Speed and Crash Reduction of DSFSs (and Maybe a Couple Low Cost Treatments) on Rural Curves

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Background

- Crash rate 3 times higher on horizontal curves than tangent roadway sections
- Iowa: 12% of fatal and 15% of major injury crashes occur on curve
- 56% of fatal run-off-road curves are speed related
- Project sponsored by FHWA, IHRB, IDOT, and the Midwest Transportation Consortium
Objectives

- Evaluate effectiveness of 24 dynamic curve signs in 7 states
- Identify low-cost safety treatments which have been used to address speed and safety on rural horizontal curves for an additional 6 sites in Iowa
Site Selection

- Worked with seven states to select potential locations
  - Crash problem
  - Speeding problem
  - 2-lane rural paved curve
  - No changes 3 years before or 3 years after application of treatment
  - Made site visits
- Installed 22 signs in 7 states (IA, WA, OR, OH, FL, AZ, TX)
- Selected 6 additional high crash curve sites in Iowa for low cost
MN Project Installations
Evaluation of DSFS

- Dynamic speed feedback signs (DSFS) have been used in other applications to slow drivers
  - School zones
- DSFS consist of speed measuring device and sign message
  - Message only displayed to drivers who are traveling over a set threshold
  - Only targets “problem” drivers
• Evaluated different types of signs and messages
• Determined 2 was optimum number
  – Sample size
  – Ability to test multiple messages
• 2 sign types were used
  – Speed display
  – Corresponding curve warning sign
Low Cost Strategies

- Selected 2 other low cost strategies
  - Reflectorized treatments on existing chevron posts
    - 4 sites
  - On-pavement curve markings
    - 2 sites
Evaluation

• Collected speed and volume data
  – Before, 1-month, 12-month, 24-mon for DSFS
  – Before, 1-month, 12-month as some sites for low cost
  – Used pneumatic road tubes
    • 0.5 miles upstream of PC
    • At PC
    • At center of curve
Results for DSFS at PC

Mean Speed at PC
- Majority of sites had 1 to < 4 mph decrease
- Up to 23% had decreases 4 to < 7 mph

85th Percentile Speed at PC
- Majority of sites had 1 to < 4 mph decrease
- Up to 28% had decreases 4 to < 7 mph
- Around 10% had decrease ≥ 7 mph
Results for DSFS at Center of Curve

Mean Speed at CC
- Majority of sites had 1 to < 4 mph decrease
- Up to 10% had decreases 4 to < 7 mph
- Around 5% had decreases ≥ 7 mph

85th Percentile Speed at CC
- Majority of sites had 1 to < 4 mph decrease
- Up to 18% had decreases 4 to < 7 mph
- Around 5% had decrease ≥ 7 mph
Results for DSFS at PC

> 5 mph over advisory or posted

> 10 mph over advisory or posted

> 15 mph over advisory or posted

> 20 mph over advisory or posted
Comparison by Sign Type

- Speed sign appeared to be slightly more effective (i.e. more sites in general had higher reductions)
- However, Wilcoxon Signed Rank test indicated no statistical difference

Change in Mean Speed at Center of Curve

1 month

12 month

24 month
Crash Modification Factors for DSFS

- Crash data for up to 4 years before and up to 3 years after
- Compared crashes by quarter
  - Allowed for removal of quarter for install and times when sign was not functioning
  - Account for seasonal differences
- Used Full Bayes model

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Direction Type</th>
<th>Observed crashes</th>
<th>Estimated crashes</th>
<th>CMF (SE)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>both</td>
<td>52.1</td>
<td>54.6</td>
<td>0.95 (0.01)</td>
<td>0.93, 0.97</td>
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<tr>
<td>Total</td>
<td>one</td>
<td>32.5</td>
<td>34.8</td>
<td>0.93 (0.02)</td>
<td>0.89, 0.97</td>
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<tr>
<td>Single-vehicle</td>
<td>both</td>
<td>38.6</td>
<td>40.7</td>
<td>0.95 (0.01)</td>
<td>0.93, 0.97</td>
</tr>
<tr>
<td>Single-vehicle</td>
<td>one</td>
<td>22.3</td>
<td>23.4</td>
<td>0.95 (0.02)</td>
<td>0.91, 0.99</td>
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</table>
COMMENTS/QUESTIONS
(or a Low Cost Treatment Discussion)
Results for Low Cost
On-Pavement Curve Signing

