Safety Benefits of Wider Edge Line Pavement Markings

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Pavement Marking Expenditures

• Unit costs: $0.07 - $4.00 per ft

• Estimated 2014 State DOTs investment?

$1.25 billion
Where are PMs Needed?

- **Warrant criteria**
  - Volume
  - Pavement width
  - Functional classification

- **Recent impact studies**
  - Louisiana
  - Texas
  - Missouri
Operational Studies

• **Lane Placement**
  – Mixed results (-10 to +14 inch)
  – Net impact → none or very subtle

• **Speed**
  – No consistent and practical differences
  – No net difference on narrow highways (9 and 10 ft lanes)
  – No consistent differences between approach and midpoint speeds
How Bright?

• **Initial retroreflectivity levels**
  – Quality control / assurance
  – Based on materials / optics specified

• **Maintained retroreflectivity levels**
  – FHWA has initiated rule-making efforts
  – Only a few safety studies
    • Relationships becoming more clear
  – Operational / visibility
  – Subjective evaluations
<table>
<thead>
<tr>
<th>Year of Research</th>
<th>General Minimum Recommendation (mcd/m²/lx)</th>
<th>General Desired Recommendation (mcd/m²/lx)</th>
<th>Measurement Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>100</td>
<td>300-400</td>
<td>12-meter</td>
</tr>
<tr>
<td>1991</td>
<td>93</td>
<td>Not applicable</td>
<td>15-meter</td>
</tr>
<tr>
<td>1996</td>
<td>121</td>
<td>Not applicable</td>
<td>15-meter</td>
</tr>
<tr>
<td>1998</td>
<td>80-120</td>
<td>200</td>
<td>30-meter</td>
</tr>
<tr>
<td>2002</td>
<td>130</td>
<td>Not applicable</td>
<td>30-meter</td>
</tr>
</tbody>
</table>
Visibility Studies

![Box plot showing the relationship between retroreflectivity and end detection distance.](image-url)
## Vehicle Headlamps

<table>
<thead>
<tr>
<th>Headlamp Era</th>
<th>30 m</th>
<th>60 m</th>
<th>100 m</th>
<th>150 m</th>
<th>30 m</th>
<th>60 m</th>
<th>100 m</th>
<th>150 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970s</td>
<td>43.4</td>
<td>5.9</td>
<td>1.4</td>
<td>0.5</td>
<td>5.9</td>
<td>1.1</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>1980s</td>
<td>33.7</td>
<td>6.6</td>
<td>1.5</td>
<td>0.5</td>
<td>6.2</td>
<td>1.2</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>2000 era</td>
<td>40.1</td>
<td>9.4</td>
<td>2.3</td>
<td>0.7</td>
<td>11.3</td>
<td>1.9</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>current era</td>
<td>33.4</td>
<td>10.3</td>
<td>3.4</td>
<td>1.3</td>
<td>16.3</td>
<td>3.8</td>
<td>1.5</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Illuminance on pavement marking (lux)
# FHWA Proposed Minimum Pavement Marking Retroreflectivity Levels

<table>
<thead>
<tr>
<th></th>
<th>Posted Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤30</td>
</tr>
<tr>
<td>Two-lane roads with center line markings only</td>
<td>n/a</td>
</tr>
<tr>
<td>All other roads</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**Exceptions:**

1. When RRPMs supplement or substitute for a longitudinal line (see Section 3B.13 and 3B.14), minimum pavement marking retroreflectivity levels are not applicable as long as the RRPMs are maintained so that at least 3 are visible from any position along that line during nighttime conditions.

