

FEDERAL SPONSORSHIP OF INNOVATIVE BRIDGE PROGRAMS

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Abstract

The Federal Highway Administration (FHWA) is committed to a significant reduction in the number of deficient bridges in the nation and a reduction in the time and cost necessary to complete new bridges and bridge improvement projects. The FHWA supports innovative bridge programs which deploy state-of-the-art technology to help achieve that goal. The FHWA structures research and technology program is highly focused with a basic philosophy of “find it” and “fix it,” i.e., identify critical bridge problems and develop workable, cost-effective solutions. Cooperative development and deployment of HPS 70W high performance steel is one excellent example

The TEA-21 Innovative Bridge Research & Construction (IBRC) program champions the use of innovative materials to repair, rehabilitate or replace bridges. Special funds are provided to promote the use of innovative materials and to evaluate their feasibility and potential for superior performance in service. The IBRC program is currently funding 13 projects which demonstrate the use of high performance steel in bridge structures. Early results already show clear cost and performance advantages of high performance steel.

Background - The Nation’s Inventory of Bridges

Prior to the collapse of the Silver Bridge at Point Pleasant, West Virginia in December 1967, there was no comprehensive, nationwide database of information about the number, type, location and condition of the nation’s bridges. The tragic loss of 47 lives at Point Pleasant soon led to legislation which mandated the National Bridge Inspection Standards and the creation of the National

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Bridge Inventory (NBI). The Federal Highway Administration (FHWA) is required to maintain a complete inventory of all highway bridges on public highways. A bridge is defined as a vehicular structure with a total span length of at least 20 feet along the centerline of the highway. One major function of the NBI is to maintain a complete inventory of bridge data related to location, type and geometry of each bridge; roadway or feature crossed, responsible owner, age, materials of construction, design load capacity, etc. The NBI makes it possible to search the database of the nation's bridges and extract data which help engineers and highway agency managers evaluate the status of bridges and develop programs to continually improve that status.

Slightly less than half (47.5%) of the bridges in the United States are owned and maintained by State Departments of Transportation (DOTs) including a small percentage owned by quasi-private roadway and bridge authorities. This includes all Interstate highway bridges and virtually all major structures such cable-stayed, suspension bridges, etcetera. The remaining 52.5% are owned and maintained by local highway agencies in the cities and counties. These latter bridges tended to be shorter and narrower than average, older, and often designed for live loads that are lower than the current standard of HS-25.

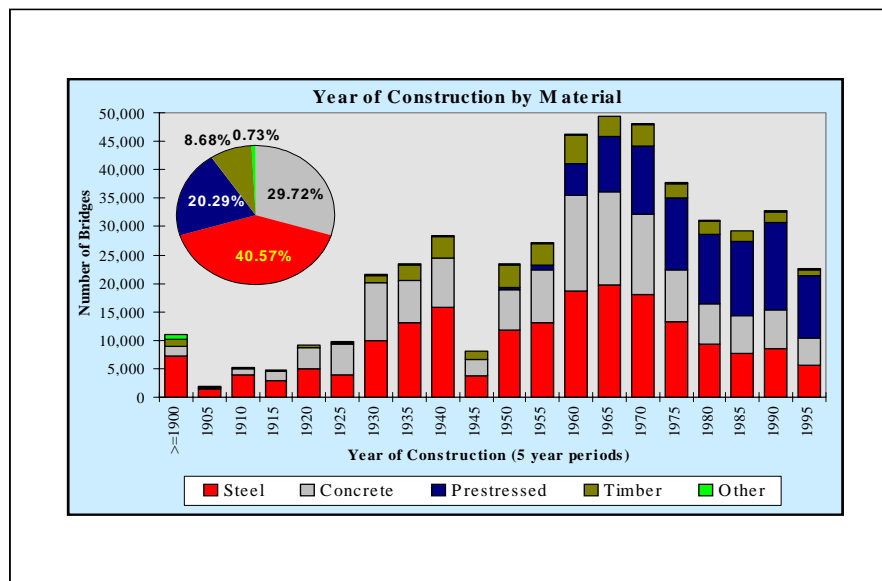


FIGURE 1. Age Range of Existing Bridges by Primary Construction Material

The range of ages of existing bridges is very wide, from bridges built within the last year to bridges that have been in service for more than 100 years. Figure 1 shows the numbers of existing bridges that were built in each five-year period in the last 100 years plus all bridges built prior to 1900. The age of a bridge is not a definitive indication of current condition or capacity of a bridge - other factors such as environment, traffic volumes, maintenance history play a strong role. However, age is still a useful indicator when examining a bridge population for potential deficiencies.

