MANAGEMENT STRATEGIES FOR THE US HIGHWAY BRIDGE NETWORK; PERSPECTIVES FROM BOTH THE STATES AND THE FEDERAL GOVERNMENT

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Abstract

The paper breaks down the processes within the National Bridge Inspection Standards that affect bridge management. The author highlights the latest developments within the USA intended to better risk manage these critical assets.

The Bridge Network, defined

The US Highway Bridge Network contains over 600,000 structures. The management of these assets is becoming more challenging for the public and for public-private owners as well. This paper focuses on the public owned bridges which constitute the vast majority of the bridges in the highway network. Bridges is a convenient term for the owners to use for all structures but it masks the immense variability of the bridge structures. The variables include bridge types, sizes, age, usage regime, environmental exposure and location constraints. The variability makes it difficult to estimate the effort, expertise and cost per square meter to inspect, conditionally rate and maintain them. The bridge network is also always changing. New structures are added, old structures are retrofitted. Sometimes the existing bridges are widened or replaced. The old structures in the network were simpler. The same detail was used repeatedly. Today's traffic challenges, public demands and public involvement add complexity to siting a new bridge project. The new bridges often have to fit in between the existing development and must be sited as to cause the least environmental impact. Computer power, new materials and construction techniques have made it practical to design and construct unique solutions for each setting. Therefore, this new generation of highway bridges is more unique and complicated. They require new tools and techniques for inspection, rating and repair.

The Owners

Who owns these structures? Who is responsible for them? With federal oversight, this responsibility is the purview of the state departments of transportation working with counties and municipal public works departments. However, these owners have many other responsibilities assigned to them by the public. In addition, these public organizations have been re-engineered and downsized several times. Organizational modifications often dilute the experience level and knowledge of the staff tasked with the bridge management duties. At the

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same time the scope of highway departments' activities have been broadened significantly. This phenomenon has the effect of also diminishing the engineering emphasis of the organization. Are these organizations strategically poised to own and maintain these bridges? One would hope so. Regardless of how many players are involved, the responsibility will always rest with the owner. The most recent example is the B's oil rig accident in the Gulf of Mexico. Irrespective of how many contractors were involved, the failures and success rested on the good intentions and technical competence of the owner. During emergencies, the owner's knowledge of the bridges in question and owner ability to mobilize and manage resources is the key to restoring services and minimizing damage. During the hurricane Katrina recovery organizations' know-how and resources management were critical for executing the recovery plan. In April 2007, CALTRANS' bridge team showed the country how their technical expertise can be brought to bear and quickly restored traffic to the heavily traveled Oakland Freeway after a tanker truck fire collapsed two bridges.

The Highway Bridge Program, (HBP) and The National Bridge Inspection Program, (NBIS)

In 1967 stress corrosion caused the Silver Bridge on the Ohio River between Ohio and West Virginia to collapse, killing 46 people. Congress held hearings on bridge design, inspection, and maintenance, and declared that serious safety concerns and problems of lost investment and replacement costs, "Elevate bridge inspection and maintenance problems to national priority." Consequently, in 1971 national inspection standards were issued by the Federal Highway Administration for locating, inspecting, evaluating, and acting upon bridge deficiencies. When deficiencies pose major safety problems, the owner is responsible for either 1) making repairs to correct the deficiencies; 2)posting restriction signs as to the bridge's load-carrying capacity with respect to size and weight of vehicles allowed to cross the bridge, or 3) closing the bridge to vehicular traffic.

The Highway Bridge Replacement and Rehabilitation Program created by Congress in 1978 provided the funding for structural deficient bridges on the Bridge Inventory. With the inspection standards and the bridge program in place the stage was set to assist the owners with the management of the bridge network. The program worked well as many eligible bridges were easily identified, rehabilitated or replaced. However, the consensus among the bridge community was that the program did not provide an incentive for the owners to establish a preventive maintenance program.

The Preventive Maintenance Program critical to Bridge Management

The bridge replacement process became more complicated. The bridge operations staff became frustrated with the delays and slowly the states recognized this fact.

