Bridge Industry

One Year After the Minneapolis Bridge Collapse

By Brian J. Leshko, P.E.

Courtesy of FEMA/Todd Swain.

It has been one year since the tragic collapse of the I-35W Bridge in Minneapolis, Minnesota. In the ensuing 12 months, what has transpired that will affect the bridge industry?

1) The collapse of the I-35W Bridge in August 2007 has focused attention on the methods and practices used to ensure the safety of highway bridges across the United States. In response to this national focus, a joint ASCE/SEI – AASHTO ad-hoc group was formed in January 2008 to identify needs and issues associated with ensuring bridge safety, and to examine how current practices and methodologies could be improved in the future. The culmination of the work is a White Paper that discusses the findings of the ad-hoc group on bridge inspection and rating (*see the sidebar to this article containing the Executive Summary of this White Paper*). The White Paper describes gaps, needs and issues associated with the current practices and policies for the condition assessment of bridges, albeit not the cause of the I-35W Bridge collapse.

2) The ASCE/SEI *Enhancing Bridge Performance* Workshop was held February 21-22, 2008 in Reston, VA to bring together invited representatives of the structural engineering community from ASCE, the Federal Highway Administration (FHWA), Departments of Transportation, the design and construction industry, and academia nationwide to establish an agenda of critical needs for enhancing the performance of bridges. The workshop was co-sponsored by the FHWA, and was organized around the six ASCE/SEI Bridge Technical Administrative Committees (TACs): Bridge Management, Inspection and Rehabilitation; Steel Bridges; Timber Bridges; Concrete Bridges; Cable Supported Bridges; and Bridge Security. The focus of the workshop was on bridge deterioration issues and on key data elements that could be included in measuring bridge behavior to ensure safety and long-term survivability, as well as the items needed most for the various bridge types in order to enhance overall bridge performance. The workshop report is being written and should be published in the near term.

3) One year after Minnesota's deadly I-35W bridge collapse, bridges nationwide are receiving more attention and more funding. Gusset plates on steel truss bridges are now inspected by inspectors and evaluated by load rating engineers. Congress is poised to issue new inspection requirements and already has passed $1 billion in additional funding for bridges. States are spending more on bridge inspection and repair, led by Minnesota, Pennsylvania and Maryland.

4) The National Highway Bridge Reconstruction and Inspection Act of 2008 (H.R. 3999) was passed by the House of Representatives in July 2008 by a vote of 367 to 55. The bill was originally introduced by Rep. Oberstar (MN) in the fall of 2007 to address the growing concern over bridge safety after the collapse of the I-35W Bridge in Minneapolis last summer. The bill requires immediate updates of bridge inspection standards; strengthens training, certification, and qualifications standards for bridge inspectors; requires immediate inspection of all structurally deficient bridges; and requires states to calculate the load rating for structurally deficient bridges to ensure that maximum weight limits are properly posted. Additionally, the legislation implements a risk-based prioritization for reconstruction of structurally deficient bridges and asks the National Academy of Sciences to conduct an independent review of the Department of Transportation's method of assigning risk-based priorities. Finally, the bill requires that states implement Bridge Management Systems to improve inspection processes and data collection. The Senate must first act on the bill before the President can either sign or veto the bill.

Highlights from the Oberstar substitute amendment include the following:

- **$1 billion** in FY2009 to replace and rehabilitate structurally deficient bridges. The bill includes the following tasks:
  - inventory of all bridges on Federal-aid highways, on public roads other than Federal-aid highways, of historic significance, on Indian Reservations and Parks;
  - identify those bridges that are structurally deficient or functionally obsolete;
  - assign a risk-based priority for replacement or rehabilitation of these bridges; and
  - determine the cost of replacing these bridges.
- Additional funding totaling **$9 million** is separately appropriated within the document to cover items in subsections to include:
  - National Academy of Science reviewing the process of assigning risk-based priorities for rehabilitation or replacement of structurally deficient bridges (*$2M*);
  - making information contained in the National Bridge Inventory (NBI) more readily available to the public/ easier to understand (*$2M*); and
  - carry out the Bridge Advanced Condition Assessment Pilot Program (*$5M*).
- The remainder of the legislation details requirements of a State, to be imposed by the Secretary of Transportation, in order to participate in the program (to realize the 80% funding provided by the Federal government).
  - approval of a State's 5-year performance plans for the inspection of highway bridges and the rehabilitation or replacement of structurally deficient or functionally obsolete bridges;
  - participation in the Highway Bridge Program (HBP);
  - inspecting and load rating all bridges on a 24-month cycle or less (annual inspections of structurally deficient highway bridges, and annual in-depth inspections of fracture critical members), with the added exception of

