Presentation Outline

• Objectives
• Study Team
• Approach
• Tasks
• Future Research
• Questions

NCHRP 14-32, Proposed Revisions to the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual
Research Objectives


- Incorporate developments in movable bridge engineering
- Develop standardized element-level descriptions and nomenclature
- Edit the manual for improved clarity of presentation. This includes filling gaps, and eliminating redundancies
- ...also improve graphics
The Study Team

LEGEND
Parsons Brinckerhoff (*)
Washington State DOT (WSDOT)
Steward Machine Company (SMC)
Brad Hollingsworth (BH)
HBM Engineering (HBM)
Necati Catbas (NC)
Research Approach

PHASE 1

Task 1: Review Relevant Literature

Task 2: Summarize Developments since 1998 Manual and Conduct Gap Analysis

Task 3: Prepare an Outline of Manual Sections Requiring Modification

Task 4: Prepare Interim Report No. 1

Task 5: Execute the Approved Work Plan to Revise the Manual

Task 7: Develop Standardized Descriptions for Inventory and Inspection on Element-Level

Task 6: Potential Impact of the Proposed Revisions

PHASE 2

Task 8: Prepare Interim Report No. 2

Task 9: Incorporate Review Comments and Prepare Ballot Items

PHASE 3

Task 10: Prepare Final Report

NCHRP 14-32, Proposed Revisions to the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual
Task 1 – Literature Review

- Annotated summaries were prepared for 44 key references

- For Example:

<table>
<thead>
<tr>
<th>DOT</th>
<th>Name</th>
<th>Scope</th>
<th>Interval</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>Special C—Suspension and movable bridges</td>
<td>Entire</td>
<td></td>
<td>Poor condition</td>
</tr>
<tr>
<td>Florida</td>
<td>Movable bridge</td>
<td>Operation</td>
<td>12 months</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Movable portion</td>
<td>Equipment</td>
<td>12 months</td>
<td></td>
</tr>
<tr>
<td>Maryland</td>
<td>Drawbridge</td>
<td>Equipment</td>
<td></td>
<td>Team has electrical engineer and mechanical engineer</td>
</tr>
<tr>
<td>Michigan</td>
<td>Movable equipment, routine</td>
<td>Equipment</td>
<td>72 months</td>
<td>Movable bridge equipment</td>
</tr>
<tr>
<td>New Jersey</td>
<td>Movable Bridge—Type I</td>
<td>Equipment</td>
<td></td>
<td>In-depth electrical, mechanical equipment inspection</td>
</tr>
<tr>
<td></td>
<td>Movable Bridge—Type II</td>
<td></td>
<td></td>
<td>Medium-depth electrical, mechanical equipment inspection</td>
</tr>
<tr>
<td></td>
<td>Movable Bridge—Type III</td>
<td></td>
<td></td>
<td>Visually monitor operation of electrical, mechanical equipment</td>
</tr>
<tr>
<td>North Carolina</td>
<td>Movable span inspections</td>
<td></td>
<td></td>
<td>Cursory inspection for operation</td>
</tr>
<tr>
<td>Oregon</td>
<td>Movable bridge</td>
<td>Entire</td>
<td>12 months</td>
<td>Special team having an electrical engineer, a bridge safety engineer, and a mechanical engineer</td>
</tr>
<tr>
<td>Virginia</td>
<td>Movable bridge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington</td>
<td>Movable bridge operation</td>
<td>Operation</td>
<td>1 month</td>
<td>Trial opening of span</td>
</tr>
<tr>
<td></td>
<td>Special feature—Movable</td>
<td></td>
<td></td>
<td>Inspector has special training or experience</td>
</tr>
<tr>
<td></td>
<td>Movable bridge equipment</td>
<td></td>
<td>12 months</td>
<td>In-depth for electrical and mechanical equipment</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>Movable bridge</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Task 2 –
Summary of Developments since 1998 Manual & Gap Analysis

- Task 2a: Gaps (36)
- Task 2b: Developments (17)
- Task 2c: Redundancies (4)
## Example Table – Task 2a List of Gaps

