LTBP Program Moving Ahead

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In April 2008, the Federal Highway Administration (FHWA) launched a major new strategic initiative, the FHWA *Long Term Bridge Performance* (LTBP) *Program*. The LTBP Program is intended to be a 20+ year undertaking, with the global objective of collecting scientific quality data from a representative sample of highway bridges nationwide. The knowledge gained from the LTBP Program will be used to solve a variety of bridge condition assessment and management problems, and to develop new tools and advance knowledge of bridge design, maintenance and preservation. Knowledge and data gained are expected to lead to:

1) Improving knowledge of bridge performance,
2) Determining how and why bridges deteriorate (i.e., advances in deterioration and predictive models),
3) Determining the effectiveness of various maintenance, repair, and rehabilitation strategies, as well as management practices,
4) Determining the effectiveness of durability strategies for new bridge construction including material selection, and
5) Enabling improvements in bridge management practice using quality, quantitative data.

The LTBP Program is a large and complex undertaking that requires a well thought out process for its success. The strategic action plan shown in *Figure 1* provides the overall direction to the program.

The strategic action plan is based on a top down heuristic approach in which *Bridge Performance* (Step 1 in *Figure 1*) first had to be defined and understood before initiating the data collection phase. This is not a linear strategic plan, and requires quality control and assurance between steps 2 through 6 as needed. This is expected to be an iterative process yielding new information during the life of the program.

Figure 1: The Strategic Action Plan for the LTBP Program.

Step 1 – Defining Bridge Performance

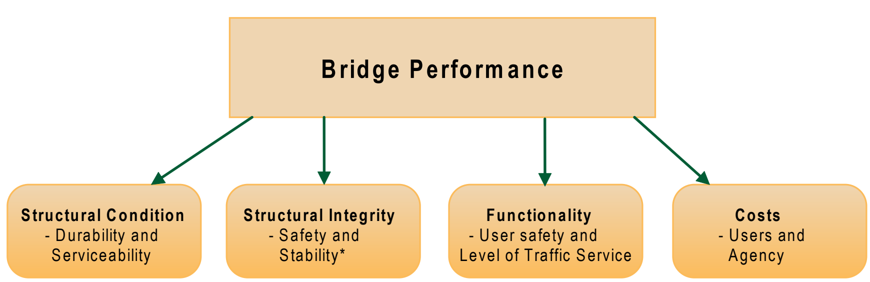
The logical starting point of the LTBP Program's path to a better understanding of bridge performance is to break down bridge performance into specific issues, and to evaluate the existing gaps in knowledge that hinder this understanding. In the early development of the LTBP Program, it was clearly understood that, in defining bridge performance, the program must be responsive to the needs of the primary program stakeholders – the state and local Departments of Transportation (DOTs), federal agencies, and private toll authorities, who own and manage the bulk of the nation's bridge infrastructure – and subsequently to the bridge engineering community at large. These are stakeholders who will apply the knowledge and lessons learned from the LTBP Program.

To best serve these stakeholders, one of the early decisions made for the program was to establish an overall definition of bridge performance that addresses four broad categories – structural condition, structural integrity, functionality, and costs. *Figure 2* illustrates this concept, which is expected to be refined and expanded as the LTBP program moves forward.

Many relevant factors combine to affect performance under each of these four main categories. *Table 1* lists the relevant factors that might combine to impact the various aspects of bridge performance. Within these categories there are many specific performance issues that are of importance to the bridge community, and that could be studied over the long term to achieve a better understanding. For each of these specific performance issues there are multiple data items that could be gathered to assist in the evaluation of performance.

A critical factor in the effort to create a more specific definition of bridge performance was a process of outreach to the state Departments of Transportation (DOTs). Focus group meetings were held at the offices of ten states across the nation. Members of the LTBP research team met with DOT bridge experts who were responsible for design, construction, inspection, management, and maintenance of bridges. The purpose of the meetings was to determine what aspects of bridge performance were the highest priorities from a state DOT perspective.

Major findings from the focus group meetings were remarkably similar from



*Stability is a measure of probability of a failure (risk assessment) which may be related to; 1 – Scour, settlement and movement; 2 – accidents (blasts, impacts and fire); 3 – Natural hazards; and 4 – Structural redundancy.

Figure 2: Main Categories of Bridge Performance Issues.

state to state. Around the country, regardless of the geographic region, the highest bridge performance issues related to concrete decks, joints for bridge decks, scour at substructures and deterioration of concrete substructure units.

Based on the internal research and the input from stakeholders, 20 bridge performance issues were identified. These performance issues are currently being refined and prioritized. *Table 2* presents a number of high priority performance issues.

