TECH**BRIEF**

Driver Yielding with LED-Embedded Pedestrian- and School-Crossing Signs

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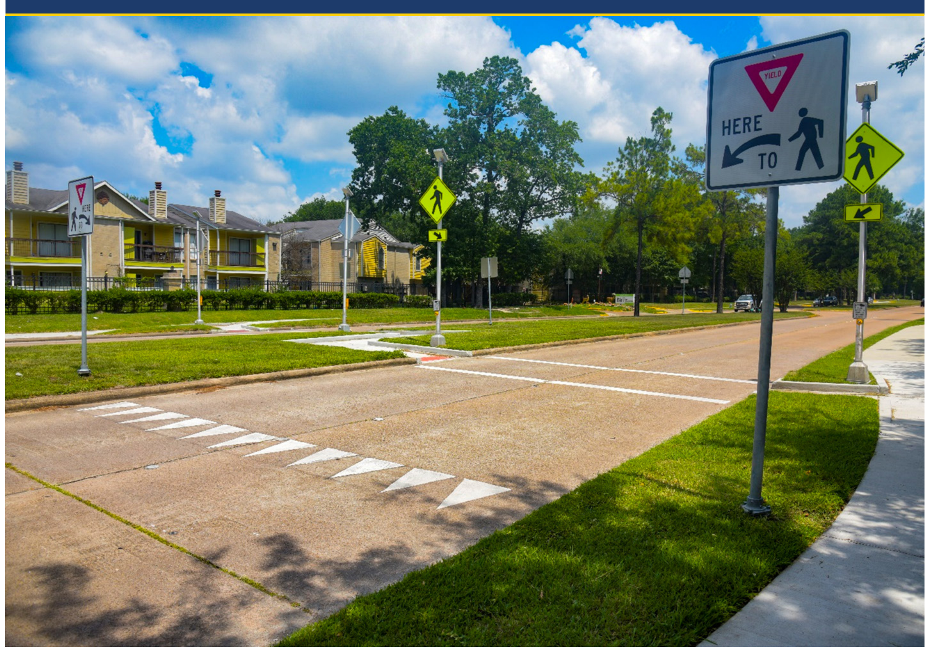
This document is a technical summary of the Federal Highway Administration report *Driver Yielding with LED-Embedded Pedestrian- and School-Crossing Signs.*

INTRODUCTION

Traffic agencies are looking for ways to address the rise in pedestrian fatalities. One traffic control treatment gaining in popularity is the pedestrian-crossing or school-crossing warning sign with light-emitting diodes (LEDs) embedded in its borders (called LED-Em in this report). An example of the treatment is provided in figure 1. The LED-Em treatment is activated by a pedestrian push button, so the LEDs only flash when a pedestrian is attempting to cross the street. Due to the increased interest in the LED-Em treatment, guidance on where to install the devices is needed.

Figure 1. Photo. Example of LED-Em treatment on a four-lane divided street.



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STUDY OBJECTIVE

This study focused on evaluating the operational performance of the LED-Em treatment with respect to the characteristics of roadway and traffic control devices. While recent studies have considered the effectiveness of the LED-Em treatment, those studies only included a limited number of study sites. This Federal Highway Administration (FHWA) project attempted to address the sample size limitation by collecting data at a greater number of sites across multiple States. The objective of this research was to identify site and traffic control device characteristics, associated with high and low driver-yielding values, in places where the LED-Em treatment has been applied. This information would provide insights into whether the LED-Em treatment is appropriate for specific locations.

SITE IDENTIFICATION

The criteria established for the inclusion of a study site in this FHWA study were as follows:

- The sign is a pedestrian- (W11-2), school- (S1-1), or trail- (W11-15) crossing warning sign with LED-Em.
- The sign is at a marked crosswalk.
- The sign is activated by a pedestrian push button.
- The crossing could have other pedestrian-related treatments such as in-pavement lights, and these supplemental features will be considered in the evaluation.
- The crossing can have advance-warning treatments.

