Testimony of
The American Society of Civil Engineers
Before the
House Committee on Science and Technology
on
Bridge Safety: Next Steps to Protect the Nation's Critical Infrastructure
September 19, 2007

Chairman Gordon, Congressman Hall and Members of the Committee:

Good morning. I am Kevin Womack, Ph.D., P.E., Chair of the Transportation Policy Committee of the American Society of Civil Engineers (ASCE)[1]. I am a Professor of Civil and Environmental Engineering at Utah State University and Director of the Utah Transportation Center, a federally funded University Transportation Center. I serve on the National Academies' Research and Technology Coordinating Committee, an advisory committee to the Federal Highway Administration. I am a structural engineer by training and have been involved in the area of bridge research for the past 15 years.

Thank you for holding this hearing. As someone who has worked in this field for many years, I can say that there are few infrastructure issues of greater importance to Americans today than bridge safety.

I am pleased to appear today to lend ASCE's expertise to the problem of the nation's crumbling infrastructure that was highlighted by the tragic events of August 1, 2007, when the I-35W Bridge in Minneapolis collapsed into the Mississippi River.

I. Bridge Conditions

More than four billion vehicles cross bridges in the United States every day and, like all man-made structures, bridges deteriorate. Deferred maintenance accelerates deterioration, which may make bridges more susceptible to failure. As with other critical infrastructure, a significant investment is essential to maintain the benefits and to assure the safety that society demands.

In 2005, ASCE issued the latest in a series of assessments of the nation's infrastructure. Our *2005 Report Card for America's Infrastructure* found that as of 2003, 27.1 percent or 160,570 of the nation's 590,753 bridges were structurally deficient or

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[1] ASCE, founded in 1852, is the country's oldest national civil engineering organization. It represents more than 140,000 civil engineers in private practice, government, industry, and academia who are dedicated to the advancement of the science and profession of civil engineering. ASCE is a 501(c) (3) non-profit educational and professional society.

functionally obsolete, an improvement from 28.5 percent in 2000. In fact, over the past 12 years, the number of deficient bridges, both structurally deficient and functionally obsolete categories, has steadily declined from 34.6 percent in 1992 to 25.8 percent in 2006.

However, this improvement is contrasted with the fact that one in three urban bridges (31.2 percent or 43,189) were classified as structurally deficient or functionally obsolete, much higher than the national average.

In 2005, the FHWA estimated that it would cost $9.4 billion a year for 20 years to eliminate all bridge deficiencies. In 2007, FHWA estimated that $65 billion could be invested immediately in a cost beneficial manner to address existing bridge deficiencies.

The 10-year improvement rate from 1994 to 2004 was a 5.8 percent (32.5 percent - 26.7 percent) reduction in the number of deficient bridges. Projecting this rate forward from 2004 would require 46 years to remove all deficient bridges. Unfortunately, bridges are now deteriorating at a rate faster than we can maintain them, so this 46 year projection has grown to 57 years to eliminate all deficient bridges. This shows that progress has been made in the past in removing deficient bridges, but our progress is now slipping or leveling off.

There is clearly a demonstrated need to invest additional resources in our nation's bridges. However, deficient bridges are not the sole problem with our nation's infrastructure. The U.S. has significant infrastructure needs throughout the transportation sector including roads, public transportation, airports, ports, and waterways. As a nation, we must begin to address the larger issues surrounding our infrastructure so that public safety and the economy will not suffer.

II. Bridge Inspection Program

The National Bridge Inspection Standards (NBIS), in place since the early 1970s, require biennial safety inspections for bridges in excess of 20 feet in total length located on public roads. These inspections are to be performed by qualified inspectors. Structures with advanced deterioration or other conditions warranting closer monitoring are to be inspected more frequently. Certain types of structures in very good condition may receive an exemption from the two-year inspection cycle. These structures may be inspected once every four years. Qualification for this extended inspection cycle is reevaluated depending on the conditions of the bridge. Approximately 83 percent of bridges are inspected once every two years, 12 percent are inspected annually, and five percent are inspected on a four-year cycle.

Information is collected documenting the conditions and composition of the structures. Baseline composition information is collected describing the functional characteristics, descriptions and location information, geometric data, ownership and maintenance responsibilities, and other information. This information permits characterization of the system of bridges on a national level and permits classification of the bridges. Safety, the primary purpose of the program, is ensured through periodic hands-on inspections and ratings of the primary components of the bridge, such as the deck, superstructure, and substructure. This classification and condition information is warehoused in the National Bridge Inventory (NBI) database maintained by FHWA. This database represents the most comprehensive source of information on bridges throughout the United States.

