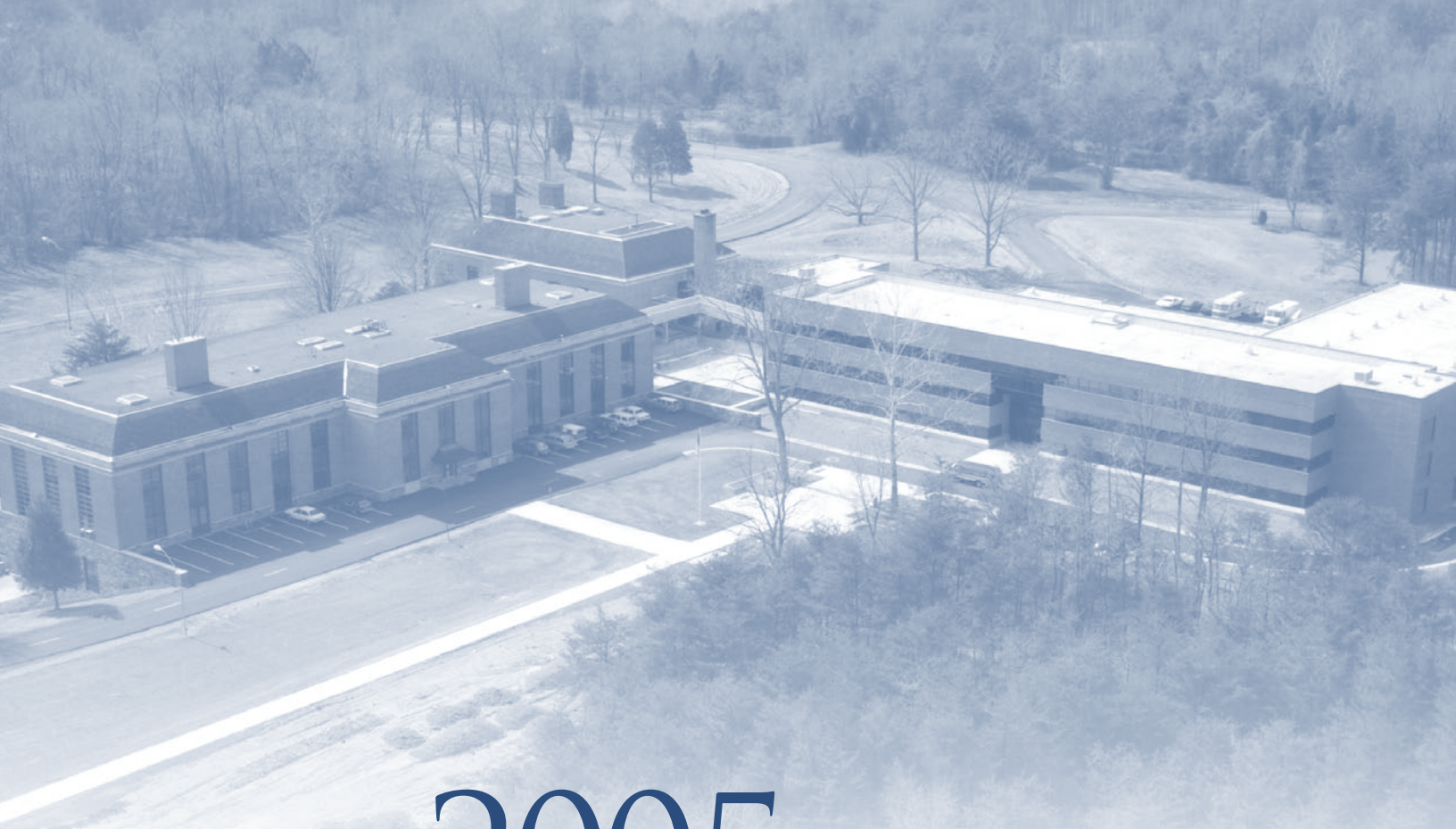

2005 PROFILE

Turner-Fairbank Highway Research Center

U.S. Department of Transportation
Federal Highway Administration

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Innovating for Results

"We welcome you to explore our research facility, accomplishments, and expertise."

