TECHBRIEF

Pedestrian and Bicycle Safety

Comparison of Driver Yielding for Rectangular Rapid-Flashing Beacons Used Above and Below Pedestrian Crossing Signs

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Introduction

Traffic control devices, such as rectangular rapid-flashing beacons (RRFBs), have been shown to increase the number of drivers yielding to crossing pedestrians. Evaluations of field installations of these devices have been conducted in several locations, including Florida, Texas, Oregon, Michigan, Arizona, Wisconsin, and Calgary, AB. (See references 1 through 10.) Before-after studies have shown a large increase in driver yielding between the before period (range of 1 to 83 percent) to the after period (range of 38 to 98 percent). Although the RRFB is allowed under interim approval from the Federal Highway Administration (FHWA), there is a growing interest in adding it to the *Manual on Uniform Traffic Control Devices* (MUTCD).[11,12] The Signals Technical Committee (STC) of the National Committee on Uniform Traffic Control Devices, which assists in developing language for chapter 4 of the MUTCD, is interested in research and/or assistance in developing materials on the design, application, and effectiveness of the RRFB. One of the areas for which the STC is seeking advice is the position of the beacons relative to the crossing sign. For example, does positioning the beacons above the sign improve the driver's ability to see a pedestrian crossing or waiting to cross and thus yield to crossing pedestrians?

This TechBrief describes the methodology and results from an open-road study sponsored by FHWA that examined driver yielding behavior at crosswalks with RRFBs positioned above the pedestrian crossing sign and at crosswalks with RRFBs positioned below the sign.

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FHWA Interim Approval of RRFB

On July 16, 2008, FHWA issued Interim Approval 11 (IA-11) for the optional use of the RRFB at uncontrolled pedestrian and school crosswalks.[11] As defined in IA-11, the RRFB shall consist of two rapidly and alternately flashing rectangular yellow indications that have light emitting diode array-based pulsing light sources.[11] When IA-11 was issued, the only position for the beacons in the pedestrian sign assembly was between the crossing warning sign and the supplemental plaque.[11] IA-11 describes the position as a specific exception to the then-current 2003 MUTCD section 4K.01 guidance, stating that the RRFB shall be located between the bottom of the crossing warning sign and the top of the supplemental downward diagonal arrow plaque (or, in the case of a supplemental advance sign, the AHEAD plaque), rather than 12 inches above or below the sign assembly.[11]

Study Objective

The objective of this study was to determine benefits of different positions for the RRFBs being used with pedestrian or school crossing signs. The study included both a closed-course and an open-road portion. This TechBrief is focused on the open-road study. Details on the closed-course study are available in another TechBrief.[13] Because the closed-course study indicated that benefits may exist for placing the beacons above the sign, the open-road study investigated whether drivers yield differently to RRFBs placed above the pedestrian crossing sign instead of below the pedestrian crossing sign. This study measured the percentage of drivers yielding to crossing pedestrians at the same pedestrian crosswalk when the beacons were located above the crossing warning signs and when the beacons were located below the crossing warning signs.

Study Sites

Near the conclusion of the closed-course study, the researchers talked to agency representatives and made requests during professional society meetings, seeking agencies that would be willing to participate in the open-road research.[13] Four agencies volunteered: Aurora, IL; Douglas County, CO; Marshall, TX; and Phoenix, AZ. The agencies were asked to identify at least two sites that could be used in this study.

Examples of study assemblies are shown in figure 1 (above position) and figure 2 (below position). The beacons were mounted on a roadside pole to supplement either a pedestrian (W11-2) or trail (W11-15) crossing warning sign with a diagonal downward arrow (W16-7p) plaque and located at or immediately adjacent to the marked crosswalk.