It is important to note, however, that the value of the NBI is limited, although it is certainly a useful tool to evaluate the condition of public bridges. Among its limitations, a user cannot tell the condition of a specific element of the bridge, i.e., a girder or diaphragm or bearing. The overall rating encompasses the superstructure, the substructure, and the deck which all have unique elements. Therefore, the NBI cannot offer the kind of information that may be required for in-depth analysis.

Two documents, the American Association of State Highway and Transportation Officals' (AASHTO) *Manual for Condition Evaluation of Bridges* and the FHWA's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*, provide guidelines for rating and documenting the condition and general attributes of bridges and define the scope of bridge inspections. Standard condition evaluations are documented for individual bridge components as well as ratings for the functional aspects of the bridge. These ratings are weighted and combined into an overall Sufficiency Rating for the bridge on a 0-100 scale. These ratings can be used to make general observations on the condition of a bridge or an inventory of bridges.

The factors considered in determining a sufficiency rating are: S1- Structural Adequacy and Safety (55 percent maximum), S2- Serviceability and Functional Obsolescence (30 percent maximum), S3- Essentiality for Public Use (15 percent maximum), and S4- Special Reductions (detour length, traffic safety features, and structure type--13 percent maximum).

In addition to the sufficiency rating, these documents provide the following criteria to define a bridge as structurally deficient or functionally obsolete, which triggers the need for remedial action. The structural capacity of a bridge is also determined and is used to decide if a bridge should be restricted to trucks of lower weights.

Structurally Deficient – A structurally deficient bridge may be restricted to light vehicles because of its deteriorated structural components. While not necessarily unsafe, these bridges usually have limits for speed and weight, and are approaching the condition where replacement or rehabilitation will be necessary. A bridge is structurally deficient if its deck, superstructure, or substructure is rated less than or equal to 4 (poor) or if the overall structure evaluation for load capacity or waterway adequacy is less than or equal to 2 (critical). This is on a condition scale with ratings between 9 (excellent) and 0 (representing a failed condition). In a worse case scenario, a structurally deficient bridge may be closed to all traffic.

Functionally Obsolete – A bridge that is functionally obsolete is safe to carry traffic but has less than the desirable geometric conditions required by current standards. A bridge is functionally obsolete if the deck geometry, underclearances, approach roadway alignment, overall structural evaluation for load capacity, or waterway adequacy is rated less than or equal to 3 (serious). A functionally obsolete bridge has older design features and may not safely accommodate current traffic volumes and vehicle sizes. These restrictions not only contribute to traffic congestion, but also pose such major inconveniences as lengthy detours for school buses or emergency vehicles.

Structural Capacity –Components of bridges are structurally load-rated at inventory and operating levels of capacity. The inventory rating level generally corresponds to the design level loads but reflects the present bridge and material conditions with regard to deterioration and loss of section. Load ratings based on the inventory level allow comparisons with the capacities for new structures. The inventory level results in a live load which can safely utilize an existing structure for an indefinite period of time. The operating rating level generally describes the maximum permissible live load to which the bridge may be subjected. This is intended to tie into permits for infrequent passage of overweight vehicles. Allowing unlimited numbers of vehicles to use a bridge at the operating level may shorten the life of the bridge.

Bridge Engineers and Bridge Inspectors:

Bridge inspection services should not be considered a commodity. Currently, NBIS regulations do not require bridge inspectors to be Professional Engineers, but do require individuals responsible for load rating the bridges to be Professional Engineers. ASCE believes that non-licensed bridge inspectors and technicians may be used for routine inspection procedures and records, but the pre-inspection evaluation, the actual inspection, ratings, and condition evaluations should be performed by licensed Professional Engineers experienced in bridge design and inspection. They should know the load paths, critical members, fatigue prone details, and past potential areas of distress in the particular type of structure being inspected. They must evaluate not only the condition of individual bridge components, but how the components fit into and affect the load paths of the entire structure. The bridge engineer may have to make immediate decisions to close a lane, close an entire bridge, or take trucks off a bridge to protect the public safety.

A new inspection protocol must be developed. This will involve visual inspection, load testing, and monitoring through instrumentation of bridges. The new protocol must be as objective as possible, with no doubt as to what steps are to be taken and when. One way to make the visual inspection less subjective is to have them all done by licensed professional engineers and not by technicians. This, however, will lead to an exacerbation of the workforce issue and the current shortage of civil engineers, particularly in the transportation arena, that is only going to get worse.