—Dennis Judycki, Associate Administrator
Research, Development, and Technology

A Dynamic Approach to Research

Research and innovation are integral to the Federal Highway Administration's (FHWA) mission. One of the primary roles of Federal transportation professionals is to serve as innovators for a better future. This role is supported by the world-class research conducted at the Turner-Fairbank Highway Research Center (TFHRC) in McLean, VA.

A federally owned and operated facility, TFHRC contains 24 indoor and outdoor laboratories. More than 300 Federal transportation researchers and private contractors at the labs focus their research and development (R&D) activity on producing innovative technologies and practical solutions to real-world problems—constituting a dynamic approach to research.

How is this approach orchestrated? The managers who oversee the TFHRC laboratories ensure that transportation stakeholders and partners nationwide—State and local governments, academia, and the private sector—are integrally involved in coordinating every phase of the research process. They work together to set a research agenda that is focused on real needs and priorities, work collaboratively to develop resources and funding, implement the results through shared deployment efforts, and build a common advocacy to enhance the national transportation research program and legislative agenda. Cooperating, sharing information, and partnering with others in the highway community are essential to the operation of TFHRC.

Together, the facility's managers and its transportation stakeholders help produce a research environment that results in technology improvements and encourages more efficient deployment of innovations. The outcome of the TFHRC approach, both for the national and the international highway communities, is the most advanced research and newest highway technologies, focused on solutions to complex technical problems.

The highway research conducted at TFHRC and the products and services provided are truly needed by our customers and partners. Those services, all of which are available to the transportation community, include technical assistance and forensic analysis of materials and structures.

Throughout this publication are examples of the innovative research, services, and expertise at TFHRC. The successes at the McLean facility were achieved because the research and resulting products were not done in a vacuum, but were vetted with other researchers and institutions and addressed real-world problems. FHWA's vision is to conduct research and provide products and services that are *essential, indispensable, and needed by our customers and partners*.

Corporate Master Plan

The employees of TFHRC's three R&D offices—infrastructure, safety, and operations—conduct research that supports the advancement of technological innovation in their areas of expertise. Other offices at TFHRC—program development and evaluation, research and technology services, and resource management—provide policy, budget, program management, outreach, communications, and administrative functions. Strategic planning, monitoring legislative activities related to highway research, analyzing research and technology issues, and developing research performance measures are all critical functions performed by these offices, as are producing and marketing publications on FHWA activities and research. The outreach and communications staff also coordinates tours for diverse groups from industry, government, and academia to visit the TFHRC research laboratories to see our capabilities and to discuss possibilities for engagement or partnership activities.

FHWA's recently adopted *Corporate Master Plan for Research and Deployment of Technology & Innovation* sets out a new focus and guiding principles for the Agency's research and technology program, such as engaging stakeholders throughout the research process. The Office of Corporate Research and Technology, new to TFHRC, serves as a focal point for providing a visible leadership and communications role in facilitating and implementing FHWA research and technology (R&T) initiatives. The office supports the FHWA leadership team's efforts to ensure a corporate approach to R&T and implementation of the corporate master plan.

The office also supports actions to overcome institutional barriers to the development and deployment of new highway technologies. Further, it helps FHWA identify and address current and future research needs of the transportation system, supports dissemination of peer-reviewed scientific information to the public and stakeholders, and assists programs to establish meaningful and measurable performance standards. The office also facilitates, upon request, the formation of research and technology partnerships among national, State, and local stakeholder networks.

FHWA's recently adopted Corporate Master Plan sets out a new focus and guiding principles for the Agency's research and technology program.

TFHRC implements additional activities to support its goals of continued improvement. Every year, it conducts a series of lab assessments to improve the quality of laboratory-based research and services. Those assessments provide regular, independent feedback from panel members drawn from other Federal laboratories, State departments of transportation (DOTs), academia, private sector organizations, and industry customers and stakeholders.

Multidisciplinary Research

The world-renown research conducted at TFHRC is a direct result of the multidisciplinary credentials of its engineers, transportation specialists, scientists, and administrators. In addition to having outstanding staff on board, TFHRC encourages opportunities for training and professional development that range from formal courses to informal mentoring, to build skills and add to competencies in TFHRC's three R&D offices.

