AID-PT

ACCELERATED IMPLEMENTATION AND DEPLOYMENT OF PAVEMENT TECHNOLOGIES

2019 2020 ANNUAL REPORT

U.S. Department of Transportation
Federal Highway Administration

CONTENTS

Executive Summary 1

About the Program 2

AID-PT Goals 3

Stakeholder Engagement 4

Quality Assurance 10

Mobile Asphalt Technology Center 16

Mobile Concrete Technology Center 20

Pavement Design Policy 24

EDC-6 Targeted Overlay Pavement Solutions 28

Sustainable Pavements Program 32

Performance Engineered Pavements 36

Pavement Condition Data 40

Appendix 46

This document is disseminated under the sponsorship of the U.S. Department of Transportation (USDOT) in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document.

The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this report only because they are considered essential to the objective of the document. They are included for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Front cover images source: FHWA

Innovative Spirit and Strong Partnerships: Keys to Progress

Those who work in transportation know the importance of being innovative. As funding and other resources become limited, demand for new services grows, and legacy infrastructure deteriorates, fresh approaches are needed more than ever. It is this pioneering spirit, combined with invaluable partnerships, that underlies the Federal Highway Administration's (FHWA) Accelerated Implementation and Deployment of Pavement Technologies (AID-PT) Program.

The AID-PT program plays a vital role in FHWA's mission to improve mobility on our Nation's highways. We partner with State and local highway agencies, industry, and academia to identify good practices, then use technology transfer efforts to deliver them to the pavement community. We do this through tools such as training courses, on-site demonstrations, equipment loans, and informative videos.

The AID-PT initiatives highlighted in this annual report exemplify how an innovative spirit and strong partnerships between the public and private sectors can lead to success. During the past year, the AID-PT program has accomplished the following together with our partners:

- Developed a stakeholder engagement plan and a formalized process for informing pavement industry partners and collecting their feedback.
- Partnered with States to develop a first-of-its-kind life-cycle assessment benchmarking tool called "LCAPave" for building more sustainable pavements.
- Created a team of stakeholders and developed an implementation plan for deploying "Targeted Overlay Pavement Solutions," an Every Day Counts round six innovation.
- Held multiple stakeholder feedback events to help us review the FHWA Pavement Design Policy.
- Continued to conduct quality assurance stewardship reviews in partnership with State departments of transportation.
- Partnered with States through a pooled fund study to establish improved standards that may be used by States for pavement condition data collection and management of data quality.

These strong partnerships have produced a spirit of collaboration and cooperation that gets things done.

- We are taking new equipment, tests, and technology to agency doorsteps with our mobile asphalt and concrete technology centers.
- We are developing a framework for performance engineered pavements that connects pavement design performance expectations to construction and final acceptance.

We will continue helping the transportation community manage pavement assets effectively and improve the condition of the highway system. I look forward to sharing more successes in the future as we develop and deploy more innovations on the Nation's roadways to keep America moving, together.

Sincerely,

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 strategic partnerships 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 partners are doing to accelerate implementation and deployment of cutting-edge 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 teaming partners 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: denbelitsky
© Fotosearch.com

FHWA Deployment Efforts Align with AID-PT Program Goals

AID-PT GOALS [Title 23,United States Code, Section 503(c)(3)]	SELECTED FHWA EFFORTS								
	Stakeholder Engagement	Quality Assurance	Mobile Asphalt Technology Center	Mobile Concrete Technology Center	Pavement Design Policy	EDC-6 Overlays	Sustainability	Performance Engineered Pavements	Pavement Management and Performance Data
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	10	16	20	24	28	32	36	40

• Indicates selected effort meets goal.

STAKEHOLDER ENGAGEMENT
IS A TWO-WAY STREET

FHWA develops a process for informing pavement industry stakeholders and collecting feedback.

At FHWA, the phrase "two-way street" is often used literally, but in recent years, leaders of the agency's Pavement and Materials Program have focused on creating a figurative two-way street for stakeholder communication. In fact, FHWA's proactive process of informing stakeholders about its pavement program areas and collecting their feedback has become so important to the success of the program that the agency developed a stakeholder engagement strategy in 2019. The plan helps fulfill the program's mission to increase the body of knowledge and advance the practice of designing, constructing, and preserving more sustainable pavements through stakeholder engagement, education, and resource development.

Technical Feedback Groups

Pavement and Materials Program stakeholders are often experts in pavement-related aspects of highway transportation projects. They include external partners from local and State departments of transportation (DOTs), academia, industry, and other Federal agencies as well as FHWA employees.

To create a path for effective two-way communication between FHWA and these diverse stakeholders, the Pavement and Materials Program manages four technical feedback groups:

In addition, FHWA hosts the ME Pavement Design User Group annually. This group is open to representatives from all State DOTs as a peer exchange forum. The groups meet up to twice per year to provide input on topics relating to FHWA's seven pavement program areas. The majority of members are representatives of specific stakeholder organizations; however, anyone interested in participating is welcome.

FHWA regularly evaluates representatives for the four technical feedback groups and can opt to rotate individuals every 2 years.

The technical feedback groups participate in activities such as in-person meetings, conferences, peer exchanges, and webinars to learn about FHWA efforts to provide safe, durable, cost-effective, and sustainable pavements. "It's a great opportunity to ensure our stakeholders know what we're doing to meet their needs, and it's also a chance for us to get valuable feedback," said FHWA Pavement Design and Performance Team Leader LaToya Johnson. "They are the Who's Who of these program areas, so to be able to vet ideas for new products and deployment techniques through them is extremely important to us."

The purpose of these groups has evolved over the years. In 2017, the FHWA Office of Infrastructure reviewed its existing programs, activities, and stakeholder groups and considered input from stakeholders on how FHWA disseminates information and gathers feedback.

THE FHWA PAVEMENT AND MATERIALS PROGRAM SUPPORTS ENGAGEMENT ACTIVITIES FOR SEVEN PROGRAM AREAS:

1. Pavement design
2. Materials
3. Quality assurance
4. Pavement construction
5. Pavement management
6. Pavement preservation and rehabilitation
7. Sustainability

Source: Noppharat
© Fotosearch.com

"We looked across the program and determine what kind of groups we had and how we were using them," said FHWA Pavement and Materials Team Leader Gina Ahlstrom. "Our goal was to create a consistent process for how stakeholder feedback is gathered and considered by the Pavement and Materials Program."

"FHWA plays a role in bringing everyone together to share perspectives," said Ahlstrom. "We work with 52 State agencies, multiple industry groups, and many academic research institutions."

"The meetings are helpful to us for not only enhancing our understanding of FHWA efforts, but also in shaping our own activities to make sure we're all pulling in the same direction," said American Concrete Pavement Association Executive Vice President Leif Wathne. "Program transparency allows us to be on the same page. We have to have a good understanding of each other's priorities and activities so we can accomplish a common goal—accelerate implementation and deployment."

FEEDBACK GROUP ROLES

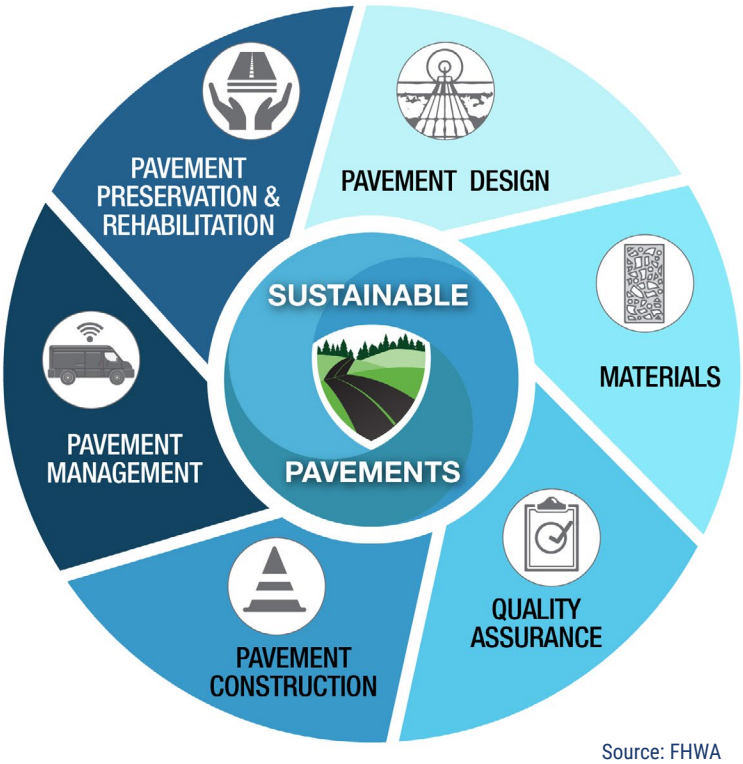
Feedback Groups WILL

- Convene representatives from stakeholder groups.
- Provide input on FHWA programs and activities.
- Discuss stakeholder needs and interests.

Feedback Groups WILL NOT

- Serve as an advisory group.
- Direct FHWA programs or activities.
- Provide a consensus opinion.
- Develop documents or other deliverables.

FHWA Pavement & Materials Program Areas



Source: FHWA

The FHWA representatives facilitate and coordinate the feedback group meetings. “We want to identify synergies between FHWA program areas and stakeholder interests,” said Sustainable Pavement Technical Feedback Group Leader Heather Dylla. “Stakeholder engagement is a way for FHWA to understand the program area gaps and needs, increase awareness of program areas, increase buy-in, develop key program area champions, and provide technical assistance.”

FHWA considers input provided by the stakeholders. Pavement and Materials Program team leaders are working on methods to effectively collect that input, consider changes to the program to address input as appropriate, and share any related program activities with stakeholders.

“It is FHWA’s goal to be a leader in the development and deployment of innovative practices and technologies to improve the safety and performance of the Nation’s transportation system,” said FHWA Office of Infrastructure Director Brian Fouch. “We are committed to engaging our stakeholders, as they provide invaluable input for developing strategies that are relevant to addressing today’s infrastructure challenges and key to meeting this goal.”

PAVEMENT RESEARCH AND TECHNOLOGY WORKSHOP

In October 2019, FHWA held a Pavement Research and Technology Workshop to collect stakeholder feedback on its Pavement and Materials Program activities. The 2-day event at Turner-Fairbank Highway Research Center attracted more than 50 representatives from State DOTs, industry, and FHWA. The workshop started with an overview of the strategic plans of the United States DOT; FHWA; and FHWA Office of Research, Development, and Technology. State and industry representatives each offered input on three key questions:

- What are the three highest-priority pavement and materials issues for your organization?
- What are the areas/products you believe should be promoted nationally in the next 5 to 7 years, and how would you like FHWA to support the effort?
- What support do you need from FHWA?

The workshop also included focused and plenary sessions about quality assurance, pavement management, pavement design policy outreach, performance-engineered mixture design/performance-related specifications, mobile technology centers, material lab research, safety, preservation, and pavement design and analysis.

“I was most excited to hear about the new direction of the Mobile Asphalt Technology Center,” said National Asphalt Pavement Association Vice President for Engineering, Research, and Technology Richard Willis. “This can help move states and industry forward if used effectively and transparently. I was also excited to hear that FHWA would continue to gather stakeholder feedback on a consistent basis moving forward.”

TECHNICAL FEEDBACK GROUP HOT TOPICS

ASPHALT

- Balance mixture design and analysis
- Performance-related and performance-based specifications
- Performance modeling and distress prediction
- Optimized pavement design
- Life-cycle cost analysis
- Material testing, analysis, and quality assurance
- Construction and inspection technologies
- Relationships among design, construction, and pavement performance
- Research, innovation, and deployment gaps and needs assessment

CONCRETE

- Rehab strategies
- Rapid repair
- Performance engineered mixtures
- Composite pavement
- Construction inspection training
- Fly ash shortage
- Concrete pavement design issues
- 28-day strength requirements
- Underutilized technologies

SUSTAINABLE PAVEMENT

- Environmental product declarations (EPDs)
- Computing EPDs
- FHWA life-cycle analysis tool (LCAPave)
- Sustainability checklist
- Pavement-vehicle interaction update
- Estimating vehicle operating cost calculator

PAVEMENT PRESERVATION

- Asset and pavement management systems
- Treatment design: selection and timing
- Materials
- Treatment application: construction and contracting
- Performance
- Benefits

ME Pavement Design User Group Meeting, November 2019.
Source: Kelly Smith, Applied Pavement Technology, Inc.

AID-PT *SHORT TAKE*

Dielectric Profiling Systems Deployment

Asphalt pavement compaction quality control and quality assurance decisions are traditionally based on coring samples, which are destructive and represent significantly less than 1 percent of the in-service pavement. Dielectric profiling systems (DPS), a form of ground-penetrating radar technology, are emerging as a means for continuous assessment of asphalt pavement compaction quality through measuring the pavement dielectric constant. DPS show great promise for providing full-width, real-time compaction and uniformity information on the asphalt mat during construction.

