

Federal Highway Administration ■ TURNER-FAIRBANK HIGHWAY RESEARCH CENTER Office of Infrastructure R&D

The Office of Infrastructure Research and Development (R&D) conducts and administers infrastructure R&D programs and projects for the Federal Highway Administration (FHWA) that address problems of national priority within the U.S. highway system.

The Office of Infrastructure R&D approaches its mission with emphasis on strong stakeholder involvement and an interdisciplinary approach founded on recognition of the following:

- Pavements and bridges are integral and interrelated components of a highway system and do not function as distinct elements.
- Although the fundamental structure and components of pavements and bridges are quite distinct, some research and development needs are common to both.
- Only by using all facilities and assets available within the FHWA's Office of Infrastructure R&D and working collaboratively with counterparts in other FHWA offices and with stakeholders throughout the highway community, will highway needs and issues in the near and long term be effectively addressed.

Goals

The goals of the FHWA's Office of Infrastructure R&D are as follows:

- Conduct research to develop knowledge, guidelines, analytical and physical tools, and test methods and procedures that:
 - Enable the delivery of a safe, environmentally-friendly, long-lasting, disaster-resilient, and cost-effective highway infrastructure that provides a high level of service.
 - Support end-user efforts to more effectively maintain and manage the Nation's infrastructure based on the realities of funding needs versus funding constraints.
- Provide specialized technical assistance to address infrastructure issues of national importance requiring research capabilities and technical expertise uniquely available at the FHWA's Turner-Fairbank Highway Research Center.

Research and Development Strategies

The FHWA Office of Infrastructure R&D focuses on the needed research and development where there is an appropriate Federal role by virtue of national needs, scope, duration, or risk. This role is reflected in the following overarching strategies:

Long-Term Infrastructure Performance

This strategy is to conduct, build upon, and integrate the current Long-Term Pavement Performance and Long-Term Bridge Performance Programs to answer critical questions concerning the long-term performance of our Nation's highway infrastructure. Activities included in this strategy include development of the following:

- A publicly available dataset documenting the performance of a well-characterized set of pavement test sections and bridges, including their design, materials, construction, preservation, and maintenance, that is representative of the majority of the Nation's highways.
- Improved bridge and pavement monitoring sensors and systems (e.g., smart sensors, embedded sensors, and systems) that permit both periodic and continuous performance evaluation and accurate condition assessment.
- High-speed and high-resolution nondestructive evaluation (NDE) technologies for inspection, evaluation, and performance monitoring.
- Analysis and data-mining tools that can be applied across a range of infrastructure databases and datasets.

Durable Infrastructure Systems

Within this strategy, durable and resilient infrastructure systems and elements are developed to improve in-service performance, reduce maintenance needs and costs, reduce life-cycle costs, and significantly improve safety during normal service and extreme hazard events. This will require that infrastructure durability and deterioration-prevention be addressed in a more systematic manner by developing the following:

- High-performance, long-life, advanced materials that increase resiliency and reduce maintenance and reconstruction needs (e.g., self-monitoring or self-healing materials).
- Improved systems, preservation techniques, analysis methods, and technologies to prevent material degradation, corrosion, cracking, fatigue, and other serviceability problems in existing highway infrastructure.
- Advanced infrastructure performance prediction and design models for both service-level and extreme events.
- Effective tools to identify and manage critical lifeline routes.
- Designs and details that provide resiliency during extreme hazard events, systems that facilitate evacuation as well as support response and recovery operations, and highways that can be rapidly repaired and returned to service.

- Intelligent disaster-resilient infrastructure (e.g., smart bridge systems and countermeasures).
- Infrastructure designs and details that facilitate effective inspection, maintenance, and repair.
- Quality assurance and quality control standards and procedures that can be effectively applied during the fabrication process and in the field.

Accelerated Highway Construction

This strategy aims to develop accelerated construction, rehabilitation, and reconstruction methodologies for highway systems and structures. This strategy directly addresses the Nation's congestion and safety needs, as well as the impending crisis due to an aging infrastructure.¹ The research and development to be pursued as a part of this strategy includes:

- Prefabricated structures and systems, including bridge sub and superstructures and geotechnical constructions.
- Advanced fabrication, construction, and erection techniques and equipment.
- Structures (bridges and pavements) that are adaptable to changing conditions and system demands.
- Technologies that enable real-time quality control and assurance in an accelerated construction setting.

