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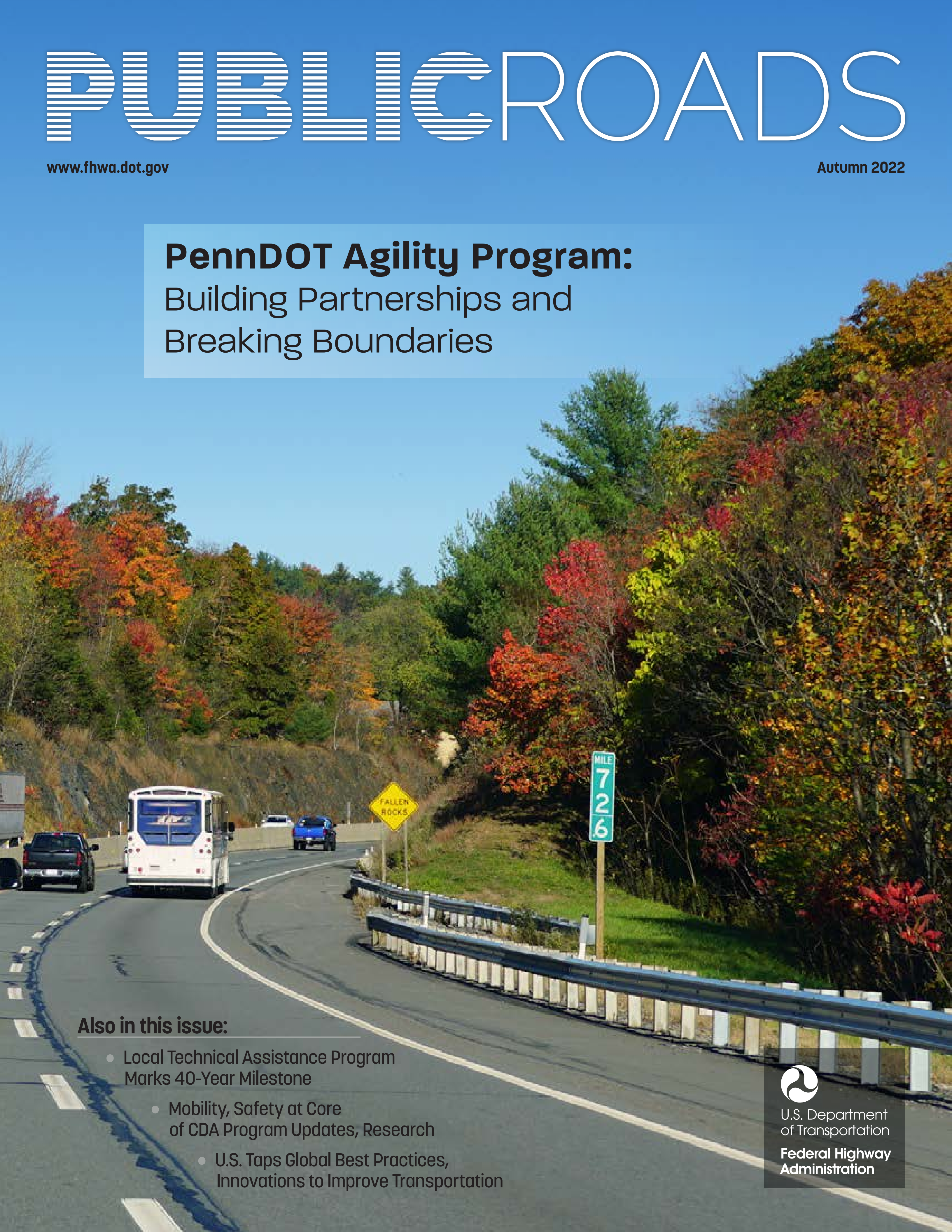

PennDOT Agility Program: Building Partnerships and Breaking Boundaries

Also in this issue:

- Local Technical Assistance Program Marks 40-Year Milestone
- Mobility, Safety at Core of CDA Program Updates, Research
- U.S. Taps Global Best Practices, Innovations to Improve Transportation

U.S. Department of Transportation
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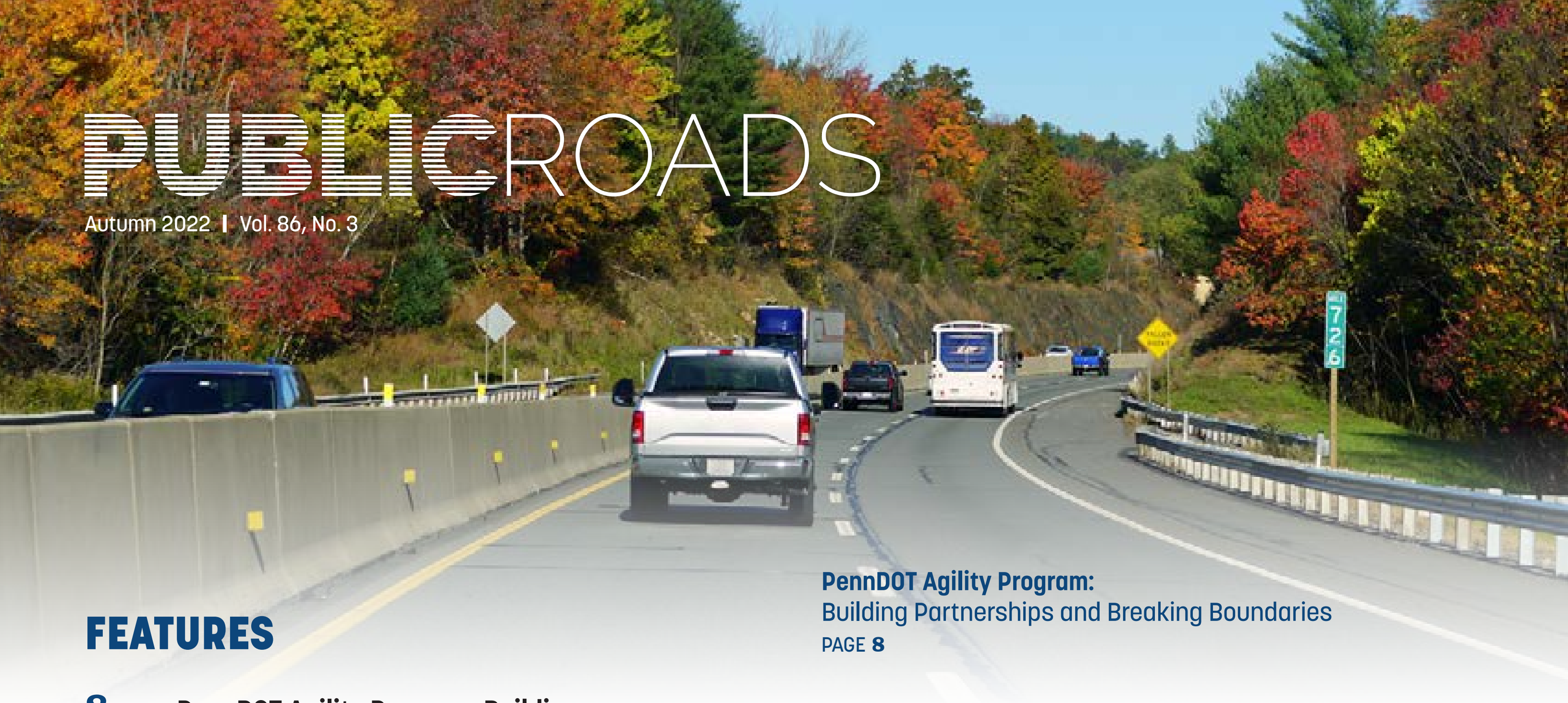

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FEATURES

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Source: FHWA.

DEPARTMENTS

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COVERS and ABOVE—Pennsylvania Department of Transportation's Agility Program helps manage its extensive network of roads and bridges.

U.S. Department of Transportation
Federal Highway Administration

U.S. Department of Transportation
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Source: FHWA.

GUEST EDITORIAL

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Putting the "World" into a World-Class Highway System

The mission of the U.S. Department of Transportation is: "To deliver the world's leading transportation system, serving the American people and economy through the safe, efficient, sustainable, and equitable movement of people and goods." The Federal Highway Administration's Office of International Programs (OIP) makes a significant contribution to achieving this mission through facilitating access to technical experts, technological advancements, and best practices abroad—beyond the Nation's borders. As the gateway to foreign innovations and collaborative relationships that advance the U.S. transportation system, OIP is ensuring that it is truly a world-class highway system in every sense of the word.

Safety, economic strength and global competitiveness, equity, climate and sustainability, transformation, and organizational excellence are USDOT's strategic goals; OIP ensures that FHWA's international activities directly support one or more of these objectives. In doing so, the office uses four primary programs or approaches, depending upon the nature of the issue: (1) Multinational Relations Program (especially the World Road Association (WRA)), (2) Global Benchmarking Program (GBP), (3) Binational Relations Program (BRP), and (4) International Visitors Program (IVP). Each of these approaches has helped to identify and disseminate transportation related technologies and best practices in the United States.

WRA is the only intergovernmental international organization focusing on road transportation technology transfer, and FHWA is the lead agency representing the United States. With access to more than 120 international road administrations and associated experts, WRA provides a one-stop shop to access global innovations and best practices.

GBP is a tool for obtaining and adapting specifically identified foreign advances that may accelerate an innovation or bring a practical improvement to U.S. infrastructure. Instead of recreating advances already developed elsewhere, this program concentrates efforts on acquiring and adopting innovations already proven abroad. The ultimate goal is to improve safety and mobility, avoid duplicative research, reduce costs, and accelerate improvements.

BRP includes FHWA's prioritized bilateral partnerships, covering a range of priority topics. The partnerships and topics are coordinated closely with program offices and are intended to complement or support existing agency activities and priorities. These engagements are mutually beneficial and foster collaborative platforms that result in long-term, strong, practical, and sustained relationships. These cooperative exchanges leverage limited resources to address FHWA's highest priorities. A sample of our binational collaborations include Australia, Brazil, Japan, Korea, the Netherlands, Switzerland, and Sweden. FHWA is also reaching out to re-engage with a number of countries in Sub-Saharan Africa on technology exchange and transfer.

Finally, IVP, at the request of another country, facilitates the sharing of information regarding U.S. technologies and best practices. While the intent is for the requesting country to learn from this Nation, their visits result in exchanges that are mutually beneficial.

Each program offers a flexible approach to address needs and complement work on the U.S. transportation system, whether it is gathering information, adopting an innovation or practice, or engaging in a technology exchange where benefits are reciprocated. These collaborative approaches work together and cross-pollinate, with developments in one area sometimes leading to opportunities in another. They also work in complementary ways to address different aspects of FHWA's international efforts, while focusing on U.S. priorities and the objectives of USDOT. Often, these approaches are used as instruments in communicating U.S. developments to the world and can lead to increased market access for U.S. firms and exports, aiding U.S. global competitiveness.

A representative list of technologies and best practices that have been learned through OIP's international exchanges and successfully implemented and integrated into the U.S. transportation system include road safety audits, anti-icing, lane control signals, and self-propelled modular transporters. This listing is a result of our efforts via the four primary approaches.

OIP makes it easy for FHWA to learn successful practices and emerging technologies from around the world, contributing to the mission of ensuring we have a world-class transportation system. A more in-depth look at OIP's extensive global efforts is featured in "International Lessons Lead to U.S. Successes" on page 12 in this issue of *Public Roads* and highlights some of the international lessons that have led to successes in the United States.

Leslie J. Wright

Leslie J. Wright
Director, Office of International Programs
Federal Highway Administration

Source: FHWA.

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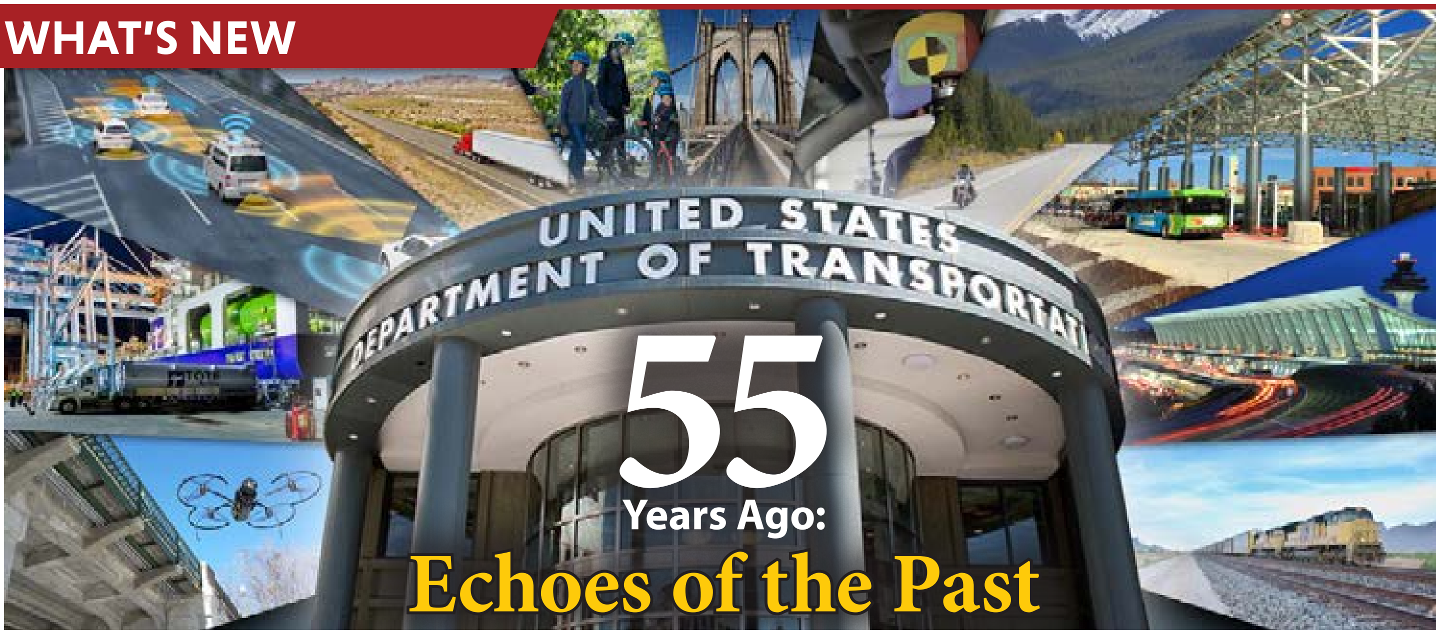


55 Years Ago: Echoes of the Past

Source: USDOT.

by **RICHARD F. WEINGROFF**

55 Years after DOT opened, some of our concerns seem very familiar.

Fifty-five years ago, the U.S. Department of Transportation opened for business on April 1, 1967. USDOT included the new Federal Highway Administration, which had by far the largest budget of $4.4 billion in a department with a total budget of only $6.6 billion. (FHWA traces its origins to October 3, 1893, when the Office of Road Inquiry opened in the Agriculture Department with a budget of $10,000.) Two of the biggest hot topics for FHWA were completing the interstate system and increasing highway safety.

Of the 41,000 miles of interstate freeways authorized at the time, a total of 58 percent, or 23,755 miles, was open to traffic, although only 18,131 miles met full design standards. The struggles over urban freeways were major concerns as protests mounted across the country. Those displaced from homes or businesses objected; minority communities often were divided by the new freeways, leading to criticism. In remarks during April 1967, the first secretary of transportation, Alan S. Boyd (1967-1969), explained that it simply came down to arithmetic. "The pure economics of expressway building force these things through the areas of lowest right-of-way cost, so it is usually the low-income citizens who suffer."

He and FHWA Administrator Lowell K. Bridwell (1967-1969) saw joint land use as one answer to the disruption. In 1970, for example, FHWA touted the benefits of a basketball court built under the I-95 viaduct in Wilmington, DE. The viaduct divided an African-American community, but the agency looked on the bright side in a press release that began, "The budding basketball star of tomorrow could be a kid who learned how to dribble, pass, and shoot because an interstate highway came through his neighborhood."

The Federal-Aid Highway Act of 1973 provided a way to resolve the urban controversies via the Interstate Withdrawal-Substitution Program. A mayor and governor, jointly, could ask FHWA to withdraw a segment from the interstate system and receive in return an equivalent amount of money that, as the law was later amended, could be used for highway or transit projects. Under this program, 342 miles of designated interstates were withdrawn from 32 withdrawal areas in 21 States.

The first Secretary of Transportation, Alan S. Boyd, explained that urban Interstate freeways sometimes divided low-income communities because of "pure economics." Today, USDOT makes it a priority prevent the previous impacts on lower-income and underserved communities around the Nation.

Source: USDOT.

As for highway safety, the problem was clear: 51,524 deaths had occurred in 1966, with a fatality rate of 5.55 per 100 million vehicle miles traveled. Much hope was placed on two safety bills President Lyndon B. Johnson signed on September 9, 1966, that FHWA would administer. The Motor Traffic and Motor Vehicle Safety Act gave USDOT authority for the first time to issue regulations requiring safety changes in motor vehicles. The Highway Safety Act established new highway safety requirements. (In 1970, DOT shifted oversight of the motor vehicle provisions to a new agency, the National Highway Traffic Safety Administration.)

Shortly after the signing of the bills, Boyd, then under secretary of commerce for transportation, said during a news conference that, "Because of the long-range nature of the problem, we don't expect any miracles. This is a long pull that we're in for." His prediction proved accurate. Fatalities would reach an all-time high of 55,600 in 1972 (fatality rate of 4.41), but totals would gradually decline despite increases in traffic volumes. In 2019, the last full year before the COVID-19 pandemic, 36,096 people lost their lives in motor vehicle crashes; in 2020, fatalities increased to an estimated 38,824 lives (a 1.33 fatality rate).

Today, 55 years later, USDOT and FHWA have many concerns, but urban freeways and highway safety remain a hot topic. As for the urban freeways that survived the battles underway 55 years ago,

On September 9, 1966, President Lyndon B. Johnson signed the Motor Traffic and Motor Vehicle Safety Act and the Highway Safety Act. President Johnson explained that nearly three times as many Americans had died in traffic accidents as died "in all our wars" of the 20th century.