The second major purpose for the NBI is to maintain bridge inspection data which describes the current condition and capacity of the major elements of every bridge. This data is virtually up to date since all bridges on public highways must be inspected at least every two years by qualified inspectors. Inventory information is verified or updated and the inspectors rate the condition of the bridge elements on a scale from zero (closed) through nine (new). Each state DOT sends an update to the FHWA every year and the new data is used to make the NBI records current. The information also includes estimated costs of rehabilitation or replacement as necessary. FHWA is able to make a uniform assessment of the status of bridges on a state-by-state basis as well as for the nation as a whole.

By law, the data in the NBI is used to apportion federal Highway Bridge Rehabilitation and Replacement Program (HBRRP) funds to each state on the basis of the total needs for bridge improvement projects. However, the eligibility of any specific bridge project for funding depends on an assessment of various factors. The so-called Sufficiency Formula is used to calculate a numerical sufficiency rating for each bridge in the NBI.

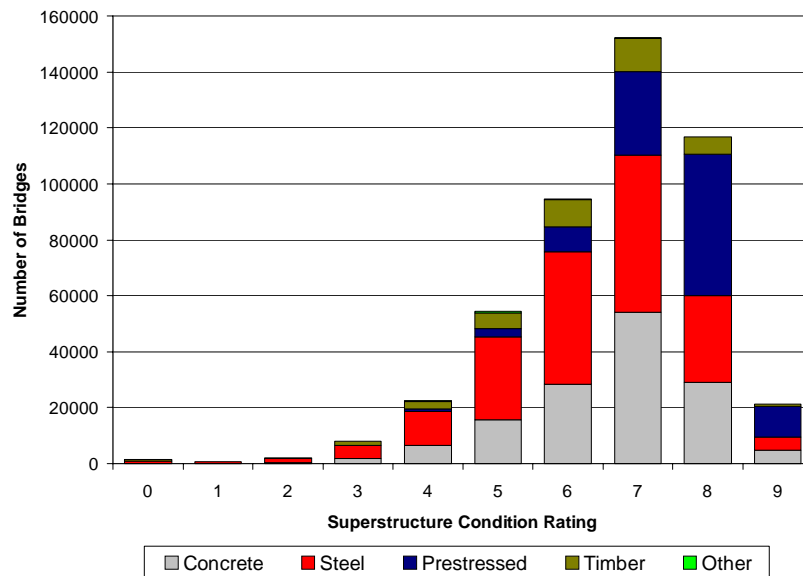


FIGURE 2. Superstructure Condition Rating Histogram

Bridges with a sufficiency rating of less than 80 are eligible for HBRRP funds for rehabilitation; a bridge is eligible for replacement with HBRRP funds if the sufficiency rating is less than 50. The information in the NBI can be examined to provide insight into what types of deficiencies are common. Figure 2 provides data on condition rating versus age of existing bridge superstructures, by primary structural material.

FHWA'S Strategic Goals

The FHWA has five strategic goals and our progress in achieving them will contribute to achieving the overall transportation goals of the Nation. Two of these goals are defined as: mobility - continually improve the public's access to activities, goods, and services through preservation, improvement, and expansion of the highway transportation system and enhancement of its operations, efficiency, and intermodal connections; and productivity - continuously improve the economic efficiency of the Nation's transportation system to enhance America's position in the global economy. Some of FHWA's goals are interrelated, e.g., improving the infrastructure and operations of the highway system promotes productivity, safety, and national security as well as mobility.

