Whatever Happened to Long-Term Bridge Design?

Why now?

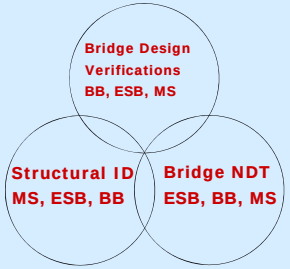
The 1956 Interstate Highway Program expanded the U.S. highway system to include over 500,000 bridges. At the time many of these bridges were designed based on a design life of fifty years. There was no comprehensive structural health monitoring system included in the original design. Currently many of these bridges have exceeded or are rapidly approaching the end of their useful life. Because of this, many bridges are now in need of major structural repairs and rehabilitations, or complete replacement. Just as in the 1950's and 1960's, a major re-construction effort is critical to the continued performance and safety of our infrastructure.

Research into structural health monitoring and the post-processing of collected field measurements for transportation system management has significantly increased in response to the growing demand to evaluate the structural integrity of United States Highway Bridge.

I35W Mississippi River Bridge Collapse
Minneapolis, Minnesota

Recent structural failures of transportation components have focused the public interest on our infrastructure and its structural health. These failures have spotlighted our bridge reliability and structural integrity assessment protocols. The Mississippi River Bridge not only highlighted the need for consistent bridge inspection, it also illustrated a situation where an in place structural health monitoring system could have for-warned of impending failure.

Sustainable Bridge Design & Health Monitoring



The research partnership assembled for this project includes experts in the area of bridge design and modeling (Professor Brian Brenner of Fay, Spofford and Thorndike, Inc.), bridge nondestructive testing, inspection and condition assessment (Professor Erin Santini Bell of the University of New Hampshire and Jeffrey Schultz of Bridge Diagnostics and W. Allen Marr of Geocomp), bridge modeling, design of the experiment, and model updating using NDT data (Professor Masoud Sanayei of Tufts University), and bridge management (Mark Richardson of the New Hampshire Department of Transportation).

The proposed research project involves the development of a baseline model for, instrumentation and monitoring of a highway bridge in New Hampshire. As part of the project, we will work as a cooperative partnership of researchers, designers, inspectors and owners to document the design process, develop an instrumentation program and non-destructive test program to evaluate long-term performance of the bridge and use the results to verify the design and develop a structural health monitoring program. The results of this work will lead to improved bridge design and maintenance, and ultimately improved safety, cost effectiveness and use of resources in the critical task of maintaining and improving the nation's bridges.

Goals and Methodology

This project will correlate to the goals of the Partnership for Innovation program. Scope of Work: The specific goals of the research include:

Goal 1: Design of instrumentation for a long-term structural health monitoring system working with the highway bridge design team.

Goal 2: Design verification of a highway bridge during construction to improve design techniques for future projects.

Goal 3: Development of a new model for bridge construction, structural health monitoring, and load ratings to be implemented in future AASHTO specifications for highway bridges.

Goal 4: Dissemination of benchmark non-destructive test data from an in-situ structure that may be used for parameter estimation and model updating research.

Goal 5: Development of standards for a "baseline" model for bridge design which can be used and updated during the structure's design life.

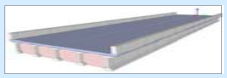
Goal 6: Evaluation and recommendations for approaches to explicitly evaluate long term bridge design issues.

Target Bridges

Black Brook Bridge

The NHDOT has recently awarded the design of the Black Brook Bridge in Manchester, NH to FST. The research partnership will work with the bridge designers at FST and the bridge management team at NHDOT to develop a modeling protocol to close the design loop and be updated through out the life of the bridge with both visual inspection and structural health monitoring data.

In April 2008, UNH researchers will perform a field test on the Rollins Road Bridge. This research partnership will also use this data to refine the modeling and updating protocol.



Rollins Road Bridge

Tasks and Implementation

The ten tasks of this research effort are focused on developing updates for the bridge design guidelines that are currently used in AASHTO bridge design. The changes to the design protocol could result in significant economic savings during bridge design, construction and life-span.

Task 1: Develop Initial Baseline Model Development of a detailed "baseline" model for the target bridge in cooperation with the design team and the bridge owner. The target bridge at this time is the reconstruction of I-293 over Black Brook in Manchester, New Hampshire.
Task 2: Comparison between the cost-to-benefit ratio for element-based and model-based long-term bridge design.
Task 3: Enhancing existing parameter estimation software to use NDT data from Task 5 using the model from Task 1.
Task 4: Design of the NDTs for the target bridge based on feasibility studies using the bridge simulated data from Task 1 and the parameter estimation software developed in Task 3.
Task 5: Instrumentation and a NDT of the target bridge during construction, data acquisition, and data quality analysis.
Task 6: Design verification of the target highway bridge using NDT data using parameter estimation results to improve design techniques for future projects.
Task 7: A NDT of the target bridge after construction, data acquisition, and data quality analysis.
Task 8: Updating the "baseline" model to account for as-built conditions using structural parameter estimation. Classifying major changes in the bridge behavior due to construction.
Task 9: Development of a protocol for the use of updated bridge "baseline" model, that captures the bridge behavior, for future monitoring, load ratings, and management.
Task 10: Dissemination of benchmark non-destructive test data from the target bridge structure that may be used by other interested researchers for parameter estimation and model updating research. Present the results of the research to appropriate AASHTO committees for implementation in future ASSHTO specifications for highway bridges.

Tufts University
FST Engineers
University of New Hampshire

Principal Investigators:
Masoud Sanayei, Ph.D.
Erin Santini Bell, Ph.D., P.E.
Brian Brenner, P.E.

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