Statement of
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United States Department of Transportation
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Bridge Safety: Next Steps to Protect the Nation's Critical Bridge Infrastructure
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Mr. Chairman and Members, we are pleased to appear before you today to report on the Department of Transportation's research, development, testing, and evaluation activities, as administered by the Federal Highway Administration (FHWA), to ensure the safety of the Nation's highway bridges. This is a very important hearing topic in the wake of the tragic collapse of the Interstate 35 West (I-35W) bridge over the Mississippi River in Minneapolis, Minnesota. On behalf of the Department, we extend our deepest sympathy to the loved ones of those who died and to the injured.

<u>Minnesota Bridge Collapse</u>

America was stunned by the collapse of the I-35W bridge at approximately 6:00 PM, Central Daylight Time, on Wednesday, August 1, 2007. Numerous vehicles were on the bridge at the time and there were 13 fatalities and 123 people injured. The I-35W bridge originally opened in November 1967 and became one of the critical facilities in a vital commercial and commuting corridor. The bridge was an 8-lane, steel deck truss structure that rose 64 feet above the Mississippi River. The main span extended to 456 feet in length to avoid putting piers in the water which would have impeded river navigation. As of the 2004 count, an estimated 141,000 vehicles traveled per day on the bridge.

We do not yet know why the I-35W bridge failed, and the Department is working closely with the National Transportation Safety Board (NTSB) as it continues its investigation to determine the cause or causes. In the interim, we are taking every step to reassure the public that America’s infrastructure is safe. The Secretary of Transportation has issued two advisories to States in response to what has been learned so far, asking that States re-inspect their steel deck truss bridges and that they be mindful of the added weight construction projects may bring to bear on bridges.

The Federal Highway Administration is assisting the NTSB in a thorough investigation, which includes a structural analysis of the bridge. Within days of the collapse, development of a computer model based upon the original design drawings for the bridge began at FHWA's Turner Fairbank Highway Research Center in McLean, Virginia. This model can perform simulations to determine the effect on the bridge of removing or weakening certain elements to recreate, virtually, the actual condition of the bridge just prior to and during the bridge's collapse.

By finding elements that, if weakened or removed, result in a bridge failure similar to the actual bridge failure, the investigators' work is considerably shortened. While examination of the physical members of the bridge being recovered from the site provides the best evidence of why the bridge collapsed, the analytical model allows the evaluation of multiple scenarios which can then be validated against the physical forensic evidence. We are committed to accomplishing this work as quickly as possible, but it is expected to take several months. Our experts will continue to be there, on the ground in Minneapolis, to provide assistance. We need to fully understand what happened so we can take every possible step to ensure that such a tragedy does not happen again. Data collected at the accident scene, with the help of the Federal Bureau of Investigation's 3-D laser scanning technology, is being used to assist in the investigation.

Federal, State, and local transportation agencies consider the inspection of our nearly 600,000 bridges to be of vital importance and invest significant funds in bridge inspection activities each year. We strive to ensure that the quality of our bridge inspection program is maintained at the highest level and that our funds are utilized as effectively as possible. On August 2, the day after the collapse, Secretary of Transportation Mary E. Peters requested the Department of Transportation's Inspector General to conduct a rigorous assessment of the Federal-aid bridge program and the National Bridge Inspection Standards (NBIS).

<u>National Bridge Inspection Program</u>

The National bridge inspection program was created in response to the collapse, in 1967, of the Silver Bridge over the Ohio River between West Virginia and Ohio, which killed 46 people. At the time of that collapse, the exact number of highway bridges in the United States was unknown, and there was no systematic bridge inspection program to monitor the condition of existing bridges. In the Federal-aid Highway Act of 1968, Congress directed the Secretary of Transportation in cooperation with State highway officials to establish: (1) NBIS for the proper safety inspection of bridges, and (2) a program to train employees involved in bridge inspection to carry out the program. As a result, the NBIS regulation was developed, a bridge inspector's training manual was prepared, and a comprehensive training course, based on the manual, was developed to provide specialized training. To address varying needs and circumstances, State and local standards are often even more restrictive than the national standards.

The NBIS require safety inspections at least once every 24 months for highway bridges that exceed 20 feet in total length located on public roads. Many bridges are inspected more frequently. However, with the express approval by FHWA of State-specific policies and criteria, some bridges can be inspected at intervals greater than 24 months. New or newly reconstructed bridges, for example, may qualify for less frequent inspections. Approximately 83 percent of bridges are inspected once every 24 months, 12 percent are inspected annually, and 5 percent are inspected on a 48 month cycle.

