

# Evaluation of Pavement Markings on Low-Volume Rural Roadways in Iowa

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# PROJECT BACKGROUND

- ▶ Iowa has extensive local system of paved rural roadways - ~18,000 miles
  - Approx. 8,800 miles serve low traffic volumes
  - Est. 1,100 miles have seal-coating treatments to address dust
- ▶ Most Iowa counties enhance paved and/or seal coated roadways with pavement markings
- ▶ Current MUTCD only requires markings for volumes much higher than 400 vpd

# GOAL, OBJECTIVE AND TASKS

- ▶ Goal: Investigate state of the practice for pavement marking use on low-volume rural roadways in Iowa
- ▶ Objective: Provide local agencies with additional information for low-volume pavement marking decision-making
- ▶ Tasks:
  - Literature Summary
  - Legal Considerations
  - Use Survey
  - Basic Safety Evaluation

# LITERATURE SUMMARY 1/4

## ▶ MUTCD Part 5

- Section 5E.02 - "*[c]enter line markings should be used ...consistent with the principles of this Manual and with the policies and practices of the road agency and on the basis of either an engineering study or the application of engineering judgment.*"
- Section 5E.03 - "[t]he purpose of edgeline markings is to delineate the left-hand or right-hand edge of the roadway..." and "*...should be considered for use on paved low-volume roads based on engineering judgment or an engineering study.*"

## ▶ MUTCD Part 3

- Section 3A.02 - Markings "*...that are no longer applicable for roadway conditions or restrictions and that might cause confusion for the road user shall be removed or obliterated to be unidentifiable as a marking as soon as practical.*"

# LITERATURE SUMMARY 2/4

## ► Safety-Related Impacts

- Highway Safety Manual - two-lane rural highway crash reduction factors from -5% to 26%
- Louisiana - multiple studies/methodologies, most robust found 15% CRF
- Kentucky - use edgelines only for lanes narrower than 8 feet, edgelines and centerlines for lanes 9+ feet
- Texas - basic crash comparison, edgelines reduced crash freq. by up to 26 percent on horiz. curves
- Virginia - no statistically significant difference in safety performance between low-volume roads with and without centerline and/or edgeline

# LITERATURE SUMMARY 3/4

## ► Operational Impacts

- Louisiana -Vehicles more centrally located in lane after addition of edgelines at night, but operated further from roadway edge
- Texas -Addition of edgelines had no significant vehicle positioning impact along narrow roads (18 feet)
- Pennsylvania -centerlines without edgeline but in combination with delineators or chevrons improved recognition of roadway geometry

# LITERATURE SUMMARY 4/4

- ▶ Costs - \$0.06 to \$0.12 per ft. based on Ntl., IA and SC figures
- ▶ Removal options
  - Blasting, grinding, burning, laser, chemical and masking
  - High percentage of marking should be removed to avoid driver confusion

# USE SURVEY 1/6

- ▶ Eight question survey distributed to county engineers
- ▶ Investigate and quantify current pavement marking practices along low-volume roadways
  - Paved (i.e., hot mixed asphalt), Portland cement concrete and seal coated
  - Factors considered when determining whether to paint centerline and/or edgelines
- ▶ 37 county engineers responded (40 percent)



# USE SURVEY 2/6

- ▶ Paved roadway markings (HMA and PCC)
  - 35 used centerlines and edgelines
  - 1 used centerline and no passing zone
  - 1 provided no response
- ▶ Seal coated roadway markings
  - 7 used centerlines and edgelines
  - 2 used centerline and no passing zone
  - 28 provided no response

# USE SURVEY 3/6

- ▶ Extent of pavement marking use - paved roadways
  - Most indicated they paint centerlines, no passing and edgelines
  - Non-response likely meant did not feel it applied to situation

Percentage of Roadway	Centerline/NPZ Only (Percent of Responses)	Centerline/NPZ and Edgeline (Percent of Responses)
100	0	82 (n = 28)
75	6 (n = 2)	9 (n = 3)
50	0	0
25	9 (n = 3)	3 (n = 1)
0	15 (n = 5)	3 (n = 1)
Non-Responsive (N/R)	70 (n = 24)	3 (n = 1)

\*Note: The percentages may not sum to 100 percent because of round off error.