The Office of Infrastructure R&D focuses on improving the performance of highway structures and pavements while significantly reducing associated long-term costs. Structural researchers employ a systems approach to integrate design, construction, durability, maintenance, inspection, long-term performance, safety, and reliability into the highway bridges of the future. Pavement researchers develop models, procedures, and processes that help predict performance and optimize life cycle costs of asphalt and portland cement concrete paving materials and construction processes. Increased understanding of why some pavements perform better than others is the key to building and maintaining a cost-effective highway system. The infrastructure office's advanced research focuses on nanoscience technology to develop materials that have been modified on an atomic level to provide macroscopic attributes such as improved strength, corrosion resistance, and longer service lives. The office also focuses on advanced research on computational structural mechanics, nondestructive evaluation methods for portland cement concrete, and new types of steel or asphalt materials to help improve highway materials and structural performance.

The Office of Operations R&D conducts research to mitigate congestion and improve safety through better management and operation of the surface transportation system. Hardware and software tools are developed to analyze operational improvements, reduce congestion, and mitigate delays in work zones. Infrastructure- and vehicle-based cooperative systems warn motorists of potential intersection collisions. Safety measures are researched for maintenance of highways

To increase opportunities for cross-fertilization of ideas, TFHRC shares staff with State DOTs, other Federal agencies, and other countries.

under winter weather conditions, as are various other safety-enabling technologies.

The Office of Safety R&D aims to reduce highway crashes and related fatalities and injuries through a nationally coordinated partnership that focuses on preventing and mitigating roadway departures, safety management, improvement of intersections, and protection of pedestrians. This office provides transportation officials with information and state-of-the-art tools to aid in making informed decisions on safety improvements. The office also conducts advanced research to determine new ways to solve highway safety challenges.

To increase opportunities for cross-fertilization of ideas, both internally and externally, TFHRC shares staff with State DOTs, other Federal agencies, and other countries. Each year, for example, Operations R&D hosts an international research fellow from the Japanese Ministry of Land, Transport, and Infrastructure to support the U.S.-Japan Intelligent Transportation System (ITS) Joint Research Program. Also, in 2005, an official from the Japanese National Police Agency spent 2 months with Operations R&D to support a program in advanced transportation management systems research. In addition, TFHRC's Tom Granda was selected as a member of the National Older Driver Safety Advisory Committee, a multidisciplinary group from across the country. He was also selected as chair of U.S. Department of Transportation's (USDOT) Human Factors Coordinating Committee.

Communicating research results among TFHRC's three R&D offices provides opportunities for sharing staff and expanding FHWA's capacity to partner. Internal and external partnerships offer opportunities for cross-fertilization of results. The TFHRC offices of safety and operations, for example, partnered with the ITS Joint Program Office and the National Highway Traffic Safety Administration to establish the new Cooperative Intersection Collision Avoidance System (CICAS) research partnership. The partnership, which includes four States and all of the major automobile manufacturers, is researching and developing advanced collision avoidance systems that use wireless communications between vehicles and the infrastructure to help prevent crashes at stop signs and signalized intersections.

Another example is a partnership between Operations R&D and the French Ministry of Transportation to implement Claire, a software package for developing strategies for mitigating congestion. A field test in Los Angeles, CA, is using the software for helping mitigate congestion caused by special events. In Houston, TX, the Claire software is helping mitigate congestion due to the reconstruction of I–10 and local flooding.

In still another partnership, the U.S.-Japan ITS Joint Research Program holds an annual workshop to exchange technical information based on each country's active research and program initiatives. For example, the 2005 topic was research in electronic digital mapping to improve safety and mobility services.

To enhance research, FHWA installed a new weather station mounted on a 9-meter (30-foot) tower at TFHRC.

The Traffic Management Center (TMC) Pooled Fund Study provides an additional opportunity for transportation agencies to take on issues collectively and address challenges that are common among public agencies that manage and operate TMCs. The TMC pooled fund study facilitates sharing of best practices with a broader audience to improve the current management, operation, and performance of TMCs. Membership in the TMC pooled fund partnership currently includes 27 States, the District of Columbia, the I–95 Corridor Coalition, and FHWA.