Performance indicators have been established to help measure FHWA's progress toward achieving those goals. As related to highway bridges, those performance indicators include: preserving and enhancing the infrastructure of Federal-aid highways and bridges by improving the condition of all bridges so that less than 25 percent are classified as deficient in 10 years; reducing delays on Federal-aid highways by 20 percent in 10 years including delays caused by bridge repair and rehabilitation projects; minimizing the time needed to return bridges to full service following disasters; improving the return on investment of the highway system by reducing the life cycle costs of building and maintaining bridges.

Improving Mobility and Productivity

In order to reach those goals of improved mobility and productivity, FHWA strategies will focus on: enhancing the infrastructure by focusing research and technology innovations on ways to make transportation investments buy more and last longer. In order to meet our objectives for bridge improvements, FHWA leverages research to foster major advances in the technology of bridge construction, repair, and maintenance. FHWA technology deployment initiatives ensure that current advancements such as high performance materials (including HPS 70W steel) are adopted to improve the performance of bridges. FHWA works with Federal, State, and local partners to ensure that highways can provide vital links for emergency relief during natural disasters and to ensure that full highway access is quickly restored to the disaster area.

Minimizing the cost to build, maintain, operate, and use the National Highway System (NHS) directly supports local, regional, and national economic growth and competitiveness. The Highway System provides the majority of passenger travel; 91 percent of the person-distance (miles) traveled are in privately owned vehicles. Trucks move nearly three quarters of the value, one half of the weight, and nearly one quarter of the metric ton-kilometer (ton-miles) of all freight shipments in the United States and its territories. FHWA programs to increase mobility through enhanced infrastructure, technology, and operations also support economic performance goals. In addition, these programs will help reduce the economic costs of providing and using the highways by increasing the return on investment of highway dollars through research and technology transfer to significantly reduce the life cycle costs of new and reconstructed bridges.

Future Demands

FHWA's strategic goals and objectives were developed based on assumptions about future demands on the highway system. The forecasted trends in personal transport and commercial transport show particularly significant growth in vehicle-distance traveled. Demographic studies indicate that as the population increases, travel demands will increase and change. The Bureau of the Census estimates a 21-percent increase in population by 2020 and a 47-percent increase by 2050. The increase in population will increase the number of trips and distance traveled. Between the 1970 and 1990 census, 91 percent of the total U.S. population growth has been in the suburbs and a large percentage of the new jobs created were also in the suburbs. The analysis supporting the FHWA's Condition and Performance Report projects that over the next 10 years the vehicle distance (miles) traveled is estimated to increase by 24 percent and by 53 percent in 20 years. More people, more cars, more miles traveled will add more strain to all aspects of the highway system. As for commercial transport, a significant portion of commercial freight is moved on the highways. The number of commercial trucks on America's highways grew by 76 percent between 1982 and 1992, while vehicle distance traveled doubled. To be competitive in the global economy, U.S. producers must maximize the efficiency of production and distribution. For example, just-in-time delivery systems have greatly reduced overhead costs and freight logistics systems have increased efficiency. As manufacturers rely more extensively on improved logistics to increase economic efficiency, demands on highway capacity and reliability increase. All of these facts will continue to produce pressure to provide bridges which are less costly and more maintenance free.

FHWA's Structures Research & Technology Program - "Find It and Fix It"

The structures research & technology (R&T) program has been designed to demonstrably improve the condition of the nation's bridges by 2007. Specifically, outputs will act synergistically and when implemented between 1999 and 2007 will reduce deficiencies on NHS bridges from 25% today to 20% and reduce deficiencies of all bridges from 31.4% to today to 25%. The goals of the structures R&T program are in full support of Infrastructure Renewal, one of the core elements of the Department of Transportation's Strategic Plan and the Federal Highway Administration's strategic goals to improve mobility through the improvement of the physical condition of the nation's bridges, to improve productivity through an improvement on the return of the public's investment and to improve safety by eliminating hazardous deficiencies and minimizing the impact of work zones. The structures R&T program directly addresses three major National Science and Technology Council (NSTC) transportation physical infrastructure strategic R&D goals to: develop technologies; advanced materials and methods to efficiently maintain and renew the aging transportation infrastructure; to improve existing infrastructure performance; and to enable efficient infrastructure response and quick recovery after major disasters. This program is designed to develop increased durability in new bridge construction and increase the service life of existing structures without degradation of either highway safety or the environment. This program reflects such an emphasis by concentrating on "Find it" and "Fix it" technologies, those technologies to identify or "find" the problems and then "fix" them. Specific objectives are to: (1) Increase the reliability, speed and ease of using local nondestructive evaluation (NDE) methods for quality control during bridge fabrication; (2) Improve the ability to detect hazardous conditions during bridge inspections; (3)

