Long-Term Bridge Performance (LTBP) Program

T-19 Technical Committee Meeting
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Presentation Outline

• Background

• Phases of Research Study

• Long-Term Data Collection
Long-Term Bridge Performance (LTBP) Program

• Definition of Bridge Performance:

Bridge Performance Encompasses How Bridges Function and Behave Under the **Complex and Interrelated Factors** they are Subjected to Daily:

- Traffic Volumes
- Loads
- De-Icing Chemicals
- Freeze-Thaw Cycles
- Environment
- Extreme Events
- Method of Design
- Construction
- Materials
- Age
- Maintenance History
Long-Term Bridge Performance (LTBP) Program

- **Vision:** The LTBP Program will Serve as the National Platform for Strategic Long-Term Investigation of In-Service Bridge Performance.

- **Mission:** Foster Improved Bridge Performance, Health, Stewardship, and Management Through the Analysis of Data Collected Over a 20-Year Period on a Large Representative Sample of U.S. Highway Bridges. To achieve this, the Program is Designed to Produce and Support Improved Deterioration Models, Reliable Life-Cycle Cost and Forecasting Models, Design Procedures, and Decision-Making Tools.
Scope of LTBP—Main Study

I. Synthesis of Existing Information
II. Create Bridge Portal with NBI Data
Bridge Portal – A Data Infrastructure Platform

- NBI and Element-Level Data
- LTBP Data
- Traffic & Truck Load Data
- Maintenance Data
- Preservation Data
- Safety Data
- Weather Data
- Seismic Data
- Others

Bridge Portal – Deterioration Model
- Life-Cycle Cost Model
- Forecasting
- Bridge Management at Program and Network-Level
Scope of LTBP—Main Study

I. Synthesis of Existing Information
II. Create Bridge Portal with NBI Data
III. Survey 15 States
State DOT Interviews

Participating State DOTs
## Bridge Performance – Study Topics

<table>
<thead>
<tr>
<th>Category</th>
<th>Issue</th>
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<tbody>
<tr>
<td>Decks</td>
<td>Untreated Concrete Bridge Decks</td>
</tr>
<tr>
<td>Decks</td>
<td>Bridge Deck Treatments</td>
</tr>
<tr>
<td>Joints</td>
<td>Bridge Deck Joints</td>
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<tr>
<td>Steel Bridges</td>
<td>Coatings for Steel Superstructure Elements</td>
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<tr>
<td>Foundations</td>
<td>Reinforced Concrete Substructures Deteriorisation</td>
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<tr>
<td>Concrete Bridges</td>
<td>Reinforced Concrete Superstructure Deteriorisation</td>
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<tr>
<td>New Bridges</td>
<td>Innovative Bridge Designs &amp; Materials (e.g. ABC, FRP)</td>
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<td>Concrete Bridges</td>
<td>Embedded Prestressing Wires and Tendons</td>
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<tr>
<td>Bearings</td>
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<tr>
<td>Decks</td>
<td>Precast Concrete Deck Systems</td>
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<tr>
<td>Joints</td>
<td>Integral Abutments and Jointless Structures</td>
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*Image of a bridge with a map of the United States in the background.*

*Source: Turner-Fairbank Highway Research Center*
## Bridge Performance – Study Topics

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<td>Scour Detection and Scour Countermeasures</td>
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<td>Steel Bridges</td>
<td>Weathering Steels</td>
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<tr>
<td>Decks</td>
<td>High-Performance Concrete Decks</td>
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<tr>
<td>Risk</td>
<td>Risk/Reliability for Structural Safety</td>
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<tr>
<td>Concrete Bridges</td>
<td>Prestressed Concrete Girders</td>
</tr>
<tr>
<td>Functional</td>
<td>Performance of Functionally Obsolete Bridges</td>
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</tbody>
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**Additional topics from Substructures Workshop (March 2011)**

- Approach Issues
- MSE Walls
- Piles and Piles Groups
- Scour Countermeasures
Scope of LTBP—Main Study

I. Synthesis of Existing Information
II. Create Bridge Portal with NBI Data
III. Survey 15 States
IV. Determine High-Priority Issues
Based on input from stakeholders and considering current resources of the program, the following key topics will initially be addressed:

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Scope of LTBP—Main Study

I. Synthesis of Existing Information
II. Create Bridge Portal with NBI Data
III. Survey 15 States
IV. Determine High-Priority Issues
V. Establish Data Gathering Protocols
Protocols

- 67 Protocols to Date
- Visual Inspection
- NDE Evaluation
- Physical Sampling
- FE Modeling
- Live-Load Testing
- Dynamic Testing
- Long-Term Instrumentation
Scope of LTBP—Main Study

I. Synthesis of Existing Information
II. Create Bridge Portal with NBI Data
III. Survey 15 States
IV. Determine High-Priority Issues
V. Establish Data Gathering Protocols
VI. Verify Data Protocols on Pilot Bridges
Pilot States and Bridge Types

New Jersey
- Simple span steel stringer

Virginia
- Continuous steel stringer
- 2-span prestressed post-tensioned continuous CIP box girder

Utah
- Simple span pre-stressed concrete stringer

California

New York
- Two simple spans of adjacent concrete box beams

Minnesota
- Steel deck truss

Florida
- Precast, segmental post-tensioned concrete box beams
Virginia Bridge Testing

- Coring
- USW
- Impact Echo
- GPR
- Electrical Resistivity
Pilot Study Phase – Lessons Learned

- Speed at which the data were collected,
- Duration of traffic interruptions,
- Specialized staffing needs,
- Coordination of field activities for deploying NDE technologies,
- Data interpretation

