Long-Term Bridge Performance Program

An Overview
U.S. Department of Transportation (DOT) Strategic Plan, FY 2012–16

• The latest U.S. DOT Strategic Plan presents **five strategic goals** for America’s transportation system:
  
  • Safety
  
  • **State of Good Repair**
  
  • Economic Competitiveness
  
  • Livable Communities
  
  • Environmental Sustainability
State of Good Repair

- Existing physical assets (Bridges, Pavements, Tunnels), both individually and as a system are:
  - functioning as designed within their useful service life, and
  - sustained through regular maintenance and replacement programs
What does it take?

Performance Data
Actionable Information

State of Good Repair

Data-Driven Decisions

Deterioration, forecasting, and life-cycle models

Data fusion, interpretation, and visualization

Reliable, research-quality, long-term performance data

Protocols for data collection

Advanced practical NDE tools and SHM
Data-Driven Decisions

Owners of Infrastructure Assets

- Do Nothing
- Rehabilitation
- Replacement
What is FHWA’s Research Role?

- Conducts and manages R&D programs and projects and provides technologies and solutions to advance practices in highway infrastructure engineering
  - LTPP and LTBP programs
  - Non-destructive evaluation
  - Tunnels and culverts
  - Hydraulics and geotechnical
FHWA LTBP Program

• Initiated in 2008

• Intended as a 20+ year *long-term research effort* to improve our knowledge of “Bridge Performance”

• Funding was designated in “SAFETEA-LU” - surface transportation authorization legislation (August 2005)

• “MAP-21” - Moving Ahead for Progress in the 21st Century
  ➢ The first multi-year transportation authorization enacted since 2005
Long-Term Bridge Performance Program

GOAL
Develop a Scientific Performance Bridge Database

Desired/Anticipated Outcomes

- Improved Deterioration Models
- Reliable Life-Cycle Cost and Forecasting Models
- Help Improve Existing Design Procedures
- Benefits of NDE Techniques
- Means to Quantify Preservation Strategies
- Data-Driven Decision Tools

Testing and Detailed Evaluation of a Representative Sample of the Most Common Bridges in the National Bridge Inventory
Meetings with States - Status Update

Northeast: CT, MA, ME, NH, NY, RI, VT
Mid-Atlantic: DC, DE, MD, NJ, PA, VA, WV
East Central: IN, KY, OH, TN, NC
Mid West (Central): IA, IL, MI, MN, WI
Gulf Coast: AL, AR, FL, LA, MS, TX
Rocky Mountains: CO, ID, MT, NE, SD, UT, WY
NW: OR, WA
SW: AZ, CA, NV
Corridor: GA, KS, OK, MO, ND, NM, SC

States on-site meetings to be scheduled
### Developmental & Execution Phases

**Identify Bridge Performance Issues**

**Focus Group Meetings**

<table>
<thead>
<tr>
<th>Category</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decks</strong></td>
<td>Untreated Concrete Bridge Decks</td>
</tr>
<tr>
<td><strong>Decks</strong></td>
<td>Treated Concrete Bridge Decks</td>
</tr>
<tr>
<td><strong>Joints</strong></td>
<td>Bridge Deck Joints</td>
</tr>
<tr>
<td><strong>Bearings</strong></td>
<td>Bridge Bearings</td>
</tr>
<tr>
<td><strong>Steel Bridges</strong></td>
<td>Coatings for Steel Superstructure Elements</td>
</tr>
</tbody>
</table>
Long-Term Bridge Performance Program

Data Collection

Data Management

Data Analysis

Products
Long-Term Bridge Performance Program

Data Collection

Data Management

Data Analysis

Products
Simple span steel stringer ~ 104,000
New Jersey

Continuous steel stringer ~ 47,000
Virginia

Simple span pre-stressed concrete stringer ~ 52,000
Utah

2-span prestressed post-tensioned continuous CIP box girder
California

Steel deck truss
Minnesota

Two simple spans of adjacent concrete box beams ~ 40,000
New York

Precast, segmental post-tensioned concrete box beams
Florida
Bridge Types and Sample Size (Most Common Bridges)

Availability of Steel Candidates by Location
Bridge Types and Sample Size
(Most Common Bridges)

Availability of PC Candidates by Location
Bridge Types and Sample Size (Most Common Bridges)

PC Box Beam or Girder Candidates by Location
Clusters

Prestressed/Post Tensioned Boxes

Steel Multi-Girder

Prestressed Multi-Girder

Corridors

East-West
I-40, I-70, I-80, I-90, I-94

North-South
LTBP Contractors and Tasks

- Rutgers University
  - Bridge Sampling, Data Collection, Analysis, Protocols, Data Management
  - Arora and Associates (visual)

- Pennoni Associates, Inc.
  - Data Collection, Validation, Protocols, Technical Support

- Parsons Brinckerhoff, Inc.
  - Data Collection, Validation

- Michael Baker Jr., Inc.
  - Data Collection, Validation

- Professional Service Industries, Inc. (PSI)
  - Legacy Data, Bridge Sampling, Validation
## Data Collection: Untreated Bridge Decks, Joints, and Bearings