Develop quick and reliable global NDE systems for bridge monitoring; (4) Develop new technologies and techniques for integrating quantitative bridge NDE data into bridge management systems; (5) Develop definitive guidance and criteria for design, fabrication and performance of high-performance materials used in building and rehabilitating bridges; (6) Develop technology to reduce the sudden loss potential of bridges to natural hazards; (7) Make bridges more secure against corrosion; (8) Produce more cost-effective bridge foundations; and (9) Advance design practice.

In order to assist in reaching the desired goals, it is necessary to identify and assess innovative research results, technology, and products related to highway bridges and promote the application of those that are determined to be of potential benefit to the highway community by providing improved mobility and increased productivity as well as enhanced safety and national security. Under the structures R&T area's philosophy of "Find It and Fix It.", the goal is to identify impediments to the economical and durable service of highway bridges and eliminate them by application of new technology. It is important to note that this philosophy is not limited to a reactive program where remedial measures are applied to structures already built; rather, much emphasis is placed on identifying situations where new technology—materials, design concepts, etc.—can be applied to structures currently being built. In the structures R&T program, two of the high priority focus areas - bridge inspection and high performance materials illustrate the commitment of FHWA to the stated goals.

Bridge Inspection

Bridge asset management is beginning to be embraced by bridge owners. Although an ISTEA mandate that originally required states to adopt a formal bridge management practice was lifted, almost all states chose to pursue the development and refinement of some form of bridge management system. Bridge management is highly dependent on being able to accurately assess the physical condition of large numbers of bridges, and based on a systematic approach, develop budgets and plans to effectively maintain the existing bridge inventory. The accuracy of bridge inspection information, coupled with how best to incorporate the inspection information into the management system itself is a recognized need in order to optimize the management system. Bridge engineers, managers and owners have historically relied upon visual inspection as an important element in the construction of bridges. Nondestructive evaluation (NDE) has always been a part of this inspection. While usually associated with quality control of materials or fabrication, it was occasionally used to resolve doubts about existing structures. The most common type of NDE is a visual inspection, but it may not be adequate for safety inspections. It is also time consuming and subjective. More scientific and reliable types of NDE, e.g. ultrasonic, radiographic, or magnetic particle, are very localized. ; i.e., they cover a very small area. By their nature, they are slow. This has led to the need for much faster and more reliable types of NDE.

The focus of the national bridge program has shifted from building new bridges to the maintenance, rehabilitation and upgrading of existing ones. An outreach effort with the public and private sectors has shown a need for rapidly "finding" the deficiencies within the inventory of existing bridges. This calls for a systems approach, and FHWA is vigorously pursuing the use of Bridge Management Systems (BMS). The use of NDE provides the technology to support States' implementation and enhancement of their systems. Such systems require more reliable technical data

than can be obtained by visual inspection to indicate what and where the problems are. Therefore, new technologies which provide quantitative estimates of bridge condition must be developed so that dollar resources can be properly directed.

In support of advancing bridge management systems, the objectives of this part of the program are to “find” the problems associated with the nation’s existing bridge inventory. More specifically issues to be addressed will: (1) Improve the reliability, speed, and user-friendliness of local NDE methods for quality control during construction; (2) Improve the ability to detect hazardous conditions during bridge inspections; (3) Develop reliable, fast and efficient global NDE for bridge monitoring; (4) Develop new technologies and techniques for integrating quantitative, nondestructive bridge evaluations into bridge management systems; and (5) Advance bridge management systems for allocating resources to effectively improve the efficiency of the highway system.