# USE SURVEY 4/6

- ▶ Extent of pavement marking use - seal coated roadways
  - Majority did not use any markings with seal coats
  - Either did not mark or did not have any seal coated roadways

Percentage of Roadway	Centerline/NPZ Only (Percent of Responses)	Centerline/NPZ and Edgeline (Percent of Responses)
100	0	8 (n = 3)
75	0	5 (n = 2)
50	5 (n = 2)	0
25	8 (n = 3)	0
0	41 (n = 15)	51 (n = 19)
Non-Responsive (N/R)	46% (n = 17)	35 (n = 13)

\*Note: Percentages may not sum to 100 percent because of round off error.

# USE SURVEY 5/6

- ▶ Centerline/NPZ marking replacement interval on paved roadways
  - 2 years (n = 16, 43%)
  - 3 years (n = 5, 14%)
  - Annually (n = 8, 22%)
  - "Other" - paint half the county each year; replace when fading
- ▶ Edgeline replacement
  - 2 years (n = 17, 46%)
  - 3 years (n = 7, 19%)
  - 4 years (n = 3, 8%)
  - "Other" - paint half the county each year; visual inspection

# USE SURVEY 6/6

- ▶ Centerline/NPZ marking replacement interval on seal coated roadways
  - 2 years (n = 4, 11%)
  - 3 years (n = 1, 3%)
  - Annually (n = 1, 1%)
  - Majority did not respond
- ▶ Edgeline replacement
  - 2 years (n = 2, 5%)
  - 3 years (n = 2, 5%)
  - Majority did not respond

# BASIC SAFETY EVALUATION 1/3

- ▶ Exploratory analysis of pavement marking benefits and costs
- ▶ Calculate percent total crash reduction required to produce benefit-cost ratio of 1.0
- ▶ Approach considered hypothetical 1-mile (i.e., 52.8 stations) segment of paved and seal coated secondary roadway
  - Pavement marking costs
    - Centerline/NPZ - \$3.25 - \$6.00 per station, Iowa DOT- \$4.25, **\$244.46 per mile**
    - Centerline/NPZ and edgeline - \$11.00 - \$14.00 per station, Iowa DOT- \$12.75, **\$660.00 per mile**

# BASIC SAFETY EVALUATION 2/3

- Secondary road crash densities
  - For 10 year period from Iowa DOT Office of Traffic and Safety
  - Collected for each individual severity level
- Crash costs
  - Broken down by severity
    - Fatal = \$4,500,000
    - Major Injury = \$325,000
    - Minor Injury = \$65,000
    - Possible Injury = \$35,000
    - Property Damage Only = \$7,400
  - Assumed one fatality or injury was produced by a fatal or injury crash

# BASIC SAFETY EVALUATION 3/3

## ▶ Percent crash reduction calculation

- Percent Crash Reduction = (Pavement Marking Cost per Mile / Annual Crash Cost per Mile) \* 100
- Centerline/NPZ markings
  - Paved roadways - 0.42 percent reduction in total crashes required
  - Seal coated roadways - 1.9 percent reduction in total crashes required
- Centerline/NPZ and edgeline markings
  - Paved roadways - 1.1 percent reduction in total crashes required
  - Seal coated roadways - 5.1 percent reduction in total crashes required



# CONCLUSIONS 1/2

- ▶ MUTCD guidance points toward low-volume installation based on engineering studies or judgement
- ▶ Research on safety/operational impacts of pavement markings on low-volume roads was limited
  - ▶ Wide range of crash reductions reported
  - ▶ More research needed on safety impacts regardless of volume
- ▶ Majority of paved secondary roadways have both centerline and edgeline pavement markings, seal coated have combination or none
- ▶ Safety evaluation indicates crash reductions between 0.42 percent to 5.1 percent needed to achieve b-c of 1.0

# RECOMMENDATIONS

- ▶ Evaluating safety impacts on high- and low-volume roadways
- ▶ Develop secondary roadway pavement marking database
  - Record costs, characteristics, etc.
  - Assist in evaluating marking installation, maintenance, costs and safety impacts
- ▶ Create committee to develop sample policies related to pavement marking removal procedures

QUESTIONS?