TECHSUMMARY April 2014

State Project No. 30000730 / LTRC Project No. 13-2P

A Comprehensive Study on Pavement Edge Line Implementation

INTRODUCTION

Reducing the number of run-off-road (ROR) crashes is a top priority for rural two-lane highways, particularly narrow, rural two-lane highways. Previous research conducted by the Louisiana Transportation Research Center has concluded that placing edge lines on narrow rural two-lane highways centralizes vehicular lateral position, which should help reduce the number of crashes. This project uses the latest safety analysis method introduced by the first edition of Highway Safety Manual (HSM) to estimate the safety benefits of edge line on narrow, rural two-lane highways. The crash data from three years before and after edge line implementation were used to develop a crash modification factor.

The crash modification factors (CMFs) for placing standard edge line markings on rural two-lane highways (without mentioning the width of pavement) is given by the first edition of HSM. However, the range of the CMF (0.09, 1.10) does not indicate a positive impact with certainty. The current Manual on Uniform Traffic Control Devices (MUTCD) does not require implementing edge lines on narrow, rural two-lane highways with average annual daily traffic volume (AADT) less than 6,000. The AADT on all narrow, rural two-lane highways in the state is less than 6,000. Thus, a comprehensive study on edge line is needed in Louisiana.

OBJECTIVE

The goal of this project was to investigate the safety impact of pavement markings on narrow rural, two-lane highways in Louisiana. Specifically, the research objectives were to:

- Conduct a complete before-and-after crash analysis to estimate the crash reduction factors.
- Conduct a crash characteristics analysis.
- Conduct a benefit-cost analysis.

SCOPE

The study used the selected two-lane highways with pavement width less than 22 ft. from all DOTD districts. The edge lines were placed on all selected segments in 2008. Thus, in the analysis the three before years were 2005, 2006, 2007, and the three after years were 2009, 2010, 2011. The improved safety prediction and Empirical Bayes (EB) methods were used in the analysis.

METHODOLOGY

Evaluating the Quality of Edge lines

Because it has been five years since edge lines were first implemented on the selected narrow two-lane highways, the research team inspected the quality of edge lines by viewing all segment videos at the District 3 office. Two segments were removed due to the fading edge lines.

Developing CMF

Theoretically speaking, the true impact of a treatment should be the difference between the predicted safety after the treatment and the predicted safety in the after period if the treatment were not implemented. Two methods are used to estimate the expected crash change between the before and after time periods with the results shown in the following table.

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	Section length (miles)	No. of control sections	$\hat{\delta}$ (expected crash difference)	$\hat{\theta}$ (estimated CMF)	$sd\ (\hat{\theta})$ (standard deviation of CMF)
Improved prediction method	109.64	28	174	0.83	0.058
Empirical Bayes method				0.84	0.039

Table 1
Expected crash change between before and after

In the last few years, the state, like the whole country, is experiencing a significant crash reduction. Based on the researchers' analysis, the crash reduction is nearly 3.52% for all rural two-lane highways and is 1.3% for narrow, rural two-lane highways (less than 22 ft. and bigger than or equal to 20 ft.) during the study period. Considering this fact, the final estimated crash modification factor by the EB method is 0.85 (0.84+0.01) with a standard deviation 0.039. The range for the estimated CMF is 0.73, 0.96.

Investigating Crash Characteristics

A crash characteristics analysis was performed to see how crash change occurs by time, collision type, pavement condition, and speed. It is clear the crash reduction occurs in all crash categories, particularly the single vehicle crash that is the targeted crash type.

Benefit-cost Analysis

The cost for placing 6-in. wide waterborne edge lines varies based on the agency rate and material. According to the Louisiana estimate, the average cost (or saving) for a fatal crash is $4,376,304, for an injury crash is $137,670, and for a property damage only crash is $3,292. The observed reduction of crashes is considered for benefit-cost analysis. One fatal crash increase in after years is excluded from the calculation because the number of annual fatal crashes is highly random with small sample size. The estimated benefit-cost ratio for edge line installation ranges from 18.89 to 117.53 based on agency rate and material.

RECOMMENDATIONS

1. Placing edge line does reduce the number of crashes. The estimated CMF is 0.85, which means there is a 15 percent expected crash reduction in edge line implementation on narrow rural two-lane highways in Louisiana.
2. The crash reduction is consistent in all crash types and particularly significant in single vehicle crashes. Most of the single vehicle crashes are ROR crashes.
3. The CMF range (0.73, 0.96) indicates a certainty in crash reduction with edge line.
4. The benefits overwhelmingly offset the cost with edge line implementation.

CONCLUSIONS

It is recommended to establish a policy for asking each district to implement edge lines if sufficient resources are available. Under financial or operational constraints, roadways with higher traffic volumes should have priority to have edge lines implemented.