The NDE Validation Center (NDEVC) was established by the Federal Highway Administration in 1998 to improve the state of the practice for highway bridge inspection. NDEVC provides state highway agencies with independent evaluation and validation of NDE technologies, develops new NDE technologies, and provides technical assistance to states exploring the use of these advanced technologies. The NDE Validation Center utilizes a series of unique resources to evaluate and assess the factors affecting the reliability and performance of NDE systems. The Validation Center is located at the Turner-Fairbank Highway Research Center in McLean, Virginia. To supplement the capabilities of the NDE laboratory facilities, a series of field-test bridges located in Northern Virginia and southern Pennsylvania are utilized to conduct field studies. In addition, an extensive collection of component test specimens is available for used in various test programs. Component specimens are small sections of highway structures (both with and without defects) that have been removed from in-service bridges or manufactured. Component specimens allow NDE technologies to be tested in the laboratory to determine their capabilities and laboratory trials on component specimens serve as the first step in evaluating NDE reliability. The inventory of small component test sections is also being supplemented with a large group of "full scale" concrete component specimens including reinforced concrete bridge deck specimens and full sized prestressed box girders with broken and de-bonded strands.

The staff at the NDEVC is nearing completion of a landmark study on the accuracy and reliability of the two most common types of bridge inspections completed to satisfy the National Bridge Inspection Program requirements. These are routine and in-depth inspections, primarily being done using visual inspection techniques. The influence of the entire inspection environment as well as the individual inspector’s physical and psychological characteristics was carefully studied and evaluated. A number of important conclusions were developed from the experimental study and are summarized in the final report. These conclusions are expected to have far reaching impacts on inspector training and performance. Accuracy and reliability of bridge inventory and inspection data will be improved significantly and usefulness for modern bridge management activities will be greatly enhanced.

The FHWA Bridge Management Information Systems (BMIS) Laboratory is another one of a kind facility devoted to research and development of tools and products to enhance the usefulness

of bridge management systems and support the FHWA's goals of improving mobility, increasing productivity and enhancing safety. The purpose of the BMIS Laboratory is to identify and analyze causes and trends of deficiencies within the Nation's bridge inventory. The BMIS facility is a small analytical laboratory where analysis is performed through three high-level, dual-processing NT workstations. Tools have been developed and acquired to support sophisticated analytical research on existing disparate data sources through a Geographical Information System (GIS) platform combined with Rational Database Management Systems (RDBMS) software and advanced mathematical and statistical software. Data acquired include the time-series National Bridge Inventory (NBI), climatological data distributions, seismic point- source information and strong-motion data, hydraulic and hydrologic information, geotechnical distributions, transportation network coverages, and base political data sets. This synthesis of data and advanced tools is not available at any other facility in the world. With such capabilities, spatial deterioration patterns are identified, deficiency causes and magnitudes are documented, and studies are performed to correlate such information with environmental variables.

The BMIS laboratory maintains all available NBI data from 1984 to the present. Using advanced statistical analysis and other relevant data on climate, traffic, hydrology, etc., trends in deterioration can be more closely defined for future planning purposes. Results provide significant insight into the problems faced by transportation agencies and identification of such problem areas helps bridge owners target resources effectively. Research is also performed on life-cycle costs to enhance bridge management system decision support models.

High Performance Materials

The objective of this portion of the program is to develop high performance structural materials to "fix" the problems found in deteriorating structures and to improve the longevity of new or replacement construction. High performance material (HPM) R&T programs are further supported because of the numerous inquiries and congressional requests for research that are received and the fact that HPM R&T is fully supportive of the Office of Science and Technology Policy (OSTP) and the National Science and Technology Council's (NSTC) program for material research. This focus area is also aligned with one of the major thrust areas of the Strategic Plan for Bridge Engineering Research recently developed under NCHRP project 20-07.

High performance materials, including variations of the more familiar construction materials such as steel and concrete and the more exotic materials such as fiber reinforced polymer (FRP) composites and aluminum each have outstanding individual properties which when integrated into the design of new bridges, or the repair or rehabilitation of existing bridges, will significantly enhance mobility, productivity and ultimately, safety. Substantial reductions in construction time and initial cost are provided; work zone duration is limited and , with improved durability life cycle costs are minimized. This has been clearly demonstrated with the use of high performance concrete with better durability and higher strength in the San Angelo, Texas bridge where first costs were about the same when compared to using "standard" concrete. High performance steel, which has greater toughness and improved weldability and durability, was used in the Martin Creek, Tennessee bridge and resulted in a reduction of the fabricated steel costs of 11%. Studies conducted by the Civil Engineering Research Foundation (CERF) acknowledged that the newer FRP composites will

