IHSDM Safety Analysis on I-83 Sec 079

Christopher Deats, PE
HNTB

Karen Colello, PE, PTOE, PSP
JMT

Melissa Mo
JMT
East Shore Section 3 (Section 079) Limits

29th Street to Susquehanna River
East Shore Section 3 (Section 079) Construction Projects
Scope of the I-83 HSM Analysis

- Completed for Point of Access Study
- Evaluate the safety performance of:
  - Existing Configuration
  - 2050 No Build
  - 2050 Preferred Build Alternative
- Components Analyzed:
  - Freeway Segments
  - Crossroad Ramp Terminal Intersections
  - Arterials
- Used IHSDM software & PennDOT Spreadsheet tool
Analysis Methodology

- New way to quantitatively evaluate safety
- Old Way: Crash Rates
  - Total Crashes (5 yrs) x 1,000,000 miles
  - AADT x 365 days x 5 yrs x Segment Length (miles)
  - Doesn’t account for roadway geometric conditions
- New Way: “Data-Driven” Analysis:
  - Uses roadway geometry, traffic volume, and historical crash data to estimate predicted safety performance of an existing or proposed roadway
HSM Methodology Overview

- Predictive Method, General Form:
  
  Predicted crash frequency =  
  
  SPF \times (CMF_1 \times CMF_2 \times \ldots) \times C

- SPF – Safety Performance Function
- CMF – Crash Modification Factors
- C – Calibration Factor
HSM Methodology Overview

- SPF, Safety Performance Function:
  - Regression models created for different facility types: Rural two-lane roads, multi-lane roads, urban/suburban arterials, freeways, intersections, etc
  - Developed for certain base conditions of that facility type

- Example: Freeway Segment, Multi-Vehicle Crashes
  \[ N_{spf,fs,n,mv,z} = L^* \times \exp(a + b \times \ln[c \times AADT_{fs}]) \]

- Where:
  - \( L^* \) = effective length of segment
  - AADT= traffic volume
  - \( a, b, c \) = coefficients specific to the SPF (and given in the HSM)

- Base conditions:
  - Lane Width = 12 ft
  - Inside Shoulder Width = 6 ft
  - Median with = 60 ft
  - Length of Horizontal Curve = 0 (not present)
  - Length of Median Barrier = 0 (not present)
  - Length of Type B Weave Section = 0 (not present)
HSM Methodology Overview

- **CMF, Crash Modification Factors**
  - A factor or a function
  - “Adjustment Factors”: Used to adjust SPF for any difference between your study site’s geometric conditions and the base conditions for the SPF

- **Example:**
  \[
  \text{Lane Width, CMF}_2 = \exp (a \times [Wl - 12]), \text{ if } Wl < 13 \text{ ft} \\
  = b, \text{ if } Wl \geq 13 \text{ ft}
  \]

- **C, Calibration Factor**
  - Calibrates the SPF for local conditions
  - Pennsylvania is currently developing these
HSM Methodology Overview

- Key Part of the Methodology = Segmentation
- Start a new segment wherever there is a change in any base condition:
  - Number of Lanes
  - Cross-Section (Lane width, shoulder width, etc)
  - Roadside Conditions
  - Alignment Change
  - Change in AADT
- HSM contains guidance for how to segment
- Segments can be of varying length
- HSM analysis results are reported by segment
HSM Methodology Overview

- **Results: What does the HSM Analysis give us?**
  - **Predicted** Average Crash Frequency, $N_{\text{predicted}}$: the number of crashes that can be expected for our site when compared with similar sites.
  - **Expected** Average Crash Frequency, $N_{\text{expected}}$: the number of crashes that can be expected for our site when compared with similar sites and weighted for the observed crash history at our site.
  - Potential for Safety Improvement, $PSI = \text{Expected} - \text{Predicted}$
    - Does not mean that a facility is “safe” or “not safe”
    - $PSI > 0$ = site experiences more crashes than predicted when compared with similar sites
    - $PSI < 0$ = site experiences less crashes than predicted when compared with similar sites
    - Tool used to prioritize projects
Tools for HSM Analysis

PennDOT Tool

- Can be used for:
  - Rural Two-Lane Roads
  - Rural Multilane Highways
  - Urban/Suburban Arterials
  - Intersections

- Not yet available for:
  - Freeways & Ramps
  - Roundabouts

- Data Needed:
  - Need Segments/Offsets
Tools for HSM Analysis

FHWA ISATE

- Can be Used for:
  - Freeway Segments
  - Ramp Segments
  - Ramp Terminal Intersections

- Data Needed:
  - Segment Freeways Manually
  - Requires Cross Section Data
  - Curve Information
IHSDM

