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6/27/16
Briefing Comment Note

NCHRP 20-07/Task 378

This investigation was sponsored by TRB under the NCHRP Program. Data reported are work in progress. The contents of this presentation has not been reviewed by the project panel or NCHRP, nor do they constitute a standard, specification, or regulation.

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Briefing Overview

Overview of NCHRP 20-07/Task 378
Objectives
Research Approach
Proposed AASHTO Guidelines

Review Phase I Research Results
Literature Review and Analysis
Methodology Development

Comments and Feedback
Research Objectives

Develop AASHTO Guidelines for assessing bridge risk

- Data-driven risk assessment at bridge level
- Natural and man-made hazards
- Suitable for Bridge Management System (BMS)

Incorporate Risk Management into Asset Management

- Reconcile data, techniques, jargon, and management methods
- Consider risk in project priorities, resource allocation, and performance management
- Clear definitions, especially “service disruption”
Major Elements of Project

1. Understanding of Approaches
   - Review of Literature & Practice
   - Synthesis

2. Methodology Development
   - Hazards
   - Likelihood
   - Data Availability

3. Guidelines Comments/Feedback
   - T-1
   - T-18
   - SCOBS

4. Final Deliverables
   - Proposed Methodology
   - Proposed Guidelines
Key Findings: Literature Review

• Hazard likelihood well documented on a site-specific basis, but difficult to characterize large groups of bridges as in BMS
• Readily-available geographic likelihood data for natural hazards
• Often missing link between adverse event and service disruption
• Interested in both structural integrity and network resilience
• By scouring the literature we found some feasible models

• Some judgment will still be necessary, but we are documenting structured assessment methods
  – Site-based risk assessments
  – Network-level planning metrics
• Rapidly developing technologies leave considerable room for future research and enhancement.
Risk Assessment Approach: Florida

- Excel spreadsheet tools:
  - Project Level Analysis Tool (PLAT): Risk and LCCA on one bridge
  - Network Analysis Tool (NAT): Efficiency and resilience of the network
- Likelihood expressed as probability, consequence in dollars
- Considers hurricanes, wildfires, tornadoes, flooding, collisions, overloads, fatigue, and advanced element deterioration
- FDOT has efficient means to collect a few additional items for risk analysis e.g. scour assessment, fatigue details
Risk Assessment Approach: Minnesota

- Risk assessment spreadsheet (BRIM), to identify and rank STIP projects
- Relies on judgment-based tables of resilience scores, summarized as Bridge Performance Index (BPI)
- Considers condition, scour, fracture criticality, fatigue, overweight trucks, over-height trucks, driver loss of control, and overtopping of the bridge or approach

BPI table for superstructure condition

BPI table for scour

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Risk Assessment Approach: New York

- Judgment-based decision tree to compute a Vulnerability Rating
- Relies on modest additional field assessment data
- Used for priority-setting within the safety assurance program, without considering project costs or long-term costs
Diversity of approaches

• All of the systems that link into asset management are network-wide bridge-level assessments
• All rely primarily rely on BMS data, but each adds a few additional items
• In each case agencies developed a separate module or spreadsheet, not integral to the BMS
• Each system is based on either utility or social cost, but only the social cost based system is fully linked with life cycle cost
Guidelines Outline I

A. Introduction
   Background on risk assessment and management, risk-based asset management, and bridge management systems
   How to use this document

B. Bridge Management System Framework for Risk
   Risk in bridge management systems
   Performance concerns and measures
   Hazards affecting bridges
   Analyzing risk in AASHTOWare Bridge Management
   Glossary

C. Risk Assessment
   Defining hazard scenarios and performance criteria
   Risk Assessment worksheets
      Estimating likelihood of service disruption scenarios (by hazard class)
      Estimating the consequences of service disruption (performance concerns)
Guidelines Outline II

D. Applications to Risk Management
   Risk management treatments
   Level of service standards for vulnerability/resilience
   Mitigation costs and treatments
   Incorporating risk in asset management

E. Incorporating Risk in Bridge Management Systems
   Established risk assessment tools
   Methodology in AASHTOWare Bridge Management
   Computation of recovery costs

F. Future Research Needs

G. References and Resources
Role of Risk in Bridge Management

- Multi-objective risk management is new in BMS
- Work along-side life cycle cost analysis
- Fit within BMS framework of benefit/cost analysis
- Use readily available data
Targeted Software Applications

- Can be implemented in AASHTOWare Bridge Management 5.2.3
- Other BMS developers can also implement
- Stand-alone spreadsheet analysis also feasible
Architecture: Modular Approach

Agencies choose based on their risk management concerns and data availability.

