NCHRP Project 22-21
Median Cross-Section Design for Rural Divided Highways
Acknowledgements

NCHRP Projects Officer, Ray Derr

Project Team

Midwest Research Institute
  PI – Jerry Graham
Pennsylvania Transportation Institute
  Eric Donnell
  Sean Brennan
Project Objectives

Develop improved guidelines for designing median typical cross sections (i.e., width, slope, and barrier) on new and existing rural divided highways.
Project Scope

• Address the design of medians on rural divided highways
• Focus on medians of rural freeways
• Rural divided non-freeways have also been considered
• Intersections on non-freeways and barrier end treatments at intersections are outside scope of research
Traversable Medians
Medians with Barriers
Participating States

- California
- Missouri
- North Carolina
- Ohio
- Pennsylvania
- Washington
Field Data Collection Alternatives

- Manual field measurement
- Use of Penn State’s digital terrain mapping system

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Roadway length (mi) by median type</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traversable</td>
<td>Barrier</td>
<td>TOTAL</td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>1,139.33</td>
<td>644.51</td>
<td>1,783.84</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>89.01</td>
<td>147.54</td>
<td>236.55</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,228.34</td>
<td>792.05</td>
<td>2,020.39</td>
<td></td>
</tr>
</tbody>
</table>
Manual Field Data Measurement

- Used in Missouri
- Sampled a portion of study sites (20%)
- Used similar technique to that used in NCHRP Report 247
- Labor intensive
- Was replaced with automated approach in other states
Scanning System
Median Design Parameters Measured in the Field

• Total median width, ft
• Barrier offset, ft, for barrier medians
• Right shoulder width, ft
• Left shoulder width, ft
• Median slope
• Ditch width, ft
• Ditch depth, ft
Target Crash Types

Crash classification - employed computerized crash data to the maximum extent, but hard copy review was necessary for some crash types
Median-Related Crash Types

- Total median-related crashes
- CMC-cross median collisions, collision with opposing vehicle
- NCMC-cross median, non-collision crashes
- Rollover crash
- Hit-fixed-object crash
- Other median-related crash
Simulation of Vehicle Encroachments on Medians
Crash Frequency for Traversable Medians

<table>
<thead>
<tr>
<th>Crash type</th>
<th>Median-related crashes (percent of total)</th>
<th>Rollover crashes (percent of median-related)</th>
<th>CMC crashes (percent of median-related)</th>
<th>NCMC crashes (percent of median-related)</th>
<th>Fixed-object crashes (percent of median-related)</th>
<th>Other median-related crashes (percent of median-related)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Crashes</td>
<td>18,386</td>
<td>4,804 (26.12)</td>
<td>1,704 (35.47)</td>
<td>159 (3.30)</td>
<td>55 (1.14)</td>
<td>1,573 (32.74)</td>
</tr>
</tbody>
</table>
Crash Severity for Traversable Medians

<table>
<thead>
<tr>
<th>Severity level</th>
<th>Total crashes</th>
<th>Median-related crashes (percent of total crashes)</th>
<th>Rollover crashes (percent of median-related crashes)</th>
<th>CMC crashes (percent of median-related crashes)</th>
<th>NCMC crashes (percent of median-related crashes)</th>
<th>Hit-fixed-object crashes (percent of median-related crashes)</th>
<th>Other median-related crashes (percent of median-related crashes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>352</td>
<td>180 (51.13)</td>
<td>104 (57.77)</td>
<td>31 (17.22)</td>
<td>1 (0.55)</td>
<td>22 (12.22)</td>
<td>22 (12.22)</td>
</tr>
<tr>
<td>Injury</td>
<td>5,852</td>
<td>2,060 (35.20)</td>
<td>1,054 (51.16)</td>
<td>85 (4.12)</td>
<td>20 (0.97)</td>
<td>419 (20.33)</td>
<td>482 (23.39)</td>
</tr>
<tr>
<td>PDO</td>
<td>12,182</td>
<td>2,564 (21.04)</td>
<td>546 (21.29)</td>
<td>43 (1.67)</td>
<td>34 (1.32)</td>
<td>1,132 (44.14)</td>
<td>809 (31.55)</td>
</tr>
<tr>
<td>Total</td>
<td>18,386</td>
<td>4,804 (26.12)</td>
<td>1,704 (35.47)</td>
<td>159 (3.30)</td>
<td>55 (1.14)</td>
<td>1,573 (32.74)</td>
<td>1,313 (27.33)</td>
</tr>
</tbody>
</table>
Results - Median Width

• Crash Analysis
  – CMC crashes decrease with wider medians but rollover crashes generally increase. Similar magnitude but opposite directions.
  – CMC crashes had greater severity

• Simulations
  – Simulation found that there are diminishing returns to making medians wider
Results - Median Slope

• Crash Analysis
  – Flatter slopes are associated with more CMC crashes and fewer rollovers and fixed-object crashes

• Simulations
  – CMC crashes are of greatest probability with median width less than 60 ft and median slopes steeper than 1V:8H.
  – CMC probability does not keep increasing with flatter slopes
Optimal Median Geometry Analysis

Rollover Prone Median Profiles

Cross-Over Prone Median Profiles
Results- Adding Barriers to Medians

• Crash Analysis
  – Virtually eliminated CMC and NCMC crashes
  – Fixed-object crashes increased 6 to 9 times.

• Simulation
  – Provided some guidance on barrier placement, but results from Project 22-22 are needed
Results- Adding Barriers to Medians (continued)

• Benefit-Cost Analysis
  – Since CMC crashes are much more severe than rollover or fixed-object crashes, median barriers are cost effective
  – In particular, cable median barriers appear cost effective on freeways even at ADT of 10,000 vpd
Design Guidelines

• Recommend 1V:8H slopes, flatter near center of median if possible (i.e., U-shaped median preferred)
• Consider median barrier for medians up to 60 ft if slopes are 1V:8H or less
• Median barrier (particularly cables) may be cost-effective at ADTs as low as 10,000 vpd
Further Research

• Currently underway in NCHRP Project 17-44 – Factors Contributing to Median Encroachments and Cross-Median Crashes
• To be completed in 2012
QUESTIONS?