White Paper on Bridge Inspection and Rating

Executive Summary

A joint ad-hoc group of American Society of Engineers/Structures Engineering Institute and American Association of State Highway and Transportation Officials (ASCE/SEI-AASHTO) was formed to address issues dealing with methods and practices used to ensure the safety of highway bridges across the United States. The group concluded that, in general, the current National Bridge Inspection Standards (NBIS) and programs developed to address those standards have adequate policies and procedures in place to ensure public safety. The group also concluded that the current system can be improved; and identified gaps and needs to improve bridge safety and ensure uniformity, consistency, and reliability of bridge inspections nationwide. As developed by the ad-hoc group, this white paper describes gaps, needs, and issues associated with the current practices and policies for the condition assessment of bridges. These have been divided into ten general categories from which the following concepts are highlighted:

- A more rational, risk-based approach to determining the appropriate inspection intervals for bridges is needed, as opposed to a set twenty-four month cycle for all bridges. This approach would consider factors such as the design, details, materials, age, and loading of specific bridges to determine the interval between inspections.
- New and more assertive types of Quality Control (QC)/ Quality Assurance (QA), such as performance testing of inspectors, could be used to encourage consistency of inspection practices.
- The consistency and effectiveness of inspections nationally could be improved if inspector qualifications were matched to the bridge type, condition, and complexity in a more uniform manner.
- A bridge inspection manual for nationwide use should be developed with expanded use of photographs, illustrations, and detailed drawings indicating specific deterioration conditions and methods of reporting deterioration.
- There is a need to have close collaboration between those responsible for maintenance and repair of a bridge and those responsible for bridge inspection.
- The load ratings process should be reliable, uniform, and consistent across the states.
- The development and maintenance of a centralized system for documenting critical deterioration in bridges, as experienced by bridge owners, is needed to support the interchange of information and provide a resource for bridge owners.
- There is a need to develop standardized procedures for special inspections involving nondestructive evaluation (NDE), for example pin inspections, to provide more guidance to bridge owners.
- Terms such as structurally deficient, functionally obsolete, and fracture critical require accurate definitions in the public arena such that public perception of bridge safety is consistent with the facts.
- A mechanism should be developed to ensure the critical conditions identified during bridge inspection are addressed in a timely manner.

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Courtesy of FEMA/Todd Swain.

being able to extend the frequency of non-structural deficient bridge inspections up to 48-months;
- requiring a State's bridge inspection project manager and bridge inspection team leaders be licensed professional engineers, in addition to the existing requirements;
- expanding the scope of the bridge inspector training program to ensure consistency in the training and certification of highway bridge inspectors;
- establishing procedures for conducting annual compliance reviews of a State's inspections/QC reviews/load ratings/weight limit postings;
- agreeing on a definition for "critical findings" and establishing procedures for States to report these findings; and
- testing of steel bridges exhibiting fatigue damage with NDT to detect crack growth activity in fatigue cracks as small as 0.01 inch.

5) At the 2008 IABSE Congress in Chicago, the ASCE/SEI Session *Bridge Inspection: Response to I-35W Bridge Collapse* in September included the following presentations:

- "I-35W Bridge: the Undersized Gusset Plates, the Overload During Construction, and the Resulting FHWA Technical Advisories";
- "The Minnesota Governor's Directive Bridge Inspections: Response to the I-35W Bridge Collapse";
- "Current Research Project Underway to Develop Improved Guidance for Design and Rating of Gusset Plates"; and
- "Specialized Rope Access Inspections of Steel Truss Bridges following the I-35W Bridge Collapse"▪

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The entire ASCE/SEI – AASHTO Ad-hoc group White Paper on Bridge Inspection and Rating is scheduled to be published in the January 2009 issue of the ASCE *Journal of Bridge Engineering*.