Some modules may have multiple computation methods, at varying levels of data requirements.
Worksheets: Estimation Approaches

Worksheet Philosophy

- Take advantage of all available data.
- Use judgment.
- Only replace data that might be gathered later through improved inspection processes or research.

Types of Worksheets

- Likelihood of Service Disruption per Hazard
- Consequences of Service Disruption

Multiple ways of estimating the likelihood and consequences.

Flexibility to adjust analysis to suit an agency’s needs.
For Earthquake hazard, need to estimate metrics that can be applied to probabilities of future seismic events.

Oregon research approach:
- Identify bridges in selected areas potentially impacted from a seismic event.
- Describe potential damage to State highway bridges from six representative earthquake scenarios most likely to occur.

Source: Seismic Vulnerability Of Oregon State Highway Bridges - Mitigation Strategies to Reduce Major Mobility Risk (Oregon State 2009)
Bridge infrastructure failure can be decomposed into infrastructure cost, human cost, environmental cost, traffic delay cost, as well as economic cost consequences.

Next Steps

• Final proposed guidelines
• Define possible implementation approaches
Questions?
Thank You

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Key Findings: Practices Review

- States are currently using different methods and models to evaluate risk. In the case of earthquakes information is relatively well developed in the seismically vulnerable states. The same expertise and capabilities can serve not only in earthquakes, but after other extreme events such as storm surge, wave action, and scour. Databases exist for vehicular impact, floods, fires and other hazards.

- Methods to quantify collision (e.g. over-height trucks) and overload likelihood are currently not well documented. Florida DOT has model of accident risk due to functional deficiencies and histograms of truck height and weight. New York and Florida DOTs have developed methods to assess the likelihood of fatigue damage.

- Florida developed a method to use element level data to compute the likelihood (as a probability) of service disruption due to advanced deterioration. Other states use condition data for this purpose (for example, elements in their worst condition state, or bridges that are structurally deficient due to condition).

- Structural integrity assessment is well established. Network resilience is a more recent practice. While traffic engineers have been focused on this aspect of transportation networks, it is a relatively new concept to structural engineers.

- A number of remote, in-situ, or portable monitoring/damage detection techniques have become available for use in post-event assessment such as sensors, sonar, ground-breaking radar, satellite imagery and unmanned aerial vehicles.
Implications for Methodology

Systems differ in the definition of hazard scenario:

- New York considers three scenarios based on extent of structure damage.
- Florida and Minnesota only consider events that interfere with normal traffic flow.
- In Florida’s system, the scenario definition differs for different hazards, depending on the available data and the nature of the hazard. The other systems tend to apply the same criteria across all hazards with less precise definitions.
- Florida and New York explicitly consider the likelihood and consequence of service disruption. Minnesota and the federal sufficiency rating approach do not.
- Florida and New York are also the only two that explicitly consider the likelihood of extreme events.

All systems rely heavily on bridge characteristics that are assessed by inspectors.

All systems apply a multi-objective perspective on consequences: they all consider safety, mobility, and recovery costs in some way, although not always explicitly in the computations.

The Minnesota and New York systems express risk in categories, as does the AASHTO Assessment feature. Florida and the federal sufficiency rating express risk on a continuous scale. The AASHTO system computes utility on a continuous scale.

Performance measures used in benefit/cost prioritization in Florida’s and AASHTO’s systems are expressed on an unbounded scale. The performance measures computed in Minnesota, New York, and the sufficiency rating are on a bounded scale and are not used in benefit/cost analysis.
Methodology Principles

• Be able to accommodate a range of preferences and perspectives as demonstrated in the various state risk models.

• Be able to address the wide variety of hazards and performance criteria so each agency can select the hazards and criteria of most importance and ignore the rest.

• Behave in a reasonable way to reflect variations in bridge size, utilization, detour distance, difficulty of incident response and recovery, extreme event probability, and other significant variables affecting risk.

• To the greatest extent possible should approximate stable and measurable engineering and economic concepts.

• Be compatible with AASHTOWare BrM and similar bridge management systems that may be developed.