Module 5: Roadsides

Low Cost Safety Improvements

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Learning Outcomes

• Define the scope of the roadway departure safety issue in the U.S.
• Identify/describe some safety improvements and strategies that address roadside safety
• Interpret and apply the crash reduction potential of different treatment strategies related to roadside safety
Scope of the Issue

- Roadway departure crashes typically account for more than 50% of all roadway way fatalities
- 17,791 roadway departure fatalities in 2014 (FARS) or 54% of all fatalities
Some Reasons for Roadway Departure

- Adverse roadway conditions
- Collision avoidance
- Vehicle malfunction
- Driver error
- Distractions
- Others?

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**Rural Percentages of Top Three**

Percentage of Roadway Departure Fatal Crashes Occurring on Rural Highways Based on the 3 Most Prevalent “Most Harmful Events”

- Overturning: 80%
- Opposing Direction: 75%
- Trees or Shrubs: 65%

*Source: FHWA Roadway Departure Strategic Plan, March 2013*
Driver Limitations

Driver’s make mistakes because of human physical, perceptive, and cognitive limitations

<table>
<thead>
<tr>
<th>FACTORS that AFFECT the DIFFERENT COMPONENTS of PERCEPTION-REACTION TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Seeing/Perceiving</td>
</tr>
<tr>
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<tr>
<td>Seeing/Perceiving</td>
</tr>
<tr>
<td>Cognitive Elements</td>
</tr>
<tr>
<td>Cognitive Elements</td>
</tr>
<tr>
<td>Initiating Actions</td>
</tr>
</tbody>
</table>

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Some Typical Roadside Hazards

- Edge drop off
- Trees
- Utility and light poles
- Sign posts and mailboxes
- Rocks and boulders
- Ditches
- Drainage features and facilities
- Steep slopes
- Others?

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Examples

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General Methods to Address Hazards

• Remove
• Redesign
• Relocate
• Reduce severity
• Shield
• Delineate

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Some Treatments We Will Discuss

- Reduce edge drop
- Add a safety edge
- Paved shoulders
- Shoulder rumble strips and edgeline stripes
- Clear zone
- Flattening slopes
- Clear/relocate/replace obstacles
  - Hazardous trees
  - Utility poles
  - Non-crashworthy sign supports and mailboxes
- Adjust drainage features
- Change/install guardrail

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Reduce Edge Drop

- AAA Study (2006) suggests drop off becomes problematic between 2.25 and 2.5 inches.
- Matches well with typical 2 inch maintenance thresholds
- May be a relationship below this height but not detected in this study

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Add a Safety Edge

Helps errant vehicles to maintain stability, and more reliably gain re-entry

<table>
<thead>
<tr>
<th>Countermeasure</th>
<th>CRF</th>
<th>Crash type</th>
<th>Crash severity</th>
<th>Area Type</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install safety edge treatment**</td>
<td>6.5%</td>
<td>All</td>
<td>All</td>
<td>Rural</td>
<td>★★★★☆</td>
</tr>
<tr>
<td>Install safety edge treatment**</td>
<td>9.1%</td>
<td>Run off road</td>
<td>All</td>
<td>Rural</td>
<td>★★★★☆</td>
</tr>
</tbody>
</table>

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### Table 6. Percent change in crashes relative to providing a 6-foot shoulder on rural two-lane roadway segments (Modified from HSM Table 13-7).

<table>
<thead>
<tr>
<th>Shoulder Width</th>
<th>Percent change in crashes in comparison to roads with 6-foot shoulders</th>
<th>Average Annual Daily Traffic (AADT) (vehicles/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 400</td>
</tr>
<tr>
<td>0 ft</td>
<td>+ 10%</td>
<td>400-2,000</td>
</tr>
<tr>
<td>2 ft</td>
<td>+ 7%</td>
<td>&gt; 2,000</td>
</tr>
<tr>
<td>4 ft</td>
<td>+ 2%</td>
<td></td>
</tr>
<tr>
<td>6 ft</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>8 ft or more</td>
<td>- 2%</td>
<td></td>
</tr>
</tbody>
</table>

* Crash types: Single vehicle run-off-road, multiple vehicle head-on, opposite direction sideswipe, and same-direction sideswipe.