White Paper on Bridge Inspection and Rating

ASCE/SEI-AASHTO Ad-hoc Group

On

Bridge Inspection, Rating, Rehabilitation, and Replacement

EXECUTIVE SUMMARY

A joint ad-hoc group of American Society of Engineers/Structures Engineering Institute and American Association of State Highway and Transportation Officials (ASCE/SEI-AASHTO) was formed to address issues dealing with methods and practices used to ensure the safety of highway bridges across the United States. The group concluded that, in general, the current National Bridge Inspection Standards (NBIS) and programs developed to address those standards have adequate policies and procedures in place to ensure public safety. The group also concluded that the current system can be improved; and identified gaps and needs to improve bridge safety and ensure uniformity, consistency, and reliability of bridge inspections nationwide. As developed by the ad-hoc group, this white paper describes gaps, needs, and issues associated with the current practices and policies for the condition assessment of bridges. These have been divided into ten general categories from which the following concepts are highlighted:

- A more rational, risk-based approach to determining the appropriate inspection intervals for bridges is needed, as opposed to a set twenty-four month cycle for all bridges. This approach would consider factors such as the design, details, materials, age, and loading of specific bridges to determine the interval between inspections.
- New and more assertive types of Quality Control (QC)/Quality Assurance (QA), such as performance testing of inspectors, could be used to encourage consistency of inspection practices.
- The consistency and effectiveness of inspections nationally could be improved if inspector qualifications were matched to the bridge type, condition, and complexity in a more uniform manner.
- A bridge inspection manual for nationwide use should be developed with expanded use of photographs, illustrations, and detailed drawings indicating specific deterioration conditions and methods of reporting deterioration.
- There is a need to have close collaboration between those responsible for maintenance and repair of a bridge and those responsible for bridge inspection.
- The load ratings process should be reliable, uniform, and consistent across the states.
- The development and maintenance of a centralized system for documenting critical deterioration in bridges, as experienced by bridge owners, is needed to support the interchange of information and provide a resource for bridge owners.
- There is a need to develop standardized procedures for special inspections involving nondestructive evaluation (NDE), for example pin inspections, to provide more guidance to bridge owners.
- Terms such as structurally deficient, functionally obsolete, and fracture critical require accurate definitions in the public arena such that public perception of bridge safety is consistent with the facts.
- A mechanism should be developed to ensure the critical conditions identified during bridge inspection are addressed in a timely manner.

INTRODUCTION

The recent collapse of the I-35W Bridge in Minneapolis, MN has focused attention on the methods and practices used to ensure the safety of highway bridges across the United States. In response to this national focus, a joint ASCE/SEI – AASHTO ad-hoc group was formed to identify needs and issues associated with ensuring bridge safety and to examine how current practices and methodologies could be improved in the future. This paper discusses the findings of the ad-hoc group on bridge inspection and rating.

The impetus for establishing a comprehensive national bridge safety inspection program was the catastrophic collapse of the Silver Bridge over the Ohio River at Point Pleasant, WV on December 15, 1967. The fracture of an eye bar at a pin connection during rush hour traffic caused 31 of 37 cars on the bridge at the time to plunge into the frigid river resulting in 46 fatalities. This tragic event set into motion federal legislation to establish safety inspection and maintenance of bridges nationwide. The U.S. Congress added a section to the "Federal Aid Highway Act of 1968," that required the establishment of National Bridge Inspection Standards (NBIS) to ensure the safety of the traveling public. In 1971, the National Bridge Inspection Standards were implemented as a Federal regulation establishing requirements for 1) inspection procedures, 2) frequency of inspections, 3) qualifications of personnel, 4) inspection reports, and 5) inventories. As summarized in the latest revision to the National Bridge Inspection Standards (NBIS), 23 CFR Part 650, published in the *Federal Register*, Vol. 69, No. 239, on December 14, 2004, the FHWA revised its NBIS regulation to clarify language that was vague or ambiguous, reorganize the standards into a more logical sequence, and make it easier for persons administering the highway bridge inspection programs at the state and federal level to read and understand the regulation.