Environmentally-Sensitive Highway Infrastructure

This strategy addresses the need for technologies to enable an environmentally-sensitive highway infrastructure. This strategy will reduce detrimental environmental impacts arising from construction and maintenance of highway infrastructure, as well as the physical, chemical, and aesthetic attributes of highway transportation. Elements of this strategy include the following:

- Quantification and characterization of the impacts of highway infrastructure on the environment.
- Technologies and knowledge to support context sensitive solutions (CSS) and initiatives.
- Technologies to enable expanded use of recycled or waste materials in highway construction.
- Pursuit of less damaging (more "green") and renewable materials and construction technologies.

Performance-Based Specifications

With this strategy, researchers will work

toward comprehensive performance-based specifications. Such specifications are needed to: (a) balance risk between agencies and industry (contractors), (b) encourage innovation, (c) provide greater consistency between design expectations and actual performance, and (d) support innovative contracting procedures and construction practices. This strategy is dependent on the ability to accurately predict future performance; it will build on outcomes from the Long-Term Infrastructure Performance and Durable Infrastructure Systems research. Specific examples of performance-based specifications follow:

- Extreme-event infrastructure design standards that provide specified levels of operation and service based on identified postevent needs but which prevent catastrophic failure.
- Service-level infrastructure design and material standards that allow more innovation than current prescriptive infrastructure design and material standards.
- Materials and construction standards that link design and construction and compel contractors to minimize constructed project life-cycle costs.
- Bridge and pavement construction standards that hold contractors responsible for meeting structural and functional thresholds over the long term (15+ years).

Comprehensive and Integrated Infrastructure Asset Management

This strategy builds on and integrates the outcomes from the previous strategies: Long-Term Infrastructure Performance, Accelerated Highway Construction, Durable Infrastructure Systems, Environmentally-Sensitive Infrastructure, and Performance-Based Specification to deliver the tools and technologies needed to achieve fully integrated processes and systems for asset management, including infrastructure planning, design, contracting, construction, preservation, and maintenance. Activities included in this capstone strategy include development of the following:

- Improved performance and life-cycle cost models that consider the full life cycle of the infrastructure from planning through design, construction, maintenance/preservation, rehabilitation, and reconstruction in an integrated and comprehensive fashion and are applicable to any combination of materials.
- Needed information from the analysis of data collected under the Long-Term Infrastructure Performance strategy to support sound decisionmaking in the asset management process.

Collaboration

In pursuing the research and development program described herein, the FHWA Office of Infrastructure R&D works closely and collaboratively with other FHWA offices and with the broader community of highway stakeholders to ensure that the program:

- Addresses agency goals, missions, and requirements.
- Serves the FHWA appropriately, covering relevant issues.
- Is aware of the work of other agencies and organizations and coordinates its work accordingly to avoid inappropriate duplication of effort and maximize the overall value of the research and development investments.
- Delivers outcomes in the form of readily implementable products at the earliest appropriate time.
- Moves products into practice as quickly as possible to achieve maximum possible benefits.

Benefits

The outcomes delivered through pursuit of these strategies will benefit the American public by enabling improvements in the safety, performance, and cost effectiveness of the Nation's highway infrastructure, while minimizing the environmental impacts of highway construction, maintenance, and rehabilitation. The results will make possible reductions in highway congestion, improvements in highway safety, and enhancement of the overall driving experience for the American public.

The FHWA is charged with ensuring minimum standards of safety for the public as it travels on the Nation's roads and highways. While there are many other organizations and agencies that conduct highway infrastructure research, the FHWA Office of Infrastructure R&D is uniquely positioned to address the continuum of highway infrastructure research from high risk, exploratory, and advanced research, through the highly applied, problem-specific research that is necessary to address current issues and immediate problems. This broad range of research capability provides a high likelihood of success that is so critical for sustaining the Nation's economy in the near and long terms.

¹ According to the FHWA National Bridge Inventory, the Nation's bridges have an average age of 43 years, and the majority of pavements on the National Highway System have surpassed their original design life.