<table>
<thead>
<tr>
<th>No.</th>
<th>Gap</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Incorporating items listed in Task 2b with regards to developments since the Manual’s last publication in 1998.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Adding condition ratings of mechanical and electrical items in Pontis.</td>
<td>Format as supplement to the AASHTO Manual for Bridge Element Inspection, 2013</td>
</tr>
<tr>
<td>3</td>
<td>Developing criteria for element level rating and what constitutes a particular condition rating.</td>
<td>Format as a supplement to the AASHTO Manual for Bridge Element Inspections, 2013</td>
</tr>
<tr>
<td>4</td>
<td>Consistency is needed for electrical and mechanical inspection methods and scopes.</td>
<td>Due to varying preferences among movable bridge owners, it may not be possible to create standardized scopes that will be accepted and used. Suggested scopes, methods, inspection frequencies, and personnel qualifications will be proposed.</td>
</tr>
<tr>
<td>5</td>
<td>Additional information to be included regarding hydraulic machinery inspection and standards.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Discuss emergency inspections after an extreme event.</td>
<td></td>
</tr>
</tbody>
</table>

...continues to 36 Gaps, 17 Developments, and 4 Redundancies
Task 3 –
Outline of Manual Sections Requiring Modification

AASHTO Movable Bridge Inspection, Evaluation and Maintenance Manual

PART 1 – INTRODUCTION

PART 2 – INSPECTION

PART 3 – MOVABLE BRIDGE ELEMENT DESCRIPTIONS

PART 4 – EVALUATION

PART 5 – MAINTENANCE

APPENDIX
2.2 Types and Scopes of Inspection

The recommended minimum types and scopes of movable inspections will be provided. A checklist for routine and in-depth movable bridge inspection will be provided for each discipline: structural, mechanical, and electrical.

Reference Literature:

Gaps to be Addressed:
- Consistency is needed for electrical and mechanical inspection methods and scopes.
- Discuss emergency inspections after an extreme event.
- Clarify requirements regarding when drive machinery should be load rated for motor sizing, brake settings, and machinery torque capacity.
- Define the various types of inspection and the recommended scope and frequency associated with each.
• Received approval to proceed to Phase II July, 2014
Task 5 – Execute the Approved Work Plan to Revise the Manual

New Cover, Proposed Title

Manual for Existing Movable Bridges

2015

DRAFT

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Task 5 – Execute the Approved Work Plan to Revise the Manual

• Graphics / Photos
• Types and Scopes of Inspections
• Frequency of Inspection
• Inspector Qualifications
• Resiliency, Security, Sustainability
• Wire Rope Retirement Criteria
• Span Balance
• Medium Voltage
• Megger Data Normalizing
Task 5 – Execute the Approved Work Plan to Revise the Manual - Graphics
Task 5 – Execute the Approved Work Plan to Revise the Manual - Graphics

FIGURE 2.8.2.11.3.6-3A & B
Task 5 – Execute the Approved Work Plan to Revise the Manual

Figure 2.8.2.3.3-1 – A bascule bridge split sleeve type trunnion bearing
Task 5 – Execute the Approved Work Plan to Revise the Manual – New Photos
Task 5 – Execute the Approved Work Plan to Revise the Manual

• Chapter 2.2 - Types and Scopes of Inspections
  • Routine Inspections: visual and operational
    C2.2 “It is recommended that each inspector – Structural, Mechanical, and Electrical witness each significant component in operation.”
  • In-Depth Inspections: routine plus measurement and disassembly
  • Special Inspections: non-destructive examination, balance testing
Task 5 – Execute the Approved Work Plan to Revise the Manual

- Chapter 2.3 Frequency of Inspections
  - Routine Inspection: 24 months
  - In-Depth Inspection: 6 years, in place of routine inspection
  - Special Inspection: as needed
Task 5 – Execute the Approved Work Plan to Revise the Manual

• Chapter 2.4 Inspector Qualifications
  
  “Inspection of a movable bridge requires a coordinated team of experienced structural, mechanical, hydraulic, and electrical inspectors.”