The NBIS mandates minimum standards for the inspection of highway bridges in the United States located on all public roads. The NBIS regulation addresses such issues as the qualifications of inspection program personnel, frequency of inspections, and required documentation. The primary emphasis of the NBIS is safety, and additional data and procedures beyond the requirements of the NBIS are typically employed at the State level. The NBIS and the programs that stem from the standards help bridge owners detect deterioration in bridges, identify critical findings from inspections, and take appropriate corrective actions. Additional data and documentation on bridge conditions that supports bridge management, maintenance, and repair activities are typically collected according to policies and practices within a particular State, and there is some variation in these practices nationally. In general, the current NBIS and programs developed to address those standards have adequate policies and procedures in place to ensure safety. However, there are areas where improvements could be made toward the goals of improving reliability and effectiveness of inspections, as well as the integration of inspection, maintenance and repair activities, focusing resources where they are most needed, and ensuring bridge safety into the future. As developed by the ad-hoc group, the following sections describe needs and issues associated with the current practices and policies for the condition assessment of bridges. These needs have been divided into ten general categories: 1. Bridge Inspection Policy, 2. Quality Control/Quality Assurance, 3. Personnel/Inspector Qualifications and Training, 4. Programmatic Considerations, 5. Bridge Load Rating, 6. Documentation, 7. New Technologies, 8. Bridge Deterioration Database, 9. Communications, and 10. Research Needs. This document can be used by bridge engineering communities to improve the current

state-of-the-art and state-of-the–practice inspection and evaluation methods and new technologies nationwide.

1. BRIDGE INSPECTION POLICY

In the United States (U.S.) today, with some exceptions, biennial inspection intervals are equally applied to the entire bridge inventory, but may not be appropriate for specific bridges. For example, recently constructed bridges typically experience fewer problems during their first decade of service. Under the present requirements, these bridges have the same inspection frequency as a 50-year old bridge that may face severe and rapid modes of deterioration. Most new bridges take advantage of improved fabrication processes, materials, and designs intended to mitigate the effects of fatigue and corrosion. However, older bridges with fracture-critical elements are inspected on the same interval as newer bridges, irrespective of better characteristics of new bridges that reduce the risk of failure.

A more rational approach to determine the appropriate inspection intervals for bridges would consider such factors as the design, details, materials, age, and loading of specific bridges. There is a growing consensus that inspection intervals could be optimized toward meeting the goal of improving the safety and maintenance of highway bridges. A recent scanning tour of bridge evaluation quality assurance practices in Europe found that longer inspection intervals were normal, extending the inspection intervals to 6 years in some cases. In general, these inspections were analogous to in-depth inspections in the U.S. system, in which there is a "within arm's reach" inspection of the bridge that may include materials sampling and the application of NDE. A more detailed inspection conducted less frequently may have a positive impact on the overall safety and maintenance of bridges in the U.S., allowing for broader application of NDE technologies and a better understanding of the condition of individual bridges. A tiered approach that includes interim, less comprehensive inspections in the time interval between more in-depth inspections should be considered. A National Cooperative Highway Research Program (NCHRP) study of this topic is planned in FY09, and the ad-hoc group supports the exploration of such innovative inspection policies. At the same time, the currently required biennial interval is easily understood by a non-technical audience, whereas variable intervals, while rational to the bridge industry, may be viewed as complicated by the public.

