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Safety Effectiveness of the Rectangular Rapid Flashing Beacon

FACT SHEET

INTRODUCTION AND STUDY OBJECTIVE

The Federal Highway Administration conducted a safety evaluation of rectangular rapid flashing beacons (RRFBs), including developing crash modification factors (CMFs) and benefit-to-cost (B/C) ratios. The RRFB includes two rapidly-flashed rectangular-shaped yellow indications, each with a light-emitting diode-array based pulsing light source that flashes in a prescribed pattern and sequence placed beneath a crossing warning sign at uncontrolled approaches (figure 1). The RRFBs emphasize the crossing sign at marked crosswalks on uncontrolled approaches, attracting drivers' attention from a greater distance and giving drivers a longer response time. Several studies reported increases in driver-yielding rates after RRFB installation.[1,2] However, additional studies using crashes to evaluate the safety benefits of RRFBs are needed.[3,4]

DATA

The study used Google® Maps™ to collect data for RRFB installation and comparison sites in California, North Carolina, Oregon, Pennsylvania, and Texas, and categorized them into three groups:[5]

- Treated (T) group: RRFBs (figure 1).
- Untreated comparison groups:
  - Signal (S) group: traffic control signal, midblock pedestrian signal, or pedestrian hybrid beacon.
  - Uncontrol (C) group: all crossings not within the treated or signal groups.

Additionally, data such as crash and volume were collected from States' online crash databases and other resources.[6,7,8]

SAFETY EFFECTIVENESS EVALUATION METHOD

The study estimated CMFs by applying cross-sectional generalized linear regression to the dataset with matched treatment and comparison sites. This method was selected because RRFB installation dates were often unavailable, limiting before-after analyses. Initially, the research team assessed the safety effectiveness compared to the C comparison group. However, due to sample size (small number of sites and the small number of crashes at each site) and model convergence issues, researchers based their analyses on comparing an aggregated C and S comparison group.

Figure 1. Photo. Example of an RRFB in Texas.

FINDINGS—SAFETY BENEFITS OF RRFB TREATED GROUPS

Compared to C Comparison Group

The CMF for any crash type (e.g., total crashes, fatal and injury crashes (F&I), pedestrian (ped), or pedestrian at night (ped night)) was not significant except for rear-end crashes (table 1). The findings from this analysis show an increase in rear-end crashes.

Compared to Aggregated C and S Comparison Group

Positive safety effects of RRFBs were observed across different crash types considered when compared to the aggregated Uncontrol (C) and Signal (S) comparison group. As shown in table 1, all CMFs were statistically significant.

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Table 1. CMF estimates obtained with different comparison groups.

Crash Type	Crash Type Subcategory	Compared to C group CMF[2]	Compared to C and S Group CMF[2]
Total[1]	All types/severities	1.11	***0.52***
	Rear-end	***1.38***	***0.52***
	Ped related	1.19	***0.57***
	Ped at night related	0.93	***0.48***
F&I	All F&I related crashes	1.17	***0.59***
	Ped related	1.23	***0.63***
	Ped night related	0.94	***0.55***

[1]California data did not contain property damage only crashes, and were, therefore, excluded from this analysis.
[2]Values greater than 1.0 indicate an increase in crashes, while values smaller than 1.0 indicate a reduction in crashes.
CMF equal to 1.0 means no change in crash frequencies.
Note: Statistically significant results (at $\alpha = 0.05$) are denoted in bold and italics.

BENEFIT AND COST ANALYSIS FOR PEDESTRIAN CRASHES

Using guidance provided in Lawrence et al., with an average RRFB installation cost of $4,500, and CMF of 0.57, the B/C ratio for pedestrian crashes was 1.45.[9]

DISCUSSION

Statistical power and choice of comparison group strongly influence results. The C comparison group had many convergence issues due to small sample sizes and low crash counts; adding signalized sites improved statistical significance. However, using signalized intersections compared to the RRFB could be questioned, especially for the vehicle-only crashes. In most, but not all situations, the RRFB is installed at a pedestrian crossing that is uncontrolled rather than signalized. In a few cases, the RRFB treatment was installed where a signal was removed. Despite these justifications, the comparison with uncontrolled crossings (C comparison group) is the preferred approach. Findings show RRFB can be associated with significant reductions in total and nighttime pedestrian crashes when compared to an aggregated set of uncontrolled and signalized sites. Still, evidence is mixed when compared strictly to uncontrolled crossings—notably showing potential increases in rear-end crashes. Decisionmakers should combine these findings with local site analyses and consider FHWA's proven safety countermeasures (e.g., signing, speed management, medians) to maximize pedestrian safety while minimizing unintended crash increases.

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