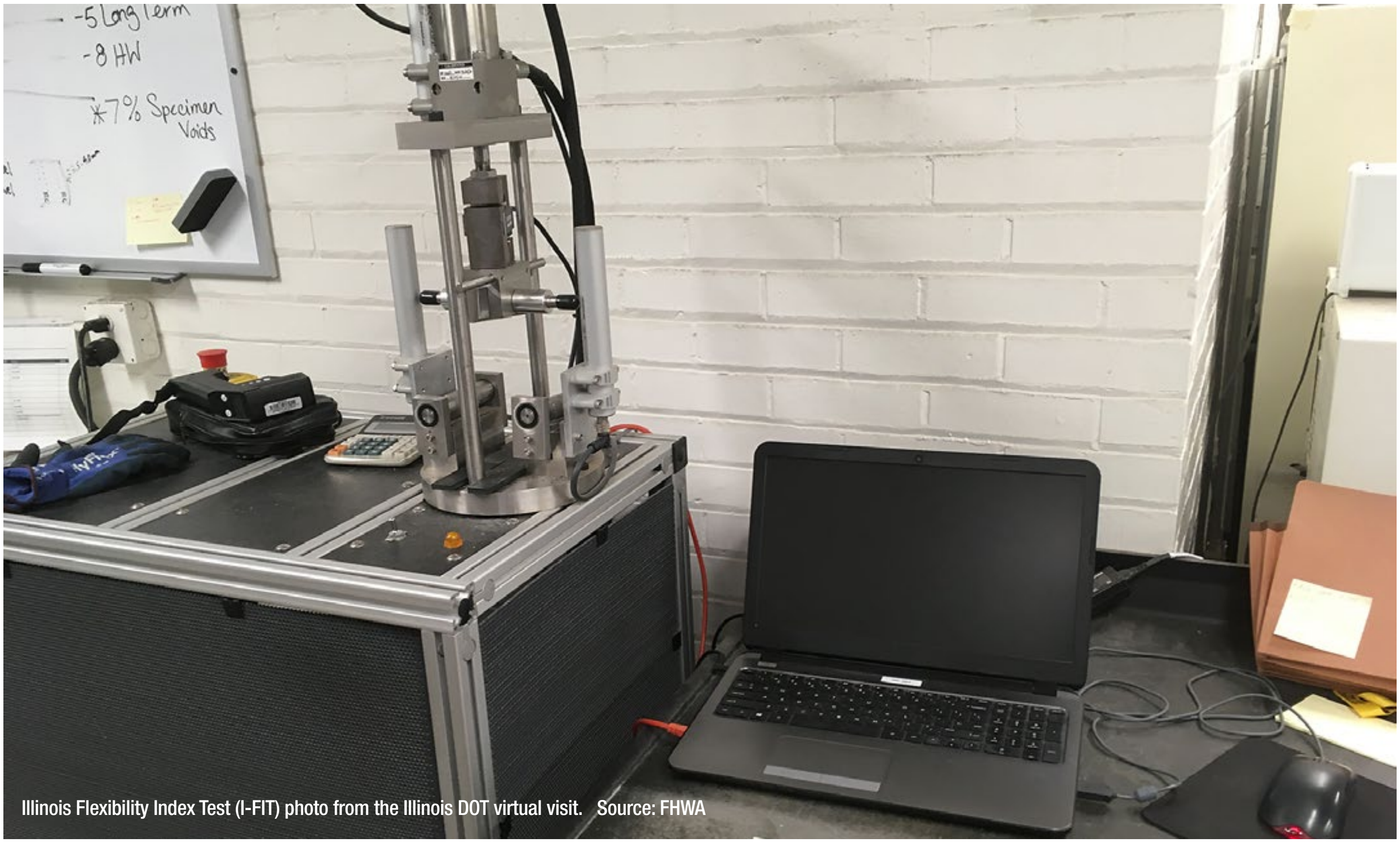
   - Volumetric properties.
   - Surrogate performance tests correlated to asphalt mixture design approval tests.
   - Actual performance tests used during mixture design.
   - Performance tests with pay adjustment factors.

7. **Train and certify.**

   Technicians may need training on test procedures and analysis of results, especially during pilot projects and before initial implementation. Many DOTs use formalized training and certification programs. In addition, many have conducted workshops, provided instructions, developed instructional videos, and offered one-on-one support and training upon request.

8. **Implement.**

   Communicating changes and new State requirements to both industry and agency personnel through meetings and workshops increases the likelihood of success. Project selection scope should be developed before BMD implementation. Scope examples include the project investment level, the rehabilitation type, the project highway functional classification and traffic level, the project length and asphalt tonnage, and the pavement layer applicable to the performance specification.