Three of the Colorado sites had a unique series of signs in advance of the crossing. The series started with a Pedestrian Crossing (W11-2) warning sign with AHEAD (W16-9P) plaque. Next was a SPEED LIMIT 25 (R2-1) regulatory sign with WHEN FLASHING (S4-4P) plaque and a 12-inch circular beacon. This beacon flashes when the RRFBs at the crossing are activated. (See example shown in figure 3.) At the crosswalk are RRFBs with the Pedestrian Crossing (W11-2) warning sign and diagonal downward pointing arrow (W16-7P) plaque. Also at the crossing and in the median are the STATE LAW YIELD TO (pedestrian symbol) WITHIN CROSSWALK (R1-6) sign and RRFB.

Table 1. Open-road study site characteristics.

Site	PSL (mi/h)	Tot CD (ft)	CD to R (ft)	ADT	CW	Ad Lines?	No. of Ln	Median	Geom	Ped/h
AZ-PH-04	35	61	20	23,700	Ladder	Yes	5	Raised	MO(50)	25
AZ-PH-05	35	49	NR	8,700	Ladder	Yes	3	TWLTL	3L	288
CO-DC-02	45/50[a,b]	63	25	7,900	Ladder	No	4	Raised	3L	20
CO-DC-03	30	35	NR	2,600	Ladder	No	2	None	4L	15
CO-DC-04	30	35	NR	4,900	Ladder	No	2	None	3L	19
CO-DC-05	45[b]	78	32	16,100	Ladder	Yes	4	Raised	3L	16
CO-DC-06	35/45[a]	63	28	19,800	Ladder	Yes	4	Raised	MB(50)	36
CO-DC-07	45[b]	78	34	18,800	Ladder	Yes	4	Raised	MB(50)	18
IL-AU-02	35	56	NR	30,800	Diagonal	No	4	TWLTL	MB(30)	17
IL-AU-03	35	30	NR	8,900	Diagonal	No	2	None	MB(360)	19
IL-AU-04	35	94	50	9,400	Transverse	Yes	5	Raised	4L	18
TX-MA-01	30	40	NR	1,400	Diagonal	No	2	None	MB(300)	137
TX-MA-02	30	30	NR	4,900	Diagonal	No	2	None	3L	17

[a]Speed limit varied by approach.

[b]Site also includes the following two advance traffic control assemblies: Pedestrian Crossing (W11-2) warning sign with AHEAD (W16-9P) plaque, and SPEED LIMIT 25 (R2-1) regulatory sign with WHEN FLASHING (S4-4P) plaque and a 12-inch circular beacon that is activated when the pedestrian pushes the pedestrian push button at the crossing.

Site = Site label (XX-YY-##) where XX = two letter code for state, YY = two letter code for city, and ## = site number within the city.

PSL = Posted speed limit.

Tot CD = Total crossing distance.

CD to R = Crossing distance to refuge.

NR = No refuge present.

ADT = Average daily traffic. Values were either provided by the agencies (Arizona, Colorado, and Texas) or estimated based on 1-h counts made from video recordings (Illinois).

CW = Crosswalk marking pattern.

Ad Lines? = Are advance stop or yield lines present at the site?

No. of Ln = Number of through or left-turn lanes crossed by the pedestrians.

Median = Type of median present.

TWLTL = Two-way left-turn lane.

Geom = Intersection geometry at crossing, where 3L = three-legged intersection, 4L = four-legged intersection, MO = midblock with median jog, and MB = midblock with the distance (ft) to nearest intersection or major driveway shown in parentheses (measured from center of crossing to center of nearest driveway/intersection).

Ped/h = Number of pedestrian crossings per hour during the daytime data collection period when the beacons were located below the crossing sign.

Figure 1. Example of beacons placed above sign.

Figure 2. Example of beacons placed below sign.

Data Collection

The data were collected at the 13 sites between October 2014 and May 2015. The research team collected the initial data following installation of the device in its initial position. Once the initial data were obtained, the research team requested the agency to move each set of beacons at a site to the second position (i.e., RRFBs above the sign were moved to below the sign and vice versa). After receiving confirmation that the beacons had been moved, the research team collected data for the second position. The time difference between the initial data collection and the second data collection trip for a site was between 1 and 8 weeks. The goal was to have similar weather conditions for both data collection trips. Data were collected primarily during the daytime; however, because few studies have collected data at night, the research team also obtained nighttime data collected at one site within each city.