The State transportation department (State DOT) must inspect, or cause to be inspected, all highway bridges on public roads that are fully or partially located within the State's boundaries, except for bridges owned by Federal agencies. States may use their Highway Bridge Program funds for bridge inspection activities. Privately owned bridges, including commercial railroad bridges and some international crossings, are not legally mandated to adhere to the NBIS requirements; however, many privately owned bridges on public roads are being inspected in accordance with the NBIS.

For bridges subject to NBIS requirements, information is collected on bridge composition and conditions and reported to FHWA, where the data is maintained in the National Bridge Inventory (NBI) database. The NBI is essentially a database of bridge information that is "frozen" at a given point in time. This information forms the basis of, and provides the mechanism for, the determination of the formula factor used to apportion Highway Bridge Program funds to the States. A sufficiency rating (SR) is calculated based on the NBI data items on structural condition, functional obsolescence, and essentiality for public use. The SR is then used programmatically to determine eligibility for rehabilitation or replacement using Highway Bridge Program funds.

Bridge inspection techniques and technologies have been continuously evolving since the NBIS were established over 30 years ago and the NBIS regulation has been updated several times as Congress has revised the inspection program and its companion program, the Highway Bridge Program (formerly Highway Bridge Replacement and Rehabilitation Program). The most recent NBIS revision took effect in January 2005. The bridge inspector's reference manual has been updated as well, and we have developed, through our National Highway Institute (NHI), an array of bridge inspection training courses.

There are five basic types of bridge inspections--initial, routine, in-depth, damage, and special. The first inspection to be completed on a bridge is the “initial” inspection. The purpose of this inspection is to provide all the structure inventory and appraisal data, to establish baseline structural conditions, and to identify and list any existing problems or any locations in the structure that may have potential problems. The “routine” inspection is the most common type of inspection performed and is generally required every two years. The purpose of “routine” inspections is to determine the physical and functional condition of a bridge on a regularly scheduled basis. An “in-depth” inspection is a close-up, hands-on inspection of one or more members above or below the water level to identify potential deficiencies not readily detectable using routine inspection procedures. A “damage” inspection is an emergency inspection conducted to assess structural damage immediately following an accident or resulting from unanticipated environmental factors or human actions. Finally, a “special” inspection is used to monitor, on a regular basis, a known or suspected deficiency.

Safety is enhanced through these inspections and by “rating” bridge components, such as the deck, superstructure, and substructure, and by the use of non-destructive evaluation (NDE) methods and other advanced technologies. Visual inspection is the primary method used to perform routine bridge inspections, and tools for cleaning, probing, sounding, and measuring, and visual aids are typically used. On occasion, destructive tests are conducted to evaluate specific areas or materials of concern, or to help identify appropriate rehabilitative work. Type, location, accessibility, and condition of a bridge, as well as type of inspection, are some of the factors that determine what methods of inspection practices are used. When problems are detected, or during the inspection of critical areas, more advanced methods are employed.

Commonly used methods for evaluating concrete elements during “routine” inspections include mechanical sounding to identify areas of delamination (the separation of a layer of concrete from the reinforcing steel in the concrete member) and other forms of concrete degradation. Similarly, for the “routine” inspection of steel members, methods include cleaning and scraping, and the use of dye penetrant and magnetic particle testing to identify cracking and areas of significant corrosion.

State-of-the-art methods utilized during “in-depth,” “damage,” and “special” inspections include impact echo, infrared thermography, ground penetrating radar, and strain gauges for concrete structures and elements, and ultrasonic, eddy current, radiography, acoustic emissions, strain gauges, and x-ray technology for steel structures and elements.

There are numerous other technologies under development that have the potential to substantially advance the practices used for bridge inspection. Some of these technologies are also being developed or are in limited use by other industries, such as the aerospace and nuclear industries. There is no one-size-fits-all approach in the use of non-destructive evaluations and testing; each technology is designed for a specific purpose and function. Although these developing technologies have the potential to augment and advance bridge inspection practice, the challenge is to find a way to make them efficient, effective, and practical for field use. FHWA, industry, academia, the Transportation Research Board (TRB), and State DOTs continue to investigate and improve the practicality of many of these technologies. As a result of these efforts, a number of systems have recently become available that can assist an inspector in the identification and quantification of such things as reinforced concrete deterioration, steel tendon distress, and the displacement or rotation of critical members in a bridge.