This Year's Highlight

To enhance research on the effect of adverse weather conditions on the safety and operation of the Nation's roads, FHWA installed a new weather station mounted on a 9-meter (30-foot) tower at TFHRC. The station includes sensors for wind, temperature, barometric pressure, and visibility, as well as a global positioning system (GPS) surface observing system. The data from these systems will support research into advanced traffic simulation models developed by the TFHRC Traffic Research Laboratory (TReL) to study the impacts of various factors on traffic movements and driver behavior and to assess the effectiveness of possible operational countermeasures. TReL researchers will use data from the new weather station to identify the model enhancements needed to achieve a more accurate representation of vehicle performance and driver response to weather.

The GPS data also will provide centimeter-level navigation accuracy to support a Vehicle Infrastructure Integration initiative underway at TFHRC. The initiative, sponsored by USDOT, the American Association of State Highway and Transportation Officials, and several major automobile manufacturers, is exploring communication and data exchange between vehicles and the roadside. Forthcoming research could reveal how vehicles and roadside stations might communicate information on vehicle speed, wind conditions, air temperature, sudden braking, and more than a dozen other indicators.

In addition to FHWA, the National Oceanic and Atmospheric Administration (NOAA) and other organizations that require current weather information will have access to data gathered by the new weather station. NOAA's Forecast Systems Laboratory, for example, will use the data to improve weather forecasting and climate monitoring. Using the GPS surface observing system, NOAA will contribute to national weather models by compiling data on precipitable water vapor.

Partnerships such as this data sharing by FHWA and NOAA, and similar cooperative setting of research agendas that focus on real needs—these are the essence of TFHRC's dynamic approach to research. The outcome? Innovations, technologies, services, and results that meet *our customers'* needs and help the Nation achieve a better transportation future.





Success Stories




New Weather Forecasting Data. *Innovation:* TFHRC's Nationwide Differential Global Positioning System (NDGPS) towers, which broadcast differential correction signals for improving the positioning accuracy of vehicle safety systems, were converted to also collect data for atmospheric measurements of water vapor to improve weather forecasting. *Result*: Today, the NDGPS towers collect data that the National Oceanic and Atmospheric Administration (NOAA) uses to improve national climate monitoring and weather forecasts.

Quantitative Technique for Evaluating Coating Failures on Steel Bridges. *Innovation*: TFHRC researchers developed this imaging technique for measuring rust on coated test panels subjected to either a laboratory or an outdoor corrosive environment to facilitate prediction of the field performance of various bridge coatings. This method is a more quantitative, repeatable, and reproducible approach than any of the conventional evaluation techniques, which were very subjective. In addition, it reduces operation time, and the software is free. *Result*: The technique has been approved and published as an ASTM standard, "Standard Test Methods for an Imaging Technique to Measure Rust Creepage at Scribe on Coated Test Panels Subjected to Corrosive Environment" (ASTM D 7087-05a).

Interactive Highway Safety Design Model (IHSDM). *Innovation*: Since the release in 2003 of this suite of safety analysis tools for evaluating the effects of geometric-design decisions on two-lane rural highways, researchers documented applications of the software. *Result*: FHWA's Western Federal Lands Highway Division Office applied IHSDM in Kootenai County, ID, to estimate a project's safety benefits, and the project's Record of Decision included the alternative for which IHSDM projected the fewest crashes in 2026.

Cost-Effective Construction Phasing in Yosemite Valley Using QuickZone. *Innovation*: The QuickZone software was developed to enable construction staff to analyze different phasing, staging, and scenarios quickly and easily, in terms of resulting queues and delays. Since the software executes in under a minute, making multiple runs with different set-ups (day versus night work, lane closure versus narrowed lanes) is easy, as is comparing the outputs. *Result*: QuickZone enabled the Central Federal Lands Highway Division and National Park Service staff to assess the feasibility of reconstructing the major roadway within Yosemite Valley Park in one season rather than two, while still minimizing the impact on visitors.

Improved Accuracy for Bridge Tests.

