NCHRP 633
Impact of Shoulder Width and Median Width on Safety

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Background

- Objectives of roadway designs
  - Safety
  - Efficiency
  - Human and natural environment fit
- Need to evaluate alternatives
- Trade off geometric elements
- Guidelines vs. standards
Background (2/2)

- Project issues
  - Uniqueness
  - Context
- Safety implications
Research Objectives

- Understand relationships and quantify trade offs for design elements
- Develop information resources and decision tools for designers
Study Approach

- Literature review
- Data acquisition and analysis
- Model development and evaluation
- Guideline development
- Final report
Research Focus

- Multi-lane rural roads
- Data of interest
  - Lane width
  - Shoulder width and type
  - Median width and type
  - Clear zone
Literature Review

- Safety implications from design element trade-offs
- Not much on multi-lane rural roads
- Highway Safety Manual AMF values
  - 2 lane rural roads
Data

- Data for MN, CA, KY
- 1991-2002 period
- Data of interest
  - Lane width
  - Shoulder width and type
  - Median width and type
  - Clear zone (KY only)
## Data Distribution

<table>
<thead>
<tr>
<th>Variable</th>
<th>CA</th>
<th>MN</th>
<th>KY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (mi)</td>
<td>835.84</td>
<td>975.16</td>
<td>576.08</td>
</tr>
<tr>
<td>Segments</td>
<td>2,726</td>
<td>4,385</td>
<td>930</td>
</tr>
<tr>
<td>Number of crashes</td>
<td>30,413</td>
<td>16,244</td>
<td>30,788</td>
</tr>
<tr>
<td>Number of injury crashes</td>
<td>7,676</td>
<td>2,173</td>
<td>10,428</td>
</tr>
<tr>
<td>Segments with no crashes</td>
<td>68%</td>
<td>80%</td>
<td>63%</td>
</tr>
</tbody>
</table>
Data Issues

- Data issues
  - Princ. Arterial
  - 4 lanes
  - 12-ft lanes
  - 8-ft shoulders

- Guidelines for 4-lane rural roads with 12-foot lanes
Methodology

All crashes

Divided
  Single
  Multi

Undivided
  All

Same for Injury only crashes
Methodology (2/5)

- Negative binomial

\[ E[N] = Le^{b_0 + b_1 \ln \text{ADT} + b_2 X_2 + b_3 X_3 + \ldots + b_n X_n} \]

where \( E[N] \) number of crashes per year
\( L \) segment length
\( \text{ADT} \) average daily traffic
\( X_i \) explanatory variables
Methodology

Variables considered
- Functional class
- Right shoulder paved
- Left turn lane presence
- Median barrier presence
- Shoulder width
- Median width
Methodology

- Accident Modification Factors (AMF)
  - Use coefficients
  - \( \text{AMF} = e^{b_i} \)
  - \( b_i = 0.407 \) then \( \text{AMF} = e^{0.407} = 1.50 \)
Methodology

Guidelines

- Review NCHRP 633 models
- Appraise current knowledge
- Consult HSM models
- Use expert panel review
- Recommend AMF
Shoulder Width

- Width impacts crashes
- Positive effect
  - Wider shoulders reduce crashes
- Wider shoulders encourage higher speeds
- Interaction with lane width and number of lanes
## Shoulder Width AMF

<table>
<thead>
<tr>
<th>Category</th>
<th>0</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undivided</td>
<td>1.22</td>
<td>1.00</td>
<td>0.94</td>
<td>0.87</td>
<td>0.82</td>
<td>0.76</td>
<td>0.71</td>
</tr>
<tr>
<td>Divided</td>
<td>1.17</td>
<td>1.00</td>
<td>0.95</td>
<td>0.9</td>
<td>0.85</td>
<td>0.81</td>
<td>0.77</td>
</tr>
</tbody>
</table>

**Notes:** AMF for all crashes and severities

- Divided: Left and right shoulder widths
- Undivided: Right shoulders widths
Medians

- **Median effect**
  - Cross median crashes
  - Median related crashes
  - Total effect unknown

- **Median barrier presence**
## Median Width AMF

<table>
<thead>
<tr>
<th>Category</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-vehicle</td>
<td>1.00</td>
<td>0.91</td>
<td>0.83</td>
<td>0.75</td>
<td>0.68</td>
<td>0.62</td>
<td>0.57</td>
<td>0.51</td>
</tr>
</tbody>
</table>

**Notes:**
- AMF for all severities
- No effect on single vehicle crashes
Median Barrier

- Impact on crashes unknown
  - Increase due to presence
  - Decrease on severity
  - Median barrier type
  - Median barrier placement

- Data and models inconclusive
Application

- AMF estimate choice impact
- Single element
  - $\Delta N = \frac{AMF_i}{AMF_j} - 1$
- Multiple elements
  - $AMF_i \times AMF_j$
Application Example

Widen shoulder from 4 to 8 ft on a four lane undivided road

\[ AMF_4 = 0.71; \ AMF_8 = 0.94 \]

\[ \Delta N = \left( \frac{0.71}{0.94} \right) - 1 = -0.24 \]

24% crash reduction per year per mile
NCHRP 633 vs. HSM (1/2)

- **Shoulder width**
  - Similar trends
  - Divided: Same magnitude
  - Undivided: Larger differences
  - No AMF for shoulders over 8 feet
  - HSM shoulder related crashes only
NCHRP 633 vs. HSM

- **Median width**
  - Similar trends
  - HSM smaller reductions
  - HSM median related only crashes and barrier present
Conclusions

- AMF can be used for all crashes
- All for 4-lane rural roads with 12-ft lanes
- Supportive of HSM
- Additional work on median barrier
  - Type and placement
  - Crash types and severity