There are also a number of monitoring systems that can be used to provide real time data and alert the bridge owner to such things as failure of load carrying members, excessive rotation or displacement of an element, overload in a member, growth of a crack, or scour around a bridge pier. The type of information provided by these systems is either very specific and provides detailed information on isolated areas or members of the bridge, or rather generic and provides general bridge behavior information. The most practical of these systems are being used by owners following an “in-depth” or “special” inspection, to monitor the performance of the element or the bridge, when some specific concern has been raised but the concern is not considered to be a short-term safety hazard. However, the effectiveness and costs associated with monitoring systems must be weighed against the benefits gained. Like any emerging technology, changes and updates in monitoring systems can become a big challenge to maintain economically over the long haul. Today, bridges are being built to last 75 to 100 years and installing any new monitoring systems and expecting them to be durable and serviceable for such a long period has never been done before. Monitoring systems that are available today require routine maintenance and repair, and continuous assessment to ensure that they are working correctly. In addition, they do not eliminate the need for regular visual inspections. In many circumstances, it is more effective to increase the inspection frequency, repair or retrofit areas of concern, or replace the structure.

Since 1994, the percentage of the Nation's bridges that are classified as "structurally deficient" has declined from 18.7% to 12.1%. The term "structurally deficient" is a technical engineering term used to classify bridges according to serviceability, safety, and essentiality for public use. Bridges are considered "structurally deficient" if significant load-carrying elements are found to be in poor or worse condition due to deterioration or damage, or the adequacy of the waterway opening provided by the bridge is determined to be extremely insufficient to the point of causing intolerable traffic interruptions. The fact that a bridge is classified as "structurally deficient" does not mean that it is unsafe for use by the public.

These infrastructure quality numbers for bridges should, and can, be improved, but it is inaccurate to conclude that the Nation's transportation infrastructure is unsafe. We have quality control systems that provide surveillance over the design and construction of bridges. We have quality control systems that oversee the operations and use of our bridges. And we have quality control over inspections of bridges to keep track of the attention that a bridge will require to stay in safe operation. These systems have been developed over the course of many decades and are the products of the best professional judgment of many experts. We will ensure that any findings and lessons that come out of the investigation into the I-35W bridge collapse are quickly learned and appropriate corrective actions are institutionalized to prevent any future occurrence.

Bridge Research and Technology Programs

The current FHWA bridge research program is focused on three areas: (1) the "Bridge of the Future," (2) effective stewardship and management of the existing bridge infrastructure in the United States, and (3) assuring a high level of safety, security, and reliability for both new and existing highway bridges and other highway structures.

The "Bridge of the Future" is intended to be a bridge that can last for 100 years or more, and require minimal maintenance and repair--while being adaptable to changing conditions, such as increasing loads or traffic volumes. FHWA's bridge research and technology (R&T) programs are focusing on improving the long-term performance of our Nation's highway infrastructure in an effective yet economical way.

In the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Congress authorized and funded research in 5 program areas: long-term bridge performance, innovative bridge delivery, high performance and innovative materials, nondestructive inspection technology, and seismic research. The specific programs authorized by SAFETEA-LU are summarized in the following:

Long-term Bridge Performance

Long-Term Bridge Performance Program (LTBPP) – The LTBPP has been designed as a 20-year effort that will include detailed inspections and periodic evaluations and testing on a representative sample of bridges throughout the United States in order to monitor and measure their performance over an extended period of time. The program will collect actual performance data on deterioration, corrosion, or other types of degradation; structural impacts from overloads; and the effectiveness of various maintenance and improvement strategies typically used to repair or rehabilitate bridges. The resulting LTBPP database will provide high quality, quantitative performance data for highway bridges that will support improved designs, improved predictive models, and better bridge management systems.

Innovative Bridge Delivery

Innovative Bridge Research and Deployment (IBRD) Program – The IBRD program encourages highway agencies to more rapidly accept the use of new and innovative materials and technologies or practices in highway structure construction by promoting, demonstrating, evaluating, and documenting the application of innovative designs, materials, and construction methods in the construction, repair, and rehabilitation of bridges and other structures. This will increase safety and durability and reduce construction time, traffic congestion, maintenance costs, and life-cycle costs of bridges.

High Performance and Innovative Materials

High-Performance Concrete (HPC) Research and Deployment Program – The HPC program is a subset of the IBRD program. It continues the advancement of HPC applications through targeted research that addresses needed improvements in design, fabrication, erection, and long-term performance in order to achieve the Bridge Program strategic outcomes. HPC research focuses on material and casting issues, including improved performance criteria, lightweight concrete, curing, and test methods; structural performance concerns, including compression, shear, and fatigue behavior for both seismic and non-seismic applications; and concepts related to accelerated construction and bridge system design and performance.