The FHWA Mobile Asphalt Technology Center (MATC) is deploying DPS as part of its equipment loan program and technology field demonstrations. A fact sheet series on DPS is in development. Additionally, FHWA is supporting this technology through user groups consisting of several State DOTs and through a DPS pooled fund.

Dielectric profiling system for measuring asphalt pavement density.
Source: Rob Sommerfeldt, GSSI

AID-PT *SHORT TAKE*

Reclaimed Asphalt Technical Briefs

FHWA is working on two technical briefs regarding the use of reclaimed asphalt pavement (RAP) and reclaimed asphalt shingles (RAS) in pavements. These align with FHWA's continuing commitment to using recycled materials in a responsible manner without compromising pavement performance.

Improvements in materials processing, handling, and mixture design have increased the amount of RAP and/or RAS that can be used in asphalt mixtures. When incorporated properly, using these materials can reduce landfill waste, provide initial cost savings, and provide comparable levels of service to asphalt mixtures with no reclaimed materials.

"We're hopeful the best practices and lessons learned shared in these tech briefs will help agencies determine the appropriate amounts of RAP and/or RAS to use to ensure good performance," said Tim Aschenbrener, FHWA senior asphalt pavement engineer. "There are large RAP stockpiles that continue to grow in various locations around the country. There are opportunities to use high RAP mixtures in certain scenarios that can help reduce these stockpiles while still maintaining good performance. Unfortunately, we are discovering that by using too much RAS in a mixture, performance can suffer."

QUALITY ASSURANCE
GETTING WHAT WE PAY FOR

FHWA quality assurance stewardship reviews identify risks and opportunities.

As custodians of taxpayer dollars, public agencies strive for long-life projects and to pay contractors properly for quality work. This is why State departments of transportation (DOTs) use quality assurance (QA) programs to determine whether materials and construction quality meet specified Federal standards for pavement projects. Requirements for Federal-aid funding applicable to these QA programs are published in Title 23, Code of Federal Regulations (CFR), Part 637, Subpart B – Quality Assurance Procedures for Construction.

FHWA conducts weeklong materials QA stewardship reviews at four to five DOTs each year. The reviews allow FHWA to accomplish the following:

- Evaluate the State's QA program.
- Assess compliance with 23 CFR 637 Subpart B and QA procedures for construction projects on the National Highway System.
- Capture and share practices.
- Assess and minimize risks.
- Improve material quality and program efficiency.

> "We want to ensure taxpayers get what they are paying for, and we want to verify that in the most efficient way possible."
>
> ***Jeff Withee***
> FHWA Quality Assurance Program Manager

FHWA has completed materials **QA stewardship** reviews for all 50 DOTs, plus Puerto Rico and the District of Columbia. According to FHWA Quality Assurance Program Manager Jeff Withee, it is challenging to draw comparisons over time because review focus areas have evolved to address emerging program risks.

"For example, using contractor data in the acceptance decision and ensuring the State has strong validation processes is an area where we've recently seen risks," said Withee. "Some States did not fully recognize the level of risk until it was discussed during a review. We've seen that it's a risk area that could have significant impact on pavement performance and the proper payment for materials quality."

Eighteen of the 27 DOTs reviewed between 2013 and 2018 use contractor test results in the acceptance decision. States can use contractor-produced test data as part of the acceptance decision but must have a validation process to ensure it is reliable and accurate (23 CFR 637.207(a)(1)(ii)).

A review of the Colorado Department of Transportation (CDOT) QA program found a strong approach for validating contractor data on pavement smoothness. "We recognized their innovative approach because it reduced the risk in the ride specification for construction acceptance without requiring an extensive investment of State resources to monitor the contractor," said Withee.

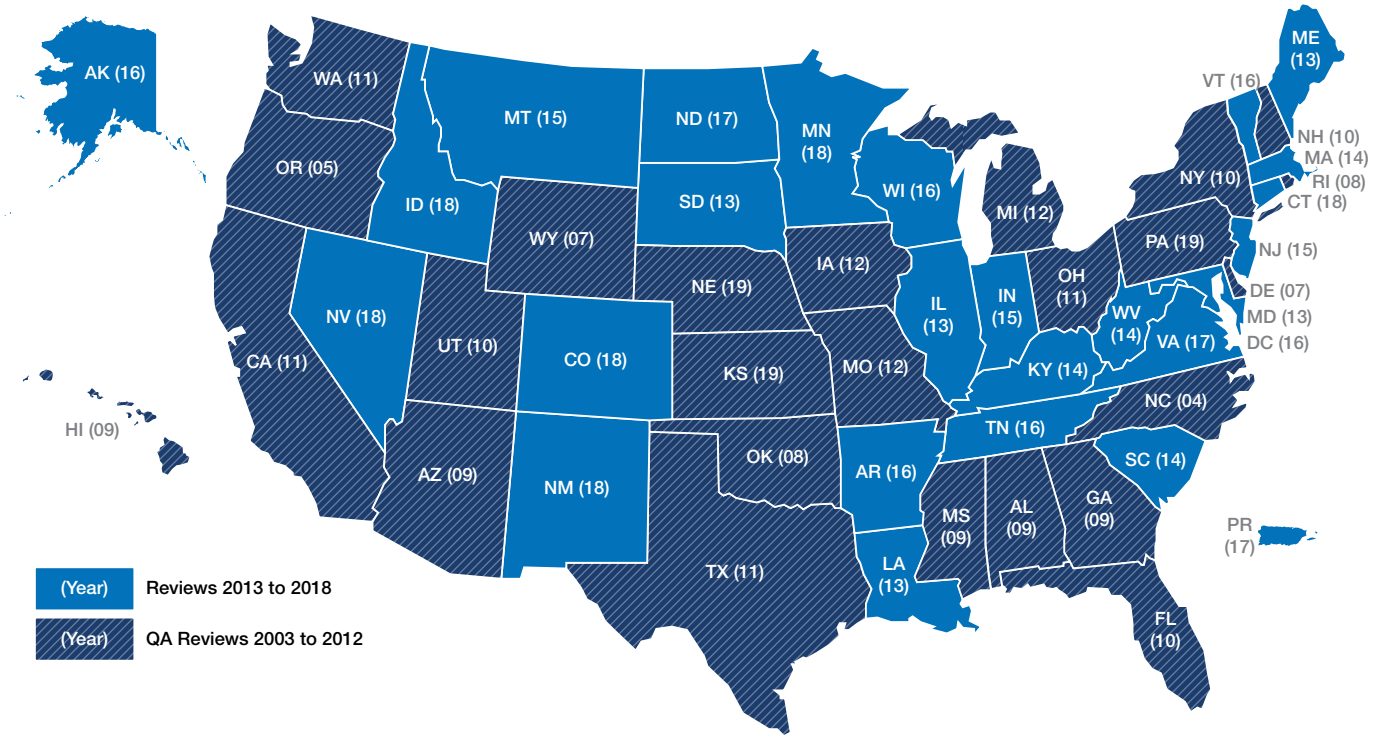
CDOT State Materials Engineer Craig Wieden said the FHWA QA review process benefits the agency. "The greatest benefit I felt was having a fresh set of eyes, so to speak, review our processes," said Wieden. "It offers a different perspective on views and also helps to identify areas we could focus on to make our program better. Having a document in hand as a result of the FHWA QA review helps us narrow our focus areas for potential program improvements and also puts us in a stronger position when approaching industry with any planned improvements."

Key Trends

Recent QA stewardship reviews revealed several significant trends:

- The majority of DOTs were meeting the Federal regulations.
- 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 be confident the sample represents the material incorporated into 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.

18 OF THE 27 DOTs USE CONTRACTOR TEST RESULTS IN THE ACCEPTANCE DECISION.



Strengths and Opportunities

FHWA identified program strengths and opportunities for improvement in four areas for the 27 DOT QA programs reviewed between 2013 and 2018—acceptance, independent assurance, technician and laboratory qualifications, and records and data management.

TOPIC AREA	DOT QA PROGRAM STRENGTHS	DOT QA PROGRAM OPPORTUNITIES
Acceptance	• Use of F & t test procedures • Use of alternative contracting methods • Use of percent within limits specifications • Use of random numbers in sampling	• Use of individual test tolerances for contractor data validation • Use of contractor-collected smoothness testing with no SHA verification testing • Inconsistent use of random numbers for obtaining samples • Issues with security of samples
Independent Assurance (IA)	• Regularly update IA comparison tolerances	• No recent updates to IA tolerances
Technician and Lab Qualifications	• Technician certifications - valid 5 years • Central labs accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program (AAP) • District or regional labs AAP accredited	• Different qualification processes for DOTs, contractors, and consultants
Records and Data Management	• Use of AASHTOWare® Project SiteManager to collect and store test results	• No central computer database to analyze material test data

The above table highlights several topics evaluated during quality assurance reviews.

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

Staff turnover is not the only challenge. DOTs are trying to keep up with new technology and incorporate tools such as materials management systems for electronic data records. This can help a DOT evaluate its QA program and easily analyze data to determine if it needs to revise its specification limits and comparison tolerances. A number of new materials are being incorporated into projects, which can alter historical performance relationships, and there are also new ways to test these materials. "We have to evolve our sampling, testing, and inspection procedures to adequately evaluate the new materials and ensure they perform as intended," said Withee.

Connecticut DOT Materials Principal Engineer Robert Lauzon said the QA stewardship review gave the agency confidence to continue working toward improved specifications and procedures. “Particularly, HMA sampling at the project site and the use of percent within limits to make the acceptance decision were two changes that the review provided valuable input on,” he said.

“Changing long-held philosophies regarding roles and responsibilities for quality and implementing procedural changes that have both internal and local industry impacts can be a long and challenging process,” said Lauzon. “I believe the FHWA QA review provided us with renewed energy and a sense that, in many ways, we were on the right path.”

New Technologies

The QA stewardship reviews also provide an avenue for FHWA to identify how new technologies benefit DOTs and how to implement them. These new technologies include:

- Optimized gradation (e.g., Tarantula Curve) for proportioning aggregates in portland cement concrete (PCC) mixtures.
- Pulse induction technology scans for determining PCC pavement thickness and dowel and tie bar location and orientation.
- Super Air Meter (SAM), which can be used to assess properties of the PCC air-void system beyond the total air content.
- PCC permeability and surface resistivity, which provide a rapid indication of concrete’s resistance to chloride ion penetration.
- Statistical validation of contractor testing.

Pulse induction technology scanning for determining thickness of hardened concrete.
Source: FHWA

New QA Training Course

FHWA piloted a new, intermediate-level National Highway Institute course in February 2020 titled **"Quality Assurance for Highway Construction Projects."** The 2-day, instructor-led course prepares students to identify and use the six core elements of a QA program for all types of highway projects, from the simplest to the most complex. All course content, including risk-based content, is related to practical experience.

Topics include the following:

- QA program requirements.
- Use of QA specifications.
- Quality control and acceptance, including contractor and agency roles and responsibilities.
- Sampling, testing, and inspection.
- Control charts.
- Using data to measure quality, including collecting data, analyzing data, interpreting data, and quantifying data variability.
- Payment, including percent within limits and pay factors.
- Verification and materials testing dispute resolution.

"Materials QA is not something that at some point we say, 'OK, we're done.'" said Withee. "We will continually have new people involved in the process, so they'll need training and education on the importance of QA and what to look out for."

Sampling behind paver to obtain loose sample of asphalt mixture.
Source: FHWA

AID-PT *SHORT TAKE*

Tools to Advance Performance Engineered Concrete Mixtures

Through a cooperative agreement with the National Concrete Pavement Technology Center at Iowa State University, FHWA is developing comprehensive quality control (QC) tools for concrete as part of FHWA's Performance Engineered Mixtures (PEM) initiative. The QC tools aim to aid contractors from production to construction of PEM and provide agencies with additional insight into the quality of their concrete. The QC tools will include sample QC plans with associated instructions for contractors to use the plans. Historically, agency specifications have been prescriptive. As agencies move toward performance specifications, the role of QC becomes more important. This document could help jumpstart State DOTs and industry and demonstrate what comprehensive QC on a project looks like, and what they should expect. Not only can contractors use the QC tools to improve their production and construction operations, but DOTs also can use them to learn how to leverage good QC in their specifications and practices.

Following creation of the QC tools, FHWA will develop specification language that agencies may consider incorporating in their performance specifications. The sample specifications are based on the American Association of State Highway and Transportation Officials (AASHTO) Standard Practice for Developing Performance Engineered Concrete Pavement Mixtures (PP 84). The specifications language will address the questions that many DOTs ask of performance specifications: What does a performance specification look like? How would it differ from the specifications we have today? How does it incorporate newer performance tests?