Steps 2 Through 4

The process by which Step 2 – the identification of bridge data to be collected – is achieved will be by addressing each high priority bridge performance issue and by identifying the knowledge currently available to analyze each issue, and the critical gaps in current knowledge. This will require identifying the specific parameters that might be useful in characterizing the issue, identifying the methodology required to obtain high quality data for each parameter (i.e., deciding amongst visual inspection, destructive or nondestructive testing, and sensors for short- or long-term monitoring), and adopting/developing specific data protocols for each of the chosen data collection methodologies.

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Table 1: Four Main Categories of Bridge Performance & Relevant Factors.

Structural Condition – Durability & Serviceability	Structure type Structural materials & material specifications As-built material qualities & current conditions As-built construction qualities & current conditions Traffic loads – trucks Environment – climate, air quality, marine atmosphere Snow & ice removal operations Type, timing & effectiveness of preventive maintenance Type, timing & effectiveness of restorative maintenance, minor & major rehabilitation Hydraulic design and scour mitigation measures Soil characteristics - settlement
Structural Integrity – Safety & Stability	Seismic performance Hurricane and Flood resistance Collision and blast impacts Fire resistance Structural redundancy and load redistribution
Functionality – User Safety & Level of Traffic Service	Structure geometry – clear deck width, skew, approach roadway alignment Skid resistance and ride quality of riding surface Vertical clearances – over & under Traffic volumes and percentage of trucks Posted speed
Costs (User & Agency)	**Users** Accident costs Detour & delay costs **Agency** Initial construction costs Maintenance, repair & rehabilitation costs Traffic maintenance costs

Table 2: High Priority Performance Issues.

Category	Issue
Decks	Performance of Untreated/Treated Concrete Bridge Decks
Joints	Performance, Maintenance and Repair of Bridge Deck Joints
Steel Bridges	Performance of Coatings for Steel Superstructure Elements
Concrete Bridges	Performance of Embedded or Ducted Prestressing Wires and Post-tensioning Tendons
Scour	Direct, Reliable, Timely Methods to Measure Scour; Performance of Scour Countermeasures

Step 2 provides critical input into Steps 3 and 4, and feedback from these steps helps refine and improve the conclusions of Step 2.

In Step 3, the LTBP research team developed an open, scalable, and extensible data management and data analysis infrastructure. State-of-the-art data warehousing and data mining techniques will be used to enable an efficient verification and large scale testing of new research hypotheses. Utilizing recent advances in visualization technologies, and to support the varying needs of a large group of potential users, the data infrastructure will include both an interactive, map-based user interface to directly interact with data, and a set of automated interfaces for programmatic access to the data. In addition, the data infrastructure will provide access to raw, unstructured data and will also provide interfaces to obtain clean, high-quality, data that has been pre-processed to support specific analysis tasks.

Design the Experimental Program, Step 4, provides the detailed framework for each experimental study developed to address one of the high priority bridge performance issues. The thought process behind each separate study also provides input into the final stage of Step 2. Once each specific study is designed, the final approach to collection of data on the critical parameters can be revised as necessary. This may mean eliminating or adding parameters to measure, fine-tuning the data collection protocols, and even modifying the testing frequencies.

The LTBP Program Pilot Study

Concurrent with Steps 2 through 4, the *Pilot Study* will be initiated. At this point, an extensive array of NDE equipment and sensors for long term monitoring have been selected for use in the program. A protocol for visual inspection of the LTBP bridges has been developed, as well as protocols for each of the testing and monitoring regimens.

The Pilot Study will be initiated in the Fall of 2009, with the primary objective being to validate the methods and protocols developed for data collection under the first phase of the program. The LTBP team selected seven states (with one bridge in each state) that provide a representation of the typical types of structures and range of environmental conditions experienced throughout the United States. The states selected for the pilot program are California, Florida, Minnesota, New Jersey, New York, Utah and Virginia.

While the Pilot Study will focus heavily on the validation of the protocols, methods and guidelines for data collection, the pilot bridges will not be viewed as independent from the long-term data collection phase. It is important that the selection, instrumentation, and data collection of the Pilot Study bridges be consistent with the objectives of the overall long-term data collection anticipated for the program. This will ensure that the information gathered will feed directly into the long-term phase and provide early results to important questions that can be answered on the basis of the short-term data and knowledge that the program creates.

The wealth of data collected through the LTBP Program, and the subsequent data analysis, when combined with legacy data, will pave the way for greater understanding of the Nation's overall bridge performance and bridge "health".▪

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For more information on the LTBP program, visit **www.tfhrc.gov/ltbp**, or contact Hamid Ghasemi at FHWA, 202-493-3024 (email: **ltbp@dot.gov**).