Framework for objective risk assessment in bridge management

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Background

- Persistent gap between risk mitigation needs and funding
- Elected officials have little understanding of risk
- Massive needs across all types of infrastructure
  - Highways and transit
  - Water and sewer systems
  - Airports and seaports
  - Schools and other public buildings
Need for new and better risk tools

• Measure and track progress, set targets related to risk
• Balance risk against other performance goals
• Balance transportation risk mitigation needs against other programs
• Develop a prioritized multi-year risk mitigation plan
  • At an appropriate level of resources
  • Consistently address the most significant risks first
• Communicate risk more clearly
Examples of existing tools

Federal sufficiency rating

- 55% of the rating:
  - Condition
  - Load-carrying capacity

- 35% of the rating:
  - Geometrics
  - Condition and load-carrying capacity
  - Waterway adequacy

- 15% of the rating:
  - Traffic volume and network importance

- Up to 13% reduction for:
  - Special safety and mobility deficiencies
Examples of existing tools

• New York State DOT multi-level vulnerability assessment
Examples of existing tools

- Minnesota DOT bridge performance index

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</tbody>
</table>

**Smart flag reduction:**
Use worst condition state of defect 6000, Scour
Examples of existing tools

- Florida DOT Project Level Analysis Tool

Diagram:
- Random event
- Hazard
- Consequence
- Impact

- Agency costs
- User and non-user costs
- Resilience built into structure
- Operational strategies
Tools we hope to see more: **Resilience**

- Opposite of vulnerability
- Use it like condition
  - Good-Fair-Poor
  - 0-100 resilience index

<table>
<thead>
<tr>
<th>Resilience Grade</th>
<th>Description</th>
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<tbody>
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<td><strong>Good</strong>:</td>
<td>The asset is fully sufficient to resist anticipated hazards.</td>
</tr>
<tr>
<td><strong>Fair</strong>:</td>
<td>The asset has elevated likelihood of mild-to-moderate disruption to mobility, safety, economic efficiency, or other performance objectives.</td>
</tr>
<tr>
<td><strong>Poor</strong>:</td>
<td>The asset is ineffective in resisting anticipated hazards, and as a result there is high likelihood of severe disruption.</td>
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</tbody>
</table>
Tools we hope to see more: Resilience

• Opposite of vulnerability
• Use it like condition
  • Good-Fair-Poor
  • 0-100 resilience index

• Good-Fair-Poor can be mapped.
Tools we hope to see more: **Resilience**

- Opposite of vulnerability
- Use it like condition
  - Good-Fair-Poor
  - 0-100 resilience index

- Also suitable for resilience targets, such as % Good and % Poor
Tools we hope to see more: **Resilience**

- Opposite of vulnerability
- Use it like condition
  - Good-Fair-Poor
  - 0-100 resilience index

- Use engineering criteria to assess Good-Fair-Poor

**Input to structural integrity evaluation**

**Screen**
- Bridge population
- Susceptibility groups

**Classify**
- Vulnerability classes

**Rate**
- Vulnerability rating

**Analysis**

- Inventory screen:
  Over/not over water

- Susceptibility screen 1:
  Culverts, slow stream velocity, no substructure unit in floodplain, non-scourable foundation material

- Susceptibility screen 2:
  Abutment and foundation type, long/short/timber piles, spread footing on earth/erodable rock, scour damage

- General hydraulic assessment:
  River slope/velocity, channel bottom & configuration, debris/ice, river confluence, backwater, scour depth, max flood depth, adequacy of opening, overflow relief

- Foundation assessment:
  Existing scour counter-measures, foundation, river bend, embankment inclination, embankment encroachment, footing or pile bottom below stream bed, angle of attack, pier width, simple spans, multiple piers in floodplain

- Likelihood:
  Vulnerability class

- Consequence:
  Failure type: catastrophic, partial collapse, damage

- Exposure:
  Traffic volume, functional classification
Tools we hope to see more: **Social cost**

- Use with life cycle cost
- Benefits of improved resilience
- Considers safety, mobility, and sustainability

- **NCHRP 20-07 (378) describes a methodology**
Tools we hope to see more: Social cost

• Setting priorities and allocating resources across dissimilar asset classes that are typically managed independently
• Prioritization that consistently and objectively considers the cost of risk mitigation and the magnitude of exposure to risks
• Combining risk avoidance with life cycle cost savings in an overall assessment of project benefits
• Quantifying the benefits of projects that combine multiple asset classes
• Evaluating projects that postpone hazardous conditions
• Suggesting a reasonable starting point for balancing safety, mobility, environmental, and economic concerns
Methodology conclusions

• Resilience is the ability to resist natural and man-made hazards
  
  Resilience and vulnerability are opposite ends of a scale
  • It can be characterized as Good-Fair-Poor
  • It can be shown on a map
  • It can be graphed using trend, forecast, and target
  • It can be assessed using objective data

• Social cost can quantify project benefits across asset classes
  • Even non-highway assets such as sewers and school buildings
  • Standardized methods and metrics already exist
  • Easy to integrate with life cycle cost
  • Basis for objective resource allocation
Implementation conclusions

• Develop a shared vision among decision-makers
  • Objectivity, verifiability, transparency
  • Understanding what information is possible to obtain

• Authorizing environment
  • Elected officials accept measurable objectives
  • Persistent communications

• Organizational capacity
  • Staffing to deliver risk mitigation projects
  • Systems and training in place

• Thank you!