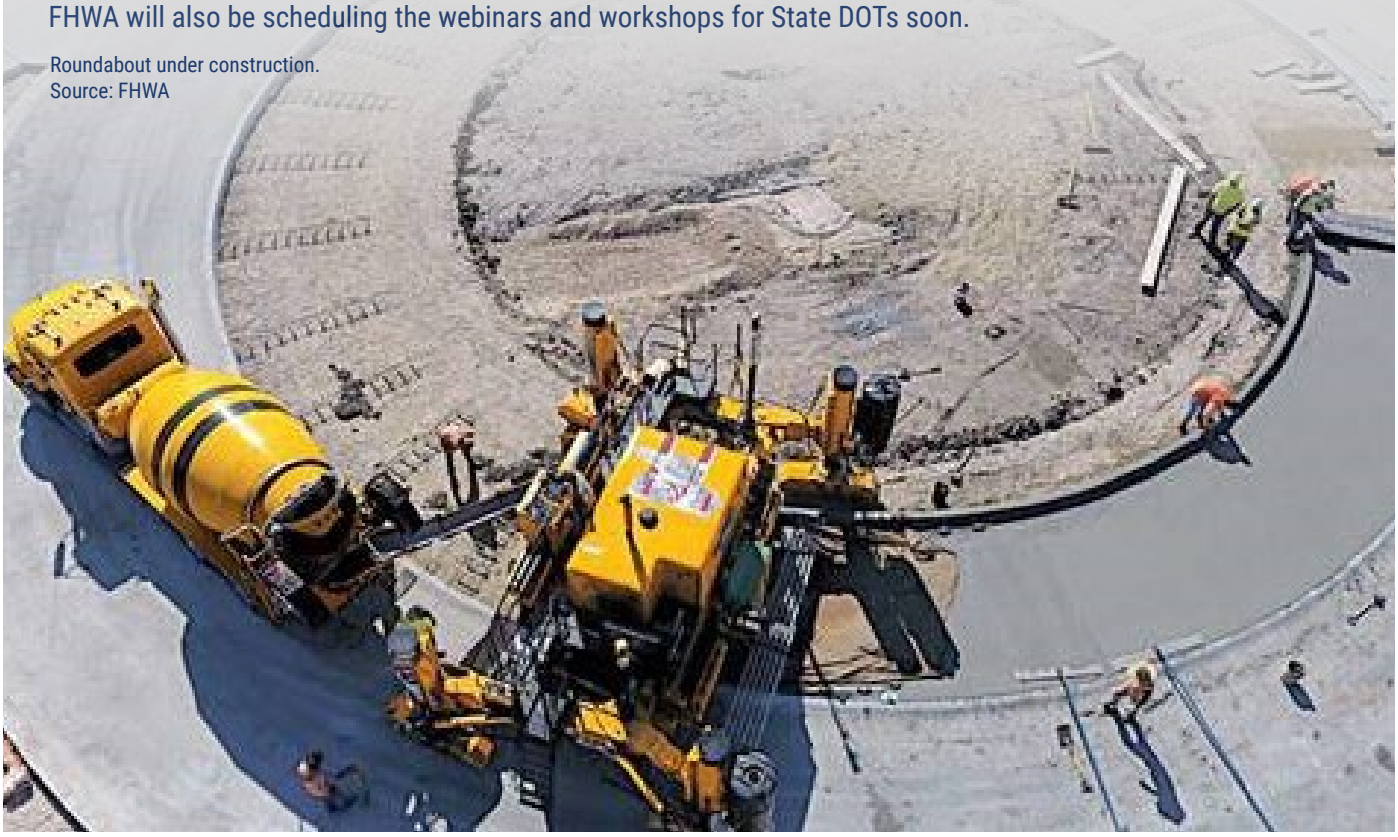
Roundabout Pavement Resources

Interest in roundabouts as a solution for managing traffic at intersections has grown rapidly, with more than 3,200 roundabouts constructed in the United States in the last decade. It is important to consider traffic staging early in the design phase of a proposed roundabout. Because roundabouts are often located at critical intersections, roundabout materials and construction methods are affected by the necessity to maintain traffic, not only during construction but also throughout the service life of the roundabout as maintenance activities required for pavement preservation are performed. Roundabouts for existing intersections are constructed under one of three traffic conditions: all traffic routed away from the work area, some traffic diverted, or full traffic.

FHWA is developing resources to highlight the benefits of four pavement types for roundabouts: jointed plain concrete (JPC), continuously reinforced concrete (CRC), precast concrete (PC), and hot-mix asphalt (HMA). The resources include technical briefs, webinars, and workshops.

Many States are using JPC for constructing roundabouts. The layout of adjoining trapezoidal panels with tie bars and dowels is accomplished similarly to jointed panels on highway ramps. CRC has a long history of use in highway pavements in the United States and has been used extensively for roundabout construction in Belgium. The standard 60-foot lengths of steel in CRC can be laid out in a curved pattern to follow the curvature of typical roundabouts, with bars spaced normally at the outermost radius and closer spacing at the innermost radius. PC has not been used for roundabouts; however, its use would follow a basic layout of trapezoidal panels with the dowels used to provide load transfer between all faces of adjacent panels. Numerous States are using HMA for approach lanes to roundabouts as well as for the circular lanes. The availability of HMA contractors and the ease of mill-and-fill maintenance make it an attractive choice for roundabouts despite its tendency to shove and rut due to shear forces from roundabout traffic.

Each of the four pavement types presents opportunities for benefits and challenges for the owner agency. FHWA will also be scheduling the webinars and workshops for State DOTs soon.



Roundabout under construction.
Source: FHWA

MATC MOBILE ASPHALT TECHNOLOGY CENTER

Taking asphalt Technology to the pavement community's doorstep — an expanded focus.

Introducing new equipment, tests, and technology within a transportation agency can be a lengthy and expensive process. Consequently, asphalt pavement best practices and solutions tend to halt at State lines and remain within the walls of research organizations and industry innovators. Pavement professionals need access to these resources and innovations, and innovators need ways to share methods and technology for implementation. For these reasons, the FHWA **Mobile Asphalt Technology Center** (MATC) was born, and it continues to be an asset for agencies to improve design, materials, construction, and performance of highway asphalt pavements.

The MATC is equipped with traditional and state-of-the-art testing equipment that shows promise, or is nearly ready, for use in the highway industry. It serves as a link between agencies, private industry, and academia to showcase best practices for asphalt pavements that make an impact on the long-term performance and sustainability of roadway programs. The MATC is a vital mechanism for technology implementation and allows FHWA to inform policy and provide technical support through identifying regional and national trends in asphalt materials and pavement construction. The MATC introduces emerging technologies into real-world construction, assisting agencies with positive change and promoting innovation within the asphalt industry. These innovative technologies and practices can help encourage agencies to take specifications and practices to the next level.

"We have the scalability to provide back-to-basics training, education, and assistance or to demonstrate the latest innovations in laboratory and field technologies for asphalt pavements," said Leslie Myers McCarthy, senior asphalt pavement engineer and the MATC program manager for FHWA. "Our capabilities are customizable to the needs of the State and its partners."

The MATC achieves its mission through four primary means:

- Project site visits
- Customized training workshops
- Equipment loan program
- Technical information factsheets

Testing Capabilities

The MATC includes a **mobile Superpave laboratory** equipped with leading-edge materials, mixtures, and field-testing equipment. All second Strategic Highway Research Program (SHRP 2) technologies that have gone through preliminary evaluation and need wider deployment are available on the MATC. During site visits, the team demonstrates these technologies for real-time field evaluation. This assists agencies and contractors in considering their eventual implementation.

Over the last year, the MATC team has expanded its laboratory testing abilities. Recently, the program added mix design tests such as the Illinois Flexibility Index Test (I-FIT), Indirect Tensile Asphalt Cracking Test (IDEAL-CT), Indirect Rutting Asphalt Cracking Test (IDEAL-RT), and the Texas Overlay Test (OT). These mix-testing capabilities support performance-engineered mixture design efforts being explored by many agencies around the country.

The MATC also has a unique relationship with the Asphalt Binder and Mixture Laboratory-Implementation and Delivery (ABML-ID) program at the FHWA Turner-Fairbank Highway Research Center. The ABML-ID program supports the mission of the MATC and adds depth to its testing capabilities and expertise. This laboratory resource delivers high-impact, shorter duration projects that address immediate needs of stakeholders and provides in-depth support to the MATC. The ABML-ID also serves State agencies by responding directly to their needs, as generated by MATC field visits. For example, the ABML-ID staff conducts binder performance testing and Fourier transform infrared spectroscopy (FTIR) testing, assists in specification reviews, and provides technical support for adoption and use of recycled and other innovative materials in asphalt mixtures. This relationship allows the MATC team to help deploy practices and technologies not just on asphalt mixtures but also in other areas where asphalt materials play a large part, such as macro texture and skid resistance.

MATC on site near an asphalt production plant.
Source: FHWA

Project Site Visits

Early in 2020, the MATC visited South Carolina, at the request of the South Carolina Department of Transportation (SCDOT) and the South Carolina FHWA division office. During the visit, MATC staff sampled and tested asphalt binder and mixture from an interstate reconstruction project while stationed at the project's asphalt plant location in Clinton, SC. Testing included in-place thickness, mix volumetrics, cyclic fatigue, stress sweep rutting, Texas OT, Semi-Circular Bending Illinois Flexibility Index Test, IDEAL-CT, FTIR, Multiple Stress Creep and Recovery test, Delta TC, Circular Track Meter, asphalt binder tester, automatic vacuum sealing field core density, sand patch, and many others.

The MATC team demonstrated new asphalt mixtures, materials, and field-testing technologies to SCDOT, FHWA South Carolina division, members of the South Carolina Asphalt Pavement Association, the host contractor, consultants, and academia from throughout South Carolina. The team provided SCDOT with their asphalt mixture's laboratory performance and field test results, which could in turn be used to help increase the performance and durability of SCDOT asphalt pavements.

Equipment Loan Program

Deploying new technologies can involve the purchase of expensive equipment, and this expense can be a significant barrier for agencies, especially if there is uncertainty as to whether the equipment will meet their needs. Specialized training and technical support also can be of benefit.

The MATC offers an equipment loan program to highway agencies and contractors to evaluate performance, receive training, and determine if the equipment meets their testing needs. The equipment is loaned for a few weeks or a few months.

Equipment can ship to an agency within 7 days of a request, and after the test is completed, the agency either returns the equipment to FHWA or sends it to the next requester in the queue.

THE FOLLOWING ARE INCLUDED IN THE MATC EQUIPMENT LOAN PROGRAM:

- Paver-mounted infrared device
- Circular track meter
- Non-destructive test for pavement thickness (pulse induction technology)
- Dielectric profiling system for mat and joint density
- Imaging system for aggregate properties
- X-ray fluorescence device for binder composition
- Jig set for fatigue testing in AMPT device
- Vacuum sealing asphalt density measurement system for bulk specific gravity of cores
- Warm-mix asphalt foaming device

Production sampling during MATC visit to South Carolina.
Source: FHWA

Specification Reviews

During travel restrictions in 2020, the MATC team has provided remote support to agencies around the country through specification reviews. With a team of subject matter experts and FHWA engineers, MATC team members communicate their observations regarding specifications to State agencies, specifically the practices with which other agencies are having success. During a specification review, the MATC team can provide technical support that may help an agency streamline (e.g., by reducing the number of pilot projects) its implementation or modification of a specification process.

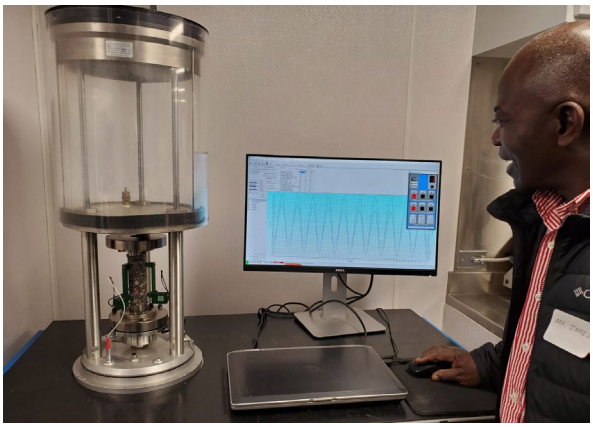
An agency can request the review of a single specification or even part of a specification—particularly one that is of concern. Specification reviews can also help an agency with a new specification, such as for use of a new mixture type or integration of a new technology. This process provides the agency assurance that they have support in implementing a new or revised specification.

When the MATC team visited the Vermont Agency of Transportation (VTrans), the State requested specification reviews be provided as part of the team's technical support.