III. Bridge Design and Research

The Highway Trust Fund has been an essential source of funding for surface transportation research and technology (R&T) for decades. Research results have led to many benefits including: materials that improve the performance and durability of pavements and structures; design methods that reduce scour (and the consequent threat of collapse) of bridges; intelligent transportation systems technologies that improve safety and reduce travel delay; methods and materials that radically improve our ability to keep roads safely open in severe winter weather; innovative management approaches that save time and money; and analytical and design approaches that reduce environmental impacts, support sustainable development and improve the aesthetic and cultural aspects of transportation facilities.

These benefits are provided through several major transportation research programs. In the highway area these programs include the FHWA program, the National Cooperative Highway Research Program (NCHRP), and state department of transportation programs largely funded through State Planning and Research (SPR) funds. In the transit area the main programs are that of the Federal Transit Administration (FTA) and the Transit Cooperative Research Program (TCRP). The University Transportation Centers (UTC) program supports various transportation modes.

In SAFETEA-LU, the Surface Transportation Research, Deployment and Development and the University Transportation Research sections were both completely programmed or earmarked and over-authorized, creating a difficult environment within which FHWA and the Research and Innovative Technology Administration (RITA) must allocate funds. An added result to this practice is that FHWA now has no discretionary funds to maintain certain core research programs, which means that its Turner Fairbank Highway Research Center laboratories are underutilized. The Research Center's contract research program is limited, as is its provision of expert technical support for states when they encounter bridge and tunnel problems. States are now made to prove they can pay for any FHWA technical support. Finally, such critical efforts as the biennial Conditions and Performance Report may be in jeopardy. The practice of extreme programming and earmarking of the research title needs to be eliminated in future surface transportation authorization bills. Competition and selection on qualifications, not special interest group influence is essential for an effective research program. And the FHWA must be left with sufficient discretionary funds to maintain certain core programs.

When looking at research on bridges, the current university and FHWA research agenda does look at materials and process. While materials and process are areas for improvement, the design of bridges is a well-developed discipline. In fact, one reason the bridges in this country have lasted so long is that those 30, 40, and 50 year old, or even older bridges were typically designed very conservatively with appropriate redundancy. Newer more efficient designs can now be made due to computer analyses (finite elements), improved materials, and construction advances, which have been researched extensively. Design methods, the newest of which is the Load and

Resistance Factor Design (LRFD) have been researched and must continue to be researched to determine the performance of these lighter structures that use materials more efficiently.

Better performing concretes can be made with increased durability and, if needed, increased strength. Evaluation of this concrete with new, high strength reinforcing bars is needed, as well as research into the engineering properties and feasibility of using lightweight high performance concrete for bridges.

Research is ongoing at NCHRP to evaluate the remaining fatigue life of existing older steel bridges in America. This is an important study. However we also need to continue the research, development, and deployment of high performance steel for bridges, with its increased toughness and improved weldability.

Fiber-reinforced polymer (FRP) composites continue to hold promise for the future for bridges. Research to develop guidelines for using FRP in bridge decks, as well as using FRP externally-bonded sheets as a strengthening repair system for concrete girders and piers, is important.

Bridge and tunnel security is an area that demands our attention. Research into blast resistant design for bridges and tunnels and development of specifications and training materials for bridge engineers is important to our nation's security.

Hurricane Katrina is most known to engineers for the damage that it did to New Orleans and the levees. What isn't as well known is the damage that it did to bridges in Louisiana, Mississippi, and Alabama due to wave action, storm surge, and debris. Research being done through a joint AASHTO-FHWA-TRB transportation pooled-fund study to develop Guide Specification and a Handbook of Retrofit Options for Bridges Vulnerable to Coastal Storms is critical work for the safety and operability of our nation's bridges during extreme events.

There is also a need to study long term bridge life to develop a better understanding of how bridges age and deteriorate. This will allow us to better predict and model bridge behavior and could lead to improved maintenance practices and better bridge management. The FHWA's Long-Term Bridge Performance Program, a planned 20-year research program, should lead the way in this effort. At present, this program is significantly under-funded.

As for maintenance, it is based on the funding available and which bridge is most in need of repair. That usually means deck repair, not the structure of the bridge. When the public notices problems, such as potholes and the like, these get attention. The public rarely notices severe structural problems unless concrete is falling from the bottom of an overpass bridge.

Obviously, to properly maintain bridges, more funds are needed, and more of those funds need to go into the maintenance of the structure, not just the deck. It is our hope that the Long-Term Bridge Performance Program will help to provide answers as to how to properly channel our nation's bridge maintenance funds.

