Inspection Data for Bridge Asset Management

New York State DOT approach and Practice

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Vermont AOT
Bridge Maintenance and Preservation Conference
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Outline

- Bridge Management Background
- NYS Bridge Evaluations
  - Background
  - Bridge inspection Program
  - Inspection Data
  - Bridge Evaluation Programs
- Bridge Asset Management Strategies
- Bridge Management analysis methods
“Transportation Asset Management is a strategic and systematic process of operating, maintaining, upgrading and expanding physical assets effectively throughout their lifecycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision-making based upon quality information and well-defined objectives.”

- AASHTO Subcommittee on Asset Management
Bridge Management Background

To manage bridges effectively we need the following primary components:

- Inventory definition
- Current condition assessment
- Knowledge of bridge vulnerabilities.
- Tracking of needs and projects
- Economic evaluation of potential actions
- Forecasting of deterioration and needs
- Photo and document archive
NYS Bridge Management System

- Inventory Data
- Bridge Inspection
- Condition Assessment
- Vulnerabilities
- Bridge Network Modeling
- Resource Allocation
NY State Bridges

- Owners: NYSDOT, Local Gov’ts, Authorities
- 17,400 bridges carry public highways, 50,000+ spans
NYS Bridge Ownership

(Local) 8587

(Other) 1187

(State) 7632
NYSDOT Bridge Evaluations

- Program, in current format, developed in early 1980’s
  - Bridge Inspection (general and diving)
  - Detailed Bridge Inventory -- BDMS
  - Load Capacity Evaluation (Rating, Posting)
  - Bridge Safety Assurance (Vulnerabilities) Program

Bridge Inspection program is the primary data source for all evaluation functions
NY’s bridge inspection program

Key Features

- Clear mandate
- Centralized Responsibility and oversight
- Funding / Resource Priority
- Quality Provisions
- Critical Findings Procedure
- Safety Centric
- Element Level
- Data source for Bridge Mgmt.
NYSDOT inspects State and Local owned highway bridges in New York State

Inspection Team Leader must be a licensed Professional Engineer (P.E.)

Biennial Inspection Program

Interim Inspections

9,500 NYSDOT inspections / year
Element Level Inspections

- Examine and evaluate all elements of the bridge *(Visual, Tactile, Sounding)*
  - Rate 47 elements
    - 22 common to all bridges
    - 25 on span by span basis
  - Document and photograph all “deficient” elements
  - Measure and sketch deterioration and scour as necessary
NYS Bridge Inspection Rating Scale

7 -- New condition, no deterioration
6 -- 
5 -- Minor deterioration and functioning as designed
4 -- 
3 -- Serious deterioration or not functioning as designed
2 -- 
1 -- Totally deteriorated or failed condition
# NYS Inspection Standards

## Deck Element Ratings:

<table>
<thead>
<tr>
<th>Element</th>
<th>001</th>
<th>002</th>
<th>003</th>
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<tbody>
<tr>
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<td>Curbs</td>
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<td>Railings, Parapets</td>
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<tr>
<td>Mono Deck Surface</td>
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## Superstructure Ratings:

<table>
<thead>
<tr>
<th>Element</th>
<th>001</th>
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<tbody>
<tr>
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<tr>
<td>Primary Members</td>
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<td>Joints</td>
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<tr>
<td>Recommendation</td>
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</table>
NYS Condition Rating

- It is a rating calculated based on weighted inspection ratings of several components
  - Uses 13 different element ratings
  - When multiple rated elements exist, such as abutment backwalls, the calculation utilizes lowest rated element
  - If C.R. < 5.00, the bridge is considered “Deficient” according to NYSDOT

- C.R. is NYSDOT’s most widely used bridge condition performance indicator
Uses of Inspection Data

- **Providing Data for Program Planning**
  - Used for developing capital program by using data with BMS software
  - Used to compute “Sufficiency Rating” (measure of the bridge’s ability to remain in service) to determine federal funding eligibility

- **Evaluation Functions**
  - Inspection report used as a basis for structural integrity evaluations, load rating, and other functions
  - Inspection report documentation as a reference
Uses of Inspection Data