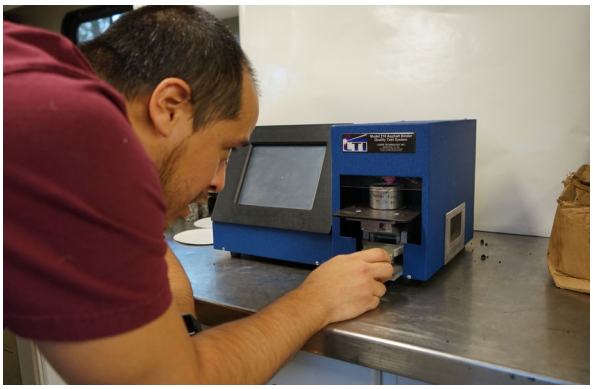
"Several of the comments and suggestions from the MATC staff were incorporated into the final version of our stone matrix asphalt specification, particularly in terms of the mix design criteria," said Aaron Schwartz, bituminous concrete engineer for VTrans.

Looking Forward

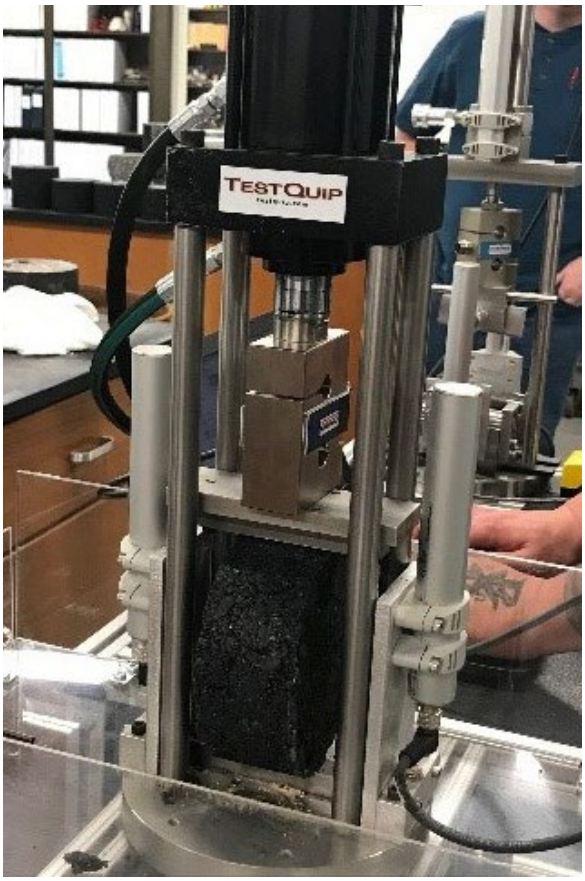
In 2021, the MATC team plans to deploy an asphalt life-cycle cost tool and other items to support advancements in sustainability for asphalt pavements. Additionally, the team is developing a new, 2-day workshop that focuses on quality in the asphalt paving process. The workshop will cover the methods, practices, and benefits of a quality asphalt paving program to increase the longevity of asphalt materials and pavements.



Asphalt Mixture Performance Tester
Source: FHWA



Asphalt Binder Tester
Source: FHWA



Indirect Tensile Asphalt Cracking Test
Source: FHWA

MCTC MOBILE CONCRETE TECHNOLOGY CENTER

Transferring advanced concrete technology and promoting quality to the pavement community.

MCTC deployed to project locations during site visits.
Source: FHWA

FHWA's Mobile Concrete Technology Center (MCTC) introduces Federal, State, and local transportation personnel, industry representatives, and academia to state-of-the-art tools and practices for concrete materials selection, mixture design, field and laboratory testing, and pavement evaluation. The MCTC promotes proven concrete paving practices and demonstrates available, but underused, technology to advance concrete for U.S. infrastructure projects.

The MCTC offers on-site demonstrations of new technologies such as the Super Air Meter, the Box Test, V-Kelly Test, and surface resistivity testing, in addition to traditional concrete tests. It features a fully equipped mobile concrete testing laboratory that can perform a **wide range of tests**, including conventional destructive and state-of-the-art nondestructive tests. FHWA uses the MCTC to spotlight best practices for concrete usage and support initiatives such as performance-engineered mixtures (PEM) for concrete.

"Concrete is a very durable and forgiving material," said Mike Praul, FHWA senior concrete engineer. "As the pavement community looks increasingly toward performance, you're now seeing States and industry become more willing to change, innovate, and implement new technology."

The MCTC achieves its mission through the following:

- On-site field testing.
- Hands-on training.
- Technical assistance, including specification review and evaluation.
- Equipment and technology showcases.
- Equipment loan program.
- Virtual training initiatives.

Site Visits

The MCTC team visited North and South Carolina, Kansas, California, and Vermont.

"The work the MCTC did this year demonstrates the customizable nature of our support," said Praul. "Five unique States with differing situations were all able to leverage our efforts to fit their local needs."

One of the States the MCTC visited in 2020 was Vermont. The Vermont Agency of Transportation (VTrans) is looking to reintroduce concrete paving to the State. In addition to the on-site visit and workshop, the MCTC supported VTrans with in-person follow-up visits, additional workshops with industry representatives, and meetings with the State and industry to put a plan together to advance concrete paving in the State.

The MCTC's benefits are not limited to States with new concrete programs, however. Agencies with mature concrete programs can also find the MCTC an effective resource.

The MCTC visited Iowa several times in the past 25 years. Demonstration projects and the equipment loan program have helped the State implement technologies such as maturity testing and MIT-SCAN-T2 and T3 pavement thickness testing. During a 2018 visit, the MCTC demonstrated many new PEM test procedures.

"The ability of the MCTC to visit States every few years aids in delivery and demonstration of new technology and testing," said Todd Hanson, concrete materials engineer at Iowa Department of Transportation (DOT). "Even a State like Iowa that has a fairly mature concrete paving program is able to gain knowledge and implement new technology."

MCTC staff demonstrating durability testing using the Super Air Meter.
Source: FHWA

MCTC staff performing testing inside the mobile concrete laboratory.
Source: FHWA

Prior to the MCTC's 2019 visit to California, the California DOT (Caltrans) required contractors to wait 10 days following placement of conventional concrete to allow construction traffic on new pavement. Based on information provided by MCTC during the site visit and the ensuing workshop, Caltrans removed the 10-day requirement if the opening strength requirement of the concrete is met. A portion of concrete placed in an Interstate 10 widening project in 2019 that would have to be specified as rapid-strength concrete was replaced with conventional concrete due to the new opening strength requirement. Dulce Feldman, senior transportation engineer at Caltrans, who worked with FHWA to implement this new specification, noted that this change saved $9.5 million for this particular project alone and will allow future projects to open to traffic earlier, reducing construction zone delays for travelers.

"This program has really moved the needle," said Praul. "Our team has been able to change perspectives in an industry not known for quickly adapting to change. Not only are agencies trying these new technologies, but they are also quickly adopting them. We can help any agency or contractor make their concrete program better—today."

More than Just a Technology Demonstration

When the MCTC visits a State, participants tap into a resource that goes well beyond a field technology demonstration.

For project site visits, the MCTC is typically on location for 2 weeks. During that time, the MCTC team holds an open house for consultants; other Federal, State, and local offices; contractors; and academia. During these events, the team conducts a show-and-tell on a number of technologies used at the project site.

The team returns at a later date to deliver a 2-day workshop on how to develop a good concrete quality assurance (QA) program and how to incorporate many of the newer technologies into that QA program. The workshop serves both agency and industry representatives. The team presents the data gathered from the project, including long-term testing conducted after the end of the on-site visit, and provides customized suggestions based on analysis of the data collected. States are under no obligation to act on the suggestions and incur no long-term commitment.

"In these workshops, we want everyone—industry and agency—to participate, ask questions, and take advantage of our multi-State expertise," said Praul.

MCTC staff delivering a post-site visit workshop to DOT and contract employees.
Source: FHWA

Hands-on demonstrations provided by MCTC staff during an open house show and tell.
Source: FHWA

Accelerating Innovation

Implementation of new technologies can take years. The advantage a resource like the MCTC can bring is significant acceleration of the process. In 2020, each of the five States visited by the MCTC implemented something new that was presented during the on-site visits.

During MCTC's visit to a North Carolina project, a demonstration of pulse induction technology led North Carolina DOT (NCDOT) and the contractor to change the acceptance criteria for the pavement mid project during the visit and begin using pulse induction technology to measure concrete thickness. This example shows that when the right technology exists for an agency and contractor, the right demonstration can remove years off the implementation timeline.

"I've been with FHWA 33 years, and I can't recall ever seeing a project where they changed the method of acceptance in the middle of the project," said Praul. "This was a big project, and both the contractor and the agency were so sold on the technology, they implemented it immediately."

"The week in which the MCTC was on our project was an invaluable experience not only for our North Carolina projects, but for all our company projects that feature concrete paving," said Fred White, quality control manager for the NCDOT contractor. "We were able to gain useful knowledge about various testing procedures, better-performing mix designs, and testing equipment. The team was able to assist us with training and information to help us make a strong case to NCDOT to use pulse induction technology to determine pavement thickness. We are now using that technology on three projects within the State and are in the process of eliminating old, destructive techniques of determining pavement thickness throughout the company."

Even in cases where immediate implementation does not occur, the MCTC still serves an important role. The West Virginia DOT (WVDOT) was introduced to surface resistivity during a 2015 MCTC visit. In 2020, WVDOT reached out to the MCTC team to discuss equipment options because the agency was ready to implement the technology.

Equipment Loan Program and Training

The MCTC offers an equipment loan program to highway agencies and contractors to test and evaluate the specialized equipment required for many of the promoted tests and techniques. The program allows agencies and contractors to borrow various pieces of equipment for a period of time to evaluate performance and determine if the equipment meets its needs.

"The equipment is available to borrow, free of charge, for States, industry, or academia," said Praul. "Our team will provide training on how to properly use the equipment and support the agency or institution borrowing it over-the-phone or through online instruction."

Operating in a travel-restricted environment for part of the year has proven to be a challenge for the MCTC team, but one that has opened the door for a greater focus on targeted training. The MCTC now offers virtual training aimed at technicians. These training opportunities are available to agencies and industry and are designed to share the decades of experience the team members have to offer.

"The training we offer covers how the equipment works plus tips and tricks for running the associated tests based on our experiences," said Praul.

Through services like these, the MCTC continues to play a key role in ensuring States and industry are better equipped to evaluate and implement new concrete technologies.

THE FOLLOWING ARE INCLUDED IN THE MCTC EQUIPMENT LOAN PROGRAM:

- Dowel bar alignment
- Pavement thickness
- Ultrasonic tomography
- Pull out strength
- Maturity testing
- Match curing
- Surface resistivity
- Super Air Meter
- Box Test
- V-Kelly Test
- Calorimeter
- Microwave water content
- Coefficient of thermal expansion

MCTC staff preparing for an open house show and tell during a site visit to Colorado in 2018. Source: FHWA

FHWA TO REVIEW 20-YEAR-OLD PAVEMENT DESIGN POLICY

Multiple stakeholder feedback events provide valuable input.

FHWA has analyzed input received from more than a year's worth of feedback events where members of the pavement industry, State departments of transportation (DOTs), and FHWA division offices discussed pros, cons, challenges, and concerns with the FHWA Pavement Design Policy and its associated guidance. An industry listening session, followed by five State DOT regional peer exchanges and a national summary workshop, focused on the Code of Federal Regulations (CFR), Title 23, Part 626; the Federal-aid Policy Guide Non-Regulatory Supplement (NRS) NS 23 CFR Part 626 *Pavement Design Considerations*, dated April 1999; and Technical Advisory T5040.39A, *Use of Alternate Bidding for Pavement Type Selection*, dated December 2012.

FHWA regulations at 23 CFR 626.3 state: "Pavement shall be designed to accommodate current and predicted traffic needs in a safe, durable, and cost-effective manner." Regulations do not specify procedures to follow to meet the requirement. Instead, each State highway agency is expected to use a design procedure appropriate for its condition.

Stakeholders broadly agreed that it is important for FHWA to clarify the current policy and clearly communicate what is required and what is best practice. Stakeholders also agreed that more frequent policy reviews are needed to keep up with industry changes and incorporate new knowledge and innovations.

Industry Listening Session

- Stakeholders offered feedback and many suggestions for FHWA to consider during the i**ndustry listening session**. Here are some highlights:
- The policy can help boost innovation and create collaborative environments through incentives for competition.
- The ability to include cost-effectiveness through life-cycle cost analysis (LCCA) or otherwise is important. More guidance could be added to LCCA to include best practices.
- Sustainability and resiliency should be considered, but left open and kept general.
- Further flexibility could be added by changing current language that prevents preservation actions if structural capacity is added.
- Because the low-bid environment does not always encourage innovation, adding further guidance in the contracting process could help boost it.
- Stakeholders were not in agreement regarding whether life-cycle assessment and expected service life should be included in the policy.
- Some participants felt asset management, preservation, and structural capacity principles are important, but issues exist currently in how they are implemented (e.g., implementation methods can encourage a "worst first" type of strategy, overly focus on preservation, and/or make certain preservation choices unavailable for use because they also add structural capacity).
- Foundation is a very important consideration during design. State DOTs could use more guidance in the NRS on pavement structure, tied to the different ways to account for end of life.
- Local calibration of AASHTOWare® Pavement ME Design must be done.