Innovation: In this successful test, the researchers constructed a full-scale, horizontally curved steel girder bridge system using typical real-world construction practices and 1,200 sensors for real-time data analysis during testing. *Result*: The test set a new standard for computerized data acquisition, demonstrating that simulation technology can predict the performance of any steel bridge. It resulted in a new set of strength equations and AASHTO specifications that set a new world standard for accuracy and ease of use.

Signalized Intersections: Informational Guide.

Innovation: This publication provides methods for evaluating the safety and operations of signalized intersections, plus tools to remedy deficiencies. *Result*: The guide helps practitioners make insightful intersection assessments and understand the tradeoffs of potential improvement measures. Continuous flow intersections (CFIs), for example, increase capacity and improve safety by removing the conflict between left-turning vehicles and oncoming traffic using a left-turn bay to the left of oncoming traffic. CFIs recently have been constructed on Maryland State Routes 210 and 228 and at Dowling College, NY. Vehicles access the left-turn bay at a midblock signalized intersection. Not only are congestion-related collisions from left turns reduced, but rear-end collisions also may decrease from stop-and-go conditions occurring less often.

Freeway Median Cable Underride Crashes.

Innovation: A partnership of the North Carolina Department of Transportation, FHWA North Carolina Division, FHWA Resource Center-Atlanta, and the National Crash Analysis Center used finite element analysis, vehicle dynamic modeling and simulations, and validation with crash tests at TFHRC to analyze replications of crashes where a vehicle went under a cable median barrier. *Result*: The problem is not the design or maintenance of the cable, but rather the location of the cable and the slope of the median can result in a few vehicles not engaging the cable. The results were provided to the involved States of North Carolina, Ohio, and Washington; translated into Federal policy; and communicated to AASHTO for publication. Representatives from Arizona and Texas are involved in additional research on cost-effective retrofits and location guidelines.

Ultra-High Performance Concrete (UHPC) for Bridges of the Future.

Innovation: Flexure and shear testing confirmed the capabilities of UHPC in prestressed superstructure elements, providing strength, durability, and workability for bridges that last longer and require less maintenance, thus reducing the traffic congestion and disruption resulting from bridge construction and rehabilitation projects. *Result*: After refinement through further TFHRC research, initial limited deployment is expected.

Adaptive Control Software Lite (ACS-Lite).

Innovation: In partnership with the National Electrical Manufacturers Association (NEMA) traffic controller manufacturers, TFHRC developed the ACS-Lite software as a low-cost way to retrofit signal systems to help keep timing plans up to date as traffic patterns change over time. *Result*: During field tests in Gahanna, OH, and Houston, TX, before/after data showed that total delays, number of stops, and fuel consumption decreased. These improvements in traffic flow resulted in annual savings of approximately $88,000 and $500,000 respectively.

Outreach

Onsite Events

Of Segways® and Sidewalks

Innovation: With the Segway Human Transporter becoming a popular form of transportation for city tours, TFHRC researchers are conducting a two-part study to learn how Segway riders negotiate typical sidewalk conditions. In late 2005, FHWA researchers began the study by selecting 20 participants, including 10 people who had never operated a Segway and 10 experienced riders. In the first part of the study, all participants navigate an obstacle course that simulates a real sidewalk. While the participants ride, the researchers collect information on several aspects of their performance, such as how they adjust their speed when they approach obstacles and pass other sidewalk users. Following participation on the obstacle course, each person views a series of videos shot from a Segway rider's perspective. The videos show typical sidewalk conditions with variations in crowding and rider speed. Participants rate the video simulations on a scale designed to measure perceptions of separation and general sidewalk ridability. *Result*: The researchers are hoping that policymakers and engineers may be able to use the study results to better understand the behavior and requirements of Segway riders and develop pedestrian facilities that meet the needs of all users.

Community Service

Hurricane Recovery

A TFHRC employee traveled to Slidell, LA, in November 2005 to assist with Hurricane Katrina relief activities. The employee participated in a week-long effort to gut and clean flooded houses. Another employee spent 6 weeks as a volunteer assisting the Federal Emergency Management Agency during the Hurricane Katrina response and recovery. As a community relations specialist, he traveled around the State, locating evacuees and helping them apply for assistance to recover from long-term losses caused by Hurricanes Katrina and Rita.