  “The lead inspectors for mechanical, hydraulic, and electrical inspections should meet the requirements of AASHTO Manual for Bridge Evaluation and the National Bridge Inspection Standards (NBIS).” “and not less than three years experience in the design, inspection, or maintenance on movable bridges in their area of expertise.”

- NBIS provides five ways to qualify – P.E., B.S., years experience, FHWA training
Task 5 – Execute the Approved Work Plan to Revise the Manual

- Chapter 1.6 Recent Industry Standards
  - Resiliency
  - Security
  - Sustainability
Task 5 – Execute the Approved Work Plan to Revise the Manual

- C2.8.2.11.3.1.1 Wire Rope Retirement Criteria

- Proposed Language: “While written for Underground Mining Hoists, the Code of Federal Regulations 30 CFR § 77.1434 Wire Rope Retirement Criteria is recommended as the most applicable standard for determining when to retire wire ropes for movable bridges.”
Task 5 – Execute the Approved Work Plan to Revise the Manual

• Span Balance

• Reference added to span balance guidance in the commentary of the AASHTO LRFD Movable Highway Bridge Design Specifications
Task 5 – Execute the Approved Work Plan to Revise the Manual

• Medium Voltage

• Electrical Insulation (Megger) Testing Normalizing for Temperature
Task 7 – Develop Standardized Descriptions for Inventory and Inspection on Element Level

- Agency Developed Elements (ADEs) for mechanical and electrical known to exist in:
  - Louisiana DOTD
  - Florida DOT
  - Washington State DOT
  - Maryland SHA

EACH COMPLETELY DIFFERENT
WSDOT Unique in Use of Hierarchy for Agency Defined Elements for Movable Bridges

- Discipline (Mechanical or Electrical)
- System (Span Drive Machinery, Locks, etc)
- Component (Motor, Speed Reducers, Hydraulic Power Unit, etc)

- However, AASHTOWare Bridge (Pontis) does not support hierarchical element definitions
- Approximate Quantity of 250 element definitions
Louisiana DOT, Florida DOT, and Maryland DOT use hybrid approach for Agency Defined Elements for movable bridges

- Element = Component of Drive System
  (motor, coupling, brake, etc.)
  
  and/or

- Element = System
  (locks, traffic gates, navigation, etc)

- The mixture of disciplines, systems, and components adds confusion.

- Element condition states do not clearly translate to system condition or repair costs.
Proposed Bridge Management Element Definitions for Movables

- Element = Movable Bridge System with Discipline

Total of 16 element definitions proposed

The proposed approach to element definitions maximizes information and minimizes confusion.
Proposed Bridge Management Element Definitions for Movables

600 Movable Bridge Support System – Structural
601 Movable Bridge Support System – Mechanical
602 Movable Bridge Balance System – Structural
603 Movable Bridge Balance System – Mechanical
604 Movable Bridge Drive System – Mechanical
605 Movable Bridge Drive System – Electrical
606 Movable Bridge Control System – Electrical
607 Movable Bridge Control System – Mechanical

...continued
Proposed Bridge Management Element Definitions for Movables

continued...

608 Movable Bridge Interlocking System – Mechanical
609 Movable Bridge Interlocking System – Electrical
610 Movable Bridge Navigation Guidance System – Structural
611 Movable Bridge Navigation Guidance System – Electrical
612 Movable Bridge Electrical Power System – Electrical
613 Movable Bridge Traffic Control System – Mechanical
614 Movable Bridge Traffic Control System – Electrical
615 Movable Bridge House - Structural
## Proposed Bridge Management Element Definitions for Movables

### Element 604 – Movable Bridge Drive System – Mechanical

**Description:** All mechanical elements of the main drive system  
**Classification:** ADE  
**Units of Measurement:** each  
**Quantity Calculation:** Number of main drive systems for the entire bridge