Illinois Flexibility Index Test (I-FIT) photo from the Illinois DOT virtual visit. Source: FHWA

Key Takeaways

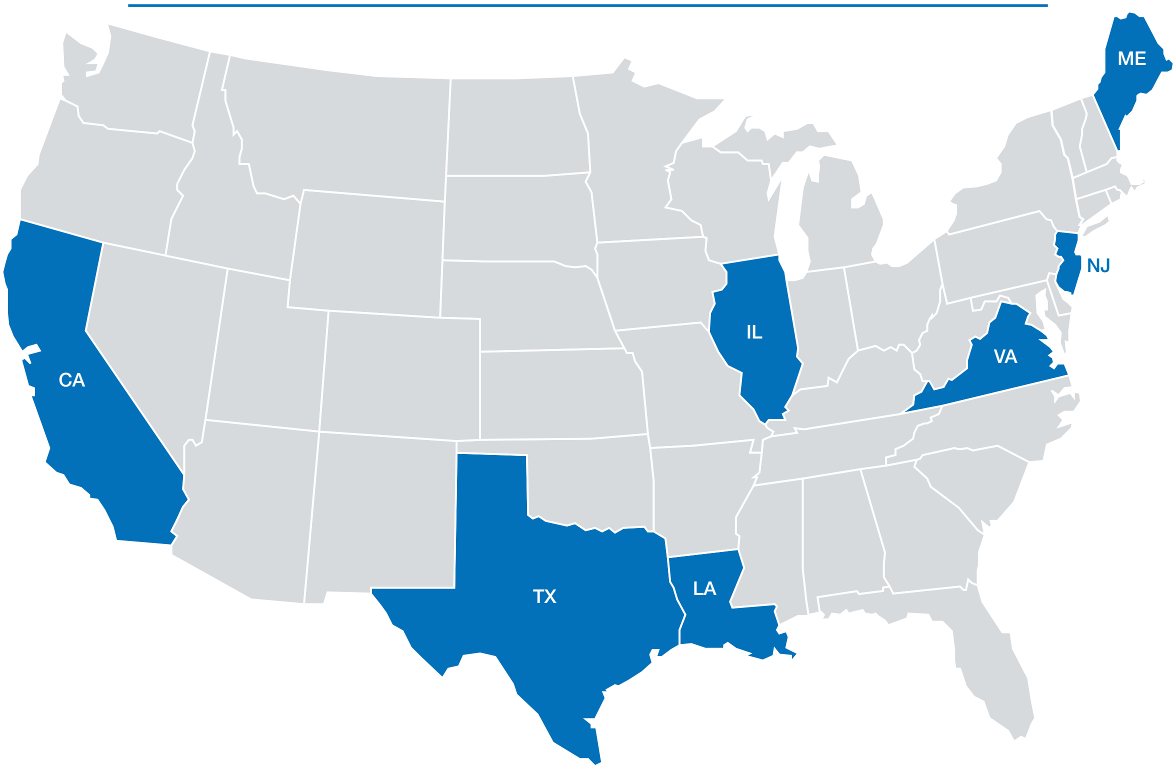
The virtual site visits identified several important points:

- Collaboration between State DOTs, industry, and academia helps with BMD implementation. This involves continuous dialogue with industry, knowledge transfer, and education and training.
- Test procedures that support efficient implementation and analysis methodologies can improve test repeatability.
- Evaluating the sensitivity of material properties on performance tests allows for development of a large performance test results database.
- Inter-laboratory studies can help build trust and comfort with the performance tests and identify single and multiple operator variability.
- Performance tests coupled with or followed by changes to the volumetric design criteria of asphalt mixtures can guide contractors in their effort to meet performance test criteria.
- A certification program for testing and evaluating asphalt mixtures that is supported by both the DOT and industry can facilitate the training of technicians on performance tests.
- Incremental implementation of Statewide shadow and pilot projects over several years can help contractors gain experience and become familiar and comfortable with the process.

In May 2021, FHWA piloted a customized virtual workshop to Georgia DOT and their stakeholders to walk through BMD implementation and highlight case studies. Additional workshops are underway, led by the FHWA Resource Center and the University of Nevada Reno with support from the FHWA Office of Infrastructure and FHWA division offices.

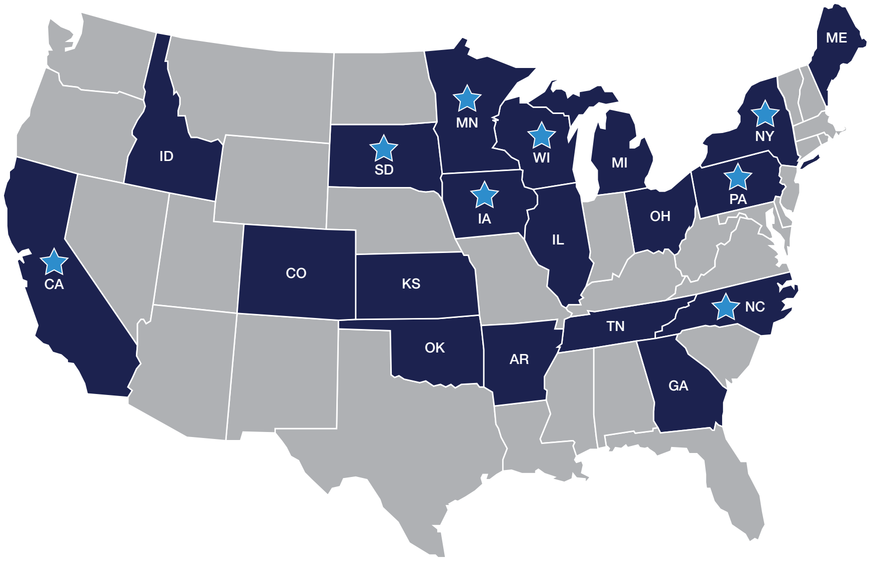
"Because different DOTs have different resources and are at different tasks in their implementation process, the tailored workshops will allow agencies to identify practices from the seven DOT case studies that they can adopt to suit their own situations," said Aschenbrener.

