Safety Performance Management achieved through Predictive Methods

Today’s Presenter

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Outline

- Fundamental Issue
- AZ HSM Implementation
- AZ Pilot Applications
- Why Implement HSM?
Fundamental Issue

Nominal Safety is an ABSOLUTE

Substantive Safety is a CONTINUUM

DESIGN DIMENSION
(Lane Width, Radius of Curve, Stopping Sight Distance, etc.)

Greater

Nominal Safety
Substantive Safety

Examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures.
The expected or actual crash frequency and severity for a highway or roadway.
Crash Frequency and AADT

Before-After Crash Trends

- SPF
- Crash Rate = 1.24
- Crash Rate = 2.28

AADT

Crash Freq

Before

After
HSM Implementation...1
Completed

- Purchased 100 copies of HSM
- HSM Overview training (NCHRP 17-38)
  - 3 x 2-day sessions
- IHSDM training (NHI)
  - 1 x 2-day session
- Safety Management System Workshop (DiExSys)
  - 1 x 2-day session
- Pilot Applications of HSM Predictive Methods
  - 3 projects on the State Highway System
HSM Implementation...2
Ongoing/Planned

- Feasibility Study for Arizona’s Roadway Management Process using HSM and Safety Analyst
- Framework for Integration of Substantive Safety into the ADOT Project Development Process
- Data Needs for Tree Removal CMFs on Arizona State Highways
- I-10, 35th Ave to Sky Harbor Blvd, Safety Planning Study
HSM Implementation...3
Pilot Applications

- SR 260 Segment – Convert 2-lane undivided to 4-lane divided highway
  - HSIP funding justification using HSM-based NCHRP 17-38 spreadsheet
- I-8 at Araby Road – Convert signalized intersections to roundabouts
  - HSIP funding justification using HSM-based NCHRP 17-38 spreadsheet
- SR 264 Segment – Evaluate safety benefits of widening shoulder to 5-feet vs. 8-feet
  - Quantifying the safety effects of geometric design elements using IHDSM software
SR 264 Project in Northeast Arizona

**Project Information**

- Rural Minor Arterial
- Navajo County, Arizona
- Undivided Two-Lane, Two-Way Road
- 12-Foot Travel Lanes
- 0-1-Foot Shoulders
- Intermittent Right and Left Turn Lanes
- Intermittent Passing Lanes
### Crash and AADT Data

<table>
<thead>
<tr>
<th>SR 264 Crash Data</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Incapacitating Injury</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Non-Incapacitating Injury</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Possible Injury</td>
<td>13</td>
<td>7</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>Property Damage Only (PDO)</td>
<td>8</td>
<td>6</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21</td>
<td>20</td>
<td>2</td>
<td>13</td>
<td>2</td>
<td>56</td>
</tr>
</tbody>
</table>

*At the time of this study, the 2011 crash data input was still in progress and was therefore omitted from the analysis.

<table>
<thead>
<tr>
<th>SR 264</th>
<th>Observed 2010 AADT (vpd)</th>
<th>Projected 2016 AADT (vpd)</th>
<th>Projected 2036 AADT (vpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP 441.02-MP 446.18</td>
<td>5,010</td>
<td>7,400</td>
<td>9,900</td>
</tr>
<tr>
<td>MP 446.18-MP 446.91</td>
<td>6,429</td>
<td>8,600</td>
<td>12,150</td>
</tr>
<tr>
<td>MP 446.91-MP 448.37</td>
<td>5,199</td>
<td>6,000</td>
<td>7,350</td>
</tr>
<tr>
<td>MP 448.37-MP 475.50</td>
<td>4,102</td>
<td>4,350</td>
<td>5,400</td>
</tr>
</tbody>
</table>
Alternative Analysis

Major Design Elements

- Widening to 5-Foot shoulders
- Widening to 8-Foot shoulders
- Improving superelevation to bring into compliance with AASHTO recommendations

Additional Elements

- Centerline and shoulder rumble strips
- Flattening of side slopes
- Installing guardrail
Segment Prioritization
Budgetary Consideration

- Split into two separate segments to be constructed independently:
  - Segment I - MP 441.19 to MP 452.00
  - Segment II - MP 452.00 to MP 465.74
- Each segment was evaluated for prioritization
- Potential reduction in the total number of crashes over the 20-year analysis period
Crash Severity Distribution

Navajo and Hopi Rural 2-Lane

- Fatal: 12.4%
- Incapacitating Injury: 4.9%
- Non-Incapacitating Injury: 13.0%
- Possible Injury: 23.2%
- Property Damage Only (PDO): 46.5%
## Rural 2-Lane 2-Way Parameters