Source: USDOT.

USDOT and FHWA are trying to find ways to reconnect the communities they severed. The Bipartisan Infrastructure Law that President Joseph Biden signed on November 15, 2021, authorized a pilot program that will reconnect as many as 20 communities by removing, retrofitting, or mitigating portions of interstates. Secretary of Transportation Pete Buttigieg explained, "if Federal dollars were used to divide a neighborhood or a city, Federal dollars should be used to reconnect it." He noted that no one solution would work in every case. "But the point is, transportation should always connect, never divide." The goal was to rebuild connections while addressing each area's unique transportation needs.

From Secretary Boyd to Secretary Buttigieg, one constant for every U.S. secretary of transportation has been safety, especially highway safety. That concern was brought home forcefully in mid-2022 when NHTSA estimated that 42,915 people died in motor vehicle traffic crashes in 2021. This estimated number would be a 10.5 percent increase from 2020—the highest number of fatalities since 2005—and the largest annual percentage increase in the history of the Fatality Analysis Reporting System.

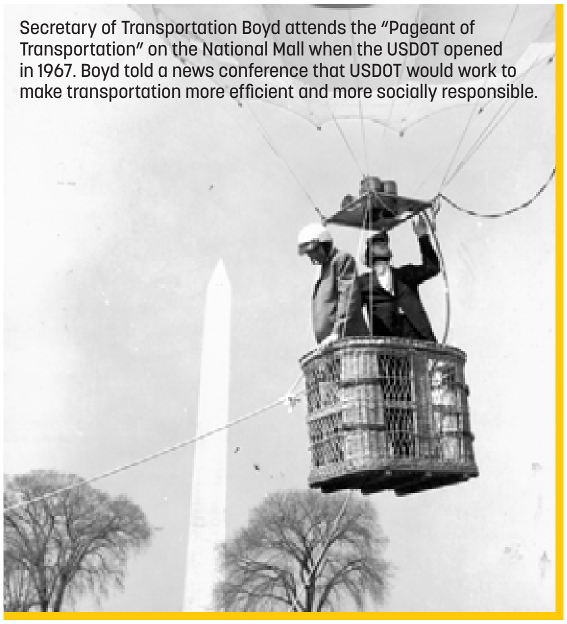
Earlier, Secretary Buttigieg said, "We cannot tolerate the continuing crisis of roadway deaths in America. These deaths are preventable." He launched the National Roadway Safety Strategy (NRSS) (available at ***https://www.transportation.gov/NRSS***), calling it "a bold, comprehensive plan, with significant new funding from President Biden's Bipartisan Infrastructure Law."

At the core of the NRSS is the Safe System Approach. The Safe System Approach addresses and mitigates the risks by building and reinforcing multiple layers of protection to prevent crashes from happening in the first place and minimizes the harm caused when those crashes occur. The objectives of the Safe System Approach are: safe, responsible behavior by people; roads that are designed to mitigate human mistakes; expanded vehicle systems to prevent crashes and minimize those that occur; thoughtful, context-appropriate design in setting safer speeds; and expedient access to emergency medical care to enhance the ability to survive crashes.

Since April 1, 1967, the country has experienced many changes, and we have many more tools now for addressing the challenges USDOT faces. However, the original declaration of purpose in the Department of Transportation Act of 1966 remains valid, namely that, "the general welfare, the economic growth and stability of the Nation and its security require the development of national transportation policies and programs" that provide for a "fast, safe, efficient, and convenient transportation system."

RICHARD F. WEINGROFF is information liaison specialist in FHWA's Office of Infrastructure and is FHWA's official historian.

For more information on the Safe System Approach, see the Winter 2022 special issue of *Public Roads*.
https://highways.dot.gov/public-roads/winter-2022



Secretary of Transportation Boyd attends the "Pageant of Transportation" on the National Mall when the USDOT opened in 1967. Boyd told a news conference that USDOT would work to make transportation more efficient and more socially responsible.

Source: USDOT.

A horse-drawn carriage was used to transport officials during the "Pageant of Transportation."

Source: USDOT.

Build a Better Mousetrap Winners Transform Transportation in Their Communities

by **TRINETTE BALLARD**

Source: FHWA.

The Federal Highway Administration's Build a Better Mousetrap is a national recognition program for local governments and Tribal agencies who use innovative solutions to solve transportation problems in their communities. These solutions increase safety, save money and time, and improve on the operational efficiency of their transportation programs.

"Highlighting Build a Better Mousetrap to agencies improves transportation programs all over the Nation because sharing brings about awareness, and [awareness] provides local agencies and Tribes with options for solutions," says Joe Conway, director of Local Aid Support in the FHWA Office of Transportation Workforce Development and Technology Deployment.

For the first time, FHWA's Build a Better Mousetrap competition received close to 70 nominations among its four national categories: Bold Steps; Innovative Project; Pioneer; and Specific, Measurable, Achievable, Realistic, and Time bound (SMART) Transformation. "[There were] a variety of innovative solutions from all over the country including Puerto Rico," says Conway. "This speaks to how the culture of transportation is changing to think more outside the box in how we solve problems. We are excited about the role FHWA has played [in] supporting the Local and Tribal Technical Assistance Programs (LTAP/TTAP) that provide training on [fostering] innovative solutions to thousands of transportation professionals annually."

The Build a Better Mousetrap program is a collaborative effort between FHWA and the LTAP/TTAP centers. The centers select their State's winners and then submit them to FHWA for consideration in the national competition. This year, a range of homegrown pioneering solutions that improved road maintenance, pandemic challenges, customer service, and emergency response were submitted—to name a few. FHWA selected one winner from each of the four national categories, with each awardee named a 2022 Build a Better Mousetrap national winner:

Bold Steps Award

The **Bold Steps Award** recognizes any locally relevant, high-risk project or process showcasing a breakthrough solution with demonstrated high reward. This year's winner is the Walsh County Highway Department in North Dakota for the Guardrail Maintainer, which is an attachment tool to quickly remove debris from around the guardrails so that they do not get into the roadway creating a safety hazard for drivers.

The Guardrail Maintainer, an innovation by North Dakota's Walsh County Highway Department, was one of four winners of the 2022 Build a Better Mousetrap competition.

© Walsh County Highway Department.

Innovative Project Award

The **Innovative Project Award** recognizes a solution that introduces new ideas that are original and involve creative thinking. The local agency winner is South Manheim Township in Schuylkill, PA, for the Sidewinder, which is a tool that is used to fill barriers or berms with compact materials such as gravel, soil, and rocks to control water flow along the roadways.

Pennsylvania's South Manheim Township created the Sidewinder, winner of the Innovative Project Award.

© South Manheim Township.

Pioneer Award

The **Pioneer Award** recognizes a locally relevant product or tool that is among the first to solve a maintenance problem with a home-grown solution. The winner is the Washington County Department of Public Works in New York for the Culvert Cleaner, which is a tool to remove dirt build-up safely and quickly from the culverts created by beavers. The Culvert Cleaner was voted Best All-Around local innovation by attendees to the 2022 National Local and Tribal Technical Assistance Program Association's Annual Meeting in July.

Winner of the Pioneer Award, New York's Washington County Department of Public Works created the Culvert Cleaner, a homegrown solution to a maintenance problem.

© Washington County Department of Public Works.

SMART Transformation Award

The **SMART Transformation Award** recognizes a locally relevant, significant change in any transportation or activity that is SMART in nature and results in improved efficiencies. This year's recipient is the Autonomous Municipality of Toa Baja in Puerto Rico for the Public Survey Tool for Emergency Events. The electronic survey tool is available to residents via social media to help improve emergency response.

Puerto Rico's Autonomous Municipality of Toa Baja invented the Public Survey Tool for Emergency Events, winner of the SMART Transformation Award.

© Autonomous Municipality of Toa Baja.

"All of the winners join a long list of local agencies who start each day thinking about how to improve the delivery of their transportation programs. Congratulations to each of them for putting safety and innovation first," says Conway.

TRINETTE BALLARD is a local support program manager in the FHWA Office of Transportation Workforce Development and Technology Deployment and worked in a variety of roles during her 15-year tenure with FHWA.

For more information on the Build a Better Mousetrap program, visit *https://www.fhwa.dot.gov/clas/babm/*. For more information on the LTAP/TTAP Centers in your State, visit *https://www.fhwa.dot.gov/clas/ltap/* and *https://www.fhwa.dot.gov/clas/ttap/* or email the FHWA Local Aid Support team at *CLAS@dot.gov*.

PennDOT Agility Program: Building Partnerships and Breaking Boundaries

Pennsylvania enters its 26th year of enhancing transportation services across jurisdictions with the Agility Program.

Agility helps PennDOT and it partners make the most of limited resources, develop strong and rewarding relationships, and conduct roadway improvements.

© r_tee / AdobeStock.com.

by **RICH KIRKPATRICK**

Pennsylvania's 67 counties share a challenging responsibility with the Pennsylvania Department of Transportation (PennDOT): to manage key components of a far-flung and extensive road and bridge network.

Pennsylvania has the third largest State-managed bridge system in the Nation and the fifth largest State-maintained road network. Pennsylvania's transportation system is comparable in size to all of the State systems in New York, New Jersey, and New England combined. Counties manage roughly 6,600 of the State's 32,000 bridges, and local governments oversee roughly 75,000 miles (120,701 kilometers) of the 120,000 miles (194,731 kilometers) of roads that crisscross the State.

Thus, an overriding issue is how does PennDOT address intricate encounters with the jurisdictional boundaries created by Pennsylvania's various State, county, and local governments with the responsibility—and mission—to offer a seamless transportation experience for the State's citizens? The answer: Through a system that enables the exchange of services, equipment, and staff, without monetary payments—the PennDOT Agility Program (also known as Agility).

The story of Agility—which celebrated its 25th anniversary in 2021—begins in 1995, when then-PennDOT Secretary Brad Mallory came across a book by Roger Nagle titled, *Agile Competitors and Virtual Organizations*. The book outlines a concept to spur businesses to think outside the box.

That December, Mallory bought each one of his deputy secretaries a copy of Nagle's book and asked them to read it and provide ideas on how to bring the agility approach to PennDOT.

"Rob Wonderling, then-PennDOT deputy secretary for administration, and later president and chief executive officer of the Chamber of Commerce for Greater Philadelphia, came back with a program layout to reach out to local governments and trade services with them," says Mallory. "Instead of stopping the plows at the borough line, [he suggested that we] continue with a straight pass, and they do a similar loop and hit some of our network."

By enabling PennDOT and partners to equally exchange services—like snow plowing, mowing grass, or street sweeping—without the exchange of money, transportation could improve in Pennsylvania. The idea for these synergies propelled itself into the Agility Program. Prior to the program, local and State jurisdictions were responsible for maintaining their respective networks with no mechanism in place to lawfully exchange services.

Reflecting on his often-stated mantra, Mallory says, "People don't care who owns the road, they want seamless service, and the Agility Program really played to that."

Service-for-Service Partnering: Tested

Mallory and his team launched Agility in May 1996. The program commenced with a six-week pilot that involved partnerships between two of Pennsylvania's counties, Crawford and Venango; three cities, Meadville, Franklin, and Oil City; three townships, Crawford, West Mead, and Vernon; and the American Federation of State, County, and Municipal Employees (AFSCME)—which represents PennDOT employees. During the pilot, PennDOT painted traffic lines on local streets while crews from local jurisdictions performed

Winter maintenance services are often exchanged with municipal governments as part of the PennDOT Agility Program.
© PennDOT.

mowing, cleaning, and other maintenance services on State highways. The initial savings amounted to about $25,000.

Within two years, the program had expanded to all 11 PennDOT engineering districts; within five years, the program was being used in all 67 counties. Since its inception, the Agility Program has united PennDOT with nearly 2,000 partners through nearly 3,300 agreements.

PennDOT and the partner organizations must enter a formal written agreement called an Agility Agreement. There are three general steps that must be followed on the road to securing an Agility Agreement:

1. The partner must evaluate what services it needs and what services it can provide to PennDOT.
2. The partner must complete the Agility Agreement, which includes a resolution indicating acceptance by the partner's officials. The resolution must be adopted at a public meeting.
3. The partner, PennDOT, and AFSCME must negotiate a work plan that spells out who will do what for whom.

Chris Robinson, roadway programs coordinator for PennDOT's Butler County operation in western Pennsylvania, noted the circumstances when partners are drawn to an Agility Agreement. "Usually, it's when you have a resource that either is unavailable to the other group or you [have and] can do at a more efficient cost than the other group," Robinson says. "If you have something that is easier for you to provide or the other group doesn't have, that's a good time to look at things."

With all levels of government trying to deliver the very best services with limited resources, the Agility Program represents an important tool to assist in meeting that goal. The program's benefits are numerous including completing work that otherwise may not have been completed, providing better service to the traveling public, and providing smoother, safer, and cleaner roads and bridges.

Service-to-Service Partnering: Proven

Creativity is a hallmark of the Agility Program as evidenced by an agreement between PennDOT and the State Correctional Institution at Mercer (SCI Mercer). As inmates performed litter pickup on various State routes and painted a PennDOT wash bay, PennDOT graded and paved an access road on SCI Mercer property. This exchange allowed PennDOT to redirect its maintenance staff to more pressing roadway concerns that otherwise would have been delayed.

"It's one of the best programs that has been offered around the State, for municipalities in general," says Jason Dailey, now former utilities director and former public works director for Cranberry Township in Butler County, located in western Pennsylvania. "We certainly had a really good experience with the program."

For Dailey, Agility inspires creativity on both sides of the exchange. "The creativity you can bring to it, the flexibility the PennDOT engineering district offices have to make this program work for everyone… the opportunities are really endless," he says. "If you can think it up, your district will work with you to make that happen."

Since it's origination, Agility has expanded its offerings to include a three-year renewal period for Agility Agreements and Web-based training for PennDOT staff. Many of the additional offerings came under the direction of PennDOT's Bureau of Innovations (BOI), which assumed management of the program in 2016. Under BOI, during 2021 alone,

A common Agility exchange over the past 25 years has involved litter pickup along PennDOT roadways by local government workers.
© PennDOT.

PennDOT executed 32 Agility Agreements—27 local governments and five non-profits or schools—in 12 of Pennsylvania's 67 counties. Additionally, three Agility Agreement renewals were attained, including with the Pennsylvania Turnpike Commission (PTC). Initial agreements between PennDOT and an eligible partner are typically over a 5-year period. BOI also has a detailed and enhanced communication plan in place to attract more agreements.

Service-to-Service Partnering: Unique Partnerships

Agility helps PennDOT and its partners to make the most of limited resources, while developing strong and rewarding relationships. And it is these relationships that help sustain the program. Those eligible to enter into an Agility Agreement with PennDOT must be an eligible public entity under Pennsylvania's Procurement Code. This includes county and local governments, metropolitan planning organizations, rural planning organizations, public school districts and colleges, volunteer fire companies, charitable hospitals, and many others.

Often, it's also the dedication of individual PennDOT staff members that helps drive the program forward. One example is Joe Rossi, former equipment operator in PennDOT's District 4, located in northeastern Pennsylvania. While working on the front lines for PennDOT, helping to maintain an extensive road network, he also worked as assistant chief and president of the Union Dale Volunteer Fire Department in Susquehanna County. In working these positions, Rossi saw an opportunity to help advance PennDOT's innovative program.

Through the years, the fire department assisted PennDOT in informal ways by hosing off PennDOT equipment and permitting the agency to park transportation equipment in the fire station's lot to keep it near a project site. It was this parking lot that needed significant repairs, and the volunteer fire department was not in a position to pay an estimated $20,000 for a full repaving.

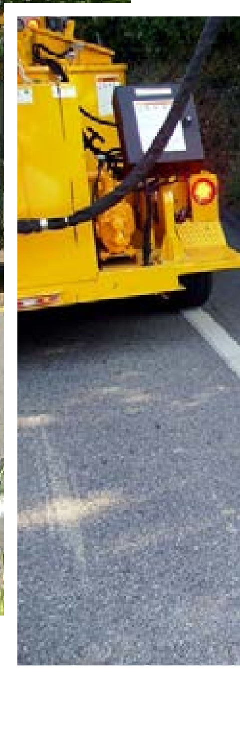
"I inquired if there was a way PennDOT could help us with patching the parking lot," Rossi says. "The Agility Program was mentioned. We could get involved since we had helped them in the past, and they were glad to help us." "It was a good idea," Rossi continues. "Being a volunteer fire department, we don't have the resources to go in and do pavement repairs. Not everyone knows how to do blacktop. It would cost us a small fortune." In return for the patching that PennDOT performed, the fire department agreed to continue to allow PennDOT to store equipment and materials (e.g., chipping stones) needed on the fire department's property for nearby projects.

"We are fortunate to have such a good partner like the Union Dale Fire Department," says Erin Mazikewich, assistant highway maintenance manager for PennDOT in Susquehanna County. "When planning future projects, it helps to know that we may have a storage location closer to the actual job site. The reduced time in hauling from the fire department's storage location to the job site can result in more timely completion of our project. We appreciate all the fire department does in and for the community, and we're happy to be able to help them out through the Agility Program."

In addition to the volunteer fire department, PennDOT has participated in exchanges with other non-traditional partners and, in some instances, in exchanges involving nontraditional services. In Warren and Forest counties, PennDOT has had a long-standing Agility Agreement with the Allegheny National Forest. PennDOT painted dividing lines on the roadway and swept and resurfaced some of their forest roads. In exchange, the U.S. Forest Service provided conference room space for PennDOT business meetings and events and graded nearby dirt roads in PennDOT's jurisdiction.

Surface treatments, such as "oil and chip," are common roadway maintenance operations exchanged as part of the Agility Program.

© PennDOT.



Agility enables PennDOT and its eligible partners to exchange services, equipment, and staff without monetary payments.

© PennDOT.