High-Performing Steel (HPS) Research and Technology Program – The HPS research and technology transfer program is focused on resolving a number of issues and concerns with the design, fabrication, erection, and long-term performance of both conventional and High Performance steels. The program focuses research and technology transfer and education in the areas of materials and joining (for example, optimized welding processes and procedures); long-term performance (including advanced knowledge on performance limitations of weathering steels and the potential development of a 100-year shop-applied permanent steel coating system); innovative design (including testing and deployment of modular steel bridge super- and substructure systems); and fabrication and erection tools and processes.

Ultra-High-Performance Concrete (UHPC) Research and Technology– UHPC is a unique material which is reinforced with short steel fibers, but requires no conventional steel reinforcing. Prior FHWA research on UHPC focused on basic material characterization, and the development of optimized structural systems using this very high performance, but costly, material. Under the UHPC program, additional work will be conducted to further understand the unique structural properties of this material and assess its corrosion-resistance properties, while addressing its use in other structural components including precast bridge deck panels and prestressed I- and bulb-tee girders.

Wood Composite Research – The University of Maine is conducting a research program focused in the development and application of wood/fiber reinforced polymer (FRP) composite materials for potential use as primary structural members in highway bridges.

Nondestructive Inspection Technology

Steel Bridge Testing Program – This program is focused on the further development and deployment of advanced NDE tools that can be used to detect and quantify growing cracks in steel bridge members and welds. As described in SAFETEA-LU, the NDE technology should ultimately be able to detect both surface and subsurface cracks, in a field environment, for flaws as small as 0.010 inches in length or depth.

Seismic Research

Seismic Research Program – The University of Nevada, Reno, and the State University of New York at Buffalo are conducting a seismic research program intended to increase the resilience of bridges and reduce earthquake-induced losses due to highway damage.

FHWA is also conducting and managing a number of other important bridge research projects in conjunction with various partners and stakeholder groups, all focused on improving the performance and durability of our Nation's highway bridges--both those exposed to normal everyday traffic and use, and those exposed to the damaging effects of extreme natural and man-made hazards.

In addition to FHWA, there are a number of other organizations that sponsor bridge research, and a much larger group of agencies that conduct bridge R&T. These include State DOTs, industry, other Federal agencies, and academia. Other transportation modes also conduct limited bridge research, including the railroad industry.

FHWA actively coordinates the National research program with our partners and stakeholders for agenda-setting, and in the conduct of research and delivery of new innovations. Our staff participates in numerous national and international organizations and serves on committees focused on bridge research, development, and technology transfer. We organize formal technical advisory groups and technical working groups, comprised of Federal, State, and local transportation officials; bridge engineering consultants and industry groups; and academia to assist in the design, conduct, and delivery of the program.

An important R&T partner for FHWA is the University Transportation Centers (UTC) Program, managed by the Research and Innovative Technology Administration (RITA). FHWA works with the UTCs to identify opportunities for collaboration that will increase knowledge and skills among State and local highway agencies. FHWA holds periodic workshops that bring together researchers and practitioners from FHWA, State DOTs, TRB, and UTCs to learn about each others' interests and capabilities, new research opportunities, and technologies under development. FHWA held an infrastructure workshop for UTCs and State DOTs at Turner-Fairbank Highway Research Center in March 2007. FHWA is working with a number of UTCs on transportation research, including the University of Tennessee, the University of Minnesota, Utah State University, Rutgers, and the University of Missouri-Rolla**.** RITA also consolidates bridge technology information from all the Department's modal administrations to assist us in having the best available technologies.

State and local highway agencies learn of new technologies developed by UTCs through a variety of events sponsored by FHWA. These include annual workshops showcasing the results of UTC research on particular topics, and numerous conferences, seminars and workshops co-sponsored with specific UTCs (for example, the "Self Consolidating Concrete Workshop" at South Dakota State University). FHWA also utilizes its highly successful Local Technical Assistance Program (LTAP) as a mechanism for transferring technologies developed through the UTC program to State and local highway agencies, and tribal governments.

FHWA is also an active participant with the American Association of State Highway and Transportation Officials (AASHTO) in technology transfer such as the AASHTO Technology Implementation Group and the Joint AASHTO/ FHWA/National Cooperative Highway Research Program International Technology Exchange Program**,** more commonly known as the International Scanning Program. Recent scans have included a scan on bridge management, and a follow-on scan in 2007 on Bridge Evaluation Quality Assurance**.** The 2007 scan identified and explored bridge inspection processes in use in European countries.