have higher first cost whose use must be justified on an as yet developed life cycle cost model basis. However, FRP composites are being used for bridge repairs in more than 20 states and have demonstrated that the time required for repair can be significantly reduced, although no cost savings have been reported from the reduction in time to repair. FRP composites are also being looked at to extend by a few years the service life of bridges which are nearing the end of their utility thus providing owners a window to plan, design, and allocate funding to replace those deficient bridges which have been given a reprieve through HPM repair. R&D activities conducted within the scope of this area will: characterize high performance material behavior; develop technical guidance and specifications for their use; demonstrate incentives to owners for their use based on quantification of life cycle cost models; demonstrate extended service life and reduction of maintenance requirements; and highlight reduced construction times resulting from HPM use.

One excellent example of this work is the development of a comprehensive definition for high performance concrete (HPC). In order to encourage widespread use of HPC, it was necessary to establish a clear understanding of what HPC is, establish specific performance criteria, develop testing procedures to measure performance and develop recommendations to relate desired performance levels to site specific service conditions. Since a major goal of HPC use is longer lasting bridges, the HPC definition is based on long term performance criteria as related to two main characteristics of concrete - strength and durability. Long term performance of concrete structures is affected by climatic conditions, by exposure to salts and chemicals and by loads. The HPC definition covers four strength parameters (e.g., compressive strength) and four durability parameters (e.g., chloride permeability) in order to adequately specify a mix design for almost all potential combinations of service conditions. To specify an HPC concrete mix, the designer selects, based on actual site conditions, the level of performance desired for each performance characteristic.

The current definition for HPC concrete can be found at <http://hpc.fhwa.dot.gov>. The definition is a work in progress and will be periodically updated as more field experience is gained. In addition to development of the HPC definition, FHWA has sponsored two other efforts in order to promote the use of HPC and to ensure widespread use. First, FHWA has provided funds to support the extra costs associated with using HPC in new bridges including engineering, mix design, higher material costs and also instrumentation to measure performance after construction. Second, in order to spread knowledge of HPC and the potential benefits, FHWA has conducted a series of HPC showcases which demonstrate the experience of using HPC on specific bridges. Over thirty states have now completed one or more HPC bridges or at least begun the design for a future HPC bridge. The definition is a major step towards FHWA's goal of using HPC in every state and making HPC an effective solution to the deficient bridge problem.

HPS 70W Steel for 21st Century Bridges

HPS 70W steel has outstanding potential to perform in many ways which directly support FHWA's goals to improve mobility and increase productivity. Savings in total first cost are possible as already shown in the case of the Martin's Creek bridge in Tennessee. This advantage cannot be underestimated since the premium cost of many newer high performance materials such as FRP composites is already seen to be a major disadvantage in the face ever increasing needs and of tight highway program budgets. Steel design codes are very well established by AASHTO and adjustments to accommodate higher strength steels are well underway. The higher strength plus

excellent weldability of the steel are advantageous in hybrid situations where HPS 70W can be utilized in high stress regions and lower strength steels in lower stress regions. Total material cost is further optimized in this manner. Finally as new, optimized shapes begin to replace the routine box and I-girder shapes, the full benefit of the strength and weldability of the HPS steels. Another important characteristic of HPS 70W steel is its resistance to corrosion. The increased durability from the improved weathering capabilities of the steel should result in longer, maintenance free life with resulting savings in life cycle costs. Additionally, in situations where use of the unpainted steel is possible, the increasingly higher costs and environmental considerations of maintenance repainting can be minimized. Development and deployment of HPS is a true success story as FHWA, working with the Navy and the steel industry, has developed an affordable new steel which possesses increased strength and toughness and improved durability - all of which makes it an ideal material for longer lasting bridges of the future. HPS 70W steel is now in use, under design or planned for 66 bridges in 25 states.