PennDOT's District 12, in southwestern Pennsylvania, had an Agility Agreement with Fayette County Airport. The airport gave PennDOT space in an empty hanger to use for equipment and spare furniture storage and, in return, PennDOT painted yellow road lines, applied crack sealing, and sprayed herbicide for weed control on the airport's taxiways and runways.

District 12 also had an Agility Agreement with the Washington County Fairgrounds in which PennDOT received storage space, and, in return, PennDOT used a flush truck to wash down the fairgrounds' bleachers and perform a few fairgrounds roadway repairs.

PennDOT District 5, based in Allentown, had an agreement with the Lehigh Valley International Airport where PennDOT applied salt brine to airport roadways and, in exchange, the airport plowed snow off of turning lanes leading into its facility and PennDOT used the airport's wash facility to clean its trucks. A key specification of Agility Agreements is that materials alone cannot be exchanged as part of an agreement except for salt brine, millings, and certain road signs.

Similarly, under an Agility Agreement with the PTC, PennDOT performed the pumping of water storage tanks and truck wash separator cleanings, and provided a salt stacker, building space, and a salt dome. In exchange, the PTC provided salt brine, an electric forklift, a salt dome, truck washes, building space, trash removal, and holding tank pumping.

"There have been numerous Agility Program success stories across Pennsylvania over the past 25 years, several with nontraditional partner organizations," says Bob Snyder, acting Agility Program manager in PennDOT's BOI. "PennDOT and its partner organizations, nontraditional or otherwise, have continued to recognize the potential for innovative 'win-win' opportunities to make the program work for everyone involved and ultimately benefit the citizens of the commonwealth."

"We welcome new ideas and partners for our Agility Program," says Yassmin Gramian, P.E., current PennDOT secretary. "The Agility Program has fostered effective and lasting cross-government relationships that have enhanced transportation services across Pennsylvania. We invite more eligible partners to consider entering into Agility Agreements with PennDOT."

RICH KIRKPATRICK served for nearly two decades as PennDOT's press secretary. Currently, he serves as an annuitant in PennDOT's Bureau of Innovations. He holds a B.S. degree in journalism from Temple University.

For more information on PennDOT's Agility Program, visit *http://www.penndot.pa.gov*. Select "Local Government" from the "Doing Business" drop-down menu and select the blue "Agility Program" tile. You can also contact *PDAgility@pa.gov*.

A common Agility exchange over the past 25 years has involved PennDOT applying crack sealing on local roads.

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PennDOT can provide salt brine to municipal governments as part of the Agility Program exchanges.

© PennDOT.

INTERNATIONAL LESSONS Lead to U.S. SUCCESSES

The Federal Highway Administration's Office of International Programs works to access, promote, and disseminate global best practices and technical innovations to ensure a safe and efficient U.S. highway transportation system.

by **LORI PORRECA** and **JIHAN NOIZET**

Around the world, countries face many of the same transportation concerns. Best practices and lessons learned in other nations can help address U.S. challenges. The Federal Highway Administration's (FHWA) Office of International Programs (HPIP) works to access, promote, and disseminate global best practices and new technologies that improve the safety and efficiency of the U.S. transportation system. HPIP's understanding of cultural and political differences between nations and its expertise in managing cross-border relationships has fostered a culture of collaboration among transportation agencies around the world.

HPIP's work has led to many measurable benefits for our Nation. HPIP programs have helped to identify and disseminate an extensive list of transportation technologies and best practices in the United States. Many of the technologies studied abroad through HPIP programs have also helped shape transportation planning and design practices throughout the Nation, enhancing road safety, and the state of the U.S. transportation system. For example, modern roundabouts, as learned through HPIP, have improved the safety of intersections and reduced project costs in the United States. A single-lane roundabout has only eight conflict points, compared to 32 in a traditional four-way intersection. A 2002 study by the Maryland State Highway Administration found that at 15 locations where roundabouts replaced traditional intersections, the crash rate fell by 60 percent, and the injury crash rate fell by 82 percent.

HPIP's Programs and Impact

The three main programs of the office are the Binational Relations Program, the Multinational Relations Program, and the International Visitors Program.

The Binational Relations Program focuses on government-to-government relations and activities designed to exchange best practices and technologies for high priority topics including, but not limited to, bridge design, pedestrian safety, climate change, and transportation infrastructure resilience. These programs facilitate exchanges that are practical, implementable, and beneficial to all participants. FHWA currently has active relationships with Australia, Brazil, Canada, Chile, Japan, the Republic of Korea, Mexico, the Netherlands, South Africa, Sweden, and Switzerland. Though some relationships are long standing, new relationships emerge as FHWA priorities change and/or new innovations come along.

The Multinational Relations Program includes the Global Benchmarking Program (GBP) (formerly known as the International Scanning Program or "Scan") and participation in the World Road Association (PIARC) and other multinational groups. The GBP is a tool to bring global innovations into the Nation's transportation system. The program focuses on acquiring and adopting proven foreign technologies and best practices that directly support U.S. Department of Transportation and FHWA priorities. To accomplish this goal, the GBP forms teams made up of Federal, State, and local subject matter experts that conduct focused study missions to countries with valuable information in a particular subject area. These studies allow participants to observe innovations firsthand and engage in face-to-face, in-depth exchanges with foreign counterparts.

The Arthur Ravenel Bridge is a long-span cable-stayed bridge over the Cooper River in Charleston, SC. Cable-stayed bridges like this one became more common in the United States after an HPIP-organized 1999 Scan and are now the most widely used bridge type for major long-span U.S. bridges.

Source: FHWA.

SELECTED PRACTICES AND TECHNOLOGIES

For the recent synthesis report, FHWA identified 30 influential practices and technologies learned through HPIP's programs. Falling into 10 broad categories, these practices and technologies were selected based on the current level of dissemination and integration in the United States.

- Bridge technologies
  - Cable-stayed bridges
  - ABC
    - Movement systems for prefabricated bridge
    - SPMTs
    - PBES
- Congestion management–Active traffic management (ATM)
  - Automated queue detection
  - Lane control signals
  - Variable speed control
- Innovative contracting
  - Design-build contracting
  - Warranties
  - P3s
- Modern roundabouts
- Pavement materials
  - Pavement recycling
  - Warm-mix asphalt
  - Stone-matrix asphalt
- Risk management
- Safety
  - Vision zero
  - Safety planning
  - Road safety audits
- Traffic incident management
  - ATM incident management
  - Traffic incident response
- Truck size and weight
  - WIM
  - HS-WIM
  - WIM database management
- Winter operations
  - Removable legs on trucks
  - Anti-icing
  - Fixed automated spray technology
  - RWIS
  - Snow and Ice Pooled Fund Cooperative Program

PIARC is an international road organization that has brought together representatives from countries around the world for over 100 years. Participation in PIARC and other multinational entities enables FHWA to access, influence, and learn from many countries in a cost-effective manner. PIARC provides information on the most recent technical and policy developments in road transportation abroad and is a significant channel for communicating U.S. developments to the rest of the world.

The International Visitors Program facilitates the sharing of information about U.S. roads and road-related technologies between FHWA experts and their international counterparts. The International Visitors Program has organized the following types of activities for visitors from all regions of the world:

- Meetings focused on a certain topic.
- Study tours with FHWA program offices, State departments of transportation (DOTs), and other transportation agencies and associations nationwide.

Through collaboration with international and domestic organizations, HPIP's programs work together and cross-pollinate, with developments in one area sometimes leading to opportunities in others. For example, a GBP study may lead to a long-term binational relationship with one or more of the countries involved, or a binational relationship can lead to a more focused GBP study on a specific topic. One consistent benefit across all programs has been the development of international relationships.

"Participants in HPIP programs often say that building relationships with international counterparts is one of the most valuable outcomes of the program," says Leslie Wright, director of HPIP. "These connections facilitate ongoing collaboration and information sharing."

Three Decades of Best Practices

HPIP's three decades of work has resulted in useful and effective best practices, technologies, and lessons learned beneficial for our Nation's roadways. A 2021 report, *Dissemination Tools and Strategies of the Federal Highway Administration's Office of International Programs* (FHWA-PL-021-025), highlights technologies and best practices learned through international exchanges that have been successfully implemented in or integrated into the U.S. transportation system.

The selected technologies fall into 10 categories:

- Bridge technologies
- Congestion management
- Innovative contracting
- Modern roundabouts
- Pavement materials
- Risk management
- Safety
- Traffic incident management
- Truck size and weight
- Winter operations

The following sections provide specific examples of technologies, methodologies, and best practices learned from HPIP's multinational and binational exchanges.

Enabling Faster, Safer Bridge Construction

Efficient, high-quality bridge construction and design methods are critical for ensuring the safety and cost-effectiveness of our Nation's bridges. In 2004, HPIP conducted an influential Scan, learning about prefabricated bridge elements and systems (PBES) in Japan and Europe. PBES is an accelerated bridge construction (ABC) method that enables construction teams to build bridge elements offsite and move them into place much more quickly, minimizing travel disruptions, construction risks, and project costs.

The 2004 Scan also studied technologies that enable PBES, such as movement systems and self-propelled modular transporters (SPMTs; multiaxle platform vehicles operated through computer-controlled systems that precisely position prefabricated bridge spans). The team for this Scan subsequently developed FHWA's *Manual on Use of Self-Propelled Modular Transporters to Remove and Replace Bridges* (FHWA HIF-07-022). The manual has served as a valuable tool for increasing the use of this technology in the United States. As of 2019, SPMTs have been widely used across the country. The Utah DOT saved $55 million on six projects using PBES and SPMTs.

In addition to the 2004 Scan, the United States has a long-standing relationship with Japan through the Binational Relations Program in which other bridge technologies and practices have been shared, including seismic design methods. These technologies and practices have been discussed with Japan through biennial workshops for more than 30 years. As a result of these workshops, U.S. transportation practitioners have learned a great deal from Japan's vast experiences with seismic design and earthquake recovery, helping them to improve the safety of U.S. west coast bridges.

Popularizing Public-Private Partnerships

HPIP has helped disseminate innovative strategies for completing crucial infrastructure projects in the U.S. transportation system. During a 2008 Scan called "Public-Private Partnerships for Highway Infrastructure: Capitalizing on International Experience," a team studied public-private partnerships (P3s) in Australia, Portugal, Spain, and the United Kingdom." In P3s, private entities take on a variety of project roles, such as design, construction, finance, and/or operations. Benefits include risk sharing, accelerated project delivery, cost efficiency, and access to new sources of capital.

Since the 2008 Scan, P3s have become more popular in the United States. For example, partnerships with private entities enabled the construction of the North Tarrant Express in Fort Worth, TX. Two-thirds of the funds came from private sources and the project was completed nine months ahead of schedule. The private partner designed, built, and financed the project and continues to oversee maintenance and operations, including collection of tolls on the facility's managed toll lanes. In another example, private debt and equity helped finance a project on the U.S. 36 Express Lanes that connected Denver, CO, to Boulder, CO, accelerating the completion date of the project by at least 10 years and shifting financial risks to the private sector.

This bridge over I–70 and Pecos Street in Denver, CO, used prefabricated bridge techniques. Bridge elements were built near the site, lifted with hydraulic jacks, and moved into place using SPMTs. The bridge weighed 2,400 tons and took 50 hours to move 800 feet. Technologies like SPMTs enable the precise positioning of prefabricated bridge elements that can weigh thousands of tons.

Source: FHWA.

WIM technology uses in-road sensors or scales to help enforce commercial motor vehicle size and weight restrictions.

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Managing Truck Size and Weight

In 2020, U.S. trucks moved over 10 billion tons of freight and, in 2019, traveled over 300 billion miles. Given the magnitude of U.S. commercial trucking, truck size and weight regulations play an important role in preserving bridge and pavement quality and ensuring road safety. Larger trucks must conform to axle loading, spacing, gross vehicle weight limitations, and size requirements based on laws and roadway design and condition. States may use weigh-in-motion (WIM) technology as a screening tool at weight stations to enforce truck weight regulations, identify roadway violators, and plan enforcement activities.

HPIP programs have helped advance WIM practices in the United States. In 2006, HPIP organized a Scan to study procedures and technologies, particularly WIM, for enforcing commercial motor vehicle size and weight laws in Belgium, France, Germany, the Netherlands, Slovenia, and Switzerland. The 2006 Scan focused on bridge weigh-in-motion (BWIM), high-speed weigh-in-motion (HS-WIM), and WIM database management. Based on bridge technologies learned in Slovenia, the Scan team worked with the Alabama DOT to install a BWIM pilot, and the Connecticut DOT installed a similar system. After observing Switzerland's high-speed-bridge weigh-in-motion (HS BWIM) technology, the 2006 Scan team invited Swiss experts to the United States for a round of seminars in 2008. This peer exchange informed the development of the Kingman Enforcement site at the Hoover Dam in Nevada. Finally, the 2006 Scan team developed a report on the Netherlands' centralized WIM database that has served as a framework for various States developing their own WIM data collection systems.

Recognizing the effectiveness of WIM technology, FHWA engaged in many follow-up development and dissemination efforts including:

- Hosting a web-based strategic planning forum.
- Developing papers and presentations as part of NCHRP 20-07 Task 254, "Vehicle Size and Weight Management (VSW) Technology Transfer/ Best Practices."
- Integrating WIM technology into the National Institute of Standards and Technology's *Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*.

Improving Winter Operations

One of HPIP's greatest success stories has been the impact of international exchanges that focused on winter operations. Through HPIP programs, the United States learned about a variety of technologies to prepare for and respond to winter weather. Within a few years, many technologies learned abroad became a common practice in the United States. "International collaboration has had a significant impact on winter operations in the U.S., which has improved the safety and efficiency of winter maintenance," according to Tony Coventry, transportation specialist with the FHWA Road Weather Management Program.

The 1994 Scan in Japan and Europe, called "Winter Road Maintenance Practices," was one of HPIP's earliest successes, and led to the widespread adoption of anti icing practices and road weather information systems (RWIS) in the United States. This Scan provided so much valuable information on winter technologies that, in response, the American Association of State Highway and Transportation Officials formed the Snow and Ice Pooled Fund Cooperative Program in 1996. The Snow and Ice Pooled Fund Cooperative Program advances the testing and dissemination of snow and ice technology systems not already in use in the United States. This program subsequently developed an RWIS training package in the early 2000s.

The widespread adoption of anti-icing and RWIS have been quite beneficial to the United States. Anti-icing, the practice of treating roads with a salt brine prior to snow and ice events, supplemented deicing, the practice of treating roads with salt after weather incidents. Under certain conditions, anti-icing is a more sustainable method because it uses significantly less labor, equipment, and materials than deicing. As a result of the method's rapid popularity, FHWA produced the *Manual of Practice for an Effective Anti-Icing Program: A Guide for Highway Winter Maintenance Personnel* (FHWA-RD-95-202) in 1996. RWIS with in-road pavement sensors for detecting pavement conditions and informing snowplow operators about road conditions were found to reduce crashes by 83 percent and labor hours by 62 percent.

Areas for Future Focus

Although there have been many successes, there are still technologies and practices learned through international exchange that have not yet been fully integrated into the U.S. transportation system. New technologies and practices offer opportunities to support local, State, and national goals including:

- Turbo roundabouts
- Multimodal bike planning
- Pedestrian safety practices
- Building information modeling
- Complete streets
- Tsunami design guidelines
- Electrically isolated tendons

"HPIP's successes go beyond the dissemination of specific technologies and practices," says Thomas Everett, former executive director of FHWA. "HPIP has fostered a culture of collaboration among transportation agencies throughout the world."

A number of pedestrian and bicycle technologies and practices identified during international Scans could be an area for further focus.

© Laura Sandt / www.pedbikeimages.org.

Through its decades of work in fostering international relationships, HPIP has:

- Facilitated the sharing and exchange of technology and information.
- Promoted the use of highway standards that are compatible around the world.
- Yielded information to improve the safety, durability, and efficiency of transportation systems.
- Provided technical assistance to other countries, so they can benefit from U.S. experiences and expertise to improve their roads.

HPIP continues to learn and share cutting-edge innovations and technologies and practices that meet our Nation's top transportation system challenges and priorities.

HPIP's Scans have had a significant impact on U.S. winter operations, introducing anti-icing practices and RWIS among other winter technologies.

© Arizona Department of Transportation.

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For more information, see ***https://international.fhwa.dot.gov/pubs/pl21025/pl21025.pdf***, or contact Lori Porreca at *lori.porreca@dot.gov* or 202-906-9241 or Jihan Noizet at *jihan.noizet@dot.gov* or 202–366–1153.

DELIVERING RESILIENCY

The existing metal culvert that channeled Fond du Lac Creek in Minnesota across the roadway had previously failed several times. In 2012, significant flows resulted in the embankment being washed out and creating a sizeable drop off. *Source: FHWA.*

The Multiple Benefits of the Emergency Relief for Federally Owned Roads (ERFO) Program

by **STEVEN F. HINZ**, **JUSTIN HENWOOD**, and **ERIC WRIGHT**

Mother Nature provides breathtaking vistas, but can also bring us some nasty surprises, especially at a time when the climate is changing and affecting storm frequency and intensity. Many of nature's vistas are accessible through the transportation network on, or through, Federal Lands. With the changing weather, it is increasingly important to incorporate resiliency into transportation improvements. In practical terms, how can incorporating resiliency be done effectively, efficiently, and for reasonable costs with limited funding?

Natural disasters and catastrophic events are inevitable and generally unpredictable. Since 1956, Congress has dedicated supplemental funding to States for roads and bridges damaged or destroyed by natural disasters or catastrophic failure. On average, the Federal Highway Administration (FHWA) Emergency Relief (ER) Program, managed under the Office of Infrastructure, provides billions of dollars annually to transportation partners throughout the Nation.

The ER Program's intention is to pay the unusually high costs accrued in the repair and reconstruction of eligible facilities. The ER Program does not cover all repair costs, but rather supplements repair programs of Federal, State, local, and Tribal transportation agencies. Furthermore, ER funds are limited and judicious decisions are inevitable when attempting to cover repair costs. To receive aid for repairs, State departments of transportation must submit an application to the FHWA division office located in their State within two calendar years of the disaster date.