Low-Cost Treatments for Horizontal Curve Safety - 2016

<table>
<thead>
<tr>
<th>Countermeasure</th>
<th>CRF</th>
<th>Crash type</th>
<th>Crash severity</th>
<th>Area Type</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pave shoulder***</td>
<td>18%</td>
<td>Fixed object, head on, run off road, sideswipe</td>
<td>Serious injury, minor injury</td>
<td>Rural</td>
<td>★★★★☆</td>
</tr>
</tbody>
</table>

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Install Shoulder Rumble Strips

<table>
<thead>
<tr>
<th>Countermeasure</th>
<th>CRF</th>
<th>Crash type</th>
<th>Crash severity</th>
<th>Area Type</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install shoulder rumble strips***</td>
<td>16%</td>
<td>Run off road</td>
<td>All</td>
<td>Rural</td>
<td>★★★★★★</td>
</tr>
<tr>
<td>Install shoulder rumble strips***</td>
<td>36%</td>
<td>Run off road</td>
<td>Fatal, Serious Injury, Minor Injury</td>
<td>Rural</td>
<td>★★★★★★</td>
</tr>
</tbody>
</table>

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### Rumble Stripes (Edgeline)

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<table>
<thead>
<tr>
<th>Countermeasure</th>
<th>CRF</th>
<th>Crash type</th>
<th>Crash severity</th>
<th>Area Type</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install Edgeline Rumble Strips***</td>
<td>33%</td>
<td>Run off road</td>
<td>Fatal, Serious Injury, Minor Injury</td>
<td>Rural</td>
<td>★★★★★☆</td>
</tr>
</tbody>
</table>

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Rumble Stripes (Combo)

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<table>
<thead>
<tr>
<th>Countermeasure</th>
<th>CRF</th>
<th>Crash type</th>
<th>Crash severity</th>
<th>Area Type</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install shoulder rumble stripe, widen shoulder 0 to 2 feet, and pavement resurface***</td>
<td>12.3%</td>
<td>Head on, run off road</td>
<td>All</td>
<td>Rural</td>
<td>★★★☆☆☆</td>
</tr>
<tr>
<td>Install shoulder rumble stripe, widen shoulder 0 to 2 feet, and pavement resurface***</td>
<td>27.1%</td>
<td>Head on, run off road</td>
<td>Fatal, Serious Injury, Minor Injury</td>
<td>Urban</td>
<td>★★★☆☆☆</td>
</tr>
</tbody>
</table>

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Clear Zone - General

The unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles.

<table>
<thead>
<tr>
<th>Countermeasure</th>
<th>CRF</th>
<th>Crash type</th>
<th>Crash severity</th>
<th>Area Type</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase distance to roadside features (3.3 to 16.7 ft)</td>
<td>22%</td>
<td>All</td>
<td>All</td>
<td>Rural</td>
<td>★★★★★★</td>
</tr>
<tr>
<td>Increase distance to roadside features (16.7 to 30.0 ft)</td>
<td>44%</td>
<td>All</td>
<td>All</td>
<td>Rural</td>
<td>★★★☆☆</td>
</tr>
</tbody>
</table>

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### Flatten Slopes

<table>
<thead>
<tr>
<th>Countermeasure</th>
<th>CRF</th>
<th>Crash type</th>
<th>Crash severity</th>
<th>Area Type</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flatten slopes from 1:3 to 1:4***</td>
<td>42%</td>
<td>All</td>
<td>Serious injury, minor injury</td>
<td>Rural</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Flatten slopes from 1:4 to 1:6***</td>
<td>22%</td>
<td>All</td>
<td>Serious injury, minor injury</td>
<td>Rural</td>
<td>★★★★★</td>
</tr>
</tbody>
</table>

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### Table 13-18. Potential Crash Effects on Total Crashes of Flattening Sideslopes (15)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Setting (Road Type)</th>
<th>Traffic Volume</th>
<th>Crash Type (Severity)</th>
<th>CMF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sideslope in Before Condition</td>
</tr>
<tr>
<td>Flatten Sideslopes</td>
<td>Rural (Two-lane road)</td>
<td>Unspecified</td>
<td>All types (Unspecified)</td>
<td>1V:2H: 0.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1V:3H: 0.95</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1V:4H: 0.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1V:5H: 0.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1V:6H:</td>
</tr>
</tbody>
</table>

Base Condition: Existing sideslope in before condition.