Balance Mix Design Virtual Site Tours



Durable Concrete Pavements, *Every Time*

The Performance Engineered Mixtures (PEM) program, a collaborative effort of FHWA, 19 State departments of transportation (DOTs), the concrete industry, and Iowa State University, is making advances in concrete specifications and PEM deployment.



PEM is based on the concept of measuring and controlling concrete mixtures around engineering properties that relate to performance. Constructing pavements with long service life can be difficult to do using typical tests for specification and acceptance that focus on slump, air content, and compressive strength. These three criteria are loosely related to deterioration, so they do not always ensure satisfactory field performance.

Performance-engineered concrete mixtures include optimized mixture designs (materials selection, gradation, cement content, etc.) and, when paired with advanced quality assurance methods, are more durable, economical, and sustainable.

A New AASHTO PEM Standard

In late 2015, FHWA, 10 highway agencies, and industry worked together to develop a new specification for concrete paving mixtures to establish performance requirements and produce more durable mixtures. This effort created American Association of State Highway and Transportation Officials (AASHTO) guide specification PP 84, Standard Practice for Developing Performance Engineered Concrete Pavement Mixtures, a voluntary specification released in 2017.

"AASHTO PP 84 involves testing for the things that matter like strength, shrinkage, freeze-thaw resistance, permeability, aggregate stability, and workability," said FHWA Senior Concrete Engineer Mike Praul. "It allows DOTs to take what they like from the document and make it their own while not giving up what they already know is important to them."

Pooled Fund Study

> *"Documented results from projects in the PEM implementation incentive study are coming in and the findings are positive," said FHWA Senior Concrete Engineer Mike Praul.*

Also in 2017, the PEM program created a pooled fund study to provide technical assistance and training, to help agencies adjust their specification based on field performance, and continue the developmental work of measuring and relating early-age concrete properties to pavement performance. Nine States submitted applications and received up to $100,000 to try PEM tests and principles. The three primary tests evaluated were the Box Test (measurement of workability), Super Air Meter or SAM (measurement of air void characteristics of concrete), and surface resistivity (rapid measurement to indicate permeability).

In addition to the pooled fund study, FHWA sponsored an implementation incentive program encouraging participants to pilot and shadow new test procedures in the mix design stage, evaluate acceptance testing during construction, develop an enhanced quality control plan, and use control charts during concrete production.

New York

When the pooled fund study began, the New York State DOT (NYSDOT) had already constructed part of a project using its traditional Class C concrete mixture. Partway through the job, the agency switched to PEM. The contractor reported that PEM looked and placed better. The supplier said he was happy to discover the PEM quality control requirements did not involve much more work than traditional mixes. NYSDOT conducted a surface resistivity test, a measure of the transport properties of the concrete and thus a factor impacting durability. After 84 days, the Class C mixture leveled off, but the PEM surface resistivity continued to improve.

NYSDOT identified several needs during the pilot project, including that staff wanted more training on PEM tests and a better understanding of roles and responsibilities in meeting the performance specification and in quality control monitoring. The agency is constructing another project using PEM concepts without Federal incentive funds.

North Carolina

The North Carolina DOT (NCDOT) received $80,000 from the pooled fund study. NCDOT plans to incorporate PEM tests in the mix design/approval process and the acceptance process and require the use of control charts. The contractor reported the Box Test was highly useful in mix development and evaluation, and NCDOT said it was easy to use. The agency may add the Box Test to its specification.

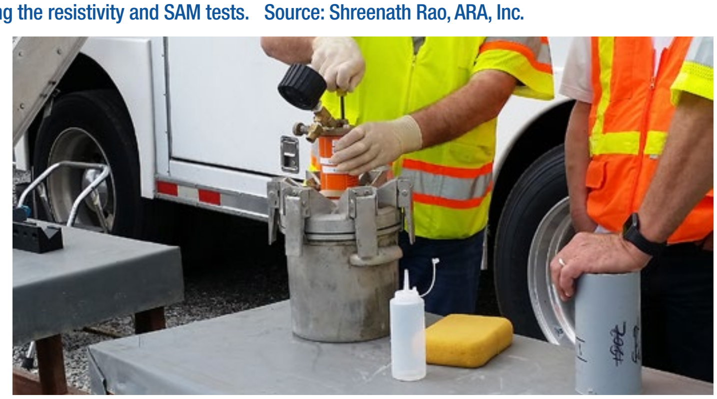
Regarding the SAM, the contractor easily incorporated it into quality control after receiving training. NCDOT plans to perform more shadow testing and then consider SAM for future use. Both the contractor and NCDOT said the surface resistivity test was easy. "North Carolina was impressed with the surface resistivity testing, and is now equipping all their State labs," said Praul. "They're also working with the University of North Carolina at Charlotte to develop a specification that will work for them."

Iowa

The Iowa DOT also received $80,000 from the pooled fund study. The agency used it to collect data and demonstrate PEM tests along an 11-mile stretch of U.S. 20. Iowa DOT requirements for PEM were 45 pounds less per cubic yard compared to Class A concrete mixture. The contractor expressed concerns with lowering the cement content, noting the Class A mixture is sometimes low in cementitious materials. Before paving, the contractor performed a trial batch using a PEM. The Box Test indicated the mixture would be workable, and the contractor reported the PEM placed well. As a result, the contractor proposed using mixtures tested with the Box Test on a project several months later.