Under FHWA, the Office of Federal Lands Highway (FLH) oversees repair projects that keep Federal Lands roads accessible. FHWA is already delivering on the Biden Administration's focus area of climate change through resiliency and sustainability, and FLH activities have been instrumental to the agency's success.

FLH and its predecessor agencies have long been directly engaged in the location, design, and construction of the public roads that give access to and through the National Parks, the National Forests, and other areas in the Federal domain since 1905. FLH Headquarters, Eastern, Central, and Western Division offices perform this work. FLH currently provides services in all 50 States, the District of Columbia, Puerto Rico, and the U.S. Territories. FLH delivers projects through partnerships with Federal Land Management Agency (FLMA), State, and local partners. To ensure successful delivery, FLH must apply innovative and diverse solutions to the unique projects it undertakes. Context sensitivity is also critical to meeting the unique missions, values, and needs of FLMA partners and the public.

In 1977, Congress established the Emergency Relief for Federally Owned Roads (ERFO) program to also assist Federal Land Management Agencies (FLMA) partners with the repair or reconstruction of Tribal transportation facilities, Federal Lands transportation facilities, and other federally owned roads that are open to public traffic and have suffered serious damage from a natural disaster or a catastrophic failure over a wide area.

So, how do repairs that provide resiliency get completed with the limited funding on

The ERFO Program funded a betterment project for the Fond du Lac Tribe in Minnesota, which included a new bridge rather than a replacement culvert. The bridge replacement option also has the secondary benefit of ensuring that fish passage would continue in the stream.

Source: FHWA.

hand? Is the more judicious decision about investment actually a higher-priced resilient replacement? These questions are frequently asked and FHWA has demonstrated that it is possible to incorporate resiliency in a cost-effective manner through practical design that requires being creative and innovative while considering betterments within the ERFO program. "The Emergency Relief Program can provide agencies with an excellent opportunity for exploring improvements to transportation system resilience," says Hari Kalla, FHWA associate administrator for infrastructure. "Roads and bridges damaged during disasters have been shown to be vulnerable, so FHWA encourages agencies to identify cost-effective measures to avoid further damage from future events."

Rebuilding to Current Standards

Repaired facilities may be rebuilt to current geometric and construction standards. Simply rebuilding to current standards may result in a resilience improvement. For example, following current hydraulic standards may result in a larger culvert, which will allow larger stream flows to pass under the roadway without washing out the pavement. Rebuilding to current standards is not considered a betterment and does not require economic justification.

Betterments are features or facilities that didn't exist before the natural disaster or catastrophic failure that are implemented or constructed that help prevent future damage. Betterments added to prevent future damage and increase resiliency must be economically justified through a life cycle analysis based on the present and future expected cost to the ER Program. The analysis period is typically limited to 25 to 50 years. FLH has implemented resiliency through practical design during implementation of the ERFO Program in several different ways.

Betterment Project Prevents Repeated Damage

During the summer of 2012, the Fond du Lac Tribe in northern Minnesota experienced a flood that damaged several of its roads. Reservation Road—a major arterial serving a significant Tribal community—suffered extensive damage. The existing 5-foot (1.52-meter) diameter metal culvert that channeled Fond du Lac creek across the roadway had previously failed several times. That year, the significant flows resulted in 100 feet (30.48 meters) of embankment being washed out and a 50-foot (15.24-meter) drop off.

The Tribe developed a feasibility study to compare the options, and the entire project team, composed of Tribal, Bureau of Indian Affairs, and FHWA staff, evaluated the options of replacing the existing culvert with an up-sized culvert for a construction cost of $1,030,000 versus a bridge structure betterment for a construction cost of $1,500,000. The team determined that the bridge structure was a justified betterment, especially considering probable future replacement costs. The bridge replacement option also had the secondary benefit of ensuring that fish passage would continue in the stream. The existing culvert had outlet scour issues and had eliminated fish passage. Studies demonstrated that re-establishing fish passage would be expensive and not covered by the ERFO Program.

John Wright, an ERFO Program coordinator, noted that this was the first time the Tribe had applied for ERFO and the first time he saw the impact of a resiliency approach, and stated the ERFO Program has not had to go back to the site in almost a decade.

New Location – Similar Costs

Between late December 2015 and early January 2016, there was a major flood event across the Midwest portion of the United States. The broad flooding event impacted the Mark Twain National Forest in Missouri with more than $500,000 in damage to

Mark Twain National Forest in Missouri suffered flooding in 2016. Damage from a rising creek included the access road to Red Bluff campground, a U.S. Forest Service facility. Rather than replacing the access road in-situ, the ERFO betterment project relocated the road to higher elevation to avoid future damage by rising creek waters.

Source: FHWA.

U.S. Forest Service facilities. One of the sites reported was the Red Bluff campground that was damaged primarily from the rise of the adjacent creek. This resulted in the loss of portions of access roads and several camping pads and embankment erosion. While replacement of the camping pads was not eligible within the ERFO Program, the replacement of the access roads was eligible. The U.S. Forest Service and FHWA collaborated on repair options, and through a formal betterment evaluation, determined that the cost to decommission existing access roads closest to the creek and relocate them to a higher elevation was near a betterment ratio of 1:1 when compared to repairing the access road in the current location. This means the access roads could be relocated for approximately the same cost as rebuilding them where they stood. To date, the campground has not suffered any subsequent losses due to flooding.

Resilient Design to Abate Debris Flow

Mount Shasta in northern California has an elevation of 14,179 feet (4,321.76 meters) and includes several glaciers, such as Konwakiton. As these glaciers melt, water is trapped within them. This water builds up over time and then develops into basins of water within the glacier. When the force of the water in these basins exceeds the strength of the glacial ice, the ice breaks and the water is released along with rocks and sediment in the form of a debris flow. These debris flows can extend for miles from the release site.

On September 20, 2014, a debris flow from Mount Shasta's Konwakiton Glacier resulted in the overtopping of two U.S. Forest Service roads and plugging of multiple drainage structures in the Mud Creek drainage system of the McCloud River basin.

One of the damaged structures was a 10-foot (3.05-meter) corrugated metal arch culvert with concrete headwall. The project team used its expertise in mud flows and fluvial geomorphology and developed a design for the replacement structure that was a 32-foot (9.75 meter) span, with an 11-foot (3.35-meter) rise precast concrete arch culvert that would accommodate the additional flows and sediment transport. After the contract was awarded, the contractor proposed a value engineering cost proposal that resulted in the construction of a 75-foot long concrete bridge at no extra cost to the Government that increased the hydraulic capacity even further. In June 2021, the new bridge structure was tested with another debris flow event and the structure performed admirably with no damage to the roadway or structure.

"At FHWA and FLH, we work diligently to ensure the flexibility and resilience that our partners and traveling public deserve, while providing stewardship of the Emergency Relief program," says Lorell Duteil, an FLH ERFO coordinator. "This crossing provided a great opportunity to put in to practice the expertise, partnerships, and program flexibilities that resulted in a replacement structure that has proven to withstand future events.

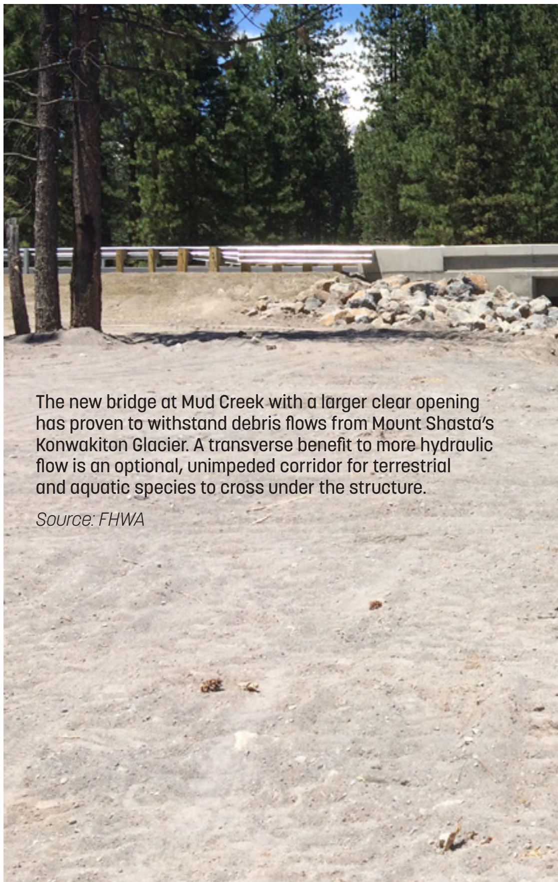
Betterment Analysis Results in Longer Bridge

From late November to early December 2007, warm heavy rains fell on deep snow in the Olympic National Forest, WA, causing extensive flooding and the Lake Cushman bridge to be severely damaged by the North Fork of the Skokomish River. The peak flow of 20,100 cubic feet per second (cfs) (6,126.48 cubic meters per second) was 20 times the mean flow and calculated to be a 75-year storm event. The west abutment embankment eroded 25 feet and swept away some of the riprap and gabion embankment protection that was installed. Scour at Pier 4 resulted in 10 feet (3.05 meters) of pile exposure, which was the largest scour experienced at the bridge.

The Lake Cushman bridge was constructed in the 1940s. At the time, the annual average daily traffic was less than 50 vehicles per day and was designed for a flow of a 25-year storm event The bridge is the primary access point to the Olympic National Park, Olympic National Forest, and private residences, and critical to remain open because there are no alternate routes.

The upper section of the Mud Creek culvert shown in 2014 after extensive emergency removal of debris from a melting glacier on Mount Shasta in northern California. The initial debris removal partially restored creek flows until the entire structure was replaced with a bridge to withstand future events.

Source: FHWA.



The new bridge at Mud Creek with a larger clear opening has proven to withstand debris flows from Mount Shasta's Konwakiton Glacier. A transverse benefit to more hydraulic flow is an optional, unimpeded corridor for terrestrial and aquatic species to cross under the structure.

Source: FHWA

The eroded west approach of the Lake Cushman Bridge over the North Fork of the Skokomish River in Washington. The bridge is the primary access point to Olympic National Park.

Source: FHWA.

The new Lake Cushman Bridge stands ready for future river flows. To date, the bridge has not experienced a significant storm event since the repairs were completed.

Source: FHWA

The U.S. Forest Service completed emergency repairs that included construction of a temporary bridge to span the eroded gap and reestablish access. A collaborative effort between FLH and the U.S. Forest Service was also initiated to determine the best permanent solution and perform a betterment analysis. The options evaluated were to: repair-in-kind for $325,000; rebuild the abutment and extend the bridge by 50 feet to accommodate a 50-year storm event for $875,000; extend the structure to accommodate a 100-year storm event for $1,625,000; and extend the structure for a 200-year storm event for $2,500,000. Based on the betterment analysis, the best solution was to accommodate a 50-year storm event and armor the abutment for protection against future storms events.

To date, the bridge has not experienced a significant storm event since the repairs were completed. In November 2017, the bridge experienced the largest flow since the repair—a flow of 11,000 cubic feet per second (311.49 cubic meters per second), which is an 8-year storm event —and the structure performed very well. All indicators are that the new Lake Cushman bridge will perform well for large flows in the future providing reliable, safe access at this primary river crossing.

Resiliency Makes Smart Business Sense

FHWA has considered and implemented resilience as a standard of practice in the ER Program for many years. FHWA and FLH have demonstrated that consideration and implementation of resiliency when rebuilding damaged transportation facilities can be accomplished in many ways. Repair projects have shown that it doesn't always require significant increases in costs to increase resilience if teams can take a creative and innovative approach to fully evaluate options and their total budget. Creativity and ingenuity are the solutions to building a resilient transportation network with limited funding.

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Cooperative Driving Automation (CDA) Research Program:

Development, Testing, and Evaluation

FHWA's CDA Program updates and research and development activities.

CDA Program research vehicles driving at the Turner-Fairbank Highway Research Center campus in McLean, VA.
Source: FHWA.

by **GOVIND VADAKPAT**, **DANIELLE CHOU**, **HYUNGJUN PARK**, and **STEVEN VU**

The Federal Highway Administration's (FHWA) new Cooperative Driving Automation (CDA) Program has put a spotlight on the entire transportation system and how infrastructure can be leveraged to support mobility and safety.

CDA is poised to transform our Nation's roadways. This technology will improve the efficiency and safety of vehicles across the transportation system. CDA applications will allow interaction between automated vehicles and nonautomated vehicles, other road users, and transportation infrastructure. The CDA Program consists of focus areas that support research, testing and evaluation, engagement, and safety. CARMA is a continuously developed set of tools within the CDA Program that aid and enable the advancement of the focus areas.

"CDA is essential for leveraging all that new and emerging transportation technologies have to offer. Communication with the infrastructure in conjunction with automation has the greatest chance of significantly improving mobility and safety," says Dr. Lily Elefteriadou, professor at the University of Florida.

In 2013, FHWA launched CARMA with a focus on studying and developing vehicle to everything (V2X) capabilities and algorithms. In 2015, FHWA was one of the first to demonstrate CDA and made CARMA software open source to encourage collaboration with other entities engaged in the research and development of CDA.

The CDA Program contains focus areas that contribute to creating an integrated and intelligent transportation system where automated vehicles work together.

The CDA Program's research tracks leverage partnerships with other U.S. Department of Transportation agencies—the Intelligent Joint Program Office, Federal Motor Carrier Safety Administration, Federal Transit Administration, and U.S. Maritime Administration—and explores CDA applications relating to traffic, reliability, and freight. The traffic research track investigates solutions to recurring traffic congestion and aims to demonstrate CDA applications in improving road safety and congestion. The reliability research track examines solutions to nonrecurring traffic congestion, such as road weather management, traffic incident management, and work zone management. Lastly, the freight research track explores CDA applications for commercial vehicles, such as buses and trucks.

The CDA Program also conducts testing and evaluation in either a simulation environment, at a physical testing site, or through a hybrid of those two approaches. CDA simulation testing leverages simulation technologies, such as software-in-the-loop—which allows the testing of source code in a simulation environment to test out CDA features before they are ready to be deployed in a real-world testing environment. CDA physical testing includes full-scale and scaled-down vehicles and is conducted at test sites throughout the United States. CDA hybrid testing combines simulation and physical testing.

The CDA Program takes a two-pronged approach to engagement. This approach intends to accelerate CDA adoption and innovation through CDA Collaborative and Support Services. CDA Collaborative engages with stakeholders to facilitate collaboration, the use of CDA technologies, and form a CARMA software user community. CDA Support Services provide help desk assistance to CARMA users and develop training materials for them.

The CARMA Ecosystem consists of open-source products performing core and support functions to advance the CDA Program's focus areas. The core products are CARMA Platform, CARMA Messenger, CARMA Cloud, and CARMA Streets. These products provide necessary software for conducting CDA research and testing.

The support components are CARMA Analytics, CARMA Simulation, and CARMA 1Tenth. The support components enable data analysis and decrease the cost of development through simulation and scaled-down testing methods.

CDA Program Updates

Over the past few months, the CDA Program has been engaged in activities involving the testing and development of CDA features and applications.

TSMO Use Case Testing

The CDA Program research team successfully completed testing for two transportation systems management and operations (TSMO) use cases at the Turner-Fairbank Highway Research Center in McLean, VA.

The first use case focuses on vehicle scheduling and CDA trajectory optimization at stop-controlled intersections. In the proof-of-concept testing, two CARMA-equipped vehicles approach a stop-controlled intersection (i.e., an intersection with stop signs) at different times. As the vehicles enter the radius of the intersection roadside unit (RSU), CARMA Streets receives their status and intent and calculates the vehicles' optimal schedules. Schedules refer to the desirable time at which each vehicle should arrive at the intersection. Using this schedule information, each vehicle adjusts its trajectory and travels through the intersection accordingly.

The validation testing tested two scenarios, conflicting and nonconflicting routes. In the conflicting scenario, the two vehicles were routed on paths that would require them to communicate with the RSU and adjust their trajectories to avoid collision and to depart the intersection based on the first-in-first-out rule.

In the nonconflicting scenario, the two vehicles were routed on nonconflicting paths. In this scenario, the starting locations of the vehicles were determined so that they both arrive at the intersection at about the same time. Since their paths had no vehicle-to-vehicle conflicts, CARMA Streets let both vehicles depart from the intersection at the same time, which would improve mobility compared to a non-CDA environment. The second use case involves a signalized intersection with fixed-time traffic signal settings (i.e., intervals for each traffic signal indication are fixed). Two vehicles approach the intersection and receive signal phase and timing (SPaT) messages from an RSU. Each vehicle adjusts its trajectory according to the received SPaT messages and travels through the intersection.

The TSMO use case testing has demonstrated successful validation of CDA features in a closed test track. These use cases aim to ultimately reduce traffic congestion, improve energy efficiency, and increase infrastructure efficiency.

Port Drayage Testing

In December 2021, in addition to TSMO use case testing, the CDA Program team traveled to a closed test track at SunTrax in Auburndale, FL, for port drayage proof-of-concept testing under the freight research track. Port drayage is the short haul of shipping containers between a port and a warehouse; during testing, a staging area served in lieu of an actual warehouse. The team equipped a commercial motor vehicle (CMV) with automation technologies,

Transportation systems management and operations testing scenarios.

1. Use case 1: conflicting routes.

2. Use case 2: nonconflicting routes.

2a. Use case 2: A vehicle is given a green signal indication and continues through the intersection at the appropriate speed (i.e., speed limit).

2b. Use case 2: A vehicle adjusts its approach to entering an intersection where it receives a red (stop) signal indication as a second vehicle receives a green (go) signal indication. The first vehicle will come to a stop if the red signal indication continues.

Source: FHWA.

Commercial motor vehicle stationed outside the staging area during a test.
Source: FHWA.

including CARMA, to demonstrate CDA applications to port infrastructure.

The testing scenario proceeded as follows: a CMV was stationed outside the entrance of the staging area. The automated driving system of the CMV was engaged, and the CMV moved toward the staging area entrance.