2. When continuous roadway lighting assures that the markings are visible, minimum pavement marking retroreflectivity levels are not applicable.
Criteria Levels for Markings

• **Visibility**
  – Based on how far/easy can they be seen

• **Safety**
  – Based on how they impact crashes

• **Automated Vehicles**
  – Yet to be established
Wide Pavement Markings (2006)

White = no response, Grey = implemented, Grid = not implemented
Wider Edgeline Markings

• May increase detection distances, but research results were inconsistent
• Little effect on lateral placement or speed
• Safety studies
  – Until now, no significant results
  – Naïve before-after crash studies
  – Insufficient data and lack of experimental control
SAFETEA-LU Study

Safety Effects of Wider Edge Lines on Rural, Two-Lane Roads

2006-2011
Statewide Retrospective Crash Analysis of Wider Edge Lines

- **Statewide surveys**
  - Do you use wider edge lines?
  - Where?
  - When?
  - Available crash data?

- **Michigan, Illinois, Kansas**
Summary of Safety Effects

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>15.0 – 30.1</td>
</tr>
<tr>
<td>Fatal and Injury</td>
<td>15.4 – 37.7</td>
</tr>
<tr>
<td>Day</td>
<td>12.0 – 29.1</td>
</tr>
<tr>
<td>Night</td>
<td>-2.4 – 30.7</td>
</tr>
</tbody>
</table>

- Kansas from 2001-2007, almost 1300 miles
- Michigan from 2001-2009, 787.8 miles
- Illinois from 2001-2006, 287 miles
Comparative B/C Analysis

• Used disaggregated fatal and injury crash reduction findings from Kansas data
• Used adjusted 2011 crash cost values from NHTSA
• Assumed waterborne paint:
  – $0.15 per foot for 6-in markings
  – 2 year service life
## Findings

<table>
<thead>
<tr>
<th>Treatment</th>
<th>B/C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wider Edge Lines</td>
<td>$33 - $55 per $1</td>
</tr>
<tr>
<td>Rumble Strips</td>
<td>$37 - $46 per $1</td>
</tr>
<tr>
<td>Chevrons</td>
<td>$9 - $46 per $1</td>
</tr>
<tr>
<td>RRPMs</td>
<td>$13 per $1</td>
</tr>
</tbody>
</table>
A Message from FHWA Associate Administrator for Safety, Tony Furst

I’d like to take this opportunity to remind the safety community of the incredible research potential that will be provided by the Strategic Highway Research Program’s (SHRP2) efforts to compile the largest, most comprehensive naturalistic driving study (NDS) ever.

Initiated several years back, the SHRP2 NDS collects data on trips taken by over 3,000 volunteers whose vehicles are instrumented to record vehicle location, forward radar, video of the forward roadway, and the driver’s face and hands. This information will be coupled with data provided by the vehicle itself, such as braking, speed, acceleration rate, brake, gear position, seat belt use, and air bag deployment. When the data collection is complete at the end of 2013, the database will include information on more than 5 million trips, 30 million travel miles, and 1 million driving hours.

This database will be linked by GIS to a Roadway Information Database (RID) so that motor vehicles can be tracked as they travel through a series of intersections, and the database will be linked to the National Spatial Data Infrastructure (NSDI) and the Federal Geographic Data Committee (FGDC) to provide the most current information on roadway geometry, weather, and conditions.

In This Issue:

- New Study Finds Overall Reduction in Crashes Due to Improvements Implemented From RSAs
- Missouri Implements Systematic Lane Departure Countermeasures to Combat Fatalities on State Roads
- ConnDOT Overhauls Crash Data Program, Partners with UConn to Establish Transportation Safety Research Center
- Report Proves Rural Two-Lane Highways See Safety Benefits from Wider Edge Lines
- New Jersey LTAP Conducts Engineering Symposium to Promote Safety in Pedestrian Design
Publications

• FHWA Final Report
  – FHWA-HRT-12-048

• Journal Accident & Analysis Prevention
  – September 2012 Edition
  – Volume 48, pages 317-325

• TTI Report Number 2012-1
  – An Evaluation of the Effectiveness of Wider Edge Line Pavement Markings
On-Going Pavement Marking Research
Day vs Night Comparisons

Chevrons

Day

Night

No Chevrons
Questions

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