They increased their investment in the preventive maintenance area instead of solely relying on the bridge replacement program to solve their deficient bridges problem. The HBP also came to the same conclusion and began funding the Preventive Maintenance Program as long as the owner demonstrated that it had a data driven plan that established the work orders and associated priorities. The idea of preventive maintenance has the added benefit of maintaining the best condition of the bridges in service in lieu of doing nothing. Let the bridges in service fall apart and then apply for bridge replacement funds. In November 2009, after evaluating best bridge management practices of selected owners nationwide the NCHRP 20-68A scan team's key recommendations for bridge management decision-making were as follows: 1) Adopt element-level bridge inspection programs and establish standard condition states, quantities, and recommended actions (i.e., maintenance, preservation, rehabilitation, and replacement) to match the operational characteristics of the agency maintenance and or preservation program; 2) Establish national performance measures for all highway bridges for comparisons among bridge owners; 3) Use owner-specific performance measures to allocate funding levels for the full range of actions (i.e., maintenance, preservation, rehabilitation, and replacement) to optimize highway bridge conditions. Determine bridge needs and a proposed multiyear treatment program based on owner-specific objectives; 4) Use the proposed program to develop a needs based funding allocation, using all types of funding within the state's prerogative for each of the recommended action types (maintenance, preservation, rehabilitation, and replacement); 5) Establish standards for preventive maintenance programs that are funded at levels set by analysis of performance measures. Programs must include the preservation needs of "cusp" bridges to keep them from becoming deficient bridges. In other words, do the right activity at the right time, keeping good bridges in good condition and moving away from the "worst first" approach. Experience in scan states has shown that preventive and minor maintenance must be a significant portion of bridge programs that optimize bridge conditions within limited budgets; 6) Develop work programs for maintenance and preservation at the lowest level of management or supervision where supervisors with extensive field maintenance knowledge and experience staff those positions. Avoid blind use of work programs from bridge management systems (BMSs), and work programs dictated by goals to maximize performance measures, (although both BMSs and performance measures do provide useful information to maintenance crews).

Bridge Inspection Process (NBIS)

After the 2007 Minnesota bridge collapse, the bridge inspection process and the federal enforcement of the current NBIS was discussed at various hearings at both the US House and US Senate. The proposed bill was to tighten the oversight, increase the qualification requirements for bridge inspectors, inspection frequency and the associated bridge load ratings.

The Bill also demanded a data based risk management plan that maximizes the benefit of the Highway Bridge Program. The states felt the proposed plan was too restrictive and that the NBIS process in place was not flawed. The states blamed the inadequate federal funding for the bridge program and a lack of flexibility in utilizing the federal bridge funds.
Currently, most bridges are inspected at 2-year intervals, but more frequent inspections are required on certain structurally deficient bridges that pose a higher than normal potential for collapse. Each state is required to have a bridge inspection organization capable of performing inspections, preparing reports, and determining bridge ratings in accordance with AASHTO and provisions in the Code of Federal Regulations. With the assistance of the Transportation Research Board and AASHTO a comprehensive study is underway to better define and rationalize inspection types and frequencies. Aside from the bridge inspection frequency, the trend has been to migrate from a general inspection to a more detailed element data based inspection. These inspections and inspector teams are generating very critical core element data. The bridge inspectors have detailed know-how of the bridges they are assigned to review. This knowledge provides the owner the best information for any action whether preventive or emergency in nature. The data collected will assist in making both bridge network decisions as well as individual issuing work orders for repairs and structural ratings.

Bridge Load Ratings and Load Posting Process

The bridge load ratings are a companion process to bridge inspections. The initial, as-built, ratings are revised as the bridge deteriorates, is modified or rehabilitated. The load rating process requires accurate drawings and inspection data, a multitude of structural analysis tools, access to non-destructive testing tools as well a family of rating vehicles that represents trucks allowed passage in a given state. The 2006 Office of Inspector General audit identified deficiencies with the load rating and posting data generated by the owner and the federal enforcement of the process. After the bridge collapse of 2007 the load rating and load posting process underwent further scrutiny. The Federal Highway Administration has worked with AASHTO and OIG to correct the perceived deficiencies. The owner's load rating and load posting activity implies that the bridge is safe as posted. Temporary and other unique situations pose difficult questions. Does the owner guarantee the load ratings during bridge rehabilitation activities or guarantee other construction affecting the bridge? Does the owner have a complete knowledge of all truck types allowed on its bridges? Are the bridge rating tools provided by AASHTO adequate to rate all bridges in the US Highway Bridge Network? In addition, one of the biggest challenges to the owner is that

the truck loads have increased and evolved while the majority of the bridges in the inventory were designed using a live load from 1944 or earlier.