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Cluster</th>
<th>States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutgers</td>
<td>Mid-Atlantic Steel; Mid-Atlantic Prestressed Concrete (Vis/NDE + Doc)</td>
<td>DE, NJ, MD, PA, VA, WV (+ Doc)</td>
</tr>
<tr>
<td>Michael Baker</td>
<td>Gulf Steel; Gulf Prestressed Concrete (Vis)</td>
<td>AL, AR, FL, LA, MS, TX</td>
</tr>
<tr>
<td>PSI</td>
<td>Mid-Atlantic Steel, Mid-Atlantic Prestressed Concrete; Mid-Atlantic Concrete Box; NE Steel (Doc)</td>
<td>CT, DC, DE, MA, MD, ME, NH, NJ, NY, OH, PA, RI, VA, VT, WV</td>
</tr>
<tr>
<td>PB</td>
<td>NW Prestressed Concrete; SW Concrete Box (Vis)</td>
<td>AZ, CA, NV, OR, WA</td>
</tr>
</tbody>
</table>
Long-Term Bridge Performance Program

- Data Collection
- Data Management
- Data Analysis
- Products
LTBP Program – Bridge Portal Update

- IRB Process Complete
- Transfer to FHWA Server underway
- Additional Security-Related Code Development Completed and Undergoing Testing
- Security Assessment to be Initiated (June 2015) – FINAL STEP Prior to DEPLOYMENT
- Concurrently – Beta Testing Version 1.0 Underway

Version 1.0 Currently Available to LTBP State Coordinators, ETGs, and BCOM (and select others) – Beta Test Period Ends June 30
LTBP Program – Bridge Portal Update

Data Sources
- NBI
- Element Level Data
- Traffic and WIM Data
- Environment Data
- Maintenance
- Bridge Documents
- Visual Inspection
- NDT/NDE

Tools
- Advanced Security
- Advanced Search
- Reporting
- Map Visualization
- Multi dimensional Charts
- Map charts
- Bridge Historical data
- Deterioration Model

Future Development
- More Statistical features
- Performance Comparison
- Bridge Timeline
- Advanced Deterioration Model
- Android App
- iPad App
- Custom Groups

Features available in V 1.0 Highlighted
Long-Term Bridge Performance Program

Data Collection

Data Management

Data Analysis

Products
Strategic Performance Matrix -- Untreated Bridge Decks

**Objectives**

Defining an integrated bridge health and performance for more effective safety, mobility, stewardship, and management through:
- Enhanced design, construction, preservation, and operating practices from probabilistic data-driven tools

**Hypotheses**

<table>
<thead>
<tr>
<th>Practical questions to be answered</th>
<th>“Practical”</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Fundamental” questions to be answered</td>
<td>“Fundamental”</td>
</tr>
</tbody>
</table>

**Questions to be answered**

- How should an untreated concrete deck be inspected?
- When should an untreated concrete deck be retained?
- When should an existing deck be preserved or replaced?
- How should an untreated concrete deck be designed and constructed?

**Solution**

Design of Experiment
- Sampling
- Paper Study
- Field Data Collection

**Data Analysis**

**Outcomes**

**Strategic Performance Matrix -- Untreated Bridge Decks**

<table>
<thead>
<tr>
<th>ENVIRONMENT</th>
<th>DECK DESIGN</th>
<th>BRIDGE DESIGN</th>
<th>LIVE LOAD</th>
<th>OWNER ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>Cover</td>
<td>Span length</td>
<td>Frequency</td>
<td>De-icing</td>
</tr>
<tr>
<td>Temperature</td>
<td>Rebar type</td>
<td>Girda stiffness</td>
<td>Axle weights &amp; spacings</td>
<td>Level of preservation</td>
</tr>
<tr>
<td>Proximity to the coast</td>
<td>Concrete mix</td>
<td>Girda spacing</td>
<td>Speed</td>
<td>Load permitting</td>
</tr>
<tr>
<td>Pollution</td>
<td>Proportioning of rebars</td>
<td>Angle of skew</td>
<td></td>
<td>Construction practices</td>
</tr>
<tr>
<td>Age/deterioration</td>
<td>Use of SIP forms</td>
<td>Bridge profile (bump at the end of the bridge)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Products**

Best practices in NDE and SHM techniques for untreated concrete decks
- Data-driven, reliability-based inspection intervals & criteria for untreated concrete decks
- Data-driven life-cycle cost models for preservation and replacement practices for untreated concrete decks

**Data Analysis**

Deterioration Modeling

**Long-Term Bridge Performance Program**

**REMEMBER THIS?**
Untreated Decks – Solution

1. Design an appropriate experiment for addressing the practical and fundamental questions
2. Select a network of bridges (reference and clusters) as the primary population source
3. Conduct paper study (tacit/legacy data collection)
4. If the paper study proves inconclusive, conduct field data collection using the appropriate LTBP data collection protocols
5. Handle all data management through the LTBP Portal
6. Conduct data analysis
   a) Develop deterioration models
   b) Develop life-cycle cost models
7. Address the question

Let’s Discuss

“Operational Matrix”
Long-Term Bridge Performance Program

Data Collection

Data Management

Data Analysis

Products
Protocols

Established over 150 protocols for bridge infrastructure field assessment and evaluation

Bridge Portal (A Data-Driven Decision Tool)

Developed an advanced web-based centralized data storage and retrieval application

Deterioration and Forecasting Model

Developed methodology for a data-driven deterioration and forecasting model to be used within the LTBP Bridge Portal
NDE Technologies

Developed, deployed, and validated a number of automated and semi-automated bridge deck assessment tools

Bridge Performance Index

Developing, testing, and validating a data-driven bridge performance index
Collaboration

• Protocols
• NDE tools and Technology
• Deterioration Model
• International Test Beds
Thank you!