Ultimately, a key measure of success of any highway technology depends on its acceptance by stakeholders on a national scale. FHWA's responsibilities for R&T include not only managing and conducting research, but also sharing the results of completed research projects, and supporting and facilitating technology and innovation deployment. FHWA's Resource Center is a central location for obtaining highway technology deployment assistance. (The multiple services offered by the Resource Center are listed at www.fhwa.dot.gov/resourcecenter/.) Education and training programs are provided through the FHWA NHI (www.nhi.fhwa.dot.gov).

There are a number of barriers to technology deployment that may explain the relatively slow adoption of highway technologies that appear cost effective. Lack of information about new technologies is one barrier that may be overcome with information and outreach programs. Long-standing familiarity with existing technologies gained through education or experience also may hamper the adoption of newer technologies. Education and training programs provided through the NHI often help to transcend these types of barriers.

It also may be difficult for stakeholders to envision the long-range benefits of a new technology relative to initial investment costs, especially if the payback (break-even) period is long. Even if stakeholders are aware of eventual cost savings from a more efficient or effective highway technology, they may have confidence in traditional ways of, for example, assessing pavement performance. Demonstration projects that provide hard quantitative data can help tip the scales so that stakeholders are more willing to try and eventually regularly use innovative technologies.

Despite these efforts, technology deployment is also slowed by residual uncertainties about performance, reliability, installation, and maintenance costs; availability of the next generation of the technology; and the need for the necessary technical and physical infrastructure to support the technology in question. These persistent barriers can be addressed with outreach programs and collaborative efforts with stakeholders--ranging from the TRB to researchers within State DOTs--as well as other incentives to enhance the cost effectiveness of new technologies. Taken together, these initiatives often encourage earlier and broader adoption of highway technologies by increasing stakeholder familiarity with new technologies.

One such program is FHWA's Highways For LIFE. (http://www.fhwa.dot.gov/hfl/hflfact.cfm). The purpose of Highways for LIFE is to advance long lasting highways using innovative technologies and practices to accomplish fast construction of efficient and safe pavements and bridges, with the overall goal of improving the driving experience for America. The program includes demonstration construction projects, stakeholder input and involvement, technology transfer, technology partnerships, information dissemination, and monitoring and evaluation. The innovative technologies that the Highways for LIFE program promotes include prefabricated bridge elements and systems, road safety audits, and tools and techniques for "Making Work Zones Work Better."

Perhaps the main barrier to technology deployment is the general lack of incentive mechanisms to encourage the deployment of new technologies. We need to develop better incentive mechanisms in the way the program is designed, the way we procure, and the extent to which we rely on the private sector.

The Missouri Safe and Sound Bridge Improvement Project provides an example of a potentially innovative way to improve incentives and encourage innovation and private sector participation.

On May 25, 2007 the Department of Transportation approved a $600 million allocation of Private Activity Bonds to the Missouri DOT for the Missouri Safe and Sound Bridge Improvement Project. The allocation will be made available to two short-listed bidders who are competing for a contract to bring 802 of Missouri's lowest rated bridges up to satisfactory condition by December 2012 and keep them in that condition for at least 25 years. The contract will be awarded largely on the basis of the lowest level of "availability payments" that the bidder will accept to improve and maintain the 802 bridges. Missouri DOT will use Federal formula funds to pay the availability payments.

SATETEA-LU authorized $15 billion in Private Activity Bonds. These bonds provide tax-exempt financing for private firms to carry out highway and surface freight transfer projects. This innovative financing approach will allow Missouri to complete these much needed bridge improvements more quickly and, it is hoped, at a lower cost. Other States, including Pennsylvania and North Carolina, are also interested in this innovative approach.

Through these and other mechanisms, FHWA supports the development and implementation of innovative technology deployment practices and processes throughout the highway community.

Conclusion

The I-35W bridge collapse was both a tragedy and wake-up call to the country. The Department's Inspector General will be monitoring all of the investigations into the collapse and reviewing our inspection and funding programs to decide and advise us what short- and long-term actions we may need to take to improve the program. Though we will have to wait for the NTSB's report before we really know the cause of the collapse, a top-to-bottom review is underway to make sure that everything is being done to keep this kind of tragedy from occurring again. The public deserves to know and trust that our Nation's highways are safe.

We look forward to continuing to work with Congress to give the people of this Nation the safe, efficient, and effective transportation system that they expect and deserve.

Thank you again for this opportunity to testify. We will be pleased to answer any questions you may have.