By implementing the new specification, highway agencies and industry are experiencing faster and improved quality control and assurance tests that better correlate to in-service performance, optimized mixtures that lead to cost savings, and longer-lasting concrete pavements.

FHWA Mobile Concrete Technology Center technicians demonstrating the resistivity and SAM tests. Source: Shreenath Rao, ARA, Inc.



Dielectric Profiling System Deployment

A technician demonstrates use of the dielectric profiling system for measuring asphalt pavement density. Source: Rob Sommerfeldt, GSSI.

During paving operations, the density of the asphalt mat is a key construction quality indicator that has a direct impact on pavement performance. State departments of transportation (DOTs) may have an easier way to gather these density measurements during construction.

Asphalt pavement compaction quality control and quality assurance decisions are traditionally based on coring samples, which are destructive to obtain and represent significantly less than 1 percent of the in-service pavement. Dielectric profiling systems (DPS) are a nondestructive means of assessing compaction quality. DPS units collect continuous asphalt pavement in-place dielectric profile data using ground penetration radar antennas. According to DOTs such as Alaska, Maine, Minnesota, and Ohio, the DPS data produces a more uniform and immediate picture of the overall density of a new pavement layer than simply obtaining sample cores at random spots along a new section.

A DPS unit, which often takes the form of a lightweight cart that one person can push along a test path, uses dielectric values to provide full-width, real-time compaction, and uniformity information on the asphalt mat. This technology can allow paving professionals to make compaction adjustments during construction, which provides opportunities to save time and money. Maintaining appropriate pavement density can help improve long-term pavement performance, which in turn can extend maintenance cycles and save millions of dollars in transportation budgets.

Based on a prior study,[1] a 1-percent increase to in-place density (or 1-percent decrease in air voids) achieved through improved compaction is estimated to improve the fatigue performance of asphalt pavements between 8 and 44 percent and improve rutting resistance by 7 to 66 percent. The study also showed a 1 percent increase in in-place density is estimated to extend service life by at least 10 percent.

1 National Center for Asphalt Technology Report 17-05: Demonstration Project for Enhanced Durability of Asphalt Pavements through Increased In-place Pavement Density.

The FHWA Mobile Asphalt Technology Center (MATC) is deploying DPS as part of its equipment loan program and technology field demonstrations. The MATC provides multiple-day, hands-on training sessions with agency stakeholders and industry as part of the DPS demonstrations. Additionally, FHWA is supporting this technology through user groups consisting of several State DOTs and through a DPS pooled fund study. “DOTs can work with FHWA and the MATC to serve as a bridge between research and implementation,” said FHWA Resource Center Pavement Engineer Stephen Cooper.

DPS in Action – Ohio

The Ohio DOT (ODOT) purchased a DPS unit in late 2018, expecting it would better identify variability in core samples and lead to quality improvements.

“We think a major step forward to getting more service life out of our pavements is to eliminate some of these built-in defects that maybe we don’t recognize during the construction process,” said ODOT Office of Pavement Engineering Administrator Craig Landefeld. “If we can improve the overall density and have uniformity, we’re going to anticipate having less mid-cycle repairs and preventive maintenance.”

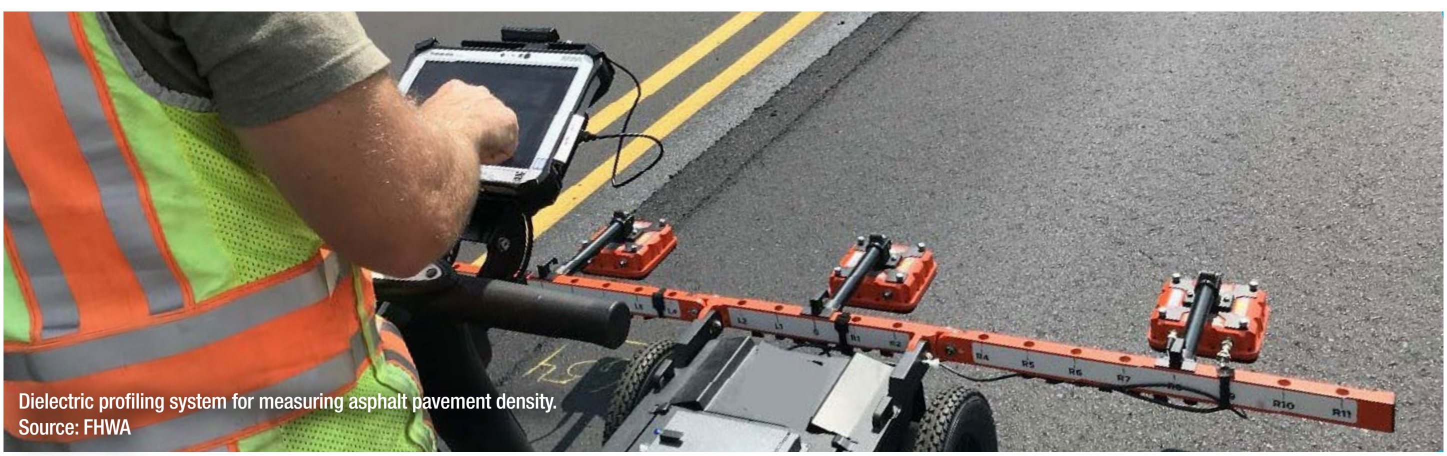
ODOT first wanted to determine if personnel could use the technology properly. The pavement staff familiarized themselves with the equipment and learned to read the intricate data, receiving technical assistance from the FHWA Ohio Division Office. They then ran DPS tests on several projects, simultaneously taking core samples, and compared results.