The Transportation Equity Act for the 21st Century (TEA-21)

Transportation legislation is authorized on a six-year basis. From fiscal year 1991 through fiscal year 1997, the Intermodal Surface Transportation Equity Act (ISTEA) was the governing legislation for transportation. Under ISTEA, several experimental applications of innovative materials, including FRP, were constructed on bridge projects. Transportation legislation was reauthorized in June 1998 when Congress passed and President Clinton signed the Transportation Equity Act for the 21st Century (TEA-21). This landmark legislation authorizes up to 162 billion dollars for highway and bridge construction over six years. Included in the reauthorization was the continuation of a major initiative intended to improve the condition, durability, and capacity of the Nation's 589,815 bridges. Since 1979, the Highway Bridge Rehabilitation and Replacement Program (HBRRP) has been instrumental in improving or replacing more than 52,000 bridges. TEA-21 authorizes \$20.4 billion to rehabilitate or replace bridges judged to be eligible because of deteriorated condition and/or reduced capacity. Certainly, the effectiveness of the investment of the past HBRRP funds cannot be simply judged on the sole basis of the number of deficient bridges which were upgraded. Equally important as the numbers are the efficiency with which the funds were used (productivity), the minimization of construction or rehabilitation times (mobility and productivity) and the ultimate extension of service life of the repaired or new bridges (mobility and productivity). One of FHWA's concerns is that the HBRRP funds are used to repair bridges or build new bridges which will have a longer, maintenance free service life.

The Innovative Bridge Research & Construction (IBRC) Program

The Transportation Equity Act for the 21st Century (TEA-21) launched an important new initiative in the effort to reduce the number of bridges in the United States which are rated as deficient, i.e., functionally obsolete and/or structurally deficient. TEA-21 establishes the Innovative Bridge Research and Construction (IBRC) Program which provides \$102 million over six years for bridge projects which demonstrate the application of innovative materials such as FRP composites. As stated in the legislation, under the program, the Secretary (of Transportation) shall make grants to, and enter into cooperative agreements and contracts with - - - States to pay the Federal share of the cost of repair, rehabilitation, replacement, and new construction of bridges or structures that

demonstrate the application of innovative materials. The Secretary shall select and approve the applications based on whether the project that is the subject of the grant meets the goals of the program, described below.

The goals of the IBRC program, as established by the Congress, are consistent with the strategic goals of the Department of Transportation which are to increase mobility in the transportation system and improve productivity - one of the key performance measures for assessing progress on these goals is the reduction of the number of bridges which are rated as deficient. In part, the Congress described the IBRC program goals as including (A) the development of new, cost-effective bridge applications of innovative materials; (B) the reduction of maintenance costs and life-cycle costs of bridges, including the costs of new construction, replacement, or rehabilitation of deficient bridges; (C) the development of construction techniques to increase safety and reduce construction time and traffic congestion; (D) the development of engineering design criteria for innovative products and materials for use in highway bridges and structures; and (E) the development of highway bridges and structures that will withstand natural disasters, including alternative processes for the seismic retrofit of bridges. Section 5103 of TEA-21 authorized funds to be available to the States for projects to demonstrate innovative materials relating to repair, rehabilitation, and construction of bridges. Eligibility is governed by the following:

- ! Funds are available for bridge projects that meet one or more of the seven program goals listed in Section 503(b)(2) of Title V-Transportation Research
- ! The project may be on any public roadway, including State and locally funded projects.
- ! Funds are available for costs of preliminary engineering, costs of repair, rehabilitation or construction of bridges or other structures, and costs of project performance evaluations including instrumentation and performance monitoring of the structure following construction.
- ! Proprietary Products - As this is a research and experimental program, it is in the public interest that proprietary and sole source products may be included in the projects, but they must be clearly identified and described.

These funds may be used for the Federal share of the cost of the repairs, rehabilitation, replacement or new construction on the “innovative materials” portion of the project.

The program was initiated by the Federal Highway Administration (FHWA) in July 1998 by solicitation to all of the States to identify and submit for funding, projects which utilize innovative materials and which meet one or more of the program goals. A subsequent call for candidate projects was made in May 1999. A total of 41 States responded and a total of 289 projects were submitted; the combined total estimated cost of the projects was \$172M. The selection criteria for eligible projects required the application of a material considered innovative in highway bridges and were also keyed to how well the application met the program goals.