Once the bridge is safely and optimally designed, it is of most use to the public if it can be built quickly and with the least disruption to traffic. Accelerated bridge construction can help to accomplish this goal. Prefabrication of bridge elements and new construction techniques are being championed by states and the Federal Highway Administration. However, some questions remain concerning performance in earthquake regions. Research into these questions is needed.

In short, how bridges are designed, withstand extreme events, age, and how construction techniques and materials for bridges can improve should continue to be researched to look for more efficient practices.

In terms of safety, inspection is the crux of this issue. I firmly believe that a more rigorous inspection and testing protocol should be developed and this should be a significant research topic. This is where an issue arises with the I-35 W bridge. It was inspected appropriately, issues were discovered, and then there were no strict guidelines as to what to do next. It was decided to more closely monitor and inspect the bridge, but that was all done visually. If a better defined protocol were developed, the next step should have been instrumentation that could have been permanently placed on the bridge to monitor its condition constantly. The chances that instrumentation would have picked up something critical in Minneapolis would have been much greater than further visual inspections alone. Whether or not this would have picked up the impending failure is something we cannot know, but chances would have definitely been better.

A more clearly defined inspection protocol should be developed, through research, which goes beyond visual inspections to include testing and monitoring with instrumentation.

Few states or their bridge contractors take advantage of new technologies due to the current practice of selecting low-cost bids. There usually is little incentive for the contractors to use new technology; it is often more expensive and may have increased risk. Until life- cycle costs, along with the consideration of innovative materials or construction practices, are considered in awarding bids, then nothing is going to happen. States are very wary of using new materials and technologies, because if the technology does not work, the state becomes legally liable.

The federal government should do more to allow states to use new technologies, without requiring the states to assume all the risk. There is an FHWA program—the Innovative Bridge Research and Deployment program, with a funding level of $13.1 million available —that is designed to provide money to states for the use of innovative material or technologies. However, I do not believe the funds are being used by all the states in a manner that would result in proof of new technologies.

Again, until procurement procedures are changed to account for life-cycle costs, innovation, and contractor qualifications, there is little motivation or financial incentive to be innovative.

IV. Addressing the Current Bridge Deficiencies

We need to adopt a risk-management approach to determine our priorities for the maintenance, rehabilitation and replacement of bridges. We must define the greatest risk, looking at the likelihood of bridge failure and the cost in lives and money of such a failure. We must then determine where the funds should go to ensure the greatest return in terms of public safety. This means that the bridges in the worst shape do not necessarily get the money for repairs if they have a low potential loss of life and economic impact. With limited funds, this is the most fiscally most responsible way to go.

The short term consequences are what we have seen occur—periodic bridge failures that result in loss of life and economic loss. The long-term consequences of doing nothing more than we do now will be potentially disastrous. As the classic bridges (unique designs that span major rivers) become older and the Interstate bridges reach the end of their design life, bridge collapses may become more frequent with time, as will the resulting loss of life, and the economic consequences of tying up the country's major shipping lanes.

V. ASCE's Public Policy Statements Regarding Bridges and Transportation Research & Development

In 1988, the National Council on Public Works Improvement estimated that a doubling of the annual expenditure on infrastructure is needed to meet national needs. Doubling of spending, even through the use of innovative financing techniques, is unlikely. To increase productivity and reduce costs through the development of innovative design, materials, construction methodologies, rehabilitation technologies, maintenance procedures, and operation techniques are essential, to reducing the correct investment gap that exists in caring for our surface transportation infrastructure.

Currently, there are a number of obstacles which discourage innovation on a widespread scale. Civil engineers, for example, are under increasing pressure to eschew innovation and to be conservative in their judgment because of lawsuits, rules, regulations, legislation, standards, budget expectations and restrictions, and a desire for financial predictability.

Fragmentation of the design and construction industry limits the support of long-term research efforts that could result in technological gains and innovation. Appropriate technical innovation and support groups can contribute to improved disaster resilience, cost effectiveness and improved productivity and quality throughout the infrastructure industry.

The public demands that the operation, maintenance, expansion, rehabilitation and new construction of the nation's infrastructure be performed to enhance economic vitality, disaster resilience and public safety, but with minimal impact on their lives. The public requirement calls for innovative solutions to minimize costs of delays, environmental costs and project costs. Establishing these innovative solutions requires coordination and sustained research and development.

INFRASTRUCTURE RESEARCH AND INNOVATION

ASCE supports efforts to foster research and development related to infrastructure facilities. The goal is to enhance support of economic vitality while assuring public safety and disaster resilience through increased innovation, productivity and security in design, materials, construction, rehabilitation, maintenance and operations as applied to America's infrastructure facilities.