2. QUALITY CONTROL/QUALITY ASSURANCE

The implementation of formal quality control and quality assurance procedures (QC/QA) is an important element for ensuring consistency in inspection results, making sure NBIS requirements are met and maintaining a program that is capable of effectively indentifying critical bridge needs. But the procedures are not defined and, at present, are left to interpretation by various agencies working with their FHWA counterparts. Thus, to obtain the consistent data to ensure safety, the establishment of minimum guidelines for QC/QA procedures for nationwide use is needed. Similarly, identifying critical findings and addressing them in a timely fashion is also left to various bridge owners, thus, more guidelines are needed. AASHTO in conjunction with NCHRP has initiated a study to review current QC/QA procedures followed in this country by various states and to provide some recommendations to highway agencies.

Even though the primary reason for bridge inspections is safety, over-conservativeness is not helpful in the effective utilization of resources and planning. Thus, obtaining uniformity and consistency of ratings done by various inspectors throughout the country is very important. Utilization of inspection data to ensure safety by identifying critical findings, reevaluating bridge capacities, and taking appropriate corrective actions is very important. Thus, there is a need to review National Bridge Inventory (NBI) data and bridge files to ensure the accuracy of condition ratings and bridge postings and to take corrective actions as necessary. New and more assertive types of QC/QA to improve reliability and consistency of inspection data have been identified in recent years. These include performance testing of inspectors, use of control/reference bridges, and inspector certification. These new practices should be encouraged and further developed to ensure that inspection results are as consistent and uniform as possible. These should be evaluated carefully in well-designed tests on a smaller scale (probably at the state level) before adopting them nationwide. Several states, such as New York, already have projects in progress to evaluate some of these methods.

3. PERSONNEL/ INSPECTOR QUALIFICATIONS AND TRAINING

It is imperative that the bridge inspection process be able to recognize, document, and alert bridge owners of critical deficiencies. Inspectors must be well-versed in structural behavior and be provided with an array of assessment techniques to accurately evaluate the structure. An accurate description of the critical deficiency is paramount to determining appropriate response actions, designing repair procedures that eliminate the cause of the deficiency, developing an accurate assessment of risk, and using as a baseline for suitable monitoring programs. Inspectors should be able to identify the damage and understand the reasons leading to that damage. Accurate diagnosis of the cause of the damage is imperative not only for determining appropriate response actions, but also for the safety of the traveling public.

Hence, the requirements by which inspectors are qualified are an important element for effective inspections. The NBIS provides minimum requirements for various inspection personnel, including team leaders and program managers. In general, these requirements address the routine inspection of highway bridges, without consideration of the complexity of the bridge to be inspected or special inspection situations; for example, fracture critical inspections. Requirements for these types of inspections are typically developed within a particular State. The consistency and effectiveness of inspections nationally could be improved if inspector qualifications were matched to the bridge type, condition, and complexity in a more uniform manner. Matching qualifications and training to the complexity of the inspection tasks could have positive effects both on the efficiency of bridge inspection and improving bridge safety. Additionally, there is a need to improve the effectiveness of inspector training to provide consistency in the appraisal and coding of bridge conditions. Periodic retraining of inspectors should be considered as a means of ensuring and promoting uniform inspection practices and consistency in condition ratings. These requirements should be considered to improve future bridge inspection practices.

4. PROGRAMMATIC CONSIDERATIONS

Ensuring the safety and efficiency of the nation's bridges extends beyond the inspection and condition assessment of the existing infrastructure. The long-term performance and safety of bridges is affected by

all stages of design, construction, maintenance, and rehabilitation that occur during the life of the bridge. There is a need to refocus on the interrelations between initial design decisions, life-cycle costs, construction, inspectability, evaluation, and maintainability of bridges. Although designing bridges for inspectability has been a long-stated goal, resources and focus on this aspect of the design process continues to have limited priority. The priority of this aspect of the design process should be elevated to improve the inspection and maintenance of bridges. Design details that facilitate maintenance and inspection of bridges should be provided to designers to address this need. The involvement of the inspection and maintenance community early in the design process to provide expertise and participate in the design process should be encouraged. The involvement of this community will help ensure that new designs provide necessary details to allow for adequate inspection and maintenance. Additionally, data on the field performance of specific design details should be highlighted to help ensure the durability of designs.