State DOT Regional Peer Exchanges

State DOT participants generally agreed their missions and values were consistent with FHWA's Pavement Design Policy—pavements should be designed in a safe, effective, economical, and durable manner. States indicated FHWA consider innovation, efficiency, reliability, education and research, environment, preservation, structural capacity, cost-effectiveness, industry competition, mobility, and quality of life.

States agreed their focus should be on proper design and maintenance and improved safety. They also agreed that FHWA can play a supportive role to help agencies achieve their mission goals by providing guidance and taking a proactive approach toward education and outreach. Additionally, many States agreed that priority should be on maintaining existing infrastructure, rather than adding new capacity.

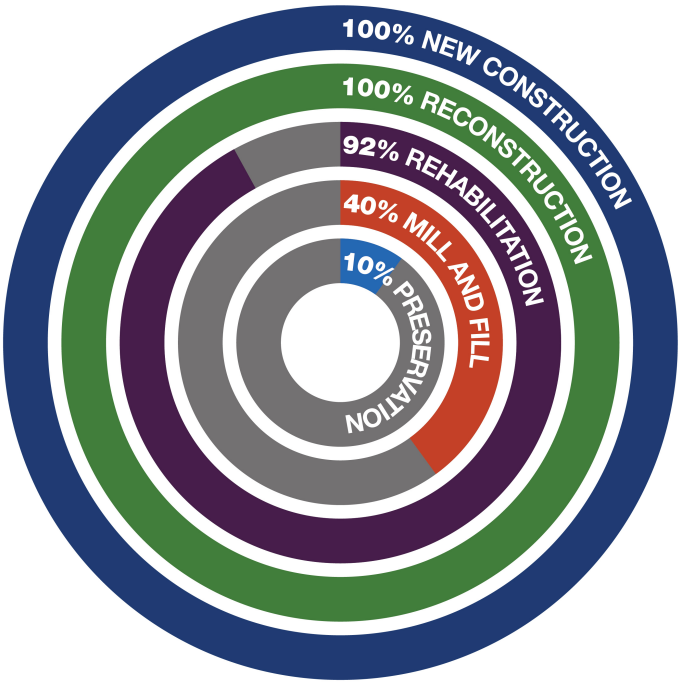
Participants also suggested revisions be made to the economic analysis portion of the policy. Not all States uniformly use LCCA for pavement design projects. States do not believe LCCA should be applied to every project and requested FHWA provide guidance or tools to help them know when LCCA is best applied. Some States that currently use LCCA reported dissatisfaction with the current practices and question whether LCCA truly leads to cost-effective decisions. States requested guidance in pavement type selection and best practices for using LCCA. Some States have life-cycle costs clearly defined in their policies, but others do not. They said clarity and communication are keystones to policy.

Generally, participants felt States should be required to have a written policy but recommended FHWA develop a checklist of minimum requirements to make expectations clear and consistent.

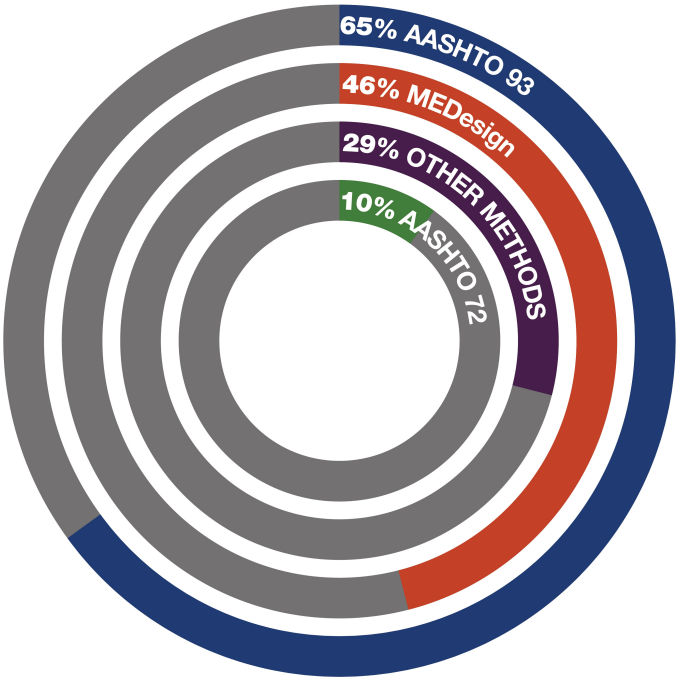
States discussed the NRS in relation to their missions and strategies. They generally agreed that the NRS includes too much narrative and suggested "sticking to the facts." States recommended engineering judgment be left up to them. Some States identified Pavement ME Design as a barrier due to cost and calibration of the tool. Some participants said as written now, the NRS, in addition to the policy, gives the impression that States must conduct LCCA for all pavement projects.

FHWA Peer Exchange 2019

WHAT TYPE OF PAVEMENT PROJECTS REQUIRE A STRUCTURAL PAVEMENT DESIGN?



WHAT STRUCTURAL PAVEMENT DESIGN METHODOLOGIES ARE AGENCIES CURRENTLY UTILIZING?



Example infographics depicting current state of practice.
Source: FHWA

Key Outcomes from Feedback Sessions

"We learned during the feedback sessions that stakeholders feel having a pavement design policy is important," said FHWA Pavement Engineer Heather Dylla. "However, there are differences in how people interpret the rule, which has its challenges. FHWA is exploring various options that strike a balance between flexibility and enforceability, including possible changes to its policy."

FHWA has engaged in four efforts as a result of the feedback sessions. These include an implementation plan; a case study developing a framework to link a State's pavement design policy to its Transportation Asset Management Plan (TAMP); current state of practice infographics and website; and a webinar series.

Implementation plan: FHWA is developing an implementation plan that addresses nearly 100 "needs" identified during the listening session, peer exchanges, and workshop. The needs were prioritized and labeled by FHWA as top, high, medium, low, or not FHWA purview. More than one-third were labeled "top" priority, and some are activities that have already started which are the subject of the upcoming webinar series. FHWA will use this information to inform changes to the pavement design program area.

TAMP Case Study: One idea that came out of the peer exchanges was that a State's pavement design policy could or should relate to the State's TAMP. The TAMP identifies a strategic and systemic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis, to identify a structured sequence of maintenance, preservation, and replacement actions to achieve and sustain a desired state of repair over the life cycle of the assets at minimum practicable cost.

While FHWA continues to evaluate the current pavement design policy and develop next steps, it is also important to further understand how the project-level pavement design policy and the network-level TAMP can be linked to achieve long-lasting, safe, cost-effective pavements.

FHWA is working with the New Jersey DOT to develop a framework to link the State's pavement design policy to its **TAMP**. Once the case study is complete, a workshop could be held to bring State DOTs together to discuss the framework and to assess its scalability and adaptability for use by other States.

Current State of Practice Website: During the peer exchanges, States were asked to share their current practices. "This exercise was initially designed to help FHWA gauge the current state of the practice related to pavement design and economic analysis," said FHWA Pavement and Materials Engineer Jennifer Albert. "But it also proved to be valuable information for the State agencies as they openly shared experiences with their counterparts." FHWA is creating a series of infographics that summarize the information gathered during this exercise. FHWA is also developing a new interactive web page to allow States to access this visual collection of information and learn what their counterparts are doing.

New Jersey DOT Transportation Asset Management Plan
Source: FHWA

Follow-up Pavement Webinar Series: Another outcome of the feedback events will be a 6-month series of webinars to further address some of the topics discussed and highlight the ongoing efforts identified in the implementation plan.

DATE/TIME	WEBINAR TOPICS
Nov. 12, 2020 A recording will be available on the FHWA Pavements website.	**Pavement Design Policy Review Effort** • Summary of activities and feedback • Ongoing efforts **Introduction to FHWA's Pavement Program** • Strategic plan • Pooled fund demonstration project • Collaboration with other FHWA program offices
Nov. 19, 2020 A recording will be available on the FHWA Pavements website.	**Pavement Design Program Updates** • Vision and objectives • Pavement foundation improvements **LCCA: History and Current State of Practice** • Real cost updates
Dec. 15, 2020 2:00-3:30 PM ET	**Pavement Preservation Program** • Pavement preservation roadmap **Long-Term Pavement Performance Program** • Web portal • Data analysis plan **Friction for Safety Performance Modeling and Analysis** • What is safety performance analysis and why is it important for pavement engineers? • Is there friction between safety engineers and pavement engineers, or should there be?
Jan. 14, 2021 2:00-3:30 PM ET	**Fostering the Tie between Asphalt Materials and Pavement Design** • Introduction to the Mobile Asphalt Technology Center, Asphalt Materials Research Program, and Asphalt Binder and Mixture Laboratory • Improving the link between materials and their impact on pavement design considerations
Feb. 24, 2021 2:00-3:30 PM ET	**Working with States and Industry to Advance Concrete Technology** • Durability research advancements • Technical resources for concrete pavement and materials engineers • Mobile Concrete Technology Center overview
Mar. 23, 2021 2:00-3:30 PM ET	**Improving Pavement Sustainability and Resiliency** • Sustainable Pavements Program Overview • Advancements in sustainability performance metrics • Introduction to a new FHWA tool: LCAPave

TARGETED OVERLAY PAVEMENT SOLUTIONS

Innovation Earns National Spotlight

Targeted overlays match treatments to high-priority, high-need locations.

Beginning in January 2021, Targeted Overlay Pavement Solutions (TOPS) will join FHWA's Every Day Counts (EDC) program as part of its sixth round. As an EDC-6 innovation TOPS will offer resources to help rapidly deploy new pavement overlay products and techniques for both asphalt and concrete to States and other agencies across the country.

TOPS will promote methods to survey and evaluate existing pavements to determine whether an overlay is the right strategy and to offer a toolbox of overlay solutions. Overlay solutions include both asphalt and bonded and unbonded concrete overlays as well as specific mixtures with potential benefits such as increased friction or targeted resistance to distresses such as rutting and cracking.

FHWA EVALUATED MORE THAN 40 INNOVATIONS BEFORE SELECTING 7 FOR EVERY DAY COUNTS.

"There's no 'silver bullet' for an agency to use," said Tim Aschenbrener, FHWA TOPS team co-lead. "There's no single answer for everyone, but by using good project selection practices, we believe every agency can find a targeted solution that is cost-effective."

What is EDC?

Since 2009, FHWA's EDC program has identified and promoted many proven but underused transportation innovations to shorten project delivery, enhance roadway safety, reduce traffic congestion, or integrate automation. Through the EDC model, FHWA works with State and local transportation agencies and industry stakeholders to identify a new collection of innovations to champion every 2 years. 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.

Asphalt overlay
Source: FHWA

Concrete overlay
Source: FHWA

Why TOPS?

Approximately half of all infrastructure dollars are invested in pavements, and more than half of that investment is in overlays. By enhancing overlay performance, State and local highway agencies can maximize this investment and help ensure safer, longer-lasting roadways for the traveling public.

"What we hope to do is improve long-life performance of overlays in concrete and asphalt," said Sam Tyson, TOPS team co-lead. "The cost savings associated with performance improvements help address the daily issue of funding with highway agencies."

Many of the pavements in the Nation's highway system have reached or are approaching the end of their design life. These roadways still carry daily traffic that often far exceeds their initial design criteria. Overlays are now available 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.

While many States are already using some form of pavement overlays, the TOPS team believes there is still room to improve the performance of existing overlays while also introducing new States to available overlay products.

Crews install a concrete overlay.
Source: FHWA

Crews install an asphalt overlay.
Source: National Asphalt Pavement Association

Asphalt Overlay Products	Concrete Overlay Products
• High-performance thin overlay (HPTO)	• Unbonded concrete on concrete (UCOC)
• Crack attenuating mixture (CAM)	• Unbonded concrete on asphalt (UCOA)
• Highly modified asphalt (HiMA)	• Unbonded concrete on composite (UCOA/Composite)
• Enhanced friction overlay	• Bonded concrete on concrete (BCOC)
• Stone matrix asphalt (SMA)	• Bonded concrete on asphalt (BCOA)
• Asphalt Rubber Gap-Graded (ARGG)	• Bonded concrete on composite (BCOA/Composite)
• Open-Graded Friction Course (OGFC)	
• Ultra-thin bonded wearing course (UTBWC)	

BENEFITS

Safety. Thousands of miles of rural and urban pavements need structural enhancement and improved surface characteristics, such as smoothness, friction, and noise. Targeted overlay solutions can improve the condition of highways significantly in a relatively short time.