The CARMA Platform communicated with an RSU interfaced with CARMA Streets, representing the infrastructure at the staging area, to get the container pickup location in the staging area. The CMV determined a route to the container pickup location and moved toward that location. When the CMV arrived at the pickup location, it communicated with the RSU which then communicated with the container handling equipment operator to load the container.

After the container loading was completed (manually), the CMV received a new route to the staging area exit from the RSU. From the staging area exit, the CMV received another route to the port entrance from the RSU within the staging area to move toward the port terminal. Once the CMV arrived at the port entrance, it communicated with an RSU interfaced with CARMA Streets within the mock port terminal and received directions to head to a location to unload the container

Afterwards, the CMV proceeded to a new pickup location within the mock port area to load another container. The CMV then moved toward an inspection checkpoint after receiving directions from the port infrastructure. If the CMV passed the inspection, it was directed toward the port exit. If the CMV did not pass, it was moved to the holding area where an inspector was waiting to perform an additional inspection. If the CMV passed the additional inspection, the inspector communicated to the port infrastructure that the CMV had passed. From there, the CMV was instructed to exit the port.

The port drayage proof-of-concept testing allowed researchers to demonstrate the capabilities of an automated CMV for port drayage operations and highlighted the benefits of CDA to port management. This proof-of-concept testing also points out the level of reliability wireless communications could provide to facilitate the movement of CMVs performing the complex port drayage process.

Software Updates

The products under the CARMA Ecosystem support the cutting-edge research and development performed by the CDA Program. The core component, CARMA Platform, and the support component, CARMA Everything-in-the-Loop (XiL), were recently released.

CARMA Platform

CARMA Platform enables CDA features to allow automated driving systems (ADS) to interact and cooperate with infrastructure and other vehicles. Version 4.0.3 was released in May 2021 and included feature enhancements and bug fixes. Version 4.0.3 is the first version of CARMA Platform to

Port Drayage Testing.

1. The commercial motor vehicle is directed to the container pickup location at the mock staging area.

2. The commercial motor vehicle is directed to the inspection point.

begin the transition to Robot Operating System 2. Feature enhancements were added to support proof-of-concept applications for TSMO use cases, including cooperative traffic signaling and CMVs in work zones.

CARMA XiL

The CARMA XiL project has developed a cosimulation tool to support the development, evaluation, and deployment of CDA technology. This tool supports the integration of CARMA Platform cooperative-ADS (C-ADS) features with open-source Cars Learning to Act (CARLA), Simulation of Urban Mobility (SUMO), and NS-3, using the MOSAIC simulator framework to simulate traffic and realistic C-ADS in one package. This cosimulation tool also uses NS-3, a network simulator, to simulate the V2X communications used by the C-ADS systems. The MOSAIC simulator framework manages the interaction between all of these. The CARMA XiL cosimulation tool is leveraged by different CDA use cases research such as traffic incident management and traffic signal priority.

Version 1.0 was released in the third quarter of 2022, and includes the following features:

- CARLA-SUMO integration with the MOSAIC framework.
- CARMA Platform integration with CARLA for a single connected and automated vehicle.
- Vehicle-to-vehicle communication research support.

The following features of cosimulation tool are under development:

- CARMA Platform integration with CARLA for multiple vehicles.
- CARMA Streets and cosimulation tool interface development.
- Vehicle-to-vehicle and vehicle-to-infrastructure communication research support.

Learn more about CARMA XiL and its components:

- CARMA Simulation GitHub: *https://github.com/usdot-fhwa-stol/carma-simulation*
- CARLA: *https://carla.org/*
- SUMO: *https://www.eclipse.org/sumo/*
- NS-3: *https://www.nsnam.org/*
- MOSAIC: *https://www.eclipse.org/mosaic/*

Looking Ahead

Over the next few months, the CDA Program will continue various activities to test CDA research and applications. The cooperative perception TSMO use case has begun initial testing at TFHRC. Cooperative perception (CP) allows entities to share data perceived locally, with the aim of improving safety for pedestrians and road users. The CP use case will lay the foundation for future use cases performed under CDA research projects. Additionally, the Integrated Highway Prototype II project will perform testing as well, with the purpose of advancing CDA freeway features.

As the CDA Program continues to develop and test CDA tools and applications, it will accelerate industry adoption of the technology and improve transportation system mobility, safety, and efficiency.

"The FHWA Saxton Transportation Operations Laboratory is conducting critical research that is required to demonstrate the potential of cooperative driving automation to achieve safety, mobility, and environmental impacts," says Dr. Larry Head, professor at the University of Arizona. "They are pushing the boundaries of the technology and developing new knowledge that will establish the roadmap for the future of automated transportation systems."

GOVIND VADAKPAT is the CDA Program Manager in FHWA's Office of Safety and Operations Research and Development, leading the open-source development and collaboration efforts of CARMA with partners and stakeholders. He holds a doctorate in civil engineering from Pennsylvania State University and a master's degree in civil engineering from the University of Wisconsin-Madison.

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HYUNGJUN PARK is a technical program manager of the CDA Freight program in FHWA's Office of Safety and Operations Research and Development. He manages various CDA activities, focusing on commercial motor vehicles and freight. He earned a B.S. in city planning from Hanyang University in South Korea, and an M.S. and a Ph.D. in civil engineering from the University of Virginia.

STEVEN VU is a contracted communications specialist in FHWA's Saxton Transportation Operations Laboratory, contributing to marketing and outreach activities. He earned his B.A. degree from the University of Virginia.

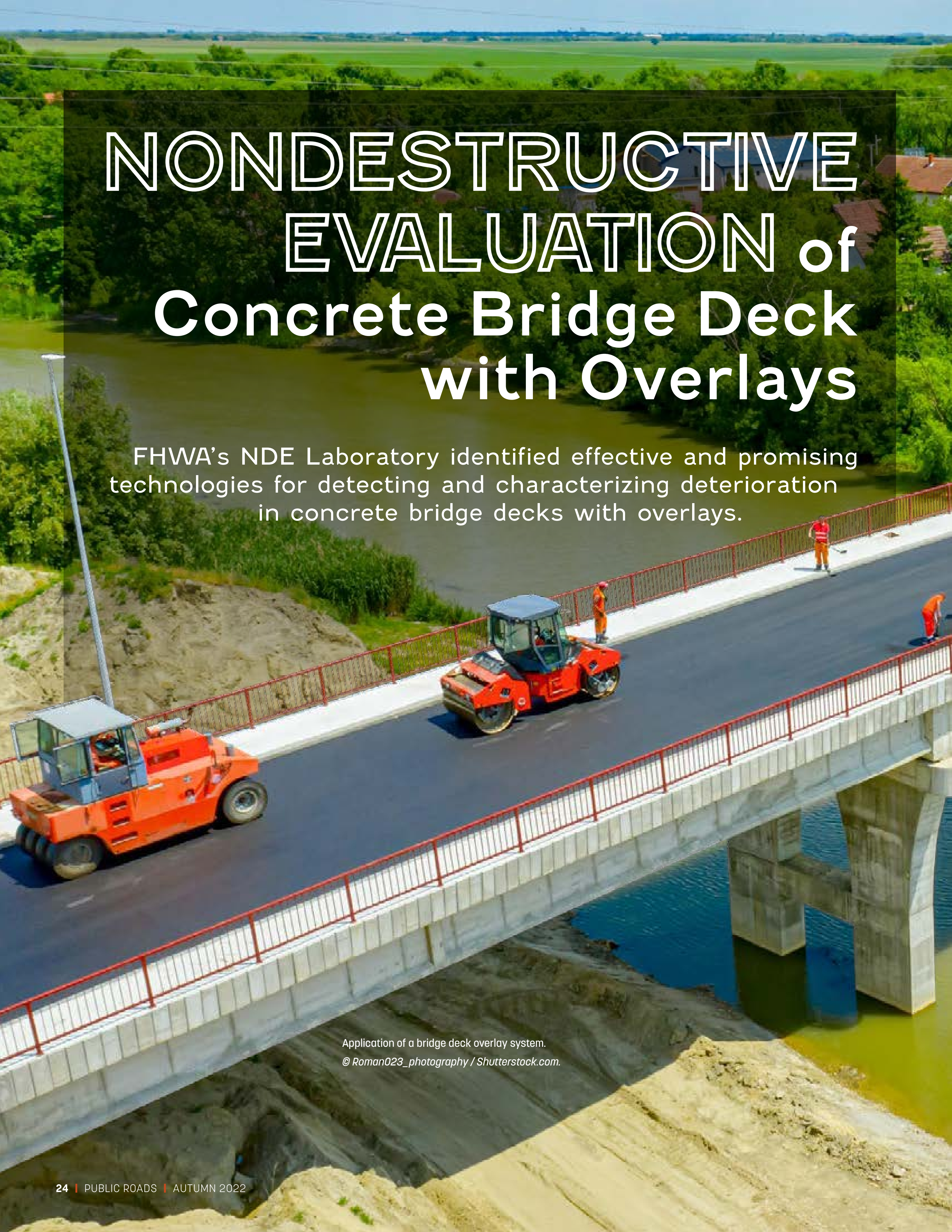
For more information on the CDA Program, visit *https://highways.dot.gov/research/operations/CARMA*.

3. If the commercial motor vehicle passed the inspection, it is directed toward the exit.

4. If the commercial motor vehicle did not pass the inspection, it is directed to the holding area.

NONDESTRUCTIVE EVALUATION of Concrete Bridge Deck with Overlays

FHWA's NDE Laboratory identified effective and promising technologies for detecting and characterizing deterioration in concrete bridge decks with overlays.

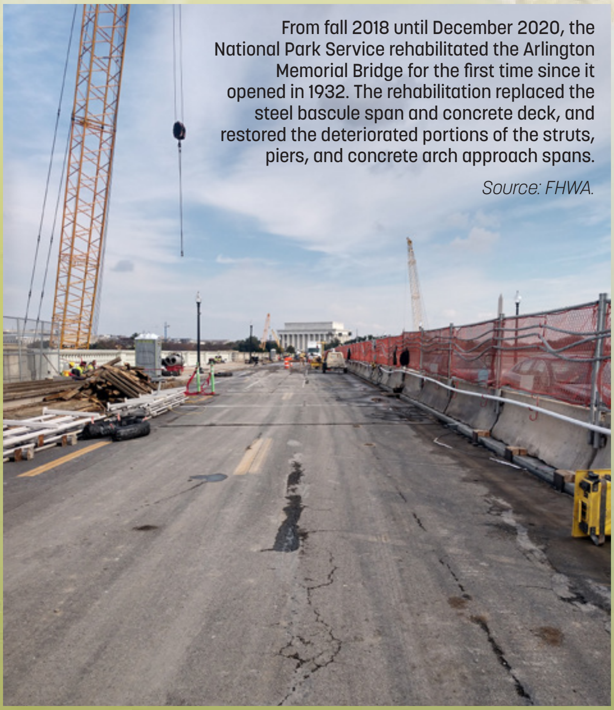


Application of a bridge deck overlay system.
© Roman023_photography / Shutterstock.com.

by **HODA AZARI** and **SADEGH SHAMS**

Overlay systems have been used by State departments of transportation (DOTs) since the 1960s to extend the service life of deteriorated concrete bridge decks by protecting the underlying concrete substrate. An overlay is a thin layer of material—such as asphalt concrete, portland cement-based concrete, latex modified concrete, epoxy polymer concrete, or polyester polymer concrete—that is placed over existing concrete. A bridge deck overlay system can improve the ride quality for drivers, add protection for embedded reinforcement, and/or modify the transverse profile and vertical alignment of the existing roadway to improve deck drainage. More than 10,000 bridges in the United States have been successfully rehabilitated using overlays. However, the overlays on bridge decks can deteriorate and debond from the underlaying concrete decks.

Debonding, a separation between overlays and the deck, is a common defect in concrete bridge decks. Even if the overlay looks intact, the underlying concrete deck may have hidden deterioration (e.g., rebar corrosion and delamination). Because the underlying concrete is not accessible for direct inspection, other methods must be used to identify these deteriorated areas throughout the overlay service life.



From fall 2018 until December 2020, the National Park Service rehabilitated the Arlington Memorial Bridge for the first time since it opened in 1932. The rehabilitation replaced the steel bascule span and concrete deck, and restored the deteriorated portions of the struts, piers, and concrete arch approach spans.

Source: FHWA.

Nondestructive Testing Advantages

Destructive and nondestructive testing are widely used by engineers to evaluate the structural integrity and characteristic differences in material properties, defects, and discontinuities of bridge structures. The sampling required for destructive testing damages a structure. In contrast, nondestructive evaluation (NDE) technologies enable assessment of structures without causing damage. Nondestructive testing also enables more comprehensive inspection since the tests can be repeated, and several technologies can be used together to better identify and characterize underlying defects.

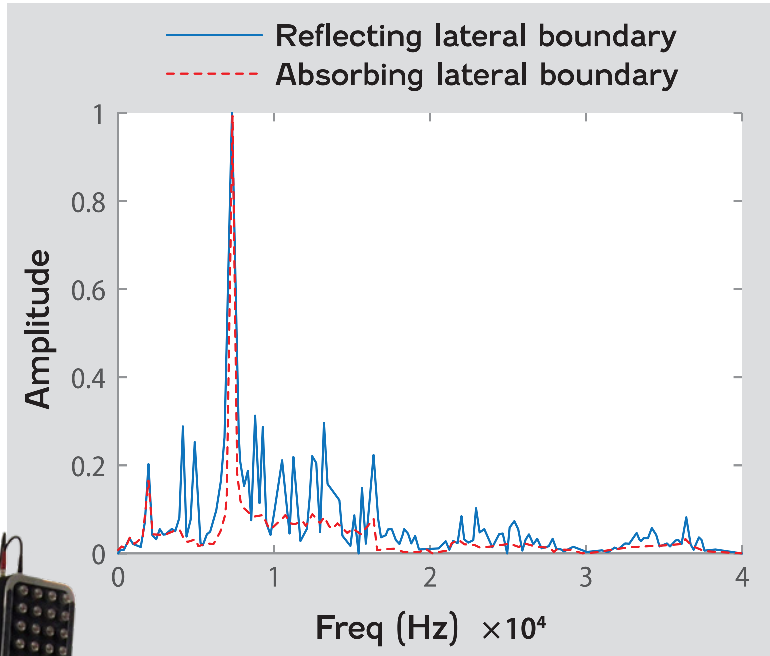
"NDE technologies provide data not otherwise available to bridge owners to support well-founded decisions concerning investments in preservation, maintenance and rehabilitation," says Hari Kalla, associate administrator, Federal Highway Administration (FHWA) Office of Infrastructure.

Through laboratory specimens under controlled conditions and in the field under actual conditions, FHWA's NDE Laboratory at the Turner-Fairbank Highway Research Center identified promising technologies for assessing concrete bridge decks with different types of overlays. The following nine technologies were considered for investigation:

- Sounding
- Impact echo (IE)
- Ultrasonic surface waves (USW)
- Ultrasonic shear-wave tomography (Ultrasonic Testing (UT)-MIRA and UT-EyeCon)
- Infrared thermography (IRT)
- Ground-penetrating radar (GPR)
- Electrical resistivity (ER)
- Half-cell potential (HCP)
- Impulse response (IR)

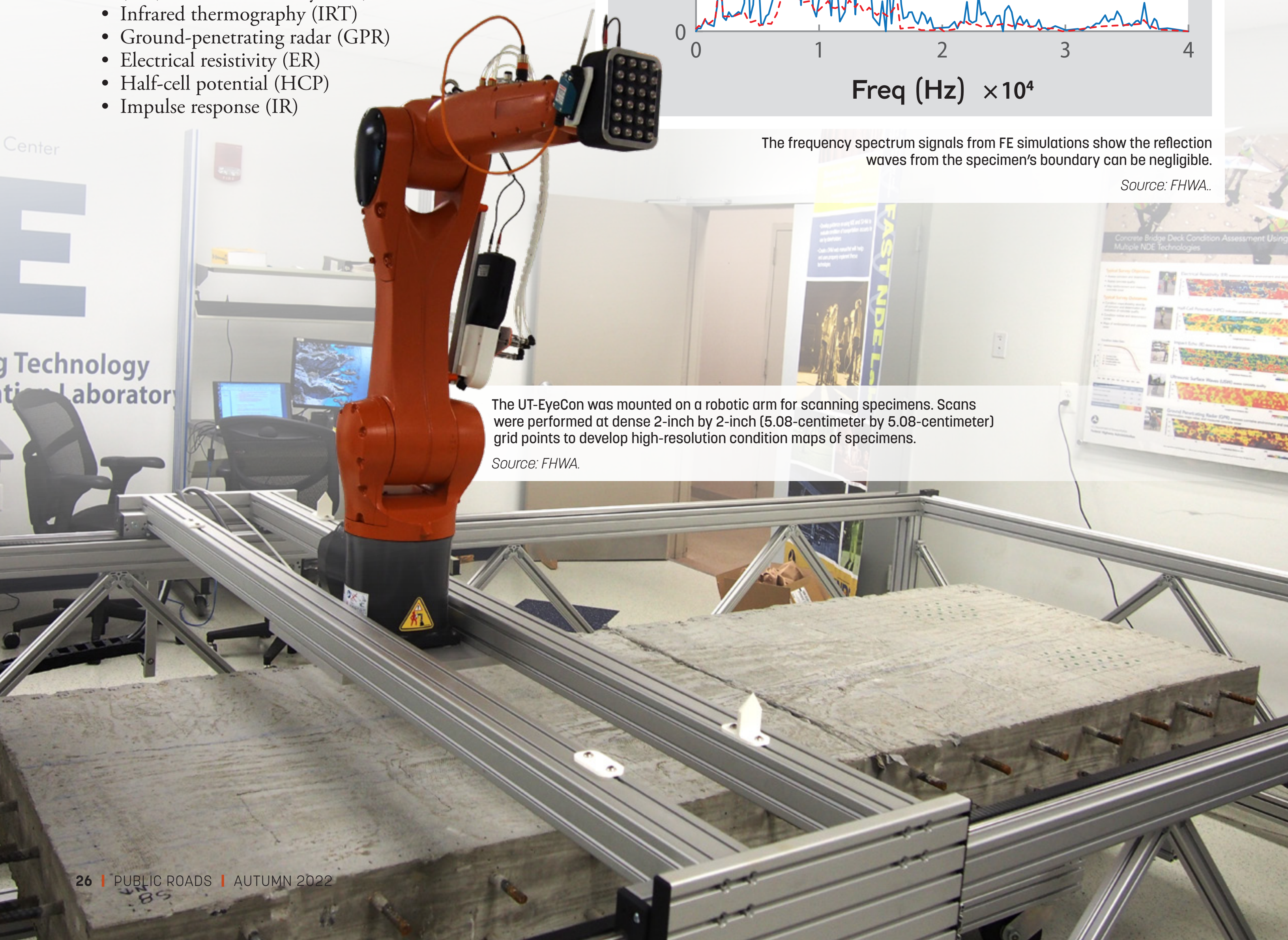
Specimen Fabrication

The researchers designed the experiments based on the results from the finite element (FE) simulations of IE, USW, and ultrasonic shear-wave methods. These FE analyses ensure that the specimen's dimension provides reliable stress-wave propagations and temperature distribution without significant disturbances from boundary effect reflections.