- Can be used for:
  - Entire Project Network
  - Freeways (No Need to Segment Manually)
  - Rural, Suburban, Urban Environments
  - Freeways, Ramps, C-D Roads
  - Arterial, Local, Collector
  - Ramp Terminals, Intersections
- Latest Update can analyze Roundabouts
- Requires Detailed Data
  - Cross sections, Alignments
  - Additional Geometric Design Elements
## Tools for HSM Analysis Summary

<table>
<thead>
<tr>
<th>Can be used for:</th>
<th>Freeways</th>
<th>Ramps</th>
<th>Ramp Terminal Intersections</th>
<th>Rural Two-Lane Roads</th>
<th>Rural Multi-Lane Highways</th>
<th>Urban/Suburban Arterials</th>
<th>Intersections</th>
<th>Local &amp; Collector Rds</th>
<th>CD Roads</th>
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<tr>
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<table>
<thead>
<tr>
<th>Data Needed:</th>
<th>Segment/Offsets</th>
<th>Manually Segment Freeways</th>
<th>Cross Section Date</th>
<th>Curve Information</th>
<th>Alignments/Baselines</th>
<th>Stations/Locations for Geometric Changes</th>
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<tr>
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</table>
I-83 HSM Analysis

- IHSDM Crash Prediction Module
- Existing, No Build, and Build Conditions
- Freeway Segments & Crossroad Ramp Terminals
I-83 HSM Analysis

This table contains data that define the horizontal alignment of the highway centerline. Horizontal alignment element types are Tangent, Curve (simple curve), Spiral (between a Tangent and a Curve, or part of a Spiral-Spiral pair), and Deflection (horizontal deflection angle without horizontal curve).

<table>
<thead>
<tr>
<th>Type</th>
<th>Start Loc. (Sta. ft)</th>
<th>End Loc. (Sta. ft)</th>
<th>Curve Radius (ft)</th>
<th>Direction of Curve</th>
<th>Curve Side of Road</th>
<th>Radius Position</th>
<th>Deflection Angle (deg)</th>
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</thead>
<tbody>
<tr>
<td>Tangent</td>
<td>17+55.700</td>
<td>32+39.100</td>
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<td>Both Roadbeds</td>
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<td></td>
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<tr>
<td>Curve</td>
<td>32+09.100</td>
<td>42+76.520</td>
<td>5.702.50 Roht</td>
<td>Both Roadbeds</td>
<td>Both Roadbeds</td>
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<tr>
<td>Tangent</td>
<td>42+76.520</td>
<td>49+18.110</td>
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<td>Both Roadbeds</td>
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<tr>
<td>Curve</td>
<td>49+18.110</td>
<td>55+50.450</td>
<td>11.100.00 Left</td>
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<td>Both Roadbeds</td>
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<tr>
<td>Curve</td>
<td>55+50.450</td>
<td>92+39.020</td>
<td>9.130.00 Right</td>
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<td>Both Roadbeds</td>
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<tr>
<td>Tangent</td>
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<td>Both Roadbeds</td>
<td>Both Roadbeds</td>
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</table>
## I-83 HSM Analysis

- **Data Organization**
- **Can Import Excel into IHSDM**
- **Import CAD if available**
- **Land XML Files**

<table>
<thead>
<tr>
<th>Element Type</th>
<th>(Target Lane)</th>
<th>Curve Radius (ft)</th>
<th>Direction of Curve (Left or Right)</th>
<th>Start Station (ft)</th>
<th>End Station (ft)</th>
<th>Side of Road (Left or Right)</th>
<th>Priority</th>
<th>Type</th>
<th>Remarkable Sites (ft)</th>
<th>Remarks (ft)</th>
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</thead>
<tbody>
<tr>
<td>Tangent</td>
<td>77+25.00</td>
<td>2900.00</td>
<td>Right</td>
<td>77+25.00</td>
<td>78+00.00</td>
<td>Right</td>
<td>1290.00</td>
<td>800.00</td>
<td>4.00</td>
<td></td>
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<tr>
<td>Tangent</td>
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<td>2900.00</td>
<td>Right</td>
<td>107+25.00</td>
<td>108+00.00</td>
<td>Right</td>
<td>1290.00</td>
<td>800.00</td>
<td>4.00</td>
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<tr>
<td>Tangent</td>
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<td>2900.00</td>
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<td>138+00.00</td>
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<td>Right</td>
<td>1290.00</td>
<td>800.00</td>
<td>4.00</td>
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</tbody>
</table>

**Notes:**
- NID Flap B Germ Park: 77+25.75
- S ID Geoflap: 77+25.75
- NID C Flap Germ Park: 77+25.75
- S ID Geoflape Germ Park: 77+25.75
- NID Flap C Germ Park: 107+25.00
- S ID Geoflape Germ Park: 107+25.00
- NID Flap C Germ Park: 137+25.00
- S ID Geoflape Germ Park: 137+25.00
- NID C Flap Germ Park: 167+25.00
- S ID Geoflape Germ Park: 167+25.00