**NOTE:** Standard error of the CMF is unknown.
Clearing/Relocating Obstacles

Table 40  Percent reductions in specific types of obstacle accidents due to clearing/relocating obstacles farther from the roadway (93)

<table>
<thead>
<tr>
<th>Increase in Obstacle Distance (I.O.D.), m (ft)</th>
<th>Trees (%)</th>
<th>Mailboxes, Culverts, &amp; Signs (%)</th>
<th>Guardrails (%)</th>
<th>Fences/Gates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9 (3)</td>
<td>22</td>
<td>14</td>
<td>36</td>
<td>20</td>
</tr>
<tr>
<td>1.5 (5)</td>
<td>34</td>
<td>23</td>
<td>53</td>
<td>30</td>
</tr>
<tr>
<td>2.4 (8)</td>
<td>49</td>
<td>34</td>
<td>70</td>
<td>44</td>
</tr>
<tr>
<td>3.1 (10)</td>
<td>57</td>
<td>N.F.</td>
<td>78</td>
<td>52</td>
</tr>
<tr>
<td>4.0 (13)</td>
<td>66</td>
<td>N.F.</td>
<td>N.F.</td>
<td>N.F.</td>
</tr>
<tr>
<td>4.6 (15)</td>
<td>71</td>
<td>N.F.</td>
<td>N.F.</td>
<td>N.F.</td>
</tr>
</tbody>
</table>

Notes:

N.F. = generally not feasible to relocate obstacles to specified distances.

I.O.D. = amount of increase in obstacle distance from roadway.

This table is appropriate for obstacle distances of 9.1 m (30 ft) or less and only on two-lane rural roadways.
Remove Hazardous Trees

- NCHRP 500 Volume 3: A Guide for Addressing Collisions with Trees in Hazardous Locations
- Highway Safety and Trees: The Delicate Balance (Video and brochure)

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Relocate Utility Poles #1

- CMF exists for change in lateral offset of utility poles
- CMF exists for change in longitudinal density of utility poles
- Ranked 3-Stars (for fixed object crashes in rural areas)
- CMFs vary by the offset and density change
- Study concluded that offset impacts are larger than spacing

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Source – NCHRP 440 (originally Zeeger and Parker, 1984)

Figure 18. Nomograph for predicting utility pole accident frequency (96).
Replace/Relocate Non-Crashworthy Sign Supports

Bad Example

MUTCD requires all sign supports within clear zone to be shielded or breakaway.

Breakaway sign supports, mailboxes and delineators that have a FHWA Eligibility Letter are on the FHWA Office of Safety website.
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Adjust Drainage Features #2

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Change/Install Guardrail

Used to shield roadside hazards

<table>
<thead>
<tr>
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<th>CRF</th>
<th>Crash type</th>
<th>Crash severity</th>
<th>Area Type</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Barrier along Embankment to Less Rigid Type</td>
<td>32%</td>
<td>Run off Road</td>
<td>Serious injury, minor injury</td>
<td>Not specified</td>
<td>★★★★★</td>
</tr>
<tr>
<td>New Guardrail along Embankment***</td>
<td>47%</td>
<td>Run off Road</td>
<td>Serious injury, minor injury</td>
<td>Not specified</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Install W-Beam Guardrail***</td>
<td>11%</td>
<td>Run off Road</td>
<td>Fatal, serious injury, minor injury</td>
<td>Rural</td>
<td>★★★★☆</td>
</tr>
</tbody>
</table>

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Learning Outcomes Revisited

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• Identify/describe some safety improvements and strategies that address roadside safety

• Interpret and apply the crash reduction potential of different treatment strategies related to roadside safety

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Review Question 1

What are the six options the Roadside Design Guide generally provides to address roadside obstacles?

- Remove
- Redesign
- Relocate
- Reduce severity
- Shield
- Delineate
Review Question 2

What are some of the roadside features that can present a hazard to vehicles if they have left the roadway?

- Pavement edge or shoulder drop off
- Slopes
- Trees
- Utility poles
- Mailboxes
- Non-Crashworthy sign supports
- Drainage features

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Some Resources

- Roadside Design Guide (2011)
- CMF Clearinghouse (www.cmfclearinghouse.org)
- NCHRP 500 - Volumes 3 (trees, 2003)), 6 (run-off-the-road, 2003), and 8 (utility poles, 2004)
- Low-Cost Treatments for Horizontal Curve Safety 2016

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