ODOT found that a DPS could assess more territory, more quickly, than the traditional core samples method. For example, in just one day on I-77, staff collected 10 cores representing nearly 3 miles of pavement, while the DPS collected over 45,000 density readings in the same area.

When an area of I-75 exhibited fine cracking and tearing, but sample cores did not show density issues, the contractor and project staff had differing opinions on the amount of pavement to replace. ODOT used a DPS to scan the section in question. The DPS data helped identify the problem areas, and the construction crew confidently set removal boundaries.

Encouraged by strong results from DPS field-testing, ODOT has begun exploring ways to further incorporate the technology into its pavement program workflow and quality assurance specifications. “We think this equipment has a lot of potential,” said Landefeld. “The improved testing coverage and cost savings are significant.”

Recognizing and removing built-in defects earlier in a pavement’s service life can avoid premature distress, such as potholes or raveling. “If we can get one more year out of our pavement treatments, ODOT’s just capitalized $50–$65 million,” said Landefeld. “That’s the magnitude.”



Dielectric profiling system for measuring asphalt pavement density.
Source: FHWA

DPS in Action – Minnesota

Looking to improve compaction quality control and agency acceptance for asphalt pavement, the Minnesota DOT (MnDOT) began evaluating DPS in 2016 through the MATC equipment loan program. MnDOT demonstrated that DPS can be used effectively to assess hot mix asphalt compaction and uniformity.

DPS accumulates extensive and continuous information on pavement compaction, allowing detection of air voids or other issues—such as irregularities on a day's paving job—right away. This allows MnDOT to be informed about paving practices during the same work shift, compared to next day results with cores.

On a project in 2020, MnDOT researchers operating the DPS alongside the paving contractor helped identify issues that did not show up through sample cores. On a 1-mile section of a 13-mile resurfacing project, compaction levels assessed by the DPS were lower than expected. The sample core taken for acceptance from this area was taken at a location where the density was good, missing the compaction issues.

The DPS team has also helped test the effectiveness of two rolling techniques at a joint. According to MnDOT, the DPS clearly showed the crew's second technique performed better than the first, a difference that was not clear from the conventional method of spot-checks through sample cores. The second method had an almost 2-percent improvement in density, which translates to a significant improvement in pavement life.

MnDOT has evaluated three DPS units on more than 20 projects with positive results. Now staff are looking for ways to make the volume of data more manageable and accurate, as well as make the DPS more user friendly to physically operate. MnDOT plans to incorporate DPS into project acceptance, write protocols for DPS users, improve software and hardware to manage data, and work with American Association of State Highway and Transportation Officials to help develop standards for data collection and analysis. MnDOT is also experimenting with ways to minimize the amount of walking required by mounting the DPS on a small robotic utility vehicle or by having the pushcart operator ride an electric scooter.

The ability to measure full-width, real-time compaction, and uniformity information in a non-destructive manner is a potential game-changer for transportation agencies. Giving paving professionals a more complete picture of compaction quality allows them to make the adjustments necessary to maximize pavement performance during construction. These adjustments to compaction can create increases in in-place density which can then result in major savings and extended service lives.

A technician uses the dielectric profiling system for measuring asphalt pavement density. Source: Harold Von Quintus, ARA, Inc.

South Carolina DOT staff participate in live virtual dielectric profiling system training presented by the MATC team. Source: SCDOT

Developing Test Protocols to Assess Pavement Macrotexture

The FHWA team identified an off-the-shelf laser texture scanner with the ability to test lab gyratory specimens and field cores. Source: FHWA

For many years, the focus for dense-graded asphalt (DGA) surface mixes has been on durability and longevity, which in some cases results in mixtures that provide less surface macrotexture. However, surface macrotexture can affect tire-pavement friction and skid resistance and therefore traffic safety, particularly at higher speeds and in wet conditions.

The FHWA is refining suggested test procedures that will allow agencies to measure macrotexture during mix design and production. “During mix design, States traditionally look at rutting, and they look at cracking,” said FHWA Senior Pavement and Materials Engineer Andy Mergenmeier. “Soon we will be able to suggest a test procedure to help them take a better look at macrotexture.”

Background

According to 23 CFR 626.3, “Pavement shall be designed to accommodate current and predicted traffic needs in a safe, durable, and cost-effective manner.” In support of nationwide efforts to reduce fatalities and serious injuries caused by traffic-related crashes, FHWA pavement engineers are investigating methods to improve pavement surface characteristics. This includes surface texture, which impacts friction and skid resistance, drainability, splash and spray, and hydroplaning. While several factors influence skid resistance, pavement surface macrotexture is one that pavement designers can measure and control.

Two types of surface texture affect pavement friction: microtexture (wavelengths of 1µm to 0.5mm) and macrotexture (wavelengths of 0.5mm to 50mm). At low speeds, microtexture dominates the skid resistance level, while at high speeds macrotexture becomes more critical in providing adequate skid resistance. According to an FHWA evaluation of pavement safety performance, providing adequate macrotexture can reduce crash rates on high-speed facilities. Microtexture is generally provided in asphalt pavements by the relative roughness of the aggregate particles, while macrotexture is generally provided in asphalt pavement by aggregate gradation.