- **Scheduling Maintenance Activities**
  - Emergency Repairs
  - Flag Repairs
  - Corrective Maintenance
  - Preventative Maintenance

- **Satisfying Federal and State Reporting Requirements**
  - Annual “Federal Tape”
  - Annual NYS “Report of Bridge Management and Inspection Programs”
Uses of Inspection Data

- **Forecasting**
  - Element deterioration
  - Condition rating trends
  - Work strategy forecasts
- **Cost estimating**
  - Combine condition and inventory data
Load Rating / Posting / Permit Reviews

- State and Federal Requirements
- NYSDOT Load Rating system
  - Bridge structural element database
  - Use AASHTOWare® VIRTIS
- Update data thru inspection program
Bridge Safety Assurance Program (BSA)  
“Vulnerability Assessments”

- Program of assessment of bridges’ vulnerability to structural failure due to their inherent characteristics or due to extreme events
- Assessments are made for individual failure modes

“Identify causes of failure beyond condition”  
(Why do Bridges Fail?)
NYSDOT Bridge Failure Database

New York State Bridge Failures

- Hydraulic, 82, 41%
- Overload, 33, 17%
- Collision, 37, 19%
- Nature, 4, 2%
- Misc, 11, 6%
- Concrete/Deter., 4, 2%
- Construction, 4, 2%
- Misc. Deterioration, 9, 5%
- Steel/Deterioration, 7, 4%
- Fire, 3, 2%
NYSDOT Bridge Safety Assurance Program

- Systematic evaluations of bridges based on failure modes.
  - Hydraulics
  - Steel Details
  - Overload
  - Concrete Details
  - Collision
  - Earthquake

- Evaluate statewide bridge population:
  - Screen → Assess → Classify

- Vuln. Classifications consider failure likelihood and consequence.

- Evaluation data needs collected during bridge inspections
NYSDOT Bridge Safety Assurance
Vulnerability Assessment Procedures

- Assessment Manuals
- Refined flowchart methods for screening
- Follow up analysis for higher vulnerabilities
- Bridge Inventory database for screening and assessment updates
Vulnerability Ratings
(for each Failure Mode)

1. Safety Priority Action
2. Safety Program Action
3. Capital Program Action
4. Inspection Program Action
5. No Action
BSA
Safety Priority Action

Scour Vulnerability Mitigation

- Scour Retrofits
- Flood Warning Action Plan
- Post Flood Inspections
BSA Capital Program Action

Retrofits: *add primary redundancy*
NYSDOT

Bridge Management Strategy

- Goal Oriented
- Decentralized - but with central oversight
- Combined Capital and Maintenance programs
- Least cost analysis for MR&R alternatives
- Maintenance /Operations First
NYSDOT Bridge Goals

- Eliminate Critical conditions:
  - Low critical element ratings
  - High BSA vulnerabilities

- Preservation:
  - Reduce the overall number of deficient bridges
  - Maintain Interstate bridges in good condition
  - Maintain NHS bridges in at least fair condition

- Serviceability
  - Reduce load restrictions
  - Eliminate highway bridge clearance restrictions
Performance Measures

- Percentage of deficient bridges
  - Statewide
  - Interstates
  - NHS

- Number of bridges with critical elements rated less than 3 (serious deterioration)

- Serviceability by Hwy. classification
  - Number of bridges with load restrictions
  - Number of bridges with clearance restrictions
NYSDOT Bridge Maintenance

- Corrective Maintenance
- Preventive (Cyclical) Maintenance
- $100 Million program
  - (out of $600 M state bridge program)
  - In-house and contracted
Bridge Maintenance

Corrective Maintenance

- "Element Level" work
- Element inspection condition info.
  - ID work candidates
  - Performance measure
- Federal-aid (HBP) eligible
- Delivery Initiatives
  - Job-order contracts
Bridge Maintenance

Preventive (Cyclical) Maintenance

- Washing (2 yr. cycle)
- Lubricate Bearings (4 yr.)
- Deck Sealing (4 yr.)
- Painting (12 yr.)
- Deck Overlay (12 yr.)
- Replace Deck Joints (as needed)

