Retroreflective Borders on Traffic Signal Backplates

A South Carolina Success Story

This case study is one in a series documenting successful intersection safety treatments and the crash reductions that were experienced. Traffic engineers and other transportation professionals can use the information contained in the case study to answer the following questions:

- What is a simple inexpensive treatment to reduce crashes at signalized intersections in urban areas that occur due to reduced visibility?
- How many crashes did this treatment reduce?
- Are there any implementation issues associated with this treatment, and if so, how can they be overcome?

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U.S. Department of Transportation
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Safe Roads for a Safer Future
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Introduction

Red-light running is one of the most serious traffic problems that Americans face today. It is estimated that vehicles running red lights cause more than 200,000 crashes, 170,000 injuries and approximately 900 deaths per year[1]. Some of these crashes occur because drivers are unaware of the presence of an intersection or are unable to see the traffic control device in time to comply.

The use of retroreflective borders on existing signal backplates to increase the visibility of traffic signals (particularly at night or under low-visibility conditions) is a simple, inexpensive countermeasure that can reduce crashes by improving driver awareness of traffic signals[2].

Objective

The following case study showcases a successful and effective low-cost treatment that measurably improved safety at three signalized intersections in Columbia, South Carolina (SC). The treatment consisted of adding a retroreflective border to the existing signal backplates.

"Since the addition of retroreflective borders at three test locations in Columbia, an overall reduction in total crashes was found. The South Carolina Department of Transportation hopes to continue to use retroreflective borders as a low cost safety improvement tool when appropriate."

Joey Riddle
South Carolina Department of Transportation

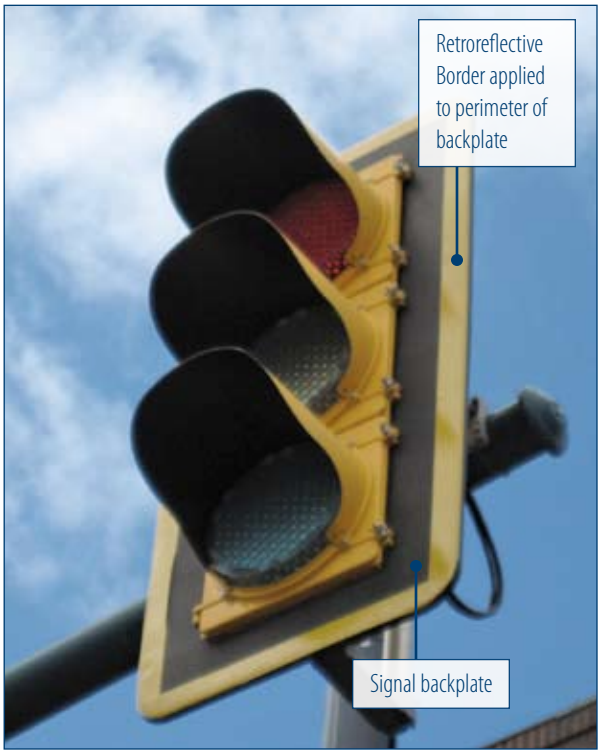

Photo courtesy of K.L.S (used with permission).

Figure 1: Retroreflective backplate border

[1] *Federal Highway Administration Office of Safety Red-Light Running web site (http://safety.fhwa.dot.gov/intersection/redlight).*

Treatment Summary

All intersection examples used in this report are from Columbia, SC. Existing intersection treatments met minimum Manual on Uniform Traffic Control Devices (MUTCD) standards.

This case study examines the application of a three-inch, yellow retroreflective border to existing signal backplates (framing the signal head) at three intersections. The border was visible during the day, but its visibility increased significantly at night and under limited visibility conditions (as shown in Figure 2). In addition, retroreflective borders added to signal backplates can help road users to more readily detect the presence of a signalized intersection during power outages.

Evaluation Methodology

This case study examines three signalized intersections in Columbia, SC, with a high incidence of crashes due to driver violation of the traffic signals. Crash reduction results were based on a review of "before and after" data from these intersections during 54 -month periods, between 2003—2007[3]. (The "before" and "after" observation periods ranged from 25 - 29 months).