Traditionally, DGA mixtures were designed for durability and long-life performance without significant consideration to their potential as-constructed macrotexture. “To address this limitation, we wanted to develop an assessment procedure for macrotexture that could be used during mix design and also be verified in the field,” said Mergenmeier.

Mean profile depth (MPD) is a popular macrotexture measurement for network assessments. The MPD standard developed by ASTM International, ASTM E1845,[1] suggests what data to collect and how to calculate MPD, but it does not address testing variability or the verification process. Currently, there are no industry certification protocols or sensor/algorithm verification protocols for MPD. The FHWA Turner-Fairbank Highway Research Center’s (TFHRC) Asphalt Binder and Mixture Laboratory Implementation and Delivery program, the FHWA Resource Center, and the FHWA Mobile Asphalt Technology Center (MATC) are working together to address this need.

1 This standard is not an FHWA requirement.


The MATC crew assesses the laboratory gyratory and field core macrotextures with field data collected using a laser texture scanner and a sand patch test. Source: FHWA

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Objectives

For phase one of this effort, a literature review was conducted to identify laboratory and field measurement test systems to measure MPD, then performed preliminary feasibility tests. The team identified a commercial off-the-shelf laser texture scanner (LTS), also known as a non-contact laser-based scanner with the ability to test lab gyratory specimens and field cores. Preliminary macrotexture measurements on specimens and field cores from the TFHRC Accelerated Loading Facility validated LTS capability.

Phase two of the study, which is currently underway, includes the following objectives:

- Assess the LTS in comparison to commonly used test methods like *circular track meter* (CTM) and sand patch.
- Draft operational procedures for collecting data on lab-prepared gyratory specimens and field core samples.
- Evaluate the MPD measured on lab-prepared gyratory specimens compared to that of the volumetric method and CTM field measurements.
- Determine whether there are correlations between field measurements and lab measurements and develop relationships between the data.
- Draft a suggested test protocol to measure macrotexture on lab-prepared specimens and on the pavement behind the paver.

Phase two's preliminary results have so far validated that the macrotexture measurement system is meeting data quality standards. Material from State-sponsored projects in Florida, North Dakota, Ohio, Rhode Island, South Carolina, and Vermont is being used to assess lab-to-field relationships and test protocols for macrotexture measurements. Initial equipment comparison experiments evaluated the LTS system's repeatability and accuracy and found it was successful in measuring macrotexture both on the field cores and lab-prepared gyratory specimens. The FHWA is now drafting and refining testing procedures to reduce variability.

Resources

In addition to reference materials developed during the project to explain testing protocols, States can receive hands-on training on the use and operation of LTS through FHWA's MATC.

Another resource is the MATC equipment loan program. Upon request and depending on availability, the MATC can loan its materials and field-testing equipment to State departments of transportation as well as industry and researchers. North Carolina DOT borrowed the LTS equipment in late 2021. Kentucky and Illinois DOTs requested loans for 2022.

Future

"While this study was focused on DGA mixes, whenever the MATC goes to different States, crews are doing macrotexture testing on all the mixes," said Mergenmeier. "This helps determine if the test may be appropriate for other mixes such as stone matrix asphalt."

"We're also building our MPD database," said FHWA Senior Asphalt Pavement Engineer Leslie Myers McCarthy. "We have several mixes with differing gradations from Virginia, and we just completed testing of a stone matrix aggregate mix from Vermont. By collecting all this data, we can see how the individual mix designs differ in terms of their MPD."

Pavement Management Roadmap Will Create New 10-Year Strategic Vision

The FHWA is updating its 2010 Pavement Management Roadmap to create a new 10-year strategic vision for pavement management planning and programming. The updated roadmap will provide short- and long-term, time-relevant strategies for addressing needs such as research, training, and technical assistance. It will help inform future FHWA pavement management activities by enabling and empowering stakeholders to advance innovation through broad collaboration.

In the last decade since the previous roadmap was published, the pavement management community has grown its understanding of practices, finalized distress standards for national consistency under the American Association of State Highway and Transportation Officials' (AASHTO's) stewardship, and confirmed the best areas to focus future efforts. Another significant change has been the requirement under Title 23, Code of Federal Regulations Part 490, Subpart C that State DOTS must establish performance measures to assess pavement conditions on the Interstate System and the National Highway System excluding the Interstate System. States have also been transitioning from manual to automated technology to collect pavement condition information. The 2010 roadmap helped prioritize resources to support technological advancements in automated data collection and analysis.