Cost Savings. Timely and well-designed overlay applications are consistently cost-effective because less subsurface work is required. In urban areas, impacts to utilities and pedestrian facilities are minimized.

Performance. Targeting overlay solutions to high-maintenance areas such as intersections, bus lanes, ramps, and curved alignments can pay immediate dividends in terms of reduced maintenance needs, fewer work zones, and improved safety.

Overlays Already Benefit Agencies Nationwide

Agencies using concrete overlays benefit from performance-engineered mixtures, including thinner-bonded and unbonded overlays with fiber reinforcement, and interlayer materials. New design procedures have also broadened concrete overlay surface treatment applicability, reliability, sustainability, and cost-effectiveness.

Iowa has seen concrete overlays in the State exceed the expected 20-year service life. The State has used bonded and unbonded concrete overlays on both asphalt and concrete. Iowa State University studied nearly 400 concrete overlays and found that almost 90 percent had a pavement condition index of good or above and over 90 percent had acceptable ride quality. Based on this data, the Iowa Department of Transportation (DOT) expects its concrete overlays to perform well to an age of approximately 35 years.*

Asphalt overlay mixtures have also advanced significantly with the use of stone-matrix asphalt (SMA), polymer-modified asphalt (PMA), and new mixture design approaches that reduce rutting, increase cracking resistance, and extend pavement life.

Several State DOTs have already adopted SMA due to increased service life and performance. The Maryland, Alabama, and Utah DOTs each used over 1 million tons of SMA during a 5-year period.*

"Stone-matrix asphalt mixtures, placed underneath open-graded mixture types, have shown durable and exceedingly superior performance on Georgia interstate roadways," said Sheila Hines, retired State bituminous construction engineer for Georgia DOT. She is currently a consultant for the agency. "These mixtures, when used in conjunction with micro-milling of the aged and deteriorating open-graded surface layer, have displayed good field performance for more than 25 years."

DOTs in Florida, Georgia, New Jersey, New York City, Tennessee, and Virginia found highly modified asphalt in thin overlays is more resistant to reflective cracking and rutting. It has increased pavement life by two to four times for DOTs in Alabama and Oklahoma.*

Visit FHWA's **Every Day Counts** web page for additional EDC-6 TOPS program details and resources.

* Source: **https://www.fhwa.dot.gov/innovation/everydaycounts/edc_6/targeted_overlay_pavement.cfm**

This 1.7 mile 9-inch thick concrete overlay project with 12-foot joint spacing was constructed in 2007 in Overland Park, Kansas. Source: American Concrete Pavement Association

Concrete Pavement Videos

A series of 17 technology transfer videos called "**Concrete Clips**" is available to help transportation agencies and industry advance the state-of-the-practice in concrete pavements. Deploying and promoting pavement technologies and practices that will improve life, performance, cost-effectiveness, safety, and user satisfaction of pavements is a requirement identified in the Moving Ahead for Progress in the 21st Century Act, known as MAP-21 (Pub. L. 112-141, Section 52003(c)(3)(B)(vi)). The key factors for achieving well-performing, long-life concrete pavements include durable concrete, adequate structural design, design features that minimize the risk of poor performance, and good construction quality. Implementing the practices featured in each video may help State DOTs consistently achieve well-performing, long-life concrete pavements that are more economical and more sustainable.

Each video is about 10 minutes long. The series has generated thousands of views.

Concrete Clips Video Topics

- Internal curing
- Aggregates for concrete paving mixtures
- Blended cements
- Cement manufacturing
- Supplementary cementitious materials
- Real-time smoothness overview
- Real-time smoothness sensor installation
- Real-time smoothness data analysis
- Mobile Concrete Technology Center
- Workability
- Maturity and strength gain
- Ensuring durability mechanisms and mitigation
- Durability test methods
- Curing
- Engineering concrete mixtures for performance
- Admixtures
- Mechanistic-empirical design for pavements

SUSTAINABLE PAVEMENTS PROGRAM MARKS 10-YEAR ANNIVERSARY

Outreach, education, and tool development used to fulfill program's mission.

Pavements are an integral part of the roadway network. They provide a smooth and durable all-weather traveling surface that benefits many types of users and vehicles. Given their key role and widespread use, a unique opportunity exists to improve the sustainability of pavement structures and the potential to deliver environmental, social, and economic benefits. This is known as the "triple bottom line."

FHWA Sustainable Pavement Engineer Heather Dylla said, "Rather than focus solely on what something costs, we encourage DOTs (departments of transportation) to ask, 'Can there be any improvements made to help society? What are the environmental benefits, and have they been quantified early on in the design process?'"

In terms of pavements, "sustainable" refers to system characteristics that encompass a pavement's ability to achieve engineering goals; preserve and restore surrounding ecosystems; use financial, human, and environmental resources economically; and meet basic human needs such as health, safety, equity, employment, and comfort. Continual improvement with an emphasis on each of these characteristics leads to more sustainable pavements. Transportation agencies that create sustainable pavements have to keep innovating and adapting to meet standards in support of people and the environment.

FHWA created a **Sustainable Pavements Program** (SPP) in 2010. The first 5 years of the SPP involved documenting the state of knowledge. From 2015 to today, the program has focused on performance metrics. Now at its 10-year anniversary, the SPP is focusing on implementation.

The SPP will focus the next 5 years on showing agencies how to use new tools and other resources. This effort is well underway. The SPP is creating a Sustainable Pavements Program Checklist, a Sustainable Pavements Environmental Impact Benchmarking Tool (LCAPave), 3 technical briefs, and 10 case studies. The SPP also conducted 10 **sustainable pavement webinars**, which included 815 participants.

Sustainable Pavement Tools

The **Sustainable Pavements Program Checklist** is a list of sustainable practices that may be applicable to pavement projects. Depending on which practices are checked as being used, a list of environmental, social, and/or economic benefits and best practice recommendations will appear in a message section of the tool. To help in this area, the SPP developed **three technical briefs**. One focuses on the **Building Blocks of Life-Cycle Thinking**. Life-cycle thinking (LCT) is a holistic approach to considering the economic, environmental, and social impacts across the complete life cycle of a product, system, or service. LCT involves two key steps: identifying the goals and performance metrics and defining the life-cycle stages. It is important to consider the entire life cycle, so all decision consequences are included and not just the initial impacts.

The second technical brief is called **Data Needs for Pavement LCA: What Agencies Need to Know**. The data needed to perform a life-cycle assessment (LCA) (including the data quality requirements and the available data sources) depend on the type of questions to be answered by the LCA. An LCA can be as simple as an evaluation of one or more environmental impact categories of a single material or may consider a full pavement life cycle with a comprehensive list of environmental impact categories.

Necessary data and associated quality requirements are often different in each project phase of the delivery process. In the early stages, when conceptual decisions are made, the project scope will be less certain. More detail is added as the project moves through the design process.

LONGER LIFE PAVEMENTS

Lower costs, reduced environmental impacts, and positive social benefits

The design lives of longer life pavements may range from 30 to more than 60 years for both asphalt and concrete pavements.

Longer life pavements are generally justified for higher volume facilities and may afford the opportunity to reduce life-cycle costs, user costs, and environmental impacts as compared to conventional pavement designs.

ECONOMIC

- Reduced pavement life-cycle costs.

ENVIRONMENTAL

- Energy use.
- Reduced noise emissions.
- Improved air and water quality.

SOCIAL

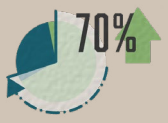
- Improved safety and ride quality.
- Improved resource conservation.
- Reduced landfill space.

CASE STUDIES

MINNESOTA

Long-Life Concrete Pavement

Minnesota reported 40% reduction in ozone depletion potential and smog formation compared to conventional MnDOT concrete pavement designs.



Minnesota reported 70% increase in service life with modest 5% increase in initial cost compared to conventional MnDOT concrete pavement designs.

IOWA

Perpetual Asphalt Pavement

Iowa reported 20% reduction in ozone depletion potential and smog formation compared to conventional asphalt pavement.

Iowa reported 27% reduction in life-cycle cost compared to conventional asphalt pavement.

The third technical brief focuses on **Environmental Product Declarations** (EPDs). State DOTs are continually assessing and choosing materials or technologies to meet their transportation needs. As part of this assessment, DOTs are turning to EPDs to quantify the environmental impacts associated with those products.

An EPD is a product label used to communicate the environmental impacts (resource use, energy, emissions) associated with the manufacture or production of construction materials such as asphalt, cement, asphalt mixtures, concrete mixtures, or steel reinforcement. EPDs document the results of an LCA. They are developed with stakeholder input and follow industry standards.

Sustainability measurement is an evolving field. It is the first step in establishing benchmarks and assessing progress. This involves a greater understanding of the LCA process and how highway agencies can use LCA to evaluate pavement systems. SPP developed a spreadsheet-based LCA benchmarking tool, known as LCAPave, so agencies can assess and quantify the environmental impacts of their pavement material and design decisions.

LCAPave is unique in three ways. First, it only uses data publicly available from background assets. Public background data sets are important for transparency and comparability, and they reduce the costs of conducting LCAs. Second, LCAPave's creation occurred with industry stakeholder engagement. The third unique aspect is that this tool incorporates EPDs, while most other tools do not. LCAPave is also one of the first tools designed specifically for use on pavement projects. As of September 2020, FHWA is evaluating it internally. Both the Delaware and Minnesota DOTs are helping evaluate its effectiveness.

"Other tools only allow for broad-based discussions," said Minnesota DOT Pavement Engineer Curt Turgeon. "LCAPave gives us detailed environmental impact information we can consider throughout the project design process to optimize impact levels and compare options."

"The tool will allow agencies to plan, design, construct, and maintain pavements by looking at the long-term costs and benefits both from an economic and 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."

"The tool will allow agencies to plan, design, construct, and maintain pavements by looking at the long-term costs and benefits both from an economic and 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."

Planning for the Future

The pavement community can use FHWA tools and resources to incorporate sustainability considerations throughout the pavement life cycle. The development of sustainable strategies will depend on the characteristics of the specific project, the materials and technologies that are readily available, and the specific economic and societal goals of the agency.

"The arena of sustainability and resilience is ever evolving for the transportation industry as new challenges occur," said Pappas. "We must work together and discuss success and failures in an open forum to learn from others and use the best practices for our State's infrastructure. We must continue to improve because ensuring transportation mobility will be key to providing opportunities for the constituents we serve."

For more information visit the SPP **website**. Stay informed about the latest pavement sustainability news and resources by joining the **SPP Friends List.**

Pavement Foundation Research

Foundation design is a key aspect of pavements structural design that needs to be considered in design processes. The basis of design in current mechanistic-empirical (ME) design procedures are pavement responses such as stresses, strains, and deflections. Because the stiffness of unbound base layers is significantly less than that of surface layers, foundation layers have a relatively minor impact on pavement response. Thus, the benefits of a good foundation are not adequately reflected in the ME design process. While fundamentally, the ME design concept is sound, the ME designs do not consider the effects of any deterioration or spatial variability in the foundation layers. Over time, the conditions of the foundation layers can degrade and deform under the influence of repeated heavy loads, leading to non-uniform support conditions and localized failures. Thus, the principal role of a robust pavement foundation is ensuring the foundation layers retain their integrity throughout the pavement life.

Improving pavement foundation design is a focus area for FHWA. A pavement foundation that does not degrade over time does not need to be replaced, which may translate to significant sustainability benefits in environmental impact and costs. In congested areas, eliminating the need to replace the foundation could be highly advantageous by expediting pavement rehabilitation.

Various activities are underway at FHWA to accomplish the following:

- Improve the understanding of the role of pavement foundation.
- Document how pavement foundation can deteriorate over time.
- Document best practices in pavement foundation design.

Activities include these ongoing projects:

- Effective Foundation Design for Concrete Pavements – demonstrate the importance of a good foundation through case-study examples.
- Failure Mechanism of Pavement Foundation – provide a clear, qualitative description of how pavement foundations fail, and use this information to develop guidelines for effective foundation designs for different site conditions.
- Feasibility of Utilizing Intelligent Compaction (IC) Equipment to Ensure Uniformity and Quality of Pavement Foundation – demonstrate the feasibility of using IC to ensure uniformity and adequacy of pavement foundation.

Foundation layers serve as platforms for construction traffic and uniform paving operations while also being crucial for long-term performance of the pavement structure. Source: Applied Research Associates, Inc.

PERFORMANCE ENGINEERED PAVEMENTS

ASPHALT

Advancing asphalt design, construction, and testing to the 21st century.

Since the 1950s, the transportation community has focused on improving pavement performance. This emphasis on performance has increased due to the Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation (FAST) Act, as well as the pavement community's desire to incorporate performance into design and acceptance.