<table>
<thead>
<tr>
<th>Roadway Alignment</th>
<th>Lane</th>
<th>Side of Road (Left or Right)</th>
<th>Priority</th>
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<tbody>
<tr>
<td>Horizontal</td>
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<tr>
<td>Alignment</td>
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<table>
<thead>
<tr>
<th>Roadway</th>
<th>Element Type</th>
<th>Start Station (ft)</th>
<th>End Station (ft)</th>
<th>Side of Road (Left or Right)</th>
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<tbody>
<tr>
<td>NID</td>
<td>Flap B Germ Park</td>
<td>77+25.00</td>
<td>78+00.00</td>
<td>Right</td>
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<tr>
<td>S</td>
<td>ID Geoflape</td>
<td>77+25.00</td>
<td>78+00.00</td>
<td>Right</td>
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<td>NID</td>
<td>Flap C Germ Park</td>
<td>107+25.00</td>
<td>108+00.00</td>
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<tr>
<td>S</td>
<td>ID Geoflape</td>
<td>107+25.00</td>
<td>108+00.00</td>
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<tr>
<td>NID</td>
<td>Flap C Germ Park</td>
<td>137+25.00</td>
<td>138+00.00</td>
<td>Right</td>
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<tr>
<td>S</td>
<td>ID Geoflape</td>
<td>137+25.00</td>
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<tr>
<td>NID</td>
<td>Flap C Germ Park</td>
<td>167+25.00</td>
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<td>ID Geoflape</td>
<td>167+25.00</td>
<td>168+00.00</td>
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</table>

**Remarks:**
- 4 + 4 + 12 + 12
- 4 + 4 + 12 + 12
- 4 + 4 + 12 + 12
- 4 + 4 + 12 + 12
- 4 + 4 + 12 + 12
Results Interpretation

- Benefit of IHSDM = segments study area for you
- Challenge = can result in a lot of segments
- Some post-processing required to manage reporting of results

<table>
<thead>
<tr>
<th>Freeway Section</th>
<th>IHSDM Segments</th>
<th>Segment Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>FS31-3</td>
<td>I-83 NB Ramp B Gore Point to I-83 SB Ramp A Gore Point</td>
</tr>
<tr>
<td>2</td>
<td>FS4-20</td>
<td>I-83 SB Ramp A Gore Point to I-83 SB Ramp D Gore Point [End of SB C-D Road]</td>
</tr>
<tr>
<td>3</td>
<td>FS21-25</td>
<td>I-83 SB Ramp D Gore Point [End of SB C-D Road] to I-83 NB Ramp C Gore Point</td>
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<tr>
<td>4</td>
<td>FS57</td>
<td>I-83 NB Ramp C Gore Point to I-83 SB Ramp F Gore Point</td>
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<tr>
<td>5</td>
<td>FS28-35</td>
<td>I-83 SB Ramp F Gore Point to I-83 SB Ramp E Gore Point [SB C-D Road On-Ramp]</td>
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<tr>
<td>6</td>
<td>FS27</td>
<td>I-83 SB Ramp E Gore Point [SB C-D Road On-Ramp] to I-83 NB Ramp G Gore Point</td>
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<td>7</td>
<td>FS38-47</td>
<td>I-83 NB Ramp G Gore Point to I-83 NB Ramp J Gore Point</td>
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<td>8</td>
<td>FS48</td>
<td>I-83 NB Ramp J Gore Point to I-83 SB Ramp K Gore Point</td>
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<td>9</td>
<td>FS49-58</td>
<td>I-83 SB Ramp K Gore Point to I-83 NB Ramp L Gore Point</td>
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<td>I-83 NB Ramp L Gore Point to End of 3rd Lane NB</td>
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<td>11</td>
<td>FS62-60</td>
<td>End of 3rd Lane NB to I-83 SB Ramp M Gore Point</td>
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<tr>
<td>12</td>
<td>FS70-75</td>
<td>I-83 SB Ramp M Gore Point to I-83 NB Ramp N Gore Point [SB C-D Road Off-Ramp]</td>
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<tr>
<td>13</td>
<td>FS75-78</td>
<td>I-83 NB Ramp N Gore Point [SB C-D Road Off-Ramp] to Eastern Project Limit</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Segment Number/intersection Name/Cross Road</th>
<th>Start Location (Sta. ft)</th>
<th>End Location (Sta. ft)</th>
<th>Effective Length (mi)</th>
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<tbody>
<tr>
<td>1</td>
<td>17+55.700</td>
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</table>
Lessons Learned

No Need to Segment
- Gore point locations
- Ramps and Crossroad locations
  - Use to group together homogenous output segments

Importing to CAD can be a challenge
- Baselines need to be exact, i.e. to the gore points
- InRoads knowledge helpful

Time Management
- Data Compilation
- Program Troubleshooting
Thank you!