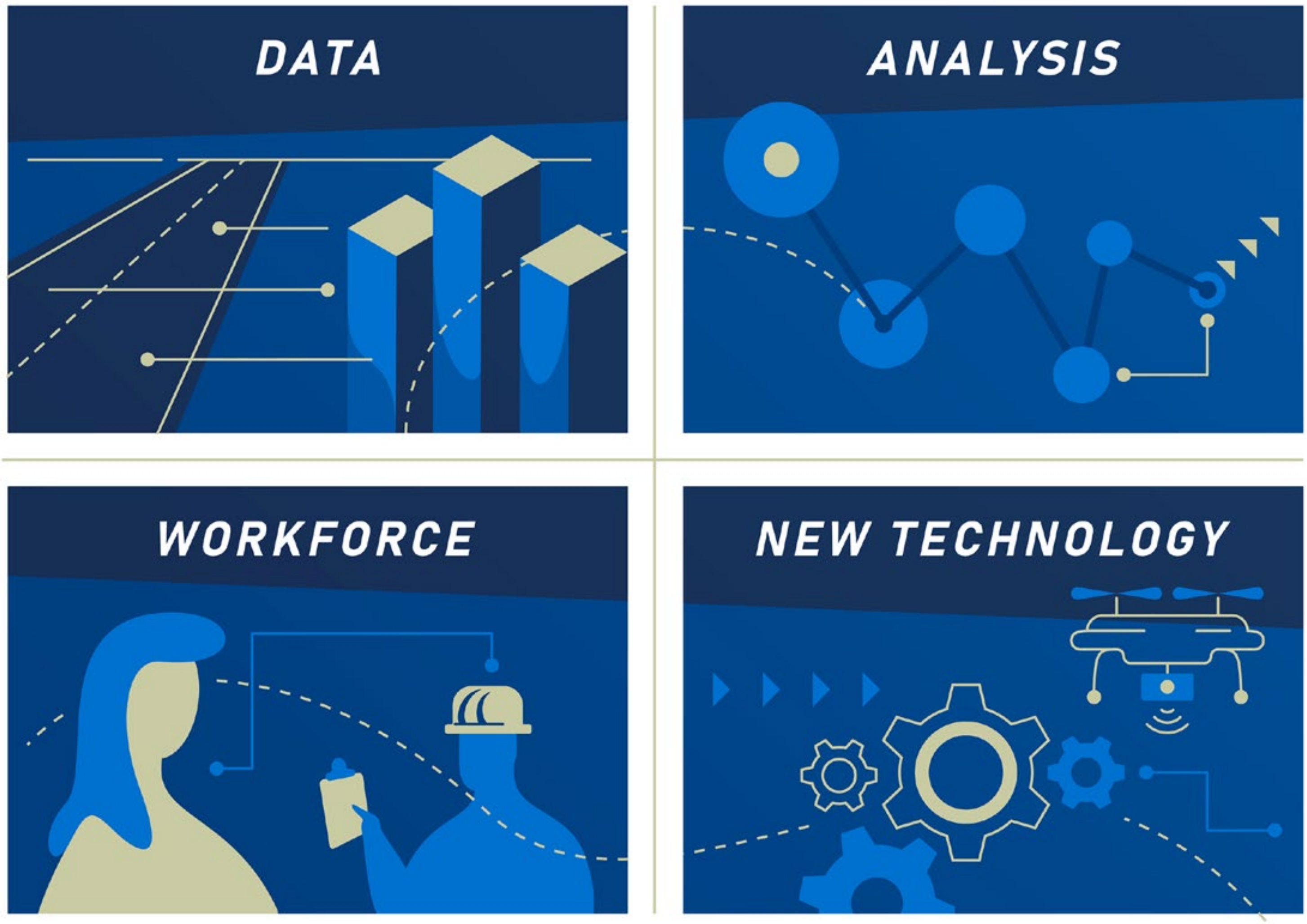
The FHWA, Transportation Research Board, and AASHTO hosted several virtual stakeholder outreach sessions in early 2021. Attendees used survey results to assess the state of pavement management practice, create a benchmark, and conduct a gap analysis. The chief focus was to identify research, technology, education, and workforce development needs to support the national goals identified in Title 23, United States Code, section 150.

Through the new roadmap, FHWA hopes to articulate a strategic vision that encourages stakeholders to explore innovative technologies and approaches and collaborate with their peers to create continuous program improvements.

"As pavement management advances in terms of institutionalizing proven and beneficial practices, both motivation and process will continue to be vital to time-relevant strategies that lead to long-term solutions," said FHWA Pavement Management Engineer Christy Poon-Atkins. "Ultimately, the results of proficient pavement management practices will drive the level of success experienced by DOTs."

The FHWA currently holds pavement management webinars quarterly. The webinar recordings and other resources are available on the FHWA Pavement Management and Performance webpage.

Under the Moving Ahead for Progress in the 21st Century Act, FHWA promulgated regulations (Title 23, Code of Federal Regulations Part 490, Subpart C) implementing** National Performance Management Measures for Assessing Pavement Condition **along with asset management plan requirements. These were continued through the subsequent Fixing America's Surface Transportation Act. As a part of these regulations incorporated by reference at CFR: 23 CFR 490.111(b)(1), DOTs are required to collect pavement condition data in accordance with the Highway Performance Monitoring System Field Manual. Additionally, CFR: 23 CFR 515.7 requires State DOTs to develop a risk-based asset management plan describing how they will manage the National Highway System to ensure performance effectiveness while achieving targets for asset condition through maximized funding cycles.



The 2021 Pavement Management Roadmap themes are data, analysis tools, workforce and organizational issues, and technological advancements. Source: FHWA

Appendix

The FHWA administers a portfolio of programs and initiatives aimed at accelerating the deployment of transformative technologies into practice.

Every Day Counts

The Every Day Counts (EDC) initiative, codified in section 1444 of the Fixing America's Surface Transportation Act (Pub. L. 114-94), is a State-based model that identifies and rapidly deploys proven, yet underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce traffic congestion, and integrate automation. Proven innovations promoted through EDC facilitate greater efficiency at the State and local levels, saving time, money, and resources that can be used to deliver more projects.