International Outreach

Technical Exchange Program with Korea

Innovation: To share ideas about ways to protect concrete structures from corrosion, a TFHRC research corrosion engineer spent 6 months at the Korea Highway Corporation's Highway & Transportation Technology Institute. *Result*: Dr. Seung-Kyoung Lee conducted a scanning tour of coastal bridges, collected useful asset management information, operated a test road, monitored structural health systems installed on major cable stay bridges, and provided technical assistance in the areas of corrosion, cathodic protection, and durability.

Nonconventional Materials to Extend Pavement Performance

Innovation: FHWA hosted a meeting of the Organisation for Economic Co-Operation and Development (OECD) Long Life Pavements Working Group at the Transportation Research Laboratory (TRL) in England. Eight countries participated: Denmark, France, Germany, New Zealand, Poland, the Ukraine, the United Kingdom, and the United States. *Result*: The discussion led to considerable progress on research associated with epoxy asphalts and high-performance cementitious materials (HPCM) for pavement surface courses, with a decision to convert from steel to polyester fibers in HPCM. TRL placed an epoxy asphalt test section at its Accelerated Loading Facility, and New Zealand is planning to conduct an accelerated pavement test of the epoxy asphalt in midsummer 2006.

Superpave® Asphalt System, Stone Matrix Asphalt (SMA), and Construction Practices in China

Innovation: Over a period of 11 days, FHWA transportation experts visited a number of Chinese construction sites and conducted a series of workshops in China on Superpave, stone matrix asphalt (SMA), and other U.S. transportation technologies. China is constructing a $500 billion (US dollars) expressway system modeled after the U.S. interstate system, including a number of toll roads. The system, which is under construction, is scheduled to be completed over a 15-year period and will link China's major cities. *Result*: The workshops and past activities with China are resulting in the export of U.S. manufactured asphalt testing equipment worth millions of dollars, as well as a technology exchange with China. The United States is helping China instrument pavement structures and is sharing in the data collection and analysis.

Publications and Materials

Snapshot of TFHRC Publications

Innovation: TFHRC publishes an award-winning bimonthly magazine, *Public Roads*, on the latest advances and innovations in Federal highway policies, programs, and research and technology; and two monthly newsletters, *Transporter*, which provides the latest information on FHWA research and technology, and *Focus*, which covers the implementation of innovative infrastructure technologies. TFHRC also communicates its research through published fact sheets, flyers, product briefs, technical reports, summaries, and TechBriefs. *Result*: TFHRC keeps its customers aware of its broad range of research subject matter, ranging from peer reviews to laboratory assessments, TFHRC laboratories, State research projects, night lane closures, bridge repair delays, High Accuracy-Nationwide Differential Global Positioning System tests, concrete pavement smoothness, red-light cameras, and capacity increase through the use of narrow lanes and shoulders.

Covered Bridge Manual

Innovation: Researchers developed a guide to restoring and protecting covered bridges, *Covered Bridge Manual* (FHWA-HRT-04-098), which is a popular resource for bridge owners, consultants, contractors, State Historic Preservation Offices (SHPOs), and others interested in or involved with covered bridges. *Result*: This technology transfer effort showcases maintenance and rehabilitation efforts nationwide and disseminates information to help preserve the U.S. cultural heritage of covered bridges. For example, rehabilitation designs were completed in 2005 for two bridges in Ohio: the Brubaker Bridge, which has now been rehabilitated, and the Newton Falls Bridge, which is undergoing work at present.

Concrete Pavement Road Map

Innovation: To help the pavement community better serve the public, FHWA in partnership with State and industry stakeholders developed the *Long-Term Plan for Concrete Pavement Research and Technology*, dubbed the *Concrete Pavement Road Map* (FHWA-HRT-05-047). The CP Road Map represents a long-term, comprehensive, innovative, and strategic approach to guide investment of research dollars and replace tried-and-true paving materials with a multitude of new materials that enable construction crews to get in, get out, and stay out, while doing more with less as highway budgets are squeezed at every level. *Result*: The Road Map will spawn a new generation of concrete pavements for the 21st century, providing an opportunity for the concrete pavement community to proactively reinvent itself through research.

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