VA Pilot Bridge
Scope of LTBP—Main Study

I. Synthesis of Existing Information
II. Create Bridge Portal with NBI Data
III. Survey 15 States
IV. Determine High-Priority Issues
V. Establish Data Gathering Protocols
VI. Verify Data Protocols on Pilot Bridges
VII. Add Pilot Bridge Data and State Element-Level Data to Bridge Portal
VIII. Select Bridges for Long-Term Data Gathering
Overview of Reference-Cluster Concept

Breadth

(Diversity and Size of Bridge Population)

Total Bridge Population of Cluster States

Candidate Bridge Population

Cluster Bridges

Reference Bridges

Depth (Confidence Level)

NBI

NBI, Paper Study

NBI, Paper Study, Chronology, Visual, Cursory
NDE and Sensing

NBI, Paper Study, Chronology, Visual, High
Resolution NDE and Sensing

Bridge Portal
Reference Bridge

Visual Inspection
- Non-standard
- Arms length
- Conventional Tools

NDE
- Impact Echo
- GPR
- Ultrasonic
- Seismic
- Resistivity

Global Testing
- Load Testing
- Modal Testing
- Continuous Monitoring

Material Testing
- Material Sampling
- Stiffness
- Strength
- Porosity
- Chloride Content

Approximate Scale: 200 ft
Multiple Clusters of Similar Bridges

Cluster of Bridge Type A

Comparison: Cluster vs. Cluster
Influences of Inputs: Climate, Maintenance Practices, etc.

Approximate Scale: 3000 mi
Representative Bridges

Based upon an analysis of the National Bridge Inventory Database:

– Steel stringer,
– Prestressed Concrete Multi-girder, and
– Prestressed Concrete Box Girder and Adjacent Box Beam Bridges

were selected as the most representative bridges
Range of representative variables

- The DOE Climatic Zones were selected as representative of the different climates that affect bridge performance.
Selection criteria for candidate bridges

- Bridge Type:
  - Steel Multi-Girder Bridge with CIP Deck
  - Prestressed Concrete Multi-Girder Bridge with CIP Deck
  - Box Girder and Adjacent Box Beam Bridges
- State Owned (also representative of local bridges)
- Eliminate if service under is RR
- $10 \, \text{m} \leq \text{Max Span Length} \leq 50\, \text{m}$
- Maximum of 4 lanes on bridge
- ADT $\leq 50,000 \, \text{VPD}$
- Built after 1960
Availability of PC Candidates by Location
Cells with fewer than 25 bridges were excluded

**Sheet1**

- Events
  - 110
- Count

**Climate Zones**

- Hot-Humid
- Mixed-Humid
- Mixed-Dry
- Hot-Dry
- Cold
- Very Cold
- Marine

**PC Box Beam or Girder Candidates by Location**
Corridor Candidates
4890 bridges of all types meeting other selection criteria
Selection of Bridges for All Clusters and Corridors to be Completed in 2013
Cluster and Corridor Bridge Selection Criteria

Individual Bridge Selection Criteria – Availability of Documentation

- Bridge Plans
- Construction Records
- Maintenance Records
- Inspection Records
- Specifications – Deck Concrete, Rebar, Girder Materials
- As-Built Plans
Cluster and Corridor Bridge Selection Criteria

- **Other Factors to Consider**
  - Number of Bridges
  - Site Access
  - Proximity to WIM Station
  - Number of Spans
  - Girder Spacing (if applicable)
  - Bridge Age Range
  - ADTT Range
  - Type of Deck – precast panels or CIP
  - Type of Rebar – black, epoxy coated, stainless
  - Overlay or Deck Treatment
  - Steel Girders – Type of steel, painted or WS, strength
  - CIP or PS Concrete – strength, rebar or strand type, girder type (AASHTO, Bulb T, Adjacent Box Beam, CIP Box)

*Selection also to consider individual states interests – what are state priorities wrt bridge type*
Field Testing – Moving Forward

Overall Plan for each Cluster and Corridor – Initially emphasis placed on “deck only” – priority items – starting with bare decks

- Goal is to have **75-100 bridges** per cluster
- Process for Selection of “Field Study” Bridges
  - Initial selection candidate bridges – “paper” study evaluates individual bridges & narrows down potential field candidates
  - With **help from individual states** these potential candidate bridges will be narrowed down to **final 75** bridges selected for field investigations
  - Initiate field studies - between 10 and 20 of 75 bridges each cluster - increase # as funding becomes available
Scope of LTBP—Main Study, continued

VIII. Select Bridges for Long-Term Data Gathering
IX. Gather Long-Term Data
X. Analyze all Data
XI. Refine Models (Deterioration and Life Cycle Cost)
XII. Make Models Available for States’ Bridge Management Systems
XIII. Create Suite of “Best Practice” Publications
Scope of LTBP—Additional Studies

Additional Studies/Products will be Undertaken Using NBI and/or LTBP Data:

I. Automated Data Collection
II. Performance of Weathering Steel Bridges
III. Detection of Condition of Prestressing Wires, Strands, and Tendons;
Scope of LTBP—Products

Major Products that will be Produced Using NBI and/or LTBP Data:

I. Bridge Portal
II. NBI Converter
III. Protocols for Gathering Research-Quality Data
IV. Automated Data Collection (Robot)
V. Refined Deterioration & Life-Cycle Cost Models
VI. Data-Driven Bridge Condition Index
VII. Suite of “Best Practices” Involving Bridge Design, Construction, Inspection, Maintenance, Preservation, and Monitoring
Key Contacts—LTBP Program


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Thank You! Questions?