The AID-PT program directly supports the pavement-related innovations advanced under EDC, including the following four: warm mix asphalt and SafetyEdge^{SM} in EDC-1 (2011–2012), intelligent compaction in EDC-2 (2013–2014), and pavement preservation in EDC-4 (2017–2018).

The FHWA selects EDC innovations through a robust stakeholder engagement process. As a result of outreach conducted between Fall 2019 and Spring 2020, targeted overlay pavement solutions (TOPS) and e-Ticketing are among seven new innovations FHWA included as part of EDC-6 (2021-2022). The objective of TOPS is to enhance overlay performance, helping agencies maximize their investment and ensure safer, longer-lasting roadways for the traveling public. Forty-five States set a goal to demonstrate, assess, or institutionalize the use of TOPS in transportation applications. The e-Ticketing innovation aims to facilitate the adoption of e-Ticketing to increase safety, efficiency, and responsible use of resources using cost-effective digital collaborative tools while saving lives, time, and taxpayer funds. The EDC Program strives to increase the knowledge and acceptance e-Ticketing and raise the number of State transportation agencies and local agencies institutionalizing e-Ticketing from zero to 12 in two years.

State Transportation Innovation Councils

Key components to innovation deployment programs such as EDC are the State-based approach and the State Transportation Innovation Council (STIC) concept. A STIC brings together public and private transportation stakeholders to evaluate innovations and spearhead their deployment in each State. The STIC Incentive program provides resources to help STICs foster a culture of innovation and make innovations standard practice in their States. Through the program, funding of up to $100,000 per State per Federal fiscal year is made available to support or offset the costs of standardizing innovative practices in a State transportation agency or other public sector STIC stakeholder. The STIC Incentive program provides resources to each STIC to advance innovation. Projects are selected at the individual STIC level and advanced through the State's Federal-aid division office for approval.

The AID-PT program directly supports pavement-related incentive projects advanced under this program. Visit the FHWA Office of Transportation Workforce Development and Technology Deployment website to view a list of STIC Incentive projects.

The following are pavement-related STIC Incentive activities between June 2020 and August 2021:

- Illinois utilized a portable laser texture meter for chip seal quality assurance testing, and Hot-Mix Asphalt handheld thermal imaging to reduce thermal segregation.
- Iowa developed a guidebook for the application of Polymer-modified Asphalt Overlays.
- North Dakota employed TOPS asphalt performance testing equipment.
- Oklahoma used innovative test methods for water/cement ratio of concrete.
- Virginia and New York implemented rolling density meter quality assurance testing.

Accelerated Innovation Deployment Demonstration Grants

The Accelerated Innovation Deployment (AID) Demonstration program helps infrastructure owners offset some of the financial risks associated with first-time adoption of new technologies or practices. The program provides funding to support pilots or demonstrations of innovations on transportation projects. Funding recipients are required to report on the experiences and lessons learned from each innovation deployment to foster technology transfer and information exchange. Agencies eligible to participate in the AID Demonstration program can submit applications through the [Notice of Funding Opportunity].

The AID-PT program directly supports pavement-related AID Demonstration grants. For example, the Alabama Department of Transportation implemented a fiberglass Reinforced Asphalt Pavement Geotextile Project and the Iowa Department of Transportation and Clinton County conducted a pilot demonstration of cape seals for pavement preservation. Visit the FHWA CAI website to view a list of AID Demonstration grant projects.

Accelerating Market Readiness

The [Accelerating Market Readiness (AMR) program] spurs the advancement of emerging and transformative innovations in the transportation industry: those that significantly advance conventional practice, address knowledge and technology gaps, significantly advance the state of the art, or constitute a sea change in the development and delivery of transportation projects and programs. The AMR program is structured with an internal and an external component. The internal component obtains topics from FHWA program offices and the Turner Fairbank Highway Research Center. Funding is approved by FHWA executive leadership. The external component topics are obtained through a Broad Agency Announcement with support from a technical evaluation panel that reviews and selects projects.

A project awarded in 2021 to the Illinois Center for Transportation at the University of Illinois at Urbana-Champaign will include the integration and field deployment of a ground penetrating radar (GPR)-based compaction monitoring system by retrofitting a conventional roller. The project will demonstrate the GPR-based tool for real-time continuous monitoring of density during asphalt concrete layer compaction. A project awarded to Applied Research Associates will focus on the dynamic, viscoelastic back calculation of flexible pavement layer properties to fine-tune a software tool for an open source release available to highway agencies for routine usage.

Increased Federal Share for Innovative Project Delivery

The [Increased Federal Share for Innovative Project Delivery], a provision of 23 U.S.C.120(c)(3), provides the option of an increased Federal share for projects carried out with funds apportioned under the National Highway Performance Program, Surface Transportation Block Grant Program, or Metropolitan Planning using innovative project delivery methods. This provision provides another vehicle to incentivize the use of innovation to help deliver projects more efficiently and to rapidly deploy proven solutions that make a difference. This program is administered at the Federal-aid division office level. Arizona has used this provision to pilot increased in-place pavement density.

AID-PT

Accelerated Implementation & Deployment of Pavement Technologies

Source: New Jersey DOT

Source: New Jersey DOT

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