Federal-aid (HBP) eligible
Justification for Corrective Maintenance Program

NYSDOT Bridge Preservation Status

- Treatment Costs / Bridge
  - $5K
  - $250K
  - $3.7M

- 2370 Good Bridges
- 4740 Fair Bridges
- 790 Poor Bridges

- Curve w/ Corrective Maintenance
- Curve w/out Corrective Maintenance

- Average Condition Rating
  - 7
  - 6
  - 5.8
  - 5.4
  - 4.4
  - 4
  - 3

- Age (Years)
  - 0
  - 10
  - 20
  - 30
  - 40
  - 50
  - 60
  - 70
  - 80
  - 90
  - 100
  - 110
  - 120
Local Projects

- Included in Regional program updates
- Fed. Aid “pass-thru” projects (local let)
- DOT Oversight and Assistance
  - Local Projects Manual documents project development process
  - Statewide Conference on Local Bridges
    - Information exchange
    - Training
Bridge Management Analysis Tools

- Deterioration modeling
- Needs assessment models
- Cost assessment
- Forecasting
- BMS Software
Deterioration Modeling
Element Deterioration Curves

Weibull Comparison between Class 1 and Class 2

Class 1:
Element: Primary Member
Element Design Type: Slab, Box or Box/Channel
Superstructure Material Type 1: Prestressed Concrete

Class 2:
Element: Primary Member
Element Design Type: Plate Girder
Superstructure Material Type 1: Weathering Steel
Cost Modeling

- Bridge unit cost data
- Replacement cost estimating model
  - Based on historical data
    - Base area costs
    - Features costs
  - Continuously updated
- Maintenance and Rehab costs:
  - Inspection condition data determines work strategies—element combinations
  - Average work strategy costs / s.f.
Bridge Network Analysis
Bridge Program Worksheet

- Identifies program candidates for goal attainment using:
  - Condition (BDMS)
    - Inventory
    - Element and bridge inspection condition values
  - BSA vulnerabilities (BSA dB)
  - Program Status (PSS)
  - Deterioration module

- Evaluates program updates
- Forecasts
Bridge Network Analysis

Bridge Needs Assessment Model (BNAM)

- Forecasting-- Identifies present and future improvement needs for highway bridges
- Regional bridge program development and evaluation
- Statewide bridge needs analysis and resource allocation
- Uses Condition Rating as performance measure
- Scenario analysis—treatment strategies, funding levels….
Bridge Network Analysis
Program Evaluation and Forecasts

State Highway Bridge Trend and Forecasts

<table>
<thead>
<tr>
<th>Year</th>
<th>Percent Deficient by Number</th>
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<tr>
<td>1994</td>
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<td>2014</td>
<td>26</td>
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<td>2016</td>
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- **History**
- **Current Funding**
- **Needs Study**
- **Proposed Program**
Next Steps

- Improve on element level data for BMS purposes
  - condition state extents
  - Improve cost estimating modules
- Optimization
  - Quantify life cycle costs
    - Preservation costs
    - User costs
  - Quantify benefits
AASHTO\textregistered\ PONTIS

BMS Software

- Licensed by most State DOT’s for over 15 years.
- Comprehensive BMS features
  - Optimization
- Pontis 5.2 (2009)
  - Software will feature a project focus with vastly improved project analysis capabilities.
  - Multiple objective modeling framework.
  - Incorporation of bridge risks.
Pontis implementation Issues

- Element level data
  - Uses AASHTO Core Element (CoRE) data
    - Collect CoRE data?
    - Translate NYS to CoRE?
    - Define new elements?

- Program Optimization assumptions
  - Optimal means the least long term benefit / cost for each element state
  - MR&R benefits can be measured in two ways: future cost avoidance or change in element value (Bridge Health Index).
Least Cost Optimization Results
Summary: Bridge Inspection data → Asset management

- Bridge inspection Data
  - Element level conditions
  - Non-condition data (serviceability, vulnerabilities)
  - Accessible
  - Quality

- Data supports program goals/ measures
  - Maintenance, Rehab, Replacement programs
  - Bridge safety
Questions?

NYSDOT Office of Structures
(518) 457-6827
www.nysdot.gov