Representative Projects Demonstrating High Performance Materials

Salem Avenue Bridge in Dayton, Ohio - One well-recognized model of incorporating new materials and technologies in bridge construction is the Salem Avenue Bridge (Montgomery SR 49) in Dayton Ohio. When completed, this twin 5-span, 680-foot-long, 48-foot-wide bridge will incorporate the largest composite bridge deck in the United States—65,280 square feet. In addition to the Ohio Department of Transportation (ODOT), partners include the FHWA, HITEC, The Composites Institute, Montgomery County Engineers, four universities, the U.S. Army Corps of Engineers, and four manufacturers. For example, environmental testing and materials testing will be by the University of Maine. The University of Kentucky tested the deck panels, and the University of Cincinnati and the Ohio University were responsible for field monitoring. The Corps of Engineers is conducting 10 million cycles of fatigue testing on the bridge materials. Half of the materials will be tested at -22 °F, the other half will be tested at 120 °F. Fiber optics will provide long-term monitoring of the internal structure.

The Martin's Creek Bridge in Tennessee -The Martins Creek bridge also demonstrates the potential of TEA-21 and IBRC. The American Iron and Steel Institute had developed a high-performance, 70-ksi yield strength steel for the U.S. Navy and the FHWA that demonstrated better fatigue resistance and weathering, and was lighter and less costly to fabricate. The Steel Institute was looking for a demonstration platform to test the steel. The FHWA saw the potential to incorporate the material into bridge construction, but it needed to build a full-scale bridge to observe construction process and monitor performance. Tennessee DOT had completed the design by load and resistance factor (LRFD) specifications on a bridge for Martins Creek based on 50,000 ksi-yield steel, but not high-performance 70-ksi yield steel. The TNDOT agreed to assume the cost of redesigning the bridge, and the FHWA agreed to assume the cost for the difference between the original and the redesigned cost and support an extensive program of monitoring scheduled for the structure during and after fabrication in order to provide valuable information and data for future projects. This early demonstration of HPS 70W steel proved the potential for first cost savings as the fabricated cost of the bridge was actually 11% less than the original design for 50 ksi steel.

Use of HPC is growing rapidly as more than 30 states have now completed one or more HPC bridges or at least begun the design for a future HPC bridge. An excellent example of a completed HPC bridge is the Virginia Avenue Bridge over the Clinch River in Richmond, Virginia. The Richlands bridge consists of two 22.6m (74-ft) spans with five AASHTO Type III prestressed concrete girders per span and a reinforced concrete deck. HPC was used in the deck, the girders and the substructure. Performance criteria for strength and chloride permeability were established for each member based on service requirements. Advantages gained from use of HPC included a reduction in girder lines from seven to five and an estimated reduction in cost of the bridge from \$743 per square meter to \$657 per square meter. Additionally, the concrete deck is expected to be more resistant to corrosion damage because of the decreased permeability to chlorides.

Summary

The FHWA Structures Research & Technology program is the joint responsibility of the FHWA Office of Infrastructure and the FHWA Office of Infrastructure Research & Development.

As resources allow, the program will continue to pursue innovative technology with the philosophy identifying or “finding” the problems and then “fixing” them. To learn more about the FHWA structures R&T program, including the NDEVC and the BMIS lab, visit <http://www.tfsrc.gov>.

The IBRC program will continue for the duration of the TEA-21 legislation and additional solicitations are planned for March 15, 2001 and on March 15, 2002. Program funds available for future projects amount to \$40M. Projects such as those described above will be supported in order to evaluate and demonstrate the role of high performance materials in bridges. FHWA will continue to administer the program and will continue to stress that each project should include a carefully planned program of monitoring and evaluating the performance of the innovative materials. This will be critically important to the future use of all the high performance materials, particularly the FRP composites, since the knowledge base of their performance in bridge applications is very limited.

To learn more about the Innovative Bridge Research and Construction Program, including the solicitation and selection of projects for FY 2000 and beyond, visit <http://ibrc.fhwa.dot.gov>. This web page will provide detailed information on projects under way, as well as related research, development, and technology transfer efforts to enhance the use of innovative materials.