<table>
<thead>
<tr>
<th>Roadway Element</th>
<th>HSM Base Condition</th>
<th>Existing SR 264 (1-Foot Shoulders)</th>
<th>Alternative A (5-Foot Shoulders)</th>
<th>Alternative B (8-Foot Shoulders)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane width</td>
<td>12-Foot</td>
<td>12-Foot</td>
<td>12-Foot</td>
<td>12-Foot</td>
</tr>
<tr>
<td>Shoulder width</td>
<td>6-Foot</td>
<td>1-Foot</td>
<td>5-Foot</td>
<td>8-Foot</td>
</tr>
<tr>
<td>Shoulder type</td>
<td>Paved</td>
<td>Paved</td>
<td>Paved</td>
<td>Paved</td>
</tr>
<tr>
<td>Roadside hazard rating</td>
<td>3</td>
<td>Varies (6 or 7 most frequent)</td>
<td>Varies (1 or 2 most frequent)</td>
<td>Varies (1 or 2 most frequent)</td>
</tr>
<tr>
<td>Driveway Density</td>
<td>≤ 5 per mile</td>
<td>Per survey &amp; Holbrook District turnout database</td>
<td>Per survey &amp; Holbrook District turnout database</td>
<td>Per survey &amp; Holbrook District turnout database</td>
</tr>
<tr>
<td>Horizontal curves: length, radius, and presence or absence of spiral transitions</td>
<td>None</td>
<td>Per best fit alignment</td>
<td>Per best fit alignment (match existing)</td>
<td>Per best fit alignment (match existing)</td>
</tr>
<tr>
<td>Horizontal curves: Super elevation</td>
<td>None</td>
<td>Per as-builts &amp; survey</td>
<td>Per as-builts &amp; survey (match existing)</td>
<td>Per as-builts &amp; survey (match existing)</td>
</tr>
<tr>
<td>Grades</td>
<td>≤ 3%</td>
<td>Per as-builts &amp; survey</td>
<td>Per as-builts &amp; survey (match existing)</td>
<td>Per as-builts &amp; survey (match existing)</td>
</tr>
<tr>
<td>Centerline rumble strips</td>
<td>None</td>
<td>None</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Passing lanes</td>
<td>None</td>
<td>Per survey</td>
<td>Per survey (match existing)</td>
<td>Per survey (match existing)</td>
</tr>
<tr>
<td>Two-way left-turn lanes</td>
<td>None</td>
<td>Per survey</td>
<td>Per survey (match existing)</td>
<td>Per survey (match existing)</td>
</tr>
<tr>
<td>Lighting</td>
<td>None</td>
<td>Present @ US 191 Intersection</td>
<td>Present @ US 191 Intersection (match existing)</td>
<td>Present @ US 191 Intersection (match existing)</td>
</tr>
<tr>
<td>Automated speed enforcement</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

### Major Variations
- Shoulder Width
- Roadside Hazard Rating
- Centerline Rumble Strips
Expected Crash Output
## Expected Number of Crashes

### Segment Prioritization

<table>
<thead>
<tr>
<th></th>
<th>2016-2036 Expected Total Number of Crashes For Entire Project Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing Conditions</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>636.38</td>
</tr>
<tr>
<td><strong>Reduction in Total Crashes over Existing Conditions</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Percentage Reduction in Total Crashes over Existing Conditions</strong></td>
<td>N/A</td>
</tr>
</tbody>
</table>
## Benefit-to-Cost Ratio

### Design Alternatives

<table>
<thead>
<tr>
<th>Benefit / Cost (5-Foot Shoulders)</th>
<th>Annual Benefit</th>
<th>Annual cost</th>
<th>Benefit / Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3,873,681</td>
<td>$1,680,561</td>
<td></td>
<td>2.30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefit / Cost (8-Foot Shoulders)</th>
<th>Annual Benefit</th>
<th>Annual cost</th>
<th>Benefit / Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5,084,207</td>
<td>$2,678,713</td>
<td></td>
<td>1.90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefit / Cost (Superelevation Improvements)</th>
<th>Annual Benefit</th>
<th>Annual cost</th>
<th>Benefit / Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>$41,807</td>
<td>$135,464</td>
<td></td>
<td>0.31</td>
</tr>
</tbody>
</table>
Conclusions

Lessons Learned

- IHSDM provides a user-friendly interface for implementing the HSM Predictive Method to real world project applications
- IHSDM can be used to quantify the safety benefits for a wide variety of proposed improvements
- Improvements that can be evaluated using IHSDM is restricted to those identified in Part C of the HSM
- Based on the analysis outcome, 5-feet shoulder provides greatest safety benefit per dollar spent
Why Implement HSM?

Better Safety Performance

- Better safety analysis using quantitative approach to support decision-making
- Cost effective investments to reach our safety goals
- More directly integrate safety in the overall program and project development process
- Better assess tradeoffs with other values such as, cost, environmental concerns, right-of-way, and operations
- Communicate direct and meaningful return on investments in safety

Bottom line: More lives and injuries saved per dollar invested
Thank You!

Questions?

Comments?

Disclaimer: Information contained in this presentation are for informational purpose only and may not necessarily reflect current ADOT policies or guidelines.

For additional information, please contact

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