The frequency spectrum signals from FE simulations show the reflection waves from the specimen's boundary can be negligible.

Source: FHWA..



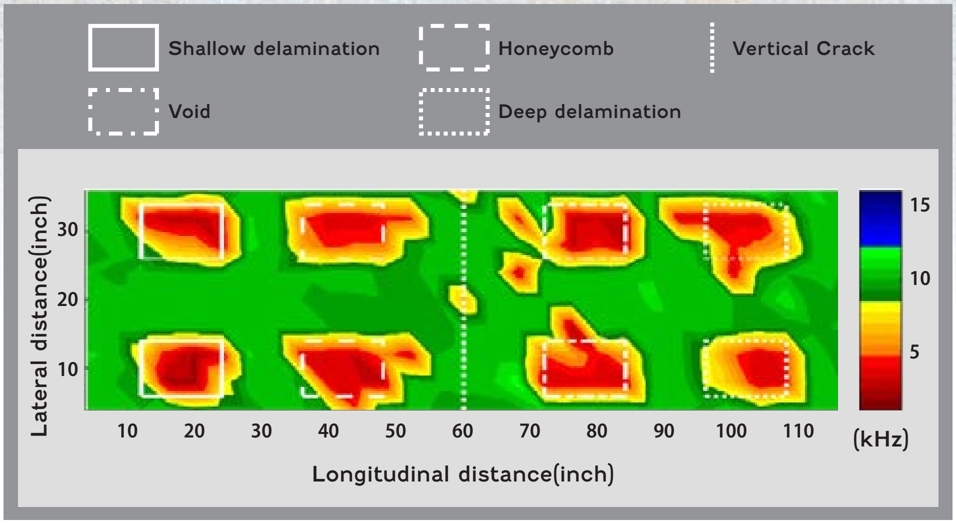
The UT-EyeCon was mounted on a robotic arm for scanning specimens. Scans were performed at dense 2-inch by 2-inch (5.08-centimeter by 5.08-centimeter) grid points to develop high-resolution condition maps of specimens.

Source: FHWA.

The researchers designed and manufactured eight identical specimens with various artificial defects. The artificial defects included delamination at upper and lower rebar levels, honeycombing, voids, vertical cracks, and precorroded rebars within an elevated chloride content environment. After fabrication, the researchers first tested bare concrete specimens with nine NDE technologies to assess their performances in detecting defects before placing the overlays.

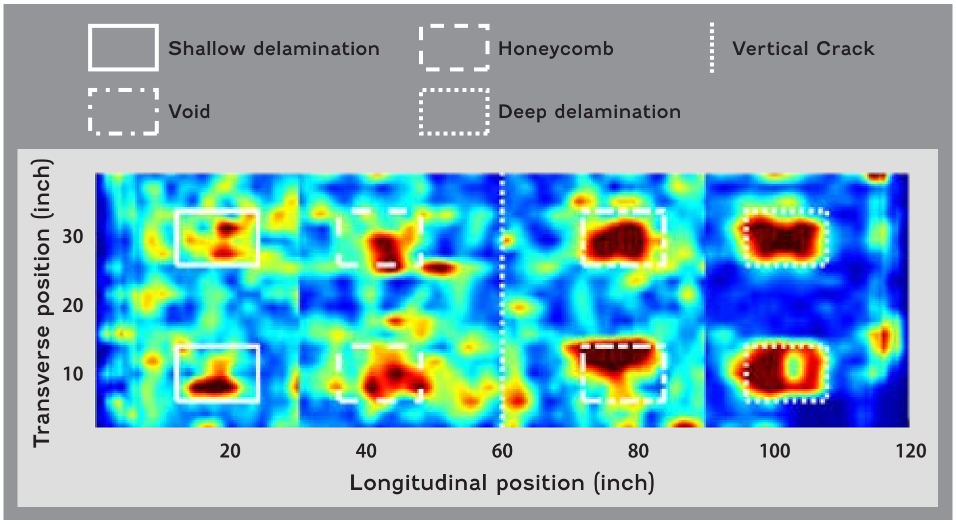
The NDE Laboratory experts evaluated the specimens before applying overlays.

Based on the NDE of eight bare concrete specimens, the researchers summarized the effectiveness of nine NDE technologies on uncovered decks.



The condition maps were developed using the dominant frequencies measured by the IE method. IE detected shallow and deep delaminations, honeycombing, and voids in all eight specimens.

Source: FHWA.



The UT-based C-Scans with EyeCon. The C-Scan is a two-dimensional section reconstructed from multiple A-Scans in the X-Y plane. The UT method detected shallow and deep delaminations and voids in all eight specimens, but only some honeycombing in some specimens.

Source: FHWA.

Specimen Testing with Overlays

The NDE Laboratory researchers studied the effectiveness of nondestructive methods in evaluating reinforced concrete bridge decks rehabilitated by seven types of widely used overlays: asphalt with a liquid membrane (S5AL), asphalt with a fabric membrane (S4AS), asphalt without a membrane (S7A), silica fume-modified concrete (S6S), latex-modified concrete (S3L), epoxy polymer concrete (S1E), and polyester polymer concrete (S8P). Epoxy-, latex-, silica fume-, and polyester polymer-based overlays were constructed by experts from the Virginia Transportation Research Council. A piece of plastic sheet covered half of each specimen to create the debonding defect between concrete and the overlays. The other half was shot-blasted to

Applicability of NDE methods for concrete bridge specimens without overlays.

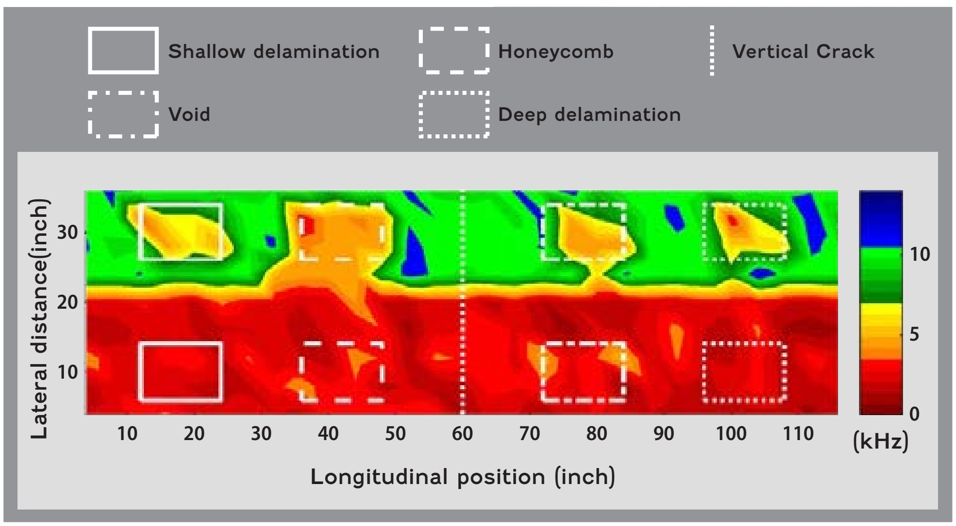
Method	Defects in concrete bridge specimen						
	Shallow delamination	Honey-combing	Void	Deep delamination	Vertical crack	Active rebar corrosion	Concrete corrosive environment
Sounding	Yes	No	Yes*	No	No	No	No
USW	Yes	Yes	Yes	Yes	Yes	No	No
IE	Yes	Yes	Yes	Yes	No	No	No
UT-MIRA	Yes	Yes	Yes	Yes	No	No	No
UT-EyeCon	Yes	Yes	Yes	Yes	No	No	No
IR	Yes	No	No	No	No	No	No
GPR	Yes	Yes	Yes	Yes	No	No	Yes
ER	No	No	No	No	Yes	No	Yes
HCP	No	No	No	No	No	Yes	No
IRT	Yes	Yes*	Yes*	No	Yes*	No	No

Note: "Yes*" means the NDE method can detect the defect from certain concrete specimens.

prepare the surface for the proper bonding of the overlays. Each overlay was placed within 24 hours after shot blasting to minimize the carbonation of the blasted concrete and ensure proper bonding. Epoxy polymer overlay was placed on S1 in two layers. Polyester polymer overlay was placed on S8 with a thickness of 0.75 inches (1.90 centimeters) and a 28-day compressive strength of 6,240 pounds per square inch (43.02 megapascals) from concrete cylinder tests. Latex- and silica fume-modified concrete overlays with a thickness of 1.5 inches (3.81 centimeters) were placed on S3 and S6, respectively. The concrete surface was saturated with water before the overlays were placed. These two overlays contained typical mixtures used on concrete bridge decks in Virginia. The 28-day compressive strengths of the latex- and the silica fume-based overlays from concrete cylinder tests

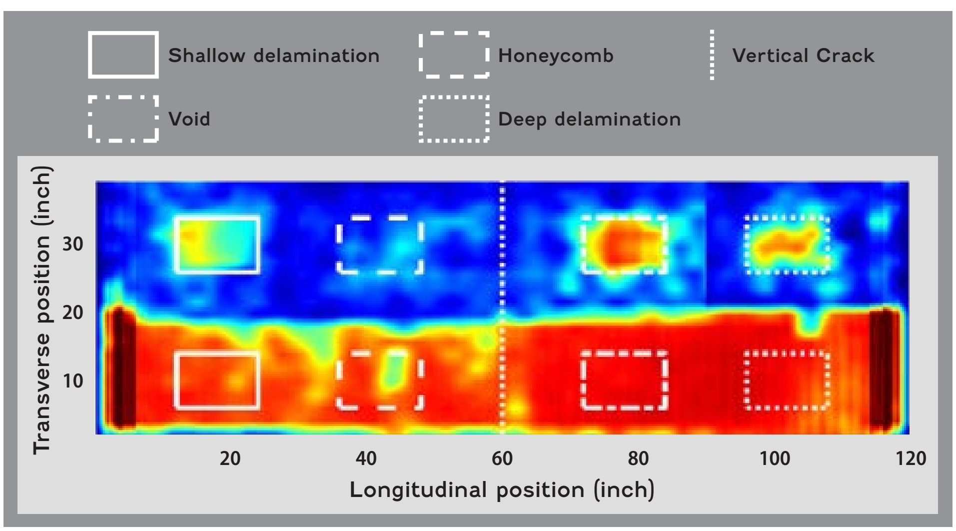

Silica fume-modified concrete overlays with a thickness of 1.5 inches (3.81 centimeters) were placed on S6.

Source: FHWA.



The condition maps of the S1E specimen using the dominant frequencies measured by the IE.

Source: FHWA.



NDE C-Scan of S3L specimen with EyeCon. The C-Scan is a two-dimensional section reconstructed from multiple A-Scans in the X-Y plane.

Source: FHWA.

were 5,490 pounds per square inch (37.85 megapascals) and 9,430 pounds per square inch (65.01 megapascals), respectively. The liquid membrane was used on sample S5, and the sheet membrane was incorporated in sample S4. Parchment paper that can withstand temperatures up to 420 degrees Fahrenheit (215.55 degrees Celsius) was used to create debonding under half of each asphalt overlay.

As the defects were placed symmetrically with respect to the longitudinal axis of specimens, half of each overlay was bonded to the underlying concrete specimens, and the other half was debonded. This approach allowed researchers to examine if debonding can be recognized by each NDE technology, and if debonding can affect defect detections.

The investigation results identified effective and promising NDE technologies to detect and characterize deterioration in concrete bridge decks with overlays. The IE method, for example, detected debonding, shallow and deep delaminations, honeycombing, and voids for the bonded halves of S1E, S3L, S6S, and S8P. For the debonded halves of the same specimens, IE stress waves were reflected at the interface, NDE methods for bridge deck with asphalt without a membrane overlay (S7A).

Method	Defects in concrete bridge specimen with bonded overlay							
	Overlay debonding	Shallow delamination	Honeycombing	Void	Deep delamination	Vertical crack	Active rebar corrosion	Concrete corrosive environment
Sounding	Yes	No	No	No	No	No	No	No
USW	Yes	No	No	No	No	No	No	No
IE*	Yes	Yes	Yes	Yes	Yes	No	No	No
UT-MIRA	No	No	No	No	No	No	No	No
IR	Yes	No	No	No	No	No	No	No
GPR	No	Yes*	Yes*	Yes*	Yes*	No	No	Yes*
ER	No	No	No	No	No	No	No	No
HCP	No	No	No	No	No	No	No	No
IRT	Yes	Yes*	No	No	No	No	No	No

Note: "Yes*" means the method can detect defects in concrete bridge specimens through the bonded and debonded overlay. "IE*" means the method can only work in cold weather.

resulting in the accurate detection of the debonded area.

The researchers conducted IE tests at different temperatures in an environmental chamber to identify the temperature threshold at which the asphalt overlay remained in a high enough stiffness state to transfer stress waves. This action is important for the detection of defects. Otherwise, the stress waves substantially lose their energy, resulting in poor quality of the received signals. Results showed that temperatures at or below 32 degrees Fahrenheit (0 degrees Celsius) would be required for IE tests to image defects successfully using the dominant frequencies approach.

The IE method was able to detect shallow delamination and debonding in S4AS and S5AL. However, it could not detect deep delaminations, honeycombing, and voids in the bonded halves of S4AS and S5AL, because the membranes significantly reduced the propagation of waves into the underlying concrete specimens.

The IE method detected debonding, shallow and deep delaminations, honeycombing, and voids in S7A, because sufficient waves could propagate into the underlying concrete specimen without a membrane underneath the asphalt overlay.

The project outcomes identified and ranked available and promising NDE technologies for assessing concrete bridge decks with overlays.

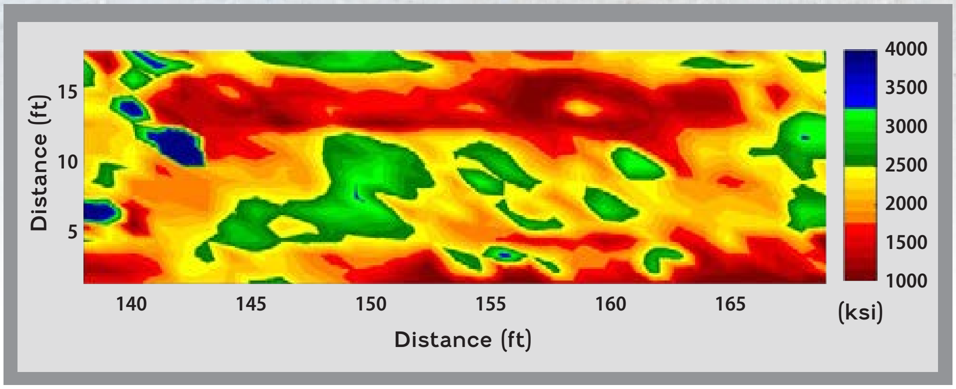
Field Testing

Because of the differences between the construction of laboratory specimens and conventional bridge decks, large-scale field testing is required to assess the performance of the NDE methods in the field. The researchers investigated the field performance of IE and USW on the Arlington Memorial Bridge, located in Washington, DC. The bridge deck was rehabilitated

NDE methods for bridge deck with latex modified concrete overlay (S3L).

Method	Defects in concrete bridge specimen with bonded overlay							
	Overlay debonding	Shallow delamination	Honeycombing	Void	Deep delamination	Vertical crack	Active rebar corrosion	Concrete corrosive environment
Sounding	Yes	No	No	No	No	No	No	No
USW	Yes	Yes	Yes	Yes	Yes	No	No	No
IE	Yes	Yes	Yes	Yes	Yes	No	No	No
UT-MIRA	Yes	Yes	Yes	Yes	Yes	No	No	No
UT-EyeCon	Yes	Yes	Yes	Yes	Yes	No	No	No
IR	Yes	No	No	No	No	No	No	No
GPR	No	Yes*	Yes*	Yes*	Yes*	No	No	Yes*
ER	Yes	No	No	No	No	No	No	No
HCP	No	No	No	No	No	No	Yes	No
IRT	Yes	Yes	No	No	No	No	No	No

Note: "Yes*" means the method can detect defects in concrete bridge specimens through the bonded and debonded overlay.



The condition map using the moduli measured with the USW method. The NDE assessment was performed on 250 feet (76.2 meters) of the bridge, starting from the north side on the left lane. The defected areas were found within 141–165 feet (42.9–50.2 meters) of the longitudinal direction.

Source: FHWA.

with an asphalt overlay. The USW method detected debonding of the asphalt overlay in an area with lower moduli than the other regions. The USW method detected two large areas of defects.

The researchers also obtained condition maps based on the dominant frequencies measured by the IE method. An area with lower dominant frequencies compared with other regions indicated defects. The IE method detected two large areas compatible with defective areas revealed by the USW method. The intact areas have a thickness mode frequency of about 10 kilohertz. The debonding areas have dominant frequencies around 2 kilohertz.