<table>
<thead>
<tr>
<th>Defects</th>
<th>1 – Good</th>
<th>2 – Fair</th>
<th>3 – Poor</th>
<th>4 – Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation</strong> (9000)</td>
<td>Movable span operates smoothly.</td>
<td>Movable span operation has minor flaws, such as light vibration or noise. No remedial action required.</td>
<td>Movable span operates with significant flaws, including vibration, noise, or undesirable heating. Short term replacement or adjustment or components may be required.</td>
<td>Movable span does not operate or operates in an erratic or uncontrolled manner. Immediate replacement of components may be required.</td>
</tr>
<tr>
<td><strong>Lubrication</strong> (9001)</td>
<td>Lubricants are fresh, clean, and well distributed.</td>
<td>Lubricant exhibits minor contamination. Oil levels slightly low. Application of grease is excessive or barely adequate.</td>
<td>Lubricant exhibits moderate contamination. Oil levels low. Application of grease is spotty and inadequate in places.</td>
<td>Lubricant exhibits heavy contamination. Oil levels extremely low. Application of grease is inadequate in many places.</td>
</tr>
<tr>
<td><strong>Wear</strong> (9002)</td>
<td>None.</td>
<td>Light wear present with less than 10% section loss. No remedial action.</td>
<td>Moderate wear present with 10% to 20% section loss.</td>
<td>Heavy wear present with greater than 20% section loss.</td>
</tr>
</tbody>
</table>
# Proposed Bridge Management Element Definitions for Movables

## Element 604 – Movable Bridge Electrical Power System – Electrical

**Description:** All electrical elements of the electrical power system

**Classification:** ADE  
**Units of Measurement:** lump sum  
**Quantity Calculation:** Electrical power system for the entire bridge

<table>
<thead>
<tr>
<th>Defects</th>
<th>Condition States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – Good</td>
</tr>
<tr>
<td>Corrosion (9014)</td>
<td>None.</td>
</tr>
<tr>
<td>Housekeeping (9004)</td>
<td>Access to pull boxes, junction boxes, motor control center are blocked. Electrical rooms are clean, sanitary, free of debris and trip or fall hazards.</td>
</tr>
<tr>
<td>Damage</td>
<td>None.</td>
</tr>
</tbody>
</table>
Task 6 – Potential Impacts of the Proposed Revisions

• Public Safety
  • Asset management approach
  • Clarified scopes and inspector qualifications
  • Improved clarity – photos, electronic native document
Task 6 – Potential Impacts of the Proposed Revisions

- Inspection Procedures
  - New sections: Sustainability, Security, Resiliency
  - Wire rope retirement criteria – CFR
  - Reference design manual for span balance criteria
  - Electrical inspection of medium voltage equipment
  - Normalizing electrical insulation (Megger) testing
Task 6 – Potential Impacts of the Proposed Revisions

Resources Needed for Implementation

- Pilot project recommended to field test new elements
- National training class recommended to qualify movable bridge inspectors
- Internal owner procedures for archiving and using the new element-level ratings
Task 8 – Interim Report No. 2

Interim Report No. 2

Prepared for:
National Cooperative Highway Research Program

Prepared by:
Parsons Brinckerhoff, Inc.
One Penn Plaza, NY, NY 10119

In Association with: HBM Engineering Group, L.L.C.; Brad Hollingsworth, P.E.; and Necati Cutbas, Ph.D., P.E., S.E.

January 30, 2015

The information contained in this report was prepared as part of NCHRP Project 14-32, Proposed Revisions to the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual, for National Cooperative Highway Research Program (NCHRP).

SPECIAL NOTE: This report is NOT an official publication of the National Cooperative Highway Research Program, Transportation Research Board, National Research Council, or The National Academies.

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES
Task 9 Ballot Item

AASHTO Movable Bridge Inspection, Evaluation and Maintenance Manual
2015

BALLOT ITEM

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Proposed Revisions to the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual

FINAL REPORT

Prepared for
The National Cooperative Highway Research Program, Project 14-32
Transportation Research Board
of
The National Academies of Sciences, Engineering and Medicine

Michael J. Abrahams, P.E., Principal Investigator
Scott Snelling, P.E., Deputy Principal Investigator
WSP | Parsons Brinckerhoff
New York, NY
November 2015
Future Research

• Expand coding guidelines with photos
• Remote bridge operation
• Reconfigure element definitions using master chart of defects
• Programmable logic controller data logging
• New section of Bridge Management
• Pilot test program