The concept of performance engineered pavements (PEP) is a long-term vision that incorporates structural pavement design, balanced mixture design (BMD), and performance-driven acceptance to increase the long-term durability and performance of the Nation's pavements. PEP is viewed as a further step down the quality assurance continuum away from prescriptive specifications and towards a more joint sharing of risk. A critical part of the vision is to develop a PEP roadmap, currently underway at FHWA.

"We are trying to create a framework that integrates pavement design with construction and final acceptance of the pavement," said Richard Duval, FHWA asphalt materials and pavement performance engineer lead.

"PEP is a big-picture, long-term vision for pavements, with several short- to medium-term achievable steps," said Tim Aschenbrener, FHWA senior asphalt pavement engineer. "From a State's perspective, it can be a heavy lift to implement all of PEP, so it is important to just take one step at a time and not get overwhelmed. If an agency is looking to begin the PEP journey, mixture design is a good place to start."

Performance testing during mixture design allows optimized mixtures for available materials and the intended traffic, climate, and service environment. PEP encourages agencies to detect prevalent failure mechanisms in their roadway network and identify the best performance tests and mixtures to address the failures. Assessing and optimizing the use of reclaimed and recycled materials along with new products in mixture design can lead to more sustainable pavements and minimize risk of premature deterioration. Integrating a properly vetted and applied BMD performance test into an agency's quality assurance program is an opportunity to increase the probability of achieving design expectations. On the contractor side, PEP provides more flexibility in material selection and mixture design.

PERFORMANCE ENGINEERED PAVEMENTS SEEK TO ENSURE THAT WHAT AN AGENCY DESIGNED IS WHAT THEY ACTUALLY GET DURING CONSTRUCTION.

Performance Mixture Design

The addition of recycled and innovative materials in mixtures causes them to perform differently than traditional mixes, so agencies need a way to measure and estimate their performance. Volumetric testing does not adequately capture the performance characteristics of asphalt mixtures containing reclaimed binder, recycling agents, polymers, and other additives common in modern asphalt pavements.

"Most States use volumetric properties to design asphalt mixtures," said Aschenbrener. "With recycled materials and new and innovative materials—RAS (reclaimed asphalt shingles), RAP (reclaimed asphalt pavement), recycling agents, and polymers—these volumetric properties don't always work well, so using a BMD performance test will give a much better picture of how the asphalt mixture will perform over time."

For asphalt pavements, BMD seeks to achieve the combination of asphalt binder, aggregate, and additives and recycled materials proportions that will meet performance criteria for a diverse number of pavement distresses and a specified level of traffic, climate, and pavement.

"NJDOT has used BMD on our specialty asphalt mixes to ensure we are getting the performance for which these mixes were designed," said Stevenson Ganthier, New Jersey Department of Transportation (NJDOT) principal engineer. "We are able to determine ahead of time if we will have cracking and rutting issues based on our Asphalt Pavement Analyzer and Overlay Tester results. The ability to determine problematic areas ahead of time can save our State from future costly repairs. Another benefit of BMD that we have noticed is choosing appropriate mixes based on field conditions allows us to use the most economical mix based on the situation. The BMD approach is vital to asphalt pavement work we currently do and plan on doing in the future at NJDOT."

"By properly designing and evaluating an asphalt mixture through BMD, agencies can be more cost-effective long term," said Duval. "Accurately assessing the pavement material properties avoids unexpected maintenance and rehabilitation costs."

Pavement Design

An important aspect of PEP is adequate structural design of the pavement surface and foundation layers to meet the targeted design life at a desired level of reliability. Selecting the right pavement materials and layer thicknesses to meet the traffic and environmental needs using distress-based performance criteria entails the use of a mechanistic-empirical pavement design procedure. "As the pavement and materials community learns more about the effectiveness of BMD performance tests in assessing the life of a pavement layer, that information can be tied to pavement design through mechanistic-empirical pavement design methods using local calibration in the near term and directly into pavement performance models in the long term," said Chris Wagner FHWA pavement and materials technical director.

FHWA IS DOCUMENTING CASE STUDIES ON BMD USE, SPECIFICATIONS, PERFORMANCE TESTS, AND PRACTICES. FHWA ANTICIPATES MAKING THESE AVAILABLE ON THE FHWA PAVEMENTS PROGRAM WEBSITE OVER THE NEXT YEAR.

Performance-Driven Acceptance

Another step along the continuum toward performance driven acceptance is Performance Related Specifications (PRS). PRS are agency-developed quality assurance specifications that describe their desired levels of key materials and construction quality characteristics that correlate with fundamental engineering properties that predict performance.

PRS systems use fundamental tests in calibrated mechanistic-empirical performance models to assign rational pay adjustments based on the difference between the expected as-designed and as-constructed service life of the pavement. The adoption of PRS specifications is a long-term vision. Some of the advanced tests and predictive pavement design models could also be used for specialized mixture comparison analysis and pavement forensics in the short term.

Interested in Pursuing PEP?

Agencies interested in the PEP journey should start with the **Performance Engineered Pavements Tech Brief**.This document breaks PEP down into segments to demonstrate how performance testing can evolve. Additionally, the University of Nevada-Reno, in a cooperative agreement with FHWA, published a report on **Balanced Mix Design for Asphalt Pavements**. This report includes procedure and evaluation factors for screening, assessing, and selecting specific performance tests as part of the BMD process dependent on an agency's specific needs, goals, capabilities, and resources. The report also provides approach examples.

"There are many performance tests to choose from," said Duval. "This can make it difficult for States to know where to begin. BMD gives States flexibility to select the most beneficial tests and procedures for their pavement performance needs."

PEP IS A HOLISTIC APPROACH TO PAVEMENT DESIGN, CONSTRUCTION, MATERIALS ACCEPTANCE, AND MAINTENANCE THAT INCORPORATES ELEMENTS OF THE OWNER'S DESIRED PERFORMANCE THROUGHOUT ALL PHASES OF THE PAVEMENT LIFE CYCLE.

AID-PT *SHORT TAKE*

Pavement Resiliency Peer Exchanges

FHWA is working with State DOTs to increase the resiliency of their pavement network. As aging infrastructure is rebuilt or upgraded, opportunities exist for States to plan and design infrastructure to meet future environmental conditions. FHWA has developed tools States can use to evaluate where weaknesses exist in their transportation system and is identifying methods to improve pavement performance, optimize funding, and increase the health and longevity of their roadways.

As part of these efforts, FHWA hosted a virtual pavement resiliency peer exchange in October 2020. The goal of the meeting was to bring together leaders from highway agencies, academia, and industry to identify methodologies for incorporating climate considerations in pavement material, structural design, and construction practices. Speakers discussed ways to address pavement infrastructure resiliency issues. Breakout sessions during the event provided a chance for smaller groups to convene and offer input and share ideas on key resiliency issues and strategies. To accommodate attendees' schedules, a second peer exchange is planned in December 2020 that will cover the same topics. **Registration** for the December meeting is available on the FHWA website.

Meeting Date:
December 16-17

Approximate Meeting Times:
Wednesday, December 16, 2020 (11 am – 4 pm ET)
Thursday, December 17, 2020 (11 am – 4 pm ET)

Agenda Topics/Activities:

- Introduction
- Overview of resilience issues
- Role of pavements in resilience
- Solutions and future needs

Several breakout sessions are planned to obtain input from attendees.

Macrotexture Measurement During Mix Design Using Rapid Laser Texture Scanner

The macrotexture of a pavement surface affects tire-pavement friction and skid resistance and therefore traffic safety, particularly at higher speeds and in wet pavement surface conditions. Traditionally, dense-graded asphalt mixtures have been designed for durability and long-life performance without significant consideration to their potential as-constructed macrotexture. To address this limitation, FHWA has initiated a project to identify equipment that will allow agencies to measure macrotexture using a discrete, non-contact system at the mix design and production phases on cores. In Phase I of the project, FHWA identified the Rapid Laser Texture Scanner (RLTS) as a technology that showed promise for use on both laboratory-prepared gyratory specimens and freshly compacted mat in the field.

As part of Phase II, the FHWA Mobile Asphalt Technology Center (MATC) is collecting laboratory and field macrotexture data from mixes and cores provided from various State DOT projects to determine testing variability. The FHWA Turner-Fairbank Highway Research Center's Asphalt Binder and Mixture Laboratory-Implementation and Delivery (ABML-ID) program, a partner lab of the MATC, is performing a deeper analysis to explore laboratory-to-field relationships based on the variety of aggregate types and asphalt binders represented in the State DOT projects to date.

Macrotexture data collection was initiated with an accelerated loading facility mix at the Turner-Fairbank Highway Research Center. The first field data collection was initiated with the MATC visit to South Carolina. During the field visit, loose mix was also collected for laboratory measurements using the RLTS. Some States, such as Florida, Rhode Island, Vermont, and California, are providing cores to FHWA for evaluation using the RLTS.

The MATC team is planning to visit several State DOTs in the future, and macrotexture data collection using RLTS, Circular Texture Meter (CTM), and Sand Patch will be included as part of the work plan for these visits. The CTM and Sand Patch offer other more established means to measure and estimate mean profile depth and are used as auxiliary data to support the investigation at the ABML-ID laboratory. FHWA plans to continue measuring macrotexture using gyratory specimens for mixture evaluation and generating data, as well as providing hands-on training on the use and operation of RLTS through the MATC.

Measuring macrotexture of laboratory-prepared gyratory specimen using rapid laser texture scanner.
Source: FHWA

SETTING THE STANDARD FOR PAVEMENT CONDITION DATA

FHWA teams with States to improve data collection standards and quality management.

Understanding the level of reliability of the pavement surface condition data used in pavement management is important for transportation officials. Repeatable and reliable pavement condition data play a role in developing condition indexes and performance models, understanding how and why some pavements perform better than others, and finding cost-effective solutions to meet pavement preservation needs. Good and reliable pavement condition data also play a role in determining performance measures, such as those required under Title 23 Code of Federal Regulations part 490 Subpart C – National Performance Management Measures for the Assessing Pavement Condition (23 CFR 490.307(a)).

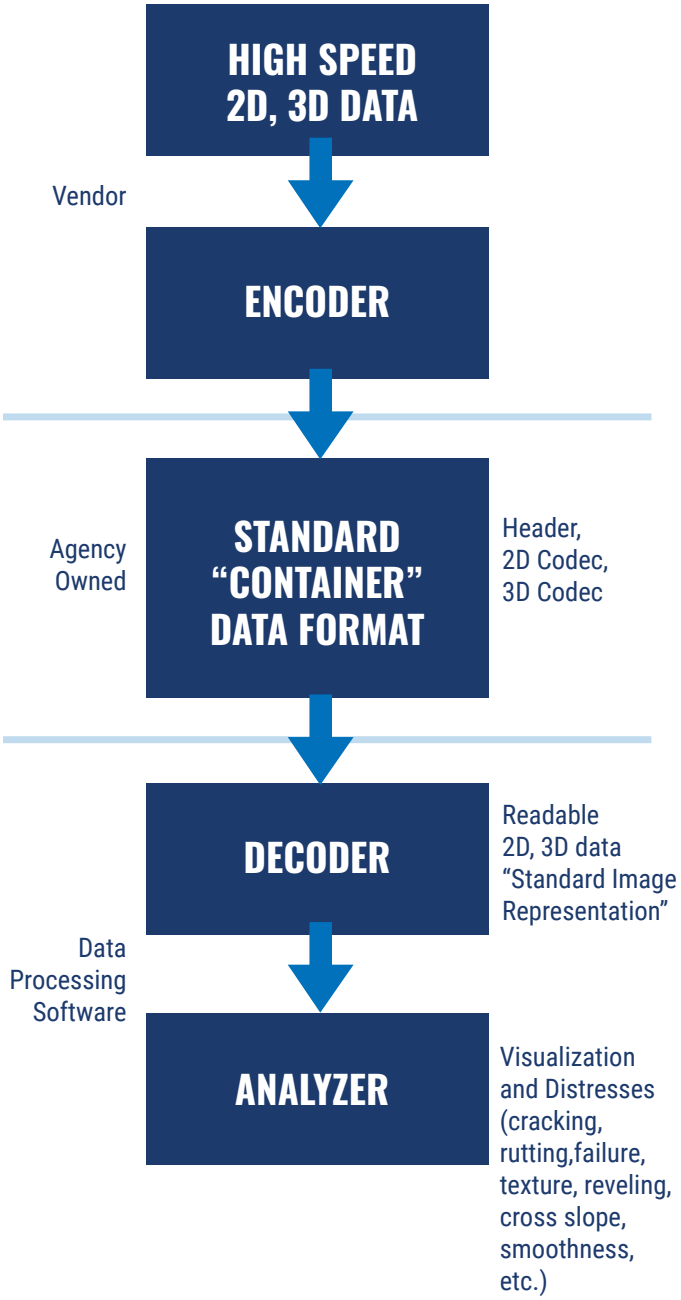
Pooling Resources

The Improving the Quality of Pavement Surface Distress and Transverse Profile Data Collection and Analysis (PSDAT) Pooled Fund Study, TPF-5(299), is a collaborative effort among participating State departments of transportation (DOTs), FHWA, and other public and private partners. Begun in 2014, the study seeks to develop pavement standards to improve the quality and longevity of public roads and to help government leaders better plan maintenance requirements and budgets.