The research team used several approaches to identify potential study sites. These approaches included making presentations at national meetings, sending emails to groups like the American Association of State Highway and Transportation Officials and State bicycle and pedestrian coordinators, and engaging in discussions with the regional offices of team members. Most of the 11 States identified with a treatment had only a few device installations. Only Texas and California had more than 10 installations. Both States were selected for inclusion in this study.

DATA COLLECTION

Researchers collected data during four periods. Data were collected at 9 Texas sites in fall 2020, 31 California sites in late spring and early summer 2021, and 6 California sites and 3 Texas sites in fall 2021. The data for 13 Texas sites collected in spring 2019 or winter 2020, as part of previous Texas Department of Transportation projects, were also available.[1,2] The data collection periods were influenced by weather, temperature (with the goal of avoiding the hotter parts of the year for the region), travel restrictions, and when the sites were identified.

Researchers employed a staged pedestrian-crossing approach in this study to obtain a sufficient sample of pedestrian-crossing observations. The staged pedestrian was trained to approach the crossing in a similar manner at every location to minimize the effects of pedestrian behavior on drivers and maintain consistency among study locations in how pedestrians approached a crossing. A video recording was made during data collection. Researchers used the video to count the number of vehicles driving across the crosswalk in both directions for 1 min before each staged pedestrian crossing. The 1-min increment provides an estimate of the amount of traffic present just before the specific pedestrian crossing.

This study included about 250 h of video recordings containing data for 7,805 drivers and 3,675 pedestrian crossings at 62 sites.

ANALYSIS APPROACHES

The data were prepared in two levels: persite and perdriver. The per-site analysis was performed based on driver-yielding rates averaged by each site, using a normal linear model, specifically the analysis of covariance (ANCOVA) model. An ANCOVA model was employed since many of the predictor variables, which are either continuous or categorical, are site-based or traffic-control device based (e.g., sign face) rather than individual crossing event based. The average driver-yielding rates also satisfied the underlying assumptions for using the ANCOVA model.

The per-driver analysis was also to explore the relationship between driver yielding and site and traffic control device variables. The nature of the per-driver analysis permits more detailed consideration of the traffic volume present when the staged pedestrian is attempting to cross the street. The dataset contains the individual driver response to the crossing pedestrian (1 if yielding or 0 if not yielding), the site and traffic control device characteristic variables, and the two-way hourly volume estimate. The estimate is based on a 1-min count for each crossing. Logistic regression was used with this dataset.

FINDINGS

The ANCOVA considered per-site mean yield rates while the logistic regression was able to consider the decision made by an individual driver. The nature of ANCOVA modeling permits easier and more intuitive interpretation of the results. Three efforts were conducted using ANCOVA:

- Sites available early in the project (53 sites, called "initial dataset").[3]
- Sites where data had been collected by the research team within the past 3 yr (62 sites, called "all dataset").
- Sites where data were collected during the pandemic (49 sites, called "pandemic dataset").

Table 1 summarizes the findings from the different ANCOVA and logistic regression analyses.

There is variation where variables are significant within the three datasets using ANCOVA and the dataset for the logistic regression analysis; however, in all cases the posted speed limit is significant. The use of the LED-Em treatment on higher speed roads is clearly associated with lower driver yielding rates. Table 2 provides the average driver yielding rates by posted speed limit for the sites, which, in addition to the findings from the ANCOVA and logistic regression analyses, clearly shows the trend of lower driver yielding on higher speed roads.

Table 1. Overview of significant variables in the statistical models.