Conclusion

This paper covered key aspects of bridge management process. In response to the recent major accidents, hearings and audits were numerous. The subsequent proposed changes to the Federal HBP have at times strained relationships between the owners and the federal government. But behind all the fussing, AASHTO recognized the present systems' shortfalls. The states with the cooperation of the federal agencies have been working diligently in the area of bridge safety. The 550 page *Manual for Bridge Evaluation* issued by AASHTO in 2008 as well as the recently approved 175 page *AASHTO Bridge Element Inspection Manual* lays the proper foundation for ensuring bridge safety and aligns the owners' processes with the transition to a performance-based federal surface transportation policy

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Bibliography

AASHTO (2008). "Bridge Element Inspection Manual 1st Edition." American Association of State and Highway Transportation Officials, Washington, D.C.

American Association of State and Highway Transportation Officials. Letter to: Representative James L. Oberstar, Chairman, House of Representatives Transportation and Infrastructure Committee, 22 July 2008.

Baker, Michael, Jr. (In Progress). "Evaluation of Load Rating by Load and Resistance Factor Rating." NCHRP 12-78. National Transportation Research Board, Washington, D.C.

Biehler, Al. Pennsylvania Secretary of Transportation (2008). Letter to: U.S. Congress Representative James L. Oberstar, Chairman, House of Representatives Transportation and Infrastructure Committee, 7 August 2008.

Kerley, Malcolm and U.S. Congress (September 5, 2007). Oral Testimony before the, House of Representatives Transportation and Infrastructure Committee. "Structurally Deficient Bridges in the United States." Hrg. No. 110-67. 110th Congress, Washington, D.C.

National Highway Bridge Reconstruction and Inspection Act of 2008. US Senate Bill S. 3338. 110th CONGRESS 2nd Session, Washington, D.C.

Office of the Inspector General (2006). "Assessment of FHWA Oversight of the Highway Bridge Program and the National Bridge Inspection Program." OIG Report Number MH-2010-039. United States Department of Transportation, Washington D.C.

Office of the Inspector General (2010). "Audit of Oversight of Load Ratings and Postings on Structurally Deficient Bridges on the National Highway System." United States Department of Transportation, Washington, D.C.

Office of the Inspector General (2009). "National Bridge Inspection Program: Assessment of FHWA's Implementation of Data-Driven, Risk-Based Oversight." OIG Report Number MH-2009-013. United States Department of Transportation, Washington, D.C.

Oklahoma Department of Transportation, Director Gary Ridley and United States Congress (2008). Oral Testimony, Senate Environment and Public Works Committee, "Improving the Federal Bridge Program: Including an Assessment of S. 3338 and H.R. 3999." Wednesday, 10 September 2008.

Siggerud, Katherine (2008). Quoted in: "Highway Bridge Program, Clearer Goals and Performance Measures Needed for a More Focused and Sustainable Program." GAO-08-1127T. U.S Government Accountability Office, Washington, D.C.

Sivakumar, Bala, Fred Moses, Gongkang Fu and Michael Ghosn (2007). "Legal Truck Loads and AASHTO Legal Loads for Posting National Cooperative Highway Research Program." NCHRP Report 575. National Transportation Research Board, Washington, D.C.

T18 Bridge Management, Evaluation and Rehabilitation Committee (2008). "Manual for Bridge Evaluation, First Edition." American Association of State Highway and Transportation Officials, Washington, D.C.

U.S. House of Representatives Transportation and Infrastructure Committee (2010). "Surface Transportation Authorization Act (STAA) Summary Update." 111th Congress, Washington, D.C.

U.S. Government Accountability Office (2008). "Highway Bridge Program, Clearer Goals and Performance Measures Needed for a More Focused and Sustainable Program." GAO-08-1043. Report to Congressional Committees. US Senate Committee on Environmental and Public Works. U.S. Department of Transportation, Washington, D.C.

University of Missouri (In Progress). "Developing Reliability-Based Bridge Inspection Practices." NCHRP 12-82. Transportation Research Board, Washington, D.C.

Weykamp, Pete, Tod Kimball, Bruce Johnson, Scot Becker, Keith Ramsey, Artur D'Andrea, George Hearn and Harry Capers (2009). "Best Practices in Bridge Management Decision-Making." NCHRP Domestic Scan 07-05, Part of NCHRP Project 20-68A, U.S. Domestic Scan, National Cooperative Highway Research Program. Transportation Research Board, Washington, D.C.