NDE Protocols

The FHWA Advanced Sensing Technology (FAST) NDE Laboratory used these testbeds to evaluate NDE technologies that can assess decks with overlays to supplement the information in the InfoTechnology web portal and the Long-Term Bridge Performance Program (LTBP) research on bridge decks with overlays. This research allows the FAST NDE Laboratory and the LTBP experts to provide bridge owners with field data collection protocols and information to identify NDE technologies to assess bridge decks with different types of overlays. The protocols provide distinctive, step-by-step instructions for data collection and comprehensive references for standards cited in the protocols (e.g., see the accompanying chart of the testing protocol for IE).

"These protocols are essential to maintain consistency in data collection and storage," says Dr. Jean Nehme, Long-Term Infrastructure Performance team leader. "These protocols will be of interest to practitioners, researchers, and decisionmakers involved with the research, design, construction, inspection, maintenance, and management of bridges with overlayed decks."

HODA AZARI is the manager of the NDE Research Program and FHWA's NDE Laboratory at the Turner-Fairbank Highway Research Center. She holds a Ph.D. in civil engineering from the University of Texas at El Paso.

SADEGH SHAMS is a contracted research engineer working in FHWA's NDE Laboratory at the Turner-Fairbank Highway Research Center. He holds a Ph.D. in civil engineering from the University of Wisconsin-Milwaukee.

For more information, see ***https://highways.dot.gov/research/turner-fairbank-highway-research-center/facility-overview*** or contact Hoda Azari, 202–493–3064, *Hoda.Azari@dot.gov*.

Impact Echo Testing Protocol for Bridge Decks with Overlays

Data Collected

- Evidence of concrete delamination and other defects such as overlay debonding.
- Conduct IE testing on concrete decks with asphalt overlays with the overlay surface temperatures lower than 35 degrees Fahrenheit. Results depend on the temperature at the time of testing and should be corrected based on a reference temperature.

Onsite Equipment and Personnel Requirements

Equipment:

- PRE-PL-LO-004, Personal Health and Safety Plan.
- Impact echo (IE) equipment/device; either of the following are acceptable:
  - Cart mounted and semiautomated to control data collection line length and spatial location on deck, spacing between individual test measurements, triggering impact/source deployment, ease of use, etc.
  - Hand deployed and triggered manually at each test point location.
  - Data acquisition controller and software capable of sampling and recording at a minimum rate of 50 kHz.
- Data controller/storage device: laptop or data logger.
- Data conditioning and analysis software capable of filtering, clipping, segmenting, and discarding noise and waveforms unrelated to the IE data.
- Impact source capable of generating and a receiver capable of recording signals, with an acceptable signal to noise ratio that exists in a range of at least 2 to 25 kHz.
- Digital camera.
- Personnel: PRE-PL-LO-005, Personnel Qualifications.

Methodology

- Use the local rectangular grid (FLD-OP-SC-001, Data Collection Grid and Coordinate System for Bridge Decks) to locate test points on the deck.
- Test preparation: Clear any debris from the deck surface.
- Measurements:
  - Collect data along any test line, as long as the location of every IE reading is properly recorded.
  - Place the impact device and sensor in direct contact with the sampled concrete surface.
  - During field operations, take care that the collected data in the time and frequency domains are consistent with expected signals from the structure being surveyed.
- Final forms for collected data include time histories and frequency response of measured raw data at all x and y test locations from gridded deck. Processed data consists of condition grading based on resonant frequency response of IE data (grades 1 to 4), also on x-y coordinate system.
- Reporting: Transfer all metadata, data, documents, and images to FHWA, and/or upload all metadata, data, documents, and images into the LTBP Bridge Portal InfoBridge.

A chart plot of the significant items from the IE method protocol.

Source: FHWA.

The Local Technical Assistance Program: 40 Years of Service and Support for Local Transportation Across the Nation

Attendees view a snowplow demonstration at the annual School for Highway Superintendents conference hosted by the New York State LTAP Center–Cornell Local Roads Program in Ithaca, NY.
© The NYS LTAP Center–Cornell Local Roads Program.

This year, the Local Technical Assistance Program celebrates its 40th anniversary serving local road agencies throughout the Nation.

by **ADAM HOWELL**

Every time you leave for work, order a delivery, or call for an ambulance, you depend on a complex system of roads and bridges that allow modern life to function. The maintenance and construction of our public roads are the responsibility of dedicated people who use skill, experience, and innovative thinking to get the job done. And while the capability and commitment of local highway departments and public works agencies across the Nation are top notch, even they need help sometimes.

For decades, local transportation agencies across the Nation have sought assistance from the Local Technical Assistance Program (LTAP). Through their local LTAP centers, these agencies have utilized a variety of low cost and accessible training, education, and support activities.

Much can be learned from the history of a government program. Examining LTAP's history and its intellectual underpinnings helps ensure that the program's opportunities for development and growth are not ignored. This year, LTAP celebrates its 40th year of serving local transportation agencies in Puerto Rico, the Virgin Islands, Native American territories, and every State.

40 YEARS LTAP Local & Tribal Technical Assistance Program

Early Examples of State Leadership and Support for Local Roads Agencies

While the LTAP system is the embodiment of formalized Federal support for local transportation training and education, the idea's roots go back much further. Initially, bicyclists brought together educational institutions, rural civic associations, agricultural interest groups, and other organizations to form what is now known as the Good Roads Movement—a roadway advocacy campaign between the 1870s and the 1920s. Existing before the days of social media, the internet, television, or even radio, the Good Roads Movement and its ideas were spread by an advocacy publication called *Good Roads Magazine*. As the movement progressed, good roads associations formed in States throughout the Nation.

While providing funding and establishing higher standards for America's roads was an important initial goal, Good Roads Movement participants also knew that entities who did local road work needed support and training. Supporting local road agencies with training, assistance, and education was an effort that took many different forms at the State level.

In New York State, interest in supporting local roads coalesced at Cornell University where a group of experts and professionals came together for a "Good Roads Week" conference held on campus in 1905. Subsequently, Cornell University held several more conferences and events dedicated to local roads in New York, leading to the creation of the Cornell Local Roads Program. The Cornell Local Roads Program would later become the official LTAP center for New York in 1984.

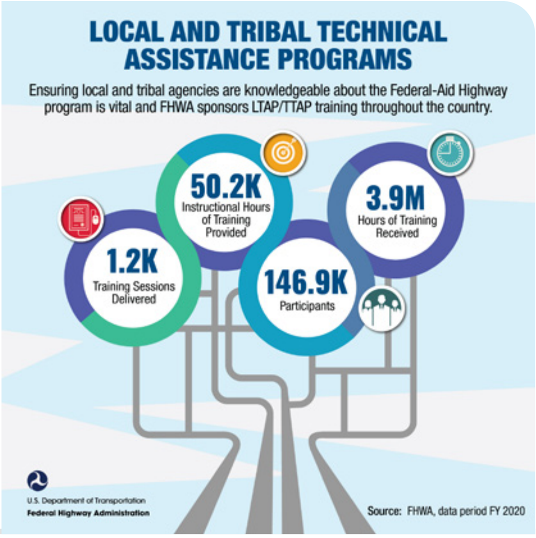
In Indiana, the Highway Extension and Research Project for Indiana Counties (HERPIC), established at Purdue University in 1959, pioneered many modern LTAP programming activities. As a cooperative effort between Indiana's county commissioners and Purdue University, HERPIC organized many activities, such as creating publications and hosting workshops. According to an early HERPIC flyer, the program would "lend guidance and assistance to county highway officials in their problems with management, planning, and operation of county highway departments throughout the State." Purdue University would go on to pilot one of the first LTAP centers in 1982.

In Oklahoma, the work of Dr. Jim Shamblin, an industrial engineering professor at Oklahoma State University (OSU), helped influence the LTAP system. In 1972, he formed the Center for Local Government Technology (CLGT) and later secured a grant from the U.S. National Science Foundation (NSF) to help local governments use computer technology. Following the success of this earlier effort, another proposal was submitted to NSF to provide broader assistance with engineering technologies to local governments through OSU's College of Engineering, Architecture, and Technology. From this initial funding, the CLGT evolved and became the model for today's LTAP system.

Formation of LTAP

The LTAP system (originally called the Rural Technical Assistance Program) was established on December 23, 1981, when President Ronald Regan signed House Bill 4209 into law. Initially, the program was allocated $5 million for numerous projects related to rural technical assistance, with the establishment of the State Technology Transfer Program for Local Transportation Agencies (T2) being the largest. At first, 10 States hosted T2 centers as part of the initial pilot program:

- The Alabama center located at Auburn University.
- The California center located at the University of California, Berkley.
- The Georgia center located at the Georgia Institute of Technology.
- The Indiana center located at Purdue University.
- The Iowa center located at Iowa State University.
- The Kansas center located at the University of Kansas.
- The Montana center located at Montana State University.
- The Pennsylvania center located at the Pennsylvania State University.
- The Oklahoma center located at Oklahoma State University.
- The Vermont center located at St. Michael's College.



In 1991, the Intermodal Surface Transportation Efficiency Act expanded LTAP to include urban areas with populations over 50,000, effectively expanding the scope of LTAP's work. The Tribal Technical Assistance Program was also added to LTAP to help American Indian Tribal governments manage their highway assets.

Over the years as new centers have emerged across the Nation, the LTAP system has expanded in size. By the early 2000s, an LTAP center existed in every State. This expansion reflects the quality work of the LTAP centers. Early on in its history, research demonstrated the success of the LTAP system. According to a 1984 National Highway Institute Evaluation Report, the State centers at that time were "fulfilling all of the objectives of the [LTAP]" and were "responsive to local agency needs."

The experts in these centers have also shaped the LTAP system, such as former director of the Kentucky LTAP center Patsy Anderson. Anderson was instrumental in starting the first Safety Circuit Rider Program and the first Roads Scholar program in 1988 to provide recognition and credentialing for local roads personnel. Both the Kentucky LTAP Center Safety Circuit Rider program and the Roads Scholar program became national models emulated by many other U.S. States and territories today. In 2007, Anderson was awarded the National Achievement Award from the National Local Technical Assistance Program Association (NLTAPA) for her leadership, service to the industry, and impact upon the national LTAP system.

Stan Ring, the first director of the Iowa LTAP center, was known as "Mr. LTAP." Prior to Iowa State University becoming the official center for the State, Ring led the university's civil engineering extension program, which provided outreach for and support to the State's transportation workforce. Ring also had a passion for developing an extensive library of resources to benefit the Iowa local transportation community—a legacy that endures today at the Iowa LTAP center. Even after his retirement in 1988, Ring continued to serve as the LTAP's part-time librarian for another 12 years.

"The strength of our association is that we are a community." David Orr, P.E., PhD, director of NYS LTAP Center–Cornell Local Roads Program.

"For the past 40 years, our LTAP team has worked tirelessly, as a part of the national LTAP program, to support the professional development of our transportation community. On a daily basis, we receive feedback from our stakeholders to let us know how important our programs are in their being better professionals, better leaders, and better people. The resources that are leveraged through the work of all of our centers are what allows us to make such a big impact with small budgets. It is rewarding to know that we are making a difference," says Donna Shea, Connecticut LTAP executive program director.

While there are certainly many more people past and present who have dedicated their careers to LTAP, the theme remains the same: serving those who keep the Nation moving forward with quality training, education, and assistance.

The National System of LTAP Centers Today

So how do these programs support local roads? Primarily, LTAP centers provide training, education, and technical assistance

New York State local roads workers attend a training workshop on work zone traffic control hosted by the New York State LTAP Center–Cornell Local Roads Program.

© The NYS LTAP Center–Cornell Local Roads Program.

to meet the needs of local transportation agencies. The work of LTAP centers includes workforce development, infrastructure maintenance, highway safety, worker safety, infrastructure design, asset management, and more.

Despite the unique nature of every LTAP center, there are some very important similarities between programs across the country. All LTAP centers make their resources, training, and outreach accessible and relevant to local communities, agencies, and transportation practitioners. These affordable services aim at dealing with common problems that affect a wide variety of local agencies. Also, LTAP centers strive to innovate and better connect with their populations. For example, many LTAP centers recently added webinars and other online training offerings to meet the needs of a modern local transportation workforce in the internet age.

LTAP centers also deliver services to communities by establishing important partnerships at the national, State, and local levels. At the national level, the Federal Highway Administration's (FHWA) Center for Local Aid Support provides national leadership and support for all LTAP centers across the Nation. Other important national partners include:

- National Association of County Engineers
- American Public Works Association
- American Association of State Highway and Transportation Officials

Finally, as a family of programs spread out across the Nation, one of the LTAP system's greatest strengths is the relationship between individual centers. NLTAPA exists to help LTAP centers in various U.S. States and territories share knowledge and resources for the benefit of all. Through this association, LTAP centers have a central organization to coordinate activities, exchange best practices, share training expertise, and cooperate on the development of new ways to improve local highways. LTAP centers in different U.S. States and territories often provide each other guest instructors that give valuable trainings.

Modern Challenges of LTAP Centers

Today, the need to provide quality training, education, and technical assistance to local transportation agencies is greater than ever. Local agencies, especially in rural areas, face ongoing workforce pressures as retirements increase, creating the need to recruit and train new workers while the local population decreases. On the regulatory side, State and Federal mandates can strain local departments without always providing the corresponding resources to facilitate compliance. Currently, LTAP centers across the Nation are providing resources and training to help meet these workforce development and agency administration needs. Whether it is vocational training, basic safety courses, or management and leadership education, LTAP centers develop resources to meet these needs.

The COVID-19 pandemic has educated the Nation about the importance of local transportation workers. Regardless of transmission rates or public lockdowns, these essential workers continued to perform their duties and assist neighboring municipalities when workers fell ill. Similarly, LTAP programming rose to the challenge by transitioning content to online formats, creating COVID-19-specific guidance, and working with partners to connect local agencies with even more resources to assist them throughout the pandemic. LTAP centers came together to create a database that organized the massive amount of digital training material, making it accessible to local agencies (many of which gained access to online training for the first time).

In the future, LTAP centers will need to help local agencies navigate the challenges and opportunities posed by aging infrastructure in the United States. Recently passed State and Federal legislation will infuse communities with much needed resources to upgrade, replace, and/or maintain its infrastructure. Educating local agencies about the availability of these resources and how to access them will be an important part of the LTAP's future work. LTAP centers are also helping communities connect to information and education about how to prepare for a future where infrastructure must be more resilient to changes in global climate and weather patterns.

A Celebration of Local Transportation

The 40th anniversary of the LTAP system is really a celebration of local communities across the country. Local agencies manage over three-quarters of all centerline miles in the United States. Local roads, streets, and public works systems are the backbone of U.S. commerce, public safety, communication, and so much more. Supporting the people that maintain these critical systems is important for the future of the Nation.

The LTAP exists to serve those who work tirelessly to maintain a safe, reliable local road system across the country. More than just a national network of resources, LTAP centers are a family of like-minded people dedicated to improving local transportation and supporting those who manage it.

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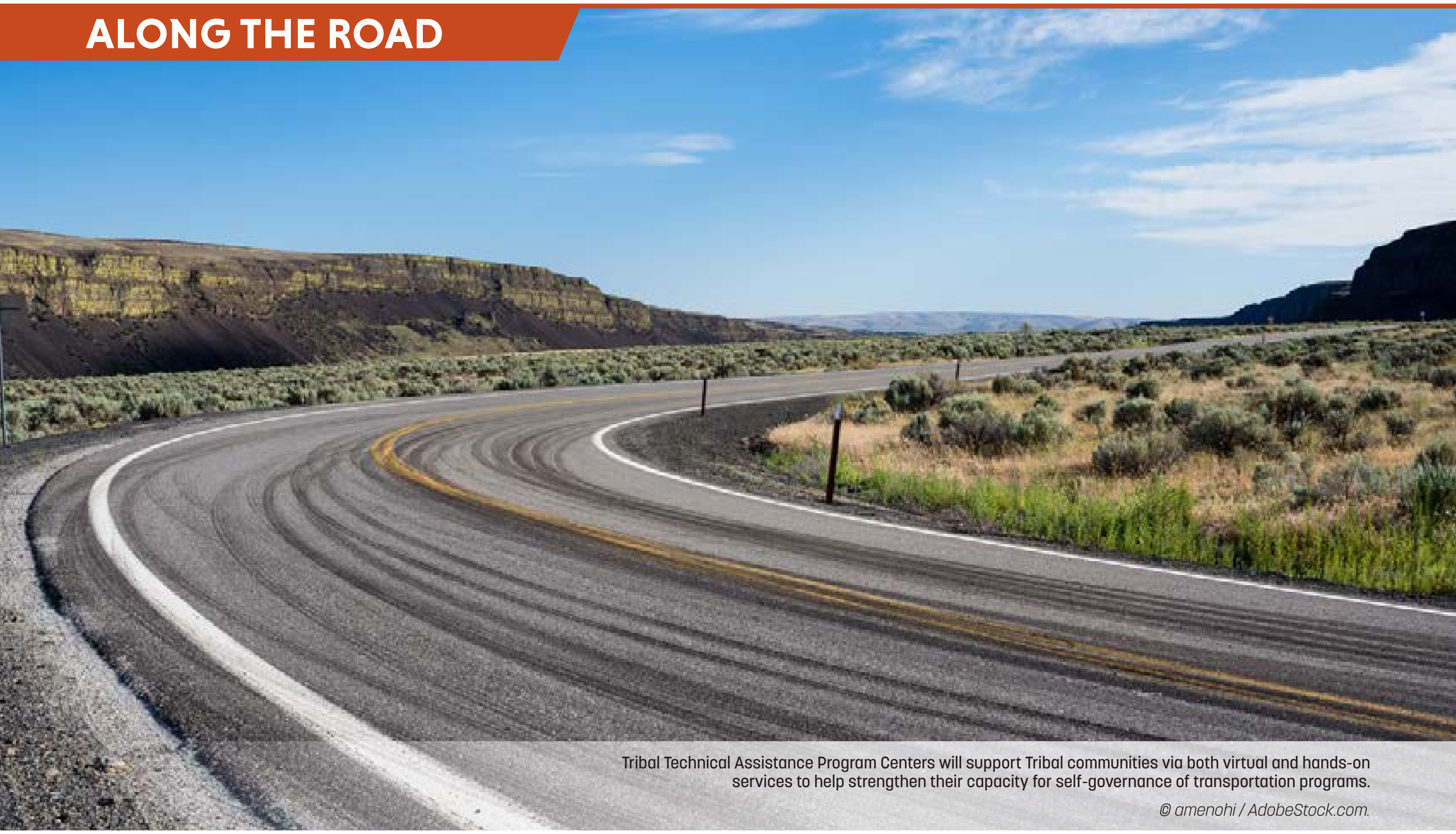
Learn more about the LTAP here:

NLTAPA *https://nltapa.org/*

FHWA Center for Local Aid Support *https://www.fhwa.dot.gov/clas/*

ALONG THE ROAD



Tribal Technical Assistance Program Centers will support Tribal communities via both virtual and hands-on services to help strengthen their capacity for self-governance of transportation programs.