VARIABLE STATISTICAL ANALYSIS APPROACH	PANDEMIC DATASET ANCOVA	ALL DATASET ANCOVA	INITIAL DATASET ANCOVA	PANDEMIC WITH VIDEO DATASET LOGISTIC
Posted speed limit	–	–	–	–
Vehicle volume	NS	–	–	–
Additional treatment [no]	–	–	–	Base
Additional treatment [yes]	Base	Base	Base	+
Bike lane [2 sides]	Base	NS	NS	+
Bike lane [none]	–	Base	Base	Base
Yield bar present [no]	NS	+	NS	NS
Yield bar present [yes]	Base	Base	Base	Base
LED flash length	NS	NS	NS	+
Curb to curb and median crossing distance	–	NS	NS	–
Sign location [right only]	Base	Base	Base	+
Sign location [right and median]	+	+	NS	+
Sign location [right and left]	–	–	NS	Base
Period [pandemic]	NA	+	NS	NS
State [California]	NS	NS	NS	+
State [Texas]	Base	Base	Base	Base

+ or – = variable (or at least one level of the variable) was significant, with + indicating a positive relationship and – indicating a negative relationship; Base = variable level represents the base condition in the model; NA = variable not applicable to the dataset; NS = variable was not significant in the model; Datasets include:

- Pandemic dataset = 49 sites where data were collected between fall 2020 and fall 2021.
- All dataset = 62 sites where data were collected between spring 2019 and fall 2021.
- Initial dataset = 53 sites where data were collected between spring 2019 and summer 2020.
- Pandemic with video dataset = 7,805 drivers within 48 sites where data were collected between fall 2020 and fall 2021.

Table 2. Per-site average driver yielding by posted speed limit and periods.

POSTED SPEED LIMIT (MPH)	PANDEMIC DATASET, *N*	PANDEMIC DATASET, DRIVER YIELDING (%)	PREPANDEMIC DATASET, *N*	PREPANDEMIC DATASET, DRIVER YIELDING (%)	ALL DATASET, *N*	ALL DATASET, DRIVER YIELDING (%)
25	8	78	0	NDY	8	78
30	12	75	6	56	18	68
35	19	61	4	26	23	55
40	6	39	0	NDY	6	39
45	4	55	1	16	5	48
50	0	NDY	2	16	2	16
Total	49	64	13	38	62	58

N = number of sites; *NDY* = no driver yielding value because 0 sites had the given posted speed limit; Datasets include:

- Pandemic dataset = 49 sites where data were collected between fall 2020 and fall 2021.
- Prepandemic dataset = 13 sites where data were collected between spring 2019 and fall 2019.
- All dataset = 62 sites where data were collected between spring 2019 and fall 2021.

When using an automated stepwise variable selection procedure with ANCOVA, the volume variable was insignificant. While vehicle volume had a statistically significant relationship with driver yielding—when included in the model by itself—it became statistically insignificant when posted speed limit was added to the model. When variable selection was guided by the research team, the vehicle volume variable was in the model with a negative coefficient. The negative coefficient indicates that as the vehicle volume increases, driver yielding decreases. Another variable that has been found to be significant in some of the models was the crossing distance for the pedestrian. As the crossing distance (roadway width) increases, driver yielding decreases.

The results of the research indicate that the LED-Em treatment is effective in certain conditions. Those conditions include:

- Lower volume roads.
- Lower posted speed limits.
- Narrower roads.
- Supplemental traffic control devices are present, such as in-street pedestrian crossing warning signs, in-roadway lights, or additional crossing warning signs.

The length of time the LED-Em flashed was significant in the logistic regression model; however, at most of the sites, that length of time was within a narrow range (between 20 and 30 s). Increasing the length of time of the LED-Em flashing can be associated with higher driver yielding, but that change is not expected to offset the lower driver yielding associated with higher speed, higher volumes, or longer crossing distances.

The presence of bike lanes on the street was associated with higher driver yielding. Bike lanes can communicate to drivers the likelihood of vulnerable road users being present. Future research could investigate what street characteristics are associated with communicating a pedestrian-friendly or bicyclist-friendly environment to drivers. Defining what is pedestrian or bicyclist-friendly is also necessary. Driver yielding or driver operating speed are two examples of metrics that could be used to develop the criteria.

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