Risk-Based Planning for Bridges

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MnDOT Bridge Office
APWA Conference 8–28–16

We all have a stake in A to B

Outline

- Bridge Data and How It’s Used
- BPI (Bridge Planning Index)
- Improvement Module
- Expert Review Process
- Bridge Deck Deterioration Curves
- Prediction of Future Condition
Bridge Data and How It’s Used

- **Inventory Data**
  - Bridge location, route, length, width, traffic volume, superstructure type, deck design, etc.

- **Inspection Data**
  - Bridge condition of deck, superstructure, substructure, etc.

- **Program Data**
  - Project number, work type, estimated cost, etc.

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**BRIM Modules**

- **Resilience Module**
  - Risk Assessment

- **Improvement Module**
  - Scope, costs, timeframe

- **Expert Review Module**
Resilience Module

- Performed in Bridge Office

Risk of Service Interruption

- Traffic Restrictions
  - Increased Maintenance
  - Increased Inspection
  - Repair Projects
  - Emergency Repairs
- Load Posting
- Unplanned Bridge Closure
Resilience Module

- Considers the Probability of a Service Interruption, and
- The Consequence of a Service Interruption

Probability of Service Interruption

- Deterioration of the Deck or other bridge elements
- Hit from an Over Height Truck
- Damage from Flooding
- Fatigue
Consequence of Service Interruption

- Traffic Volume
- Route & Classification
  - (Interstate vs. Minor Arterial)
- Detour Length
- Length of Bridge

Risk Factors in BRIM and their Weights

- Deck - 25%
- Superstructure - 20%
- Substructure - 15%
- Scour - 10%
- Fracture Critical - 10%
- Fatigue - 5%
- Load Rating – 10%
- Vertical Clearance – 5%
Importance Factors in BRIM

- Traffic Volume (ADT)
- Detour
- Bridge Length
- Roadway Classification

Bridge Planning Index (BPI)

- BPI Score for each bridge
  - Probability x Consequence
  - Score of 1 (highest priority)
  - Score of 100 (lowest priority)
- BPI Rank for each bridge
  - District or Statewide basis
BRIM Resilience Module

Bridges

<table>
<thead>
<tr>
<th>Review</th>
<th>25.0</th>
<th>20.0</th>
<th>15.0</th>
<th>10.0</th>
<th>5.0</th>
<th>0.0</th>
<th>Sum</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td></td>
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<td></td>
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</tr>
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</table>

Other

Scaled BRIM scores relative weight

Raw R importance factor | BRIM score | Entire state | Each district

BRIM Improvement Module

- Performed in Bridge Office
BRIM Improvement Module

Determine future work type:
(Replace, Redeck, Overlay, No Work)

Determine future time period:

**STIP (programmed):** Years 0-4
**CHIP (planned):** Years 5-10 (6)
**2nd Time Period:** Years 11-20 (10)
**3rd Time Period:** Years 21-26 (6)

Matrix is Used to Determine Consistent Work Types and Time Periods

Notes:
(A) If deck by deck condition fail, then ADT
(B) Plan Move to ADT if warranted
(C) Projects in 2016-2018 will begin early
(D) Projects in 2019-2020 will begin late due to in-service work
(E) Projects necessary before 2000 will follow ADT table currently after 2000
(F) ADT charts before 2016: use up removing the and chart remove after 2016
### Improvement Module – scope

<table>
<thead>
<tr>
<th>Bridge Id</th>
<th>Facility</th>
<th>Action and timing selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

### Improvement Module – costs

<table>
<thead>
<tr>
<th>Bridge Id</th>
<th>Facility</th>
<th>Cost estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Improved bridge size (ft)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Action selection using the grid

- Grid row: 8
- Grid column: 5
- Action: Replace/Rehab
- Period: 2017-22
Improvement Module – PPMS

Expert Review Module

- Results sent to Districts
- District review based on first-hand knowledge of bridges
### Expert Review Module – scope

<table>
<thead>
<tr>
<th>Bridges</th>
<th>Action and timing selection</th>
<th>Engineer over-ride</th>
<th>Final decision</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
<td>Period</td>
<td>Action</td>
<td>Period</td>
<td>Action</td>
</tr>
<tr>
<td>Remedy</td>
<td>project</td>
<td>project</td>
<td>period</td>
<td>period</td>
</tr>
</tbody>
</table>

### Expert Review Module – costs

<table>
<thead>
<tr>
<th>Bridges</th>
<th>Cost breakdown</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
<td>Period</td>
<td>Cost breakdown</td>
</tr>
<tr>
<td>Remedy</td>
<td>project</td>
<td>project</td>
</tr>
</tbody>
</table>
Predict Future Condition

- Deck condition is used as the basis to predict future condition because it is a good indicator of when bridge projects are needed.
- We can check superstructure and substructure condition during forecasting, but do not have deterioration curves for these elements.
Predict Future Condition

- Deck Deterioration Curves developed through research of historical MnDOT deck condition data
  - Assumes no additional investment except for preventative maintenance
  - Curves are based on historical policy changes in bridge deck design (rebar coating, depth of rebar, overlays, etc.), ADT, location (Metro vs Outstate)

MnDOT’s Deck Protection Policy Changes by Year

<table>
<thead>
<tr>
<th>Year Built</th>
<th>Policy Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 and after</td>
<td>All epoxy coated bars in deck</td>
</tr>
<tr>
<td>1975–1989</td>
<td>3” cover to top mat of steel</td>
</tr>
<tr>
<td>Before 1975</td>
<td>Less than 3” cover to top mat of steel</td>
</tr>
</tbody>
</table>
Deterioration Curves 1&2

Curve 1: Metro bridges built 1990 and later;
       Outstate bridges built 1990 and later with ADT > 10K
Curve 2: Outstate bridges built 1990 and later with ADT ≤ 10K

Deterioration Curves 3&4

Curve 3: Metro bridge built 1975 – 1989 with epoxy coated top bars
Curve 4: Outstate bridges built 1975 – 1989 with epoxy coated top bars
Deterioration Curves 5&6

Curves 5: bridge built 1975-1989 with black bars
Curves 6: Bridges built before 1975 – with less than 3” of cover and black bars

RSL (Remaining Service Life)

- RSL = 0 when bridge deck turns to ‘poor’ condition (NBI = 4)
- RSL = 0 does NOT mean the bridge has failed!
- RSL is NOT the number of years to next project
RSL can be used to:
- Aid in planning level forecasts of bridge needs
RSL can be used to:

- Forecast performance outcomes in a particular year in the future
- Tool to predict Federal condition targets are achieved (FAST Act)

BRIM Updates:

- Updating for changes to NBIS elements
- Adding a culvert module (>10’ span)
Local Bridge Planning:

- Developing a risk-based system for local bridges
- Will be similar to resilience module, but will not include improvement and expert review modules
- Allows owner to adjust risk factors based on their bridge inventory

Questions?

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