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Along the Road is the place to look for information about current and upcoming activities, developments, trends, and items of general interest to the highway community. This information comes from U.S. Department of Transportation sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Public Information and Information Exchange

Tribal Technical Assistance Program Centers Get Reboot

In January 2022, the Federal Highway Administration announced the availability of nearly $18 million in grants toward the reopening of seven Tribal Technical Assistance Program (TTAP) Centers across the Nation.

TTAP was originally created to provide comprehensive transportation training and technical assistance to Tribal communities in maintaining the safety and structure of Tribal roads. With the reestablishment of these centers over the past five years, the mission of TTAP remains the same: help Native American and Alaska Native Tribal governments build capacity within their organizations, deliver important training resources, and help Tribal communities plan, construct, and maintain their transportation networks.

Prior to their closing, the seven TTAP centers were serving the 12 Bureau of Indian Affairs regions and associated Tribes; the centers expired in 2017 once FHWA began a pilot to establish one central TTAP center. However, feedback from stakeholders, along with the results of the pilot program, favored the opening of several centers nationwide instead of one. Consequently, the seven TTAP centers are reopening to better accommodate the needs of the Tribal communities.

For more information, visit *https://www.fhwa.dot.gov/clas/ttap/*.

Open Call: Innovate with e-Ticketing

Electronic ticketing (e-Ticketing), a product of the Federal Highway Administration's Every Day Counts-6 initiative, is a market-ready innovation that automates the real-time recording and transfer of material delivery information in digital format on highway construction and maintenance projects.

For agencies interested in advancing e-Ticketing, FHWA is offering free outreach events, such as peer exchanges and a national workshop through 2023.

FHWA is also offering free technical customer service support to help implement e-Ticketing and other e-Construction technologies in the areas of implementation planning, information technology, specifications, etc.

For more information on events and customer service support, visit *https://www.fhwa.dot.gov/construction/econstruction/overview.cfm* or email *eticketinghelp@dot.gov*.

Electronic ticketing improves the tracking, exchange, and archiving of materials tickets.

Source: FHWA.

The DBE program has several goals, including helping small businesses compete for Federally funded transportation projects.

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$10 Million Pledge to Minority, Women-Owned Businesses from FHWA

In March 2022, the Federal Highway Administration unveiled $10 million in funding from the FY2021 Disadvantage Business Enterprise/Supportive Services (DBE/SS) Program to assist minority- and women-owned businesses with competing for Federal highway contracts.

The DBE program helps ensure that small businesses can compete for Federally funded transportation projects and assists DBEs in competing outside of the DBE Program.

The funding is provided to State departments of transportation, the District of Columbia, Puerto Rico, and the U.S. Territories that provide training and assistance to DBEs competing on Federally assisted contracts. To be eligible for the DBE program, persons must own 51% or more of a "small business," establish that they are socially and economically disadvantaged within the meaning of the U.S. Department of Transportation regulations, and prove they control their business. FHWA distributes DBE/SS funds each year based on submitted statements of work and through an administrative formula that determines funding for each recipient.

For more information on the DBE program, visit *https://www.transportation.gov/civil-rights/disadvantaged-business-enterprise*. Funding for the DBE/SS Program for FY2022 through FY2026 was provided by the Bipartisan Infrastructure Law.

FHWA and NOAA Collaboration Propels Environmental Advances and Wins Big

Early in 2022, a partnership between the Federal Highway Administration and the National Oceanic and Atmospheric Administration (NOAA) was honored with a U.S. Department of Transportation FHWA Environmental Excellence Award (*https://www.fhwa.dot.gov/environment/environmental_excellence_awards/eea_2022/*).

Roadways and transportation corridors often intersect coastal ecosystems, making it crucial to understand how the coastline will change and how these changes will impact the integrity of transportation infrastructure. This collaboration married the best coastal science on nature-based solutions with the best science on pavement deterioration due to inundation, and established the goals of:

- Delivering approaches to predict future water level conditions and resultant pavement deteriorations.
- Producing physical, ecological, and infrastructure models for local assets and corridor-scale planning.
- Developing outputs for transportation planning and coastal decisionmaking.

The FHWA and NOAA collaboration represents one component of an emerging work plan, which will integrate climate change considerations into new and adapted transportation systems.

© NOAA

Flooding on a main street in Annapolis, MD.

© NOAA

FHWA and NOAA were recognized for two projects, Pavement Resilience to Sea Level Rise and Potential Mitigation Options Using Natural and Nature-Based Features (*https://coastalscience.noaa.gov/project/coastal-communities-pavement-resilience-to-sea-level-rise-using-natural-and-nature-based-features/*) and Surface Transportation, Sea Level Rise, and Coastal Storms: A Sustainable Path to Increased Resilience (*https://coastalscience.noaa.gov/project/surface-transportation-sea-level-rise-and-coastal-storms-a-sustainable-path-to-increased-resilience/*). For both projects, "each agency brought their unique expertise to develop this funding opportunity and shared the opportunity with their networks, resulting in interdisciplinary teams and a breadth of coverage that could not have been achieved without this collaboration," shares Dr. Steve Thur, director of the NOAA National Centers for Coastal Ocean Science. "It will require these types of collaboration between infrastructure experts and environmental experts at the Federal, State, and local level to ensure successful coastal communities in the face of rising seas."

For more information, contact Amir Golalipour at *amir@golalipour@dot.gov*.

Technical News

Smart Work Zone System Aims to Protect Workers

A partnership between the Virginia Department of Transportation, Virginia Tech Transportation Institute, and a geohazard mitigation firm led to the pilot deployment of a prototype vehicle-to-everything (V2X) Smart Work Zone technology system. A demonstration of this innovative work zone spanned across two days in May 2022 on U.S. Route 23 in Wise, VA.

This partnership produced a Smart Work Zone system that supports accurate localization of workers within a work zone and monitors their position relative to geo-fenced boundaries, moving construction vehicle hazards, and, in the future, passing connected vehicles. Warnings are provided to a worker through lights, buzzers, and vibrotactors built into their smart vest. Worker locations are transmitted to a mobile cellular-V2X base station and forwarded to passing connected vehicles to warn them of the presence of workers and any potential collisions.

The award-winning Smart Work Zone system has been tested on the Virginia Smart Road as well as in Northern Virginia, and other areas within the State are being considered.

An innovative vehicle-to-everything Smart Work Zone technology system shows promise in decreasing injuries and fatalities commonly associated with work zones and roadway construction workers.

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Policy and Legislations

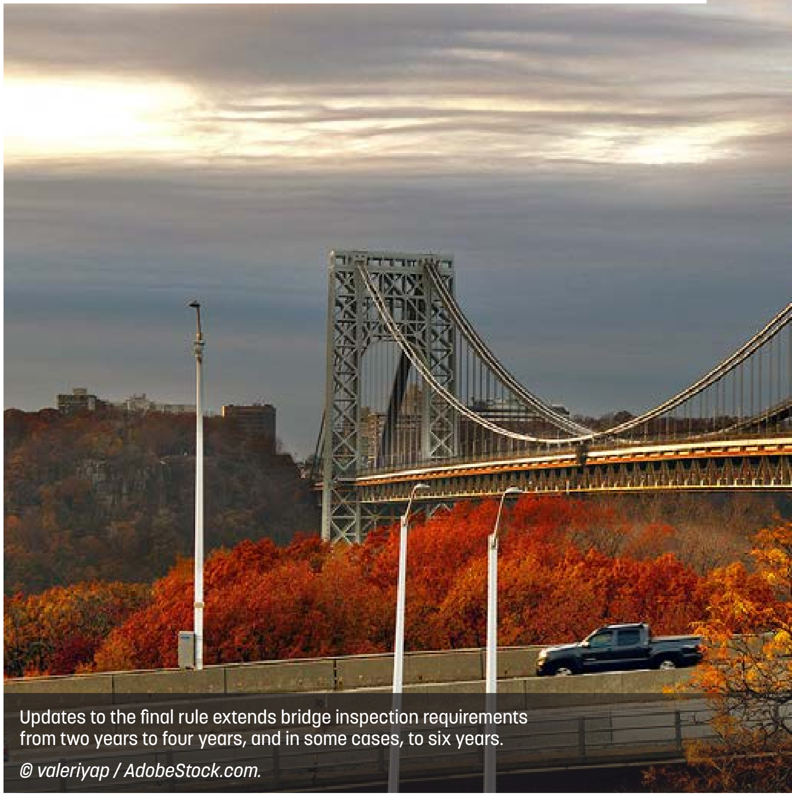
New Rules for Bridge Inspection Timeframes

In May 2022, the Federal Highway Administration published updates to the National Bridge Inspection Standards—the standards established for safety inspections of highway bridges. Routine inspections serve to maintain safe bridge operations and prevent structural and functional failures.

The updates are designed to improve bridge safety by clarifying responsibilities, standardizing the processes for bridge inspections and evaluations, and requiring distinct actions for higher risk issues. One of the most noticeable upgrades pertain to the amount of time between bridge inspections. The new rule extends bridge inspection requirements from two years to four years; some inspections are eligible every six years.

FHWA's final rule went into effect on June 6, 2022, and applies to structures defined as highway bridges on all public roads, on and off Federal-aid highways, and now, highway bridges within Tribal communities. Also, noted in the updates are training and qualification requirements for bridge inspectors—including a national certification process—and the use of technological advancements used in transportation like unmanned aircraft systems.

For more information on the updates, visit *https://www.fhwa.dot.gov/bridge/nbis2022.cfm*.



Updates to the final rule extends bridge inspection requirements from two years to four years, and in some cases, to six years.

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Internet Watch

Local Road Safety Plans Website: A Guide to Mapping Safer Roads

The Federal Highway Administration estimates that nearly 40 percent of the fatalities on the Nation's roadways within the past few years occurred on local roads. In hopes of decreasing this percentage, local transportation agencies are developing a plan—the Local Road Safety Plan (LRSP).

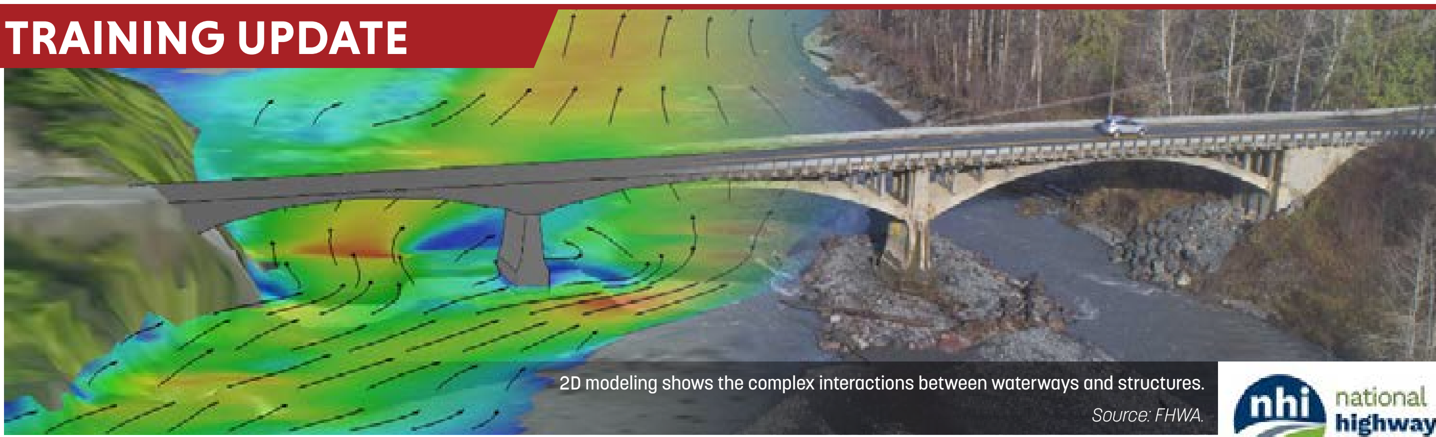
LRSPs are proven to help reduce severe crashes on local road systems. Hence, FHWA established a LRSP do-it-yourself website (*https://safety.fhwa.dot.gov/LRSPDIY/*) to provide a bounty of information needed to create and implement a customized LRSP. For example, the website outlines the four steps needed to complete a plan:

- Step 1: Identify stakeholders.
- Step 2: Use safety data.
- Step 3: Choose proven solutions.
- Step 4: Implement solutions.

What's more, each step is accompanied by a brief written description and a series of videos providing more comprehensive explanations. Sample plans from more than 10 U.S. counties and cities—including Nevada County, CA; Palm Beach County, FL; and Portland, OR—are also posted as guides alongside several other types of training material like a pre-recorded, web-based tutorial and instructions on gathering, utilizing, and incorporating community-specific data into a plan.

The Federal Highway Administration's Local Road Safety Plans do-it-yourself website provides a plethora of information on how to create a plan.

Source: FHWA.



2D modeling shows the complex interactions between waterways and structures.
Source: FHWA.

Updates on Two-Dimensional Hydraulic Modeling Training

BY SCOTT HOGAN and **SABRINA SYLVESTER**

For several decades, hydraulic engineers have used one-dimensional (1D) hydraulic models to perform hydraulic analyses for transportation projects involving waterway crossings and encroachments. Although 1D modeling required several assumptions to simplify the analysis that often led to inaccurate results, it was the best technology available for many years. In recent years, however, significant advances in computing power have ushered in the practical use and application of two-dimensional (2D) modeling. Most of the assumptions that were needed in 1D modeling have been eliminated and replaced by direct computations, allowing for significant advances in the hydraulic discipline. 2D modeling results provide a better understanding of the complex partnership between waterway environments and transportation assets, leading to safer designs and more cost-effective structures.

Drawing on this technological advancement, the U.S. Bureau of Reclamation (USBR) developed the Sedimentation and River Hydraulics (SRH) 2D model—a 2D flow hydraulic and mobile-bed sediment transport model for river systems. This SRH-2D model solves 2D dynamic wave equations and depth-averaged velocity using the finite volume numerical method. Since 2013, USBR and Federal Highway Administration (FHWA) have partnered to expand the transportation hydraulics capabilities of the SRH-2D model and improve the graphic user interface features for more efficient and effective applications. Because of these SRH-2D model improvements, the FHWA's National Highway Institute (NHI) has developed a series of courses to train hydraulic personnel on the best methods to use and apply this engaging model for highway encroachments.

Achieving Success with NHI

NHI offers an updated 2D hydraulic modeling course as well as data source training to study how to appropriately apply 2D hydraulic models of rivers in highway encroachment scenarios. Participants can register for the *2D Hydraulic Modeling of Rivers at Highway Encroachments* training (FHWA-NHI-135095), which is now offered in person and online, to learn how to use and apply the SRH-2D model. This training teaches SRH-2D modeling principles and techniques through use of the latest version of the Surface Water Modeling Systems (a graphical pre and postprocessor for multiple 2D modeling engines).

NHI also offers online web-conference training (WCT) courses that provide more comprehensive SRH-2D model data information, including:

SRH-2D Model Data Files, Diagnosis & Verifying 2D Model Results WCT (FHWA-NHI-135095A)

This WCT presents numerous data files created and used for SRH-2D input and output as well as for SRH Pre. Participants will learn:

- How files are used and formatted.
- How to verify model convergence and various diagnostic message outputs by SRH-2D.
- How to use monitor lines.

Model Terrain Development with Various Data Sources WCT (FHWA-NHI-135095B)

This WCT shows participants how to use and process light detection and ranging (LiDAR) efficiently and other elevation format types to define geometry for 2D hydraulic models. Applicants will also learn to identify potential data issues, use methods for modifying geometry, and import and export data from other data sources.

Prerequisite Information

Basic Hydraulic Principles Review (FHWA-NHI-135091), a web-based training, is available at no cost to participants who wish to refresh their knowledge of the fundamental hydraulic concepts of open channel flow.

How to Attend or Host a Course

NHI invites professionals interested in earning continuing education units or professional development hours to visit *http://bit.ly/NHIHome* and browse the complete digital course catalog. The catalog lists over 350 courses in 19 program areas.

To sign up for email alerts and to see when a particular course session is available, visit the description page for that course and then click on the "Sign Up for Session Alerts" link.

Organizations interested in hosting an NHI course can submit a host request form, or find more information, by visiting *https://www.nhi.fhwa.dot.gov/training/host.aspx*.

NHI is an approved accredited provider by the International Accreditors for Continuing Education and Training (IACET). As an IACET Accredited Provider, NHI offers continuing education units for its programs that qualify under the American National Standards Institute/IACET Standard.

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FHWA's Transportation Pooled Fund Program

TPF

Source: FHWA.

Leveraging Resources to Achieve Common Research Goals

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The Transportation Pooled Fund (TPF) Program enables public and private entities to combine resources to conduct high priority research on a wide variety of shared, highway related problems. Over more than 45 years, the TPF Program has supported more than 750 successful multi-agency projects.

Participate in Diverse Research and Topic Areas

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Learn more about initiating a pooled fund study and browse the list of open solicitations on the TPF website at ***www.pooledfund.org***.

For more information, contact Tricia Sergeson, TPF Program Manager, at ***Patricia.Sergeson@dot.gov***.

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TaMara McCrae, Editor-in-Chief June 27, 2022

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