There is also a need to have close collaboration between those responsible for maintenance and repair and those responsible for bridge inspection and condition assessment. Bridge deterioration that affects the durability of the bridge should be identified in its early stages and repaired before progressing to a critical condition. Use of inspection results for determining load rating cycles based on deterioration of the bridge between subsequent inspections would also be beneficial. Capacity and stability evaluations for bridges under construction should be included. Overall, more holistic practices for the design and management of bridges are needed to promote long-term durability and safety.

5. BRIDGE LOAD RATING

The importance of load ratings cannot be overstated. They must be performed to a level of accuracy required for the intended purposes (e.g., load posting, repairs, etc.), and load ratings should be reliable, uniform, and consistent nationwide. If nondestructive evaluation (NDE) results, other inspection results, or the results of structural monitoring are available, these findings should be incorporated into the rating process. Development of structural models at the design stage, in such a way that they can be used during the evaluation phase by incorporating issues found during the bridge inspection, will be very valuable. Additionally, documenting load ratings both for the bridge and critical elements will provide more value for effective bridge management.

6. DOCUMENTATION

Individual states develop their own inspection programs, policies, and supporting documentation to meet the requirements of the NBIS and State-specific laws and regulations. The documentation used by inspectors in the field, or inspection manuals, can be improved with the expanded use of photographs, illustrations, and detailed drawings indicating specific deterioration conditions and methods of reporting that deterioration. Descriptions of the cause of specific deterioration modes and effects of that deterioration on the structural behavior and durability of the bridge, as well as rehabilitation strategies, could improve the efficiency of the inspection and repair process, and lead to more consistent and accurate results. Also needed are inspection forms for documenting and rating bridge conditions that are tailored to specific bridge designs and emphasize critical deterioration modes or areas of concern. These forms should allow for the inclusion of key photographs, illustrations, and notes in a format suitable for

analysis. In the longer term, the development of such detailed and illustrated manuals for bridge inspection on a national level would be beneficial, encouraging more uniform protocols for bridge inspection.

7. NEW TECHNOLOGIES

Visual inspection by experienced professionals has been effective in identifying critical conditions affecting bridge safety. But, in some cases, material defects and concealed elements do not lend themselves well for visual inspection and may need supplemental methods. Nondestructive evaluation and condition monitoring technologies have been developed in recent years that can, in some cases, assist in the effective condition assessment and monitoring of bridges. However, the application of these technologies within the context of routine NBIS inspections continues to be a challenge due to the complexity and accessibility of these technologies and a lack of effective guidance on the appropriate application of the technologies.

The use of the most effective technologies and techniques for bridge condition assessment is an important element in preserving the continued safety of highway bridges, and several needs in this arena have been identified. First, there is a need to develop standardized procedures for special inspections (e.g., pin inspections), such that the use of NDE technologies can be more widespread, uniform, and accessible to bridge owners. Specific technologies and methods of applying those technologies for situations where visual inspection may be inadequate need to be developed. This may include specific guidelines on the application of new technologies that consider cost, difficulty, field use, and effectiveness of these technologies. Reliability and cost effectiveness, when compared to benefits and ease of use of these methods, should be thoroughly investigated before adopting them nationwide.

8. BRIDGE DETERIORATION DATABASE

There is a lack of nationwide data on the deterioration rates for bridges and for specific bridge components or elements, and there is no centralized reporting system for documenting bridge or bridge component failures and other bridge problems. The effect of maintenance procedures, innovative materials, environmental parameters, loading, permit operations, and construction and fabrication procedures are not yet readily available. Availability of such centralized information on bridge performance could increase the effectiveness of the bridge management systems used at both the national and state levels. The FHWA's Long-Term Bridge Performance Program, though in its initial stages, is intended to address some of the needs in this arena. The development and maintenance of a centralized system for documenting critical deterioration in bridges experienced by bridge owners is needed to support the exchange of information and provide a resource for bridge owners. This is particularly important for off-system bridge owners whose experience with bridge problems and issues may be localized in nature.