Highway speed 3D data collection equipment.
Source: Applied Research Associates, Inc.

An earlier national pooled fund study, led by FHWA, resulted in near-universal adoption of the current roadway ride quality standards. The DOTs involved with that study believed using the same type of collaborative process, this time focusing on pavement rutting, cracking, and faulting, would be beneficial. This was the genesis of TPF-5(299), for which 24 DOTs are involved in developing project need statements, evaluating new approaches, demonstrating technologies, and implementing solutions. The goal of the study is to develop robust quality measures that a DOT could use, for example, for certification. Andy Mergenmeier, senior pavements and materials engineer at the FHWA Resource Center, noted the difficulty in achieving this. "Recognizing that technologies for measuring pavement conditions at high speed are evolving," he said, "it is a challenge for DOTs to establish standards that are robust enough to meet the high standards necessary to be included in a certification process."

To accommodate for future technologies, DOTs are developing certification standards blind to the technology used in data collection and analysis. This requires a balancing act between achieving standardization and allowing for innovation. The study prioritized projects recognizing that some condition data—such as transverse profile, rutting, and faulting—may have a clearer path to development of certification standards, while others—such as transverse cracking—may be more challenging. The study is focusing on developing best practices that participating DOTs can choose to use to improve what is currently being done, while recognizing that the longer-term solution may be different. Road performance measurement technologies will continue to evolve over the next 3 to 5 years, and as technologies improve, study participants can continue to incorporate them into the standards and, ultimately, a comprehensive certification process.



THE TECHNICAL POINTS

The transverse profile assessment standard practices are designed for equipment collecting transverse pavement profiles for analysis of rut depth, cross slope, and edge/curb detection. To fully evaluate the transverse measurements along the data process flow, the study team developed five standard practices, along with a sixth containing a set of terms and definitions. Four of the standard practices were developed to assess the static performance, body motion cancellation capability, navigation drift mitigation, and highway performance capabilities of transverse pavement profiling systems. The fifth standard practice assesses the accuracy and precision of the ground reference data.

An Inclusive Process

Participating DOTs are involved at every step, with DOT employees serving on project oversight panels. They have funding participation in the pooled fund study, and they each have a vote. They review all the products, providing comments and recommendations, and they decide on what actions to take next.

New Standards

The study team has submitted six proposed transverse profile-related standards to the AASHTO Committee on Materials and Pavements (COMP), including standard practices for the following:

- Assessment of Body Motion Cancelation in Transverse Pavement Profiling Systems
- Assessment of Ground Reference Data for Transverse Pavement Profiling System Assessment
- Assessment of Highway Performance in Transverse Pavement Profiling Systems
- Assessment of Navigation Drift Mitigation in Transverse Pavement Profiling Systems
- Assessment of Static Performance in Transverse Pavement Profiling Systems
- Definition of Terms Related to Transverse Pavement Profiling Systems and Ground Reference Equipment

The team also submitted a proposed standard to AASHTO COMP for a standard data format for recording two-dimensional (2D) and three-dimensional (3D) data. Based on these standards, the 2D and 3D data collected by a vendor can be stored in the standard data format and extracted by an DOT to perform pavement condition evaluation.

As part of the study's collaborative process, before these proposed standards went forward, all study participants cast votes to submit them for AASHTO consideration.

Current Activities

Many DOTs have shifted from manual inspection methods to automated methods for collection of faulting on jointed concrete pavements since other pavement management system data are also being collected in an automated fashion. In addition, automated methods keep personnel off the roads, resulting in greater worker safety. However, the accuracy of automated means of network-level faulting measurement has been mixed. If accurate faulting data is not available or properly analyzed, treatments such as pavement grinding might not be triggered at the appropriate time or location in a pavement's life cycle. Faulting is also one of the Federal national pavement performance metrics codified in 23 CFR 490.311(b)(4)(iii). The pooled fund study is working to develop traceable, objective, practical, and transparent procedures for faulting data collection and analysis. The effort also entails developing certification and verification procedures to evaluate the precision and accuracy of faulting information collected at the prevailing speed limit.

In addition to the pooled fund study, other FHWA projects are doing related work to tie the standards together. One of these projects, Guidelines for Quality Management of Pavement Surface Condition Data Collection and Analysis, is considering the individual standards together as part of the Quality Management Plan (QMP) guidelines for pavement surface condition data collection and analysis and incorporating those guidelines into certification procedures. This project involves working with three DOTs to test the QMP guidelines.

WHY IT MATTERS

Through implementation of the standard practices and requirement statements, highway agencies will have the ability to identify the accuracy and precision of transverse pavement profile measurements, identify whether two or more measurement systems are providing results within tolerances, and determine whether measurements taken at different times are consistent.

Looking Forward

To keep making progress, study participants continue to gather best practices for evaluating and tracking information from automated inspection systems. Together, partner DOTs will identify future projects to determine good candidates for inclusion in future standards.

As the study continues, opportunities exist for more DOTs to join the effort. From the outset, the work within the study was recognized as requiring many years to perform. With that in mind, study participants requested a follow-on study be initiated to continue the work. Within the national pooled fund program administrative procedures, TPF-5(299) is no longer accepting new agencies/funds, but a follow-on study, TPF-5(399) was approved and is accepting new agencies/funds. This is a nationwide pooled fund study, so DOTs can join at any time and can contribute funds at any time. Participants would not only have a voice in the process and be part of the decision-making, they would also gain insight on new developments, influence future projects, and participate in projects important to their unique circumstances.

"Based upon this and earlier pooled fund study efforts, such as the longitudinal profiler and ride quality predecessor, interested DOTs can be assured that this is a tried-and-true approach that has resulted in success. The current membership of 24 active DOTs speaks volumes, and the project is getting a national and geographically diverse perspective from their participation to help meet the needs of the entire U.S.," said Mergenmeier.

Visit the **TPF-5(299)** transportation pooled fund web page for more information and go to the **TPF-5(399)** web page to join the study.

Assessment of navigation drift.
Source: FHWA

AID-PT *SHORT TAKE*

New Pavement Management Roadmap

The 2010 **Pavement Management Roadmap** prioritized short-term and long-term needs for pavement management. Since the release of the Roadmap, several changes have occurred in pavement management. These changes include FHWA's 2015 regulations implementing the Moving Ahead for Progress in the 21st Century Act (MAP-21) National Performance Management Measures for Assessing Pavement Condition requirements along with asset management plan requirements that were continued under the subsequent Fixing America's Surface Transportation Act (FAST Act).

As a part of these regulations, State DOTs were required to collect Interstate and non-Interstate pavement condition data in accordance with the Highway Performance Monitoring System (HPMS) Field Manual (23 CFR 490.307). Additionally, each State DOT was required to develop a risk-based asset management plan describing how the National Highway System will be managed to achieve system performance effectiveness while achieving targets for asset condition through maximized funding cycles (23 CFR 515.7). Other changes include general advancements in technology and pavement management knowledge.

FHWA is updating the Pavement Management Roadmap to comprehensively reflect these changes in pavement management. The updates will share newly identified short-term and long-term needs and adaptability for continual, efficient adjustments for future transformative needs. FHWA anticipates the updated Roadmap will include a 10-year pavement management strategy that can be used by FHWA and other transportation agencies to support continued identification of research needs, transformative innovation development, and technology transfer opportunities. The Pavement Management Roadmap is expected to also include education and workforce development considerations that may be used with risk-based strategic planning efforts.

AID-PT *SHORT TAKE*

Workshop on Certifying Pavement Surface Condition Data Collection Equipment

In 2017, FHWA released regulations that directed States to develop data quality management plans, as required under the Moving Ahead for Progress in the 21st Century Act (MAP-21) and continued under the Fixing America's Surface Transportation Act (FAST Act). Per 23 CFR 490.319(c)(1), States shall use the data quality management plans to describe their methods for the following:

- Certifying data collection equipment.
- Certifying manual data collectors, if used.
- Describing data quality control measures used by collection crews.
- Identifying data sampling methodologies.
- Error resolution methodologies.

Each State developed a plan and worked with its local FHWA Division Office to gain approval of the selected methods. A number of States expressed difficulty in certifying the equipment used to measure pavement roughness, rutting, cracking, and faulting.

To address this gap, FHWA plans to offer a workshop in 2021 to provide hands-on training in certification programs for pavement surface data collection and evaluation equipment and procedures. The objective of the training and testing is to provide States with an adequate understanding of the techniques to establish their own programs or to actively participate in regional certification programs. The workshop will be conducted at locations where reference measurements for roughness, rutting, cracking, and faulting can be established so that the participants can use the references to certify their own equipment or equipment provided by their contractors.

AID-PT *SHORT TAKE*

Demonstration to Advance New Pavement Technologies Pooled Fund

FHWA is leading the solicitation for a new pooled fund study aimed at accelerating the delivery of safe, smooth, and durable pavements and ensuring a good return on highway funding investment. The **Demonstration to Advance New Pavement Technologies** pooled fund, initiated in September 2020, will leverage Federal investments with State partnerships to support and showcase the implementation of innovative pavement technologies, products, and processes by State DOTs.

The FHWA has identified three technology focus areas for consideration from its Pavement and Materials Research and Development Program. The following topics are planned for the initial solicitation, but the technical advisory committee may consider others as well:

- Development of Balanced Mix Design (BMD) for asphalt and performance engineered mixture (PEM) for concrete programs.
- Implementation of strategic pavement preservation programs.
- Integration of sustainability and resiliency into decision-making processes, technical frameworks, education efforts, and stakeholder engagement.

FHWA anticipates contributing $2 million annually for a period of 5 years (fiscal years 2021–2025) subject to availability of funds. The FHWA contribution is expected to be used to provide up to $250,000, up to 100 hours of technical assistance, and resources for developing case study reports and videos for each selected demonstration project. Participating State DOTs are expected to contribute $10,000 annually, submit and administer projects, collaborate actively with other States and FHWA to advance initiatives, and develop reports documenting project outcomes. To participate, go to solicitation 1542 on the **Transportation Pooled Fund Program website**.

Source: csp_logoboom
© Fotosearch.com

APPENDIX

Related Pavement Technology Development and Deployment Activities Supporting the AID-PT Program.

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 (FAST) Act, 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**℠ in EDC-1 (2011–2012), **intelligent compaction** in EDC-2 (2013–2014), and **pavement preservation** in EDC-4 (2017–2018).

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) is among seven new innovations FHWA introduced in September 2020 as part of EDC-6 (2021-2022).

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 Center for Accelerating Innovation (CAI) website to view a list of **STIC Incentive projects**.

The following are pavement-related STIC Incentive activities between June 2019 and May 2020:

- Louisiana developed a pilot program for pavement preservation.
- New York improved pavement skid resistance specifications through accelerated polishing of aggregates and dynamic friction testing.
- North Dakota implemented and expanded the use of density profiling system technology.
- Ohio incorporated ground penetrating radar rolling density meters as an accepted method for determining asphalt density.
- Oklahoma demonstrated fiber-reinforced asphalt concrete using aramid fibers.

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.

The AID Demonstration program operates under a rolling solicitation. Eligible agencies can submit applications through the Notice of Funding Opportunity. The AID-PT program directly supports pavement-related AID Demonstration grants. For example, the Illinois Department of Transportation and City of Jerseyville used compacted concrete pavement to improve roadway surface conditions this past year. 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.

Increased Federal Share for Project-Level Innovation

The **Increased Federal Share for Project-level Innovation**, a provision of Section 120(c)(3) of title 23, United States Code, provides the option of an increased Federal share for projects using innovative project delivery methods. Established by the Moving Ahead for Progress in the 21st Century Act (MAP-21) and amended by the FAST Act, this provision builds on the EDC initiative. The 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 approved at the Federal-aid Division Office level.

AID-PT

ACCELERATED IMPLEMENTATION AND DEPLOYMENT OF PAVEMENT TECHNOLOGIES

2019 2020 ANNUAL REPORT

Publication Number: FHWA-HIF-21-024

Office of Preconstruction, Construction, and Pavements

Brian Fouch
Director
202–366–5915
brian.fouch@dot.gov

Pavement Design and Performance Team

LaToya Johnson
Team Leader
202–366–0479
latoya.johnson@dot.gov

Pavement Materials Team

Gina Ahlstrom
Team Leader
202–366–4612
gina.ahlstrom@dot.gov

Contacts for More Information

Federal Highway Administration
Office of Preconstruction, Construction, and Pavements
www.fhwa.dot.gov/pavement

U.S. Department of Transportation
Federal Highway Administration

Source: csp_actionsports
© Fotosearch.com