Photos courtesy of South Carolina Department of Transportation (used with permission).

Figure 2: Retroreflective backplate borders

[2] *The Manual of Uniform Traffic Control Devices (MUTCD) allows the optional use of signal backplates, stating that a signal backplate is "a thin strip of material that extends outward from and parallel to a signal face on all sides of a signal housing to provide a background for improved visibility of the signal indications" (Section 4A.02 Definitions Relating to Highway Traffic Signals of the 2003 MUTCD). While the use of only the backplates does increase the contrast between the signal head and its background, backplates are only effective in lighted conditions for increasing the signal head's visual target size and for providing contrast against backgrounds such as trees, sky, clouds, and, especially, sun. (Section 4D.17, Visibility, Shielding, and Positioning of Signal Faces of the 2003 MUTCD).*

[3] *Note that crash reduction averages in this report reflect the percent reduction per year based on the difference between the total number of "before" and "after" crashes. Only crashes occurring within 250 feet of the intersections were considered.*

Results

Problem: Drivers were violating traffic signals at three signalized intersections due to low visibility, leading to a high number of crashes at these intersections.

Solution: The South Carolina Department of Transportation (SCDOT) installed yellow retroreflective borders around the perimeter of the face of existing signal backplates at selected signalized intersections in June, 2005.

Table 1: Summarizes the "before and after" crash analysis at the treated intersections Following the table is a brief discussion of the results at each intersection.

Locations	Implementation Date	Before				After				Percent Reduction In Crashes/Year		
		Months	Total Crashes	Injury Crashes	Late-night/Early-morning Crashes	Months	Total Crashes	Injury Crashes	Late-night/Early-morning Crashes	Total Crashes	Injury Crashes	Late-night/Early-morning Crashes
Sumter Highway (US 378) with Lower Richland Boulevard (S-37)	June-05	29	33	17	7	25	21	10	6	26.2%	31.8%	0.6%
I-26 Westbound (WB) with Piney Grove Road (S-1280)	June-05	29	13	5	8	25	9	1	1	19.7%	76.8%	85.5%
Piney Grove Road (S-1280) with Jamil Road (S-1791)	June-05	29	19	0	8	25	10	1	3	38.9%	NA	56.5%
TOTAL		**87**	**65**	**22**	**23**	**75**	**40**	**12**	**10**	**28.6%**	**36.7%**	**49.6%**

Table 1: Summary of "Before" and "After" Results at the Treated Intersections.

Sumter Highway (US 378) with Lower Richland Boulevard (S-37)

Sumter Highway (US 378) has three lanes in each direction; while Lower Richland Boulevard (S-37) consists of a single lane in each direction, with an additional right-turn lane at US 378. Both roadways have a speed limit of 45 mph. Average daily traffic (ADT) at this intersection decreased from 37,900 in the "before" period to 35,725 in the "after" period[4]. Retroreflective borders were installed only on signal backplates on Sumter Highway (US 378).

The treatment resulted in an average crash reduction of 26.2 percent and reduced injury crashes by 31.8 percent per year at this intersection. The total number of late-night/early-morning crashes remained relatively stable.

I-26 Westbound (WB) with Piney Grove Road (S-1280)

The I-26 WB on-ramp has two lanes, while the off-ramp has three lanes (one left-turn only, one shared left/through lane, and one right-turn only). Piney Grove Road (S-1280) has a speed limit of 40 mph, with two through lanes and a separate left-turn lane in each direction. Intersection ADT was 29,480 for both the "before" and "after" periods. Retroreflective borders were installed only on Piney Grove Road (S-1280).

The treatment resulted in an average crash reduction of 19.7 percent, reduced injury crashes by 76.8 percent per year and reduced late-night/early-morning crashes by 85.5 percent per year at this intersection.

Piney Grove Road (S-1280) with Jamil Road (S-1791)

Piney Grove Road (S-1280) has a speed limit of 40 mph with two through lanes and a separate left-turn lane in each direction. Jamil Road (S-1791) has a 35 mph speed limit with a single through lane and a separate left-turn lane in each direction. Intersection ADT was 35,940 for both the "before" and "after" periods. Retroreflective borders were installed only on Piney Grove Road (S-1280).