9. COMMUNICATIONS

The safety of the traveling public is of paramount concern to transportation officials nationwide. Recent events have brought increased public awareness and focus on the issue of bridge safety. In many cases,

information communicated regarding the status of the nation's bridges has not been clearly understood by the public. There is a need for the bridge community to communicate a better understanding of key terminology used in conjunction with the implementation of the NBIS. Specifically, terms such as structurally deficient, functionally obsolete, and fracture critical require accurate definitions in the public arena such that public perception of bridge safety is consistent with the facts. Bridge condition assessment activities, such as routine and in-depth inspections, continuous monitoring strategies, and detailed evaluations, need to be more clearly defined in the public arena such that the expectations from these activities can be more clearly understood by those outside the bridge industry. A summary document and public information videos could be developed that outline the bridge inspection process and procedures, describing how it is done, and highlighting the program value and successes. Additionally, more effective means of communicating and differentiating between information related to bridge conditions, information related to bridge safety, and information related to bridge funding eligibility need to be developed to support a fuller understanding by the public. A searchable, easy-to-access version of the NBI available to the public, in conjunction with improved communication, could support a broader understanding by the public and the media. At the same time, better mechanisms should be investigated/developed to share best practices and technical advisories, which are developed by bridge owners when issues or concerns are uncovered, with the rest of the bridge community.

10. RESEARCH NEEDS

Looking forward, there are a number of research and development needs that could improve the tools and methodologies available to help ensure the long-term health and safety of bridges. A study of the consistency and reliability of condition ratings obtained from various states could help improve data quality. Developing procedures or databases to take inspection information and prepare appropriate corrective actions and making sure these actions are addressed is very important. Research needs associated with some of the items in this white paper have been developed into initial problem statements with the potential to be developed into future funded research activities. These include the following:

- Develop criteria that better describes the overall condition of a bridge (health index)
- More investigation into overload, blanket permits, and the long-term effects of overloads
- Illustrated bridge inspection and component behavior manuals
- NDE tools and procedures for special inspections
- Converting inspection information into bridge agency actions: Best Practices

The items in the bulleted list above have already been submitted to the appropriate AASHTO technical committee for possible consideration.

ACTION ITEMS

Short Term

These items include actions that are now beginning to be developed /researched, as a result of domestic and international technology scans or other existing programs, and can be performed within a fairly short period of time without extensive funding.

- Educate bridge owners and inspectors on readily available nondestructive evaluation technologies and their applications.
- Review bridge files for structurally deficient bridges and ensure the accuracy of the condition ratings and bridge postings.
- Review the qualification and training requirements listed in the NBIS and determine if the current requirements are sufficient.
- Develop a public relations guideline for bridges that clearly defines bridge condition, inspection, rating, and funding terms in a way that is understandable to the public.
- Investigate how each state communicates needs between those responsible for maintenance and repair and those responsible for bridge inspection and identify best practices.
- Develop research proposals for needed research as listed in this paper and investigate possible funding sources.

Long Term

- Develop a national model inspection manual with expanded use of photographs, illustrations, and detailed drawings indicating specific deterioration conditions. This model manual could be incorporated into existing state and local inspection manuals.
- Develop guidelines on the use of new inspection technologies and incorporate information on cost, ease of use, and effectiveness/reliability.
- Incorporate more quality control/quality assurance checks and balances within bridge inspection programs, such as performance testing of inspectors and the use of control bridges.
- Work with FHWA's Long-Term Bridge Performance Program to develop and maintain a centralized database of bridge deterioration data.
- Develop a more rational, risk-based approach to determining appropriate inspection intervals for bridges through research, and consider incorporating these methods into future bridge inspection programs.
- Develop training and refresher courses that promote more uniform inspection practices and consistency in condition ratings.
- Incorporate inspectability guidelines into design specifications for new bridges to ensure the ease of inspecting details.

NOTE: All the views represented in this white paper are those of the ad-hoc group and may not necessarily represent the organizations they are employed for or associated with.

APPENDIX: MEMBERS OF THE ASCE/SEI-AASHTO AD-HOC GROUP

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