ASCE believes appropriate methods to implement infrastructure research, innovation and security include:

- Supporting legislation and policies that encourage development of new technology and processes;
- Supporting and encouraging, through appropriate incentives, research to accelerate the development of existing technology and develop new technology in the fields of design, materials, construction, maintenance, rehabilitation, and operation of the infrastructure with understanding of the need for disaster resilience;
- Supporting appropriate funding for infrastructure research at the federal level in conjunction with state/local agencies, universities and private enterprise;
- Supporting efforts to identify and disseminate information on federal, state, and local governments, academia and private sector infrastructure research and development activities;
- Supporting efforts to limit the risk and liability that would discourage innovative infrastructure technology;
- Focusing national attention on infrastructure needs through cooperative efforts;
- Providing opportunities for academia and practicing engineers to conduct research and development activities; and
- Supporting efforts that develop and implement new strategies and technologies to mitigate the impact of disasters on the nation's infrastructure in a consistent manner.

The Role of the Federal Government in Civil Engineering Research and Development

Federal R&D funding currently provides a substantial percent of the total U.S. civilian R&D investment. Federal leadership is essential to civil engineering research. With inadequate federal funding, the ability to maximize the leveraging of R&D funds through government-university-industry partnerships would not be possible.

ASCE supports a focused federal civil engineering research and development (R&D) program consistent with national goals. Programs should promote new U.S. capabilities, improve efficiencies and advance the practice of civil engineering to improve the quality of life.

ASCE encourages coordinated and integrated basic and applied civil engineering research that leverages federal R&D funds through government-university-industry partnerships. Programs fostering basic research should focus on maintaining a steady flow of talent and technology to U.S. industry and agencies. Programs focusing on higher risk research with the potential for high payoff should meet national needs and improve the quality of life by:

- Enhancing public health and safety;
- Enhancing environmental quality;
- Supporting the goals of sustainable development;
- Improving public works infrastructure;
- Improving global competitiveness in U.S. civil engineering products and processes; and
- Enhancing national security.

SURFACE TRANSPORTATION RESEARCH FUNDING

ASCE supports the following general principles in the reauthorization of research and technology programs in the nation's surface transportation legislation:

- Improvements resulting from research and technology (R&T) are critical to achieving national transportation goals in safety, quality of life, economic health, environmental impacts, sustainability, and security.
- Adequate funding should be dedicated to R&T activities.
- Research programs should be conducted according to the highest scientific and engineering standards, from priority-setting to award of contracts and grants to review and evaluation of research results for implementation.
- Research programs should be carried out with appropriate involvement from stakeholders in the public, private, and academic sectors.
- Technology transfer activities are critical to successful implementation of research results and should be supported with R&T funds.
- Public-private partnerships should be fostered by identifying appropriate roles for each partner and providing incentives for private investment.

Within the context of the general principles set out above, ASCE supports the following actions regarding specific surface transportation R&T programs.

- The research and technology portion of the State Planning and Research (SPR) program should be maintained to help support state-specific activities while continuing to encourage the states to pool these resources to address matters of more general concern.
- University research should continue to be supported through the University Transportation Centers (UTC) program using a competitive selection process that guarantees quality participants and fairness in the allocation of funds. The

Federal Highway Administration's (FHWA) program should be strengthened by giving it sufficient funding and flexibility to implement the recommendations of TRB Special Report 261 The Federal Role in Highway Research and Technology: to focus on fundamental, long-term research; to perform research on emerging national issues and on areas not addressed by others; to engage stakeholders more consistently in their program; and to employ open competition, merit review, and systematic evaluation of outcomes.
- A continuation of the Strategic Highway Research Program SHRP II beyond the life of SAFETEA-LU, ensuring that critical research will be continued in key areas of surface transportation.
- The Federal Transit Administration's (FTA) research program should be given sufficient funding and flexibility to work with its stakeholders to develop and pursue national transit research priorities.
- The new Research and Innovative Technology Administration (RITA) should have a well-defined scope and responsibility and appropriate funding, in addition to currently authorized research funding, so that it may supplement and support the R&T programs of the modal administrations.

VI. Conclusion

Successfully and efficiently addressing the nation's infrastructure issues, bridges and highways included, will require a long-term, comprehensive nationwide strategy— one that includes research and identifying potential financing methods and investment requirements. For the safety and security of our families, we, as a nation, can no longer afford to ignore this growing problem. We must demand leadership from our elected officials, because without action, aging infrastructure represents a growing threat to public health, safety, and welfare, as well as to the economic well-being of our nation.

Thank you, Mr. Chairman. That concludes my statement. I would be pleased to answer any questions that you may have.

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