This intersection experienced the largest drop in total crashes—The treatment resulted in an average crash reduction of 38.9 percent and reduced late-night/early-morning crashes by 56.5 percent per year. Injury crashes increased slightly from zero in the before period to one in the after period.

[4] Note that crash reduction averages in this report reflect the percent reduction per year based on the difference between the total number of "before" and "after" crashes.

Discussion

Implementation Issues

SCDOT experienced no implementation issues with this countermeasure. However, if a traffic signal is not equipped with a backplate, implementation plans will need to account for the addition of backplates, as well as an increase in needed support strength to accommodate the backplate load on the mast arm or cable.

Cost

The costs for implementing the countermeasure were approximately $1,500 per intersection[5].

Time Frame

The installation of the retroreflective border on existing signal backplates at each intersection was completed within two hours.

Effectiveness

The addition of a retroreflective border (as shown in Figure 3) to existing signal backplates was effective in reducing overall crashes at these signalized intersections. SCDOT attributes their success to targeting appropriate intersection approaches that would benefit from this enhanced treatment—specifically, intersections where conditions allow an approaching driver to see the enhanced traffic signal at a distance, in time to respond. Further, SCDOT is in the process of implementing a district wide (District One) program to install retroreflective borders at other signalized intersections.

Summary of Results

The "before" treatments at all three intersections met minimum MUTCD standards. The safety enhancement discussed in this study increased the visibility of the traffic signal and reduced crashes. **The three intersections combined experienced a 28.6 percent reduction in total crashes, 36.7 percent reduction in injury crashes, and 49.6 percent reduction in late-night/early-morning crashes after the installation.** The average reductions in crashes achieved by the treatments exceed the expected crash reductions for adding retroreflective borders to signal backplates in urban areas of 15 percent mentioned in the Desktop Reference for Crash Reduction Factors (September 2007), published by the United States Department of Transportation (USDOT) FHWA[1].

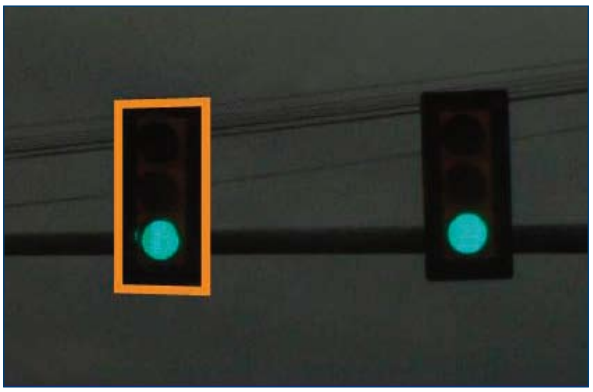

Photo courtesy of KLS (used with permission).

Figure 3: Retroreflective borders installed on signal backplates

[5] *Cost estimate does not include costs of the signal backplate.*

References

1) Desktop Reference for Crash Reduction Factors, FHWA-SA-07-015, USDOT FHWA September 2007.

2) Senior Mobility Series: Article 4: Marking the Way to Greater Safety by Gene Amparano and David A. Morena FHWA July/August 2006 · Vol. 70 · No. 1.

3) MUTCD - Interim Approval for Use of Retroreflective Borders on Signal Backplates, Regina S. McElroy, Director, Office of Transportation Operations. February 6, 2004; (can be accessed at http://mutcd.fhwa.dot.gov/res-interim_approvals.htm).

4) Miska, E., P. de Leur, and T. Sayed. "Road Safety Performance Associated with Improved Traffic Signal Design and Increased Signal Conspicuity." ITE, 72nd Annual meeting, Philadelphia, PA. Washington, DC, 2002.

5) Sayed, T., Abdelwahab, W., and Nepomuceno, J., "Safety Evaluation of Alternative Signal Head Designs," Transportation Research Record, Transportation Research Board, Vol. 1635, pp. 140-146, 1998.

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