The research team used a staged pedestrian protocol to collect driver-yielding data to present oncoming drivers with a consistent presentation of the approaching pedestrian. Under this protocol, a member of the research team acted as a pedestrian using the crosswalk. Each staged pedestrian wore similar clothing (gray T-shirt, blue jeans, and gray tennis shoes) and followed specific instructions in crossing the roadway. A second researcher accompanied the staged pedestrian and was responsible for observing and recording the yielding data on datasheets. Additional details regarding the protocol are available elsewhere.[6]

The protocol specified the completion of a minimum of 40 (and a desired 60) staged pedestrian crossings at each site within each time period. The same time period

Figure 3. Example of speed limit sign assembly used at three sites in Colorado.

was used for the below and above data collection; for example, data were collected in the afternoon (or the morning) for both the below and above conditions at a site.

Results

During the daytime, driver yielding to staged pedestrians averaged 64 percent for the above position and 61 percent for the below position (see table 2). The range of driver yielding to staged pedestrians at these 13 sites did show a large range from a low of 19 percent to a high of 98 percent. Similar results were found for yielding during nighttime crossings (see table 3). For most sites, neither position (i.e., above or below) showed a large increase in driver yielding as compared to the other. Therefore, the site characteristics appear to have greater influence on driver yielding decisions rather than the beacons' placement above or below the sign.

The statistical analyses were conducted using individual crossing data and found that there were no significant differences between the tested beacon positions. A similar driver yielding was observed when the beacons were above the sign as compared to below the sign.

Conclusions

This study investigated whether the position of RRFBs in relation to the pedestrian crossing sign is associated with different driver yielding rates. For the two positions tested, no statistically significant differences were found; therefore, the position of the yellow rapid-flashing beacons did not have an impact on whether a driver decided to yield to pedestrians. Variables that did have an impact on driver yielding for this set of sites include natural light (day or night), intersection configuration (i.e., the number of approaches), and city.

The open-road study found that the position of the RRFBs (either above or below the sign) did not affect a driver's decision to yield. With the apparent benefits identified

Table 2. Daytime driver yielding rate by site and position of beacons.

Site	Above Position, Number of Staged Crossings	Above Position, Driver Yielding (Percent)	Below Position, Number of Staged Crossings	Below Position, Driver Yielding (Percent)
AZ-PH-04	60	47	60	54
AZ-PH-05	60	88	43	94
CO-DC-02	61	93	58	98
CO-DC-03	60	82	41	66
CO-DC-04	58	90	60	86
CO-DC-05	60	92	60	79
CO-DC-06	60	82	56	93
CO-DC-07	60	89	60	87
IL-AU-02	59	20	58	19
IL-AU-03	61	42	64	59
IL-AU-04	60	67	60	32
TX-MA-01	42	93	63	87
TX-MA-02	61	85	62	77
Total	**762**	**64**	**745**	**61**

Table 3. Nighttime driver yielding rate by site and position of beacons.

Site	Above Position, Number of Staged Crossings	Above Position, Driver Yielding (Percent)	Below Position, Number of Staged Crossings	Below Position, Driver Yielding (Percent)
AZ-PH-05	44	81	60	85
CO-DC-06	41	80	40	73
IL-AU-03	60	50	62	46
TX-MA-01	60	73	39	74
Total	**205**	**68**	**201**	**65**

from the closed-course study (i.e., lower discomfort and improved ability to detect the pedestrian as measured by identifying the direction a cutout photo of a pedestrian is traveling) and the lack of difference in driver yielding due to the beacons' position, locating the beacons above the warning sign could improve the overall effectiveness of this treatment.[13]

Based on the findings from this study, FHWA issued an official interpretation to permit agencies to place the beacons either above or below the warning sign for RRFB installations.[14] Other official interpretations on the RRFB, including the recent interpretation regarding flash pattern, are available on the MUTCD Web site.[15]

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