- Applied on 2 rural curves
- thermoplastic

<table>
<thead>
<tr>
<th>Description of test sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>DMC 99</td>
</tr>
<tr>
<td>CR L20</td>
</tr>
</tbody>
</table>
On-Pavement Curve Signing

- DMC 99 site:
  - change in mean and 85th percentile speeds showed mixed results
  - Also mixed results for high end speeders
    - percentage of vehicles traveling 5 or 10 or more mph over the posted speed limit increased by up to 10 percent at the north PC but decreased significantly at the center of the curve and at the south PC.

- CR L20 site
  - mean and 85th percentile speeds decreased by up to 2 mph
  - moderate decreases in the percentage of vehicles exceeding the advisory speed by 5, 10, 15, or 20 or more mph resulted for the north and south PC (up to 7 percent)
  - significant decreases occurred at the center of the curve for all thresholds (up to 16 percent).
Additional Delineation

- 4 sites
- Added reflective sheeting to existing chevron post

**Description of test sites**

<table>
<thead>
<tr>
<th>Site</th>
<th>AADT (vpd)</th>
<th>Posted Speed Limit</th>
<th>Curve Advisory Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 52</td>
<td>2,280</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>CR Y52</td>
<td>1,710</td>
<td>55</td>
<td>40</td>
</tr>
<tr>
<td>221st Street</td>
<td>2,410</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>IA 141</td>
<td>830</td>
<td>55</td>
<td>35</td>
</tr>
</tbody>
</table>
Additional Delineation

• CR Y52
  – 2 mph decreases in mean and 85th percentile speeds
  – up to 10 percent in the percentage of vehicles traveling 5 or 10 or more mph over the advisory speed
  – Significant decreases in the percent of vehicles traveling 15 or 20 or more mph over the advisory speed.

• 221st Street
  – decreases up to 2 mph in mean and 85th percentile speeds
  – significant decreases resulted for vehicles traveling 5, 10, 15, or 20 mph or more over the advisory speed

• IA 141:
  – Decreases up to 1.9 mph resulted in mean and 85th percentile speeds
  – percentage of vehicles traveling a certain threshold over the advisory speed increased for the daytime period but decreased at night in most cases

• US 52:
  – mean and 85th percentile speeds were relatively constant from the before to 1 month after period.
  – moderate decreases in the percent of vehicles traveling 5, 10, 15, or 20 or more mph over the advisory speed (up to 6 percent) occurred for the daytime period
  – Up to 13% increase in percentage of vehicles traveling 5 or 10 more mph over the advisory speed for nighttime
  – Up to 6% decrease for vehicles traveling 15 or 20 mph over
Toolbox of Strategies

Table 1. Outline for countermeasure information in this toolbox

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Summarizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Countermeasure</td>
</tr>
<tr>
<td>Application</td>
<td>How the countermeasure has been applied, where the countermeasure is most effective, and so forth</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>Studies showing whether the countermeasure is effective, information about crash reductions, and speed changes, with the assumption that speed change can be used as a crash surrogate</td>
</tr>
<tr>
<td>Advantages</td>
<td>Countermeasure advantages, such as low cost</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>Main countermeasure disadvantages, such as long-term maintenance</td>
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</table>
Toolbox of Strategies

- Advance curve warning and advisory speed signs
- Chevrons and oversized chevrons
- Widening/paved shoulders
- Reflective barrier treatment
- High friction treatment
- Raised pavement markers
- Edge lines and wide edge lines
- Transverse pavement markings
- Vertical delineation
- Rumble strips and rumble stripes
- On-pavement curve signing
- Flashing beacons
- Dynamic curve warning systems
- Pavement inset lights