Center for Transportation Research and Education

August 2012

RESEARCH PROJECT TITLE
Evaluation of Low-Cost Treatments on Rural Two-Lane Curves: Post-Mounted Delineators

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Iowa Department of Transportation
Iowa Highway Research Board
(IHRB Project TR-579)
Midwest Transportation Consortium
(InTrans Project 08-320)

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Evaluation of Low-Cost Treatments on Rural Two-Lane Curves: Post-Mounted Delineators

tech transfer summary

The majority of lane departure crashes occur in rural areas, and mostly on two-lane roadways. A disproportionate number of these crashes occur on horizontal curves.

Background

A large number of rural crashes occur on curves. Some sources estimate the crash rate on curves to be three times the crash rate of tangent sections. Curve-related crashes involve a number of roadway and driver causative factors. Driver errors on horizontal curves are often due to inappropriate selection of speed and inability to maintain lane position.

Factors that contribute to excessive speed include driver inexperience, workload, sobriety, distraction, fatigue, sight distance, misperception of degree of roadway curvature, and situational complexity.

As agencies attempt to improve safety, they are often looking for low-cost measures that can be applied quickly and economically. The use of several low-cost treatments—such as post-mounted delineators, on-pavement curve warning signs, raised pavement markings, and wider edge lines—have been used to provide additional delineation on curves.

Problem Statement

Even though agencies have been applying a number of different low-cost treatments, the effectiveness of those treatments toward improving safety is not well understood or documented.

With this supplementary treatment, additional retroreflective material is added to existing chevron posts on curves

Project Objectives

The Center for Transportation Research and Education (CTRE) conducted a study to evaluate low-cost strategies to reduce speeds and crashes on curves. Adding reflectorized material to the posts of existing chevrons to provide additional curve delineation is one of several strategies evaluated and is the focus of this tech transfer summary.

Treatment Description

With post-mounted delineators (PMDs), retroreflective material is added to existing chevron posts. PMDs are used to reinforce the presence of a curve to drivers and can be effective for several reasons.

First, PMDs draw attention to the curve so that drivers who did not receive other cues are able to detect the curve. Second, PMDs can help drivers determine where lane boundaries are at night or during periods of limited visibility, such as rain or snow events. Finally, PMDs can also help drivers gauge the sharpness of a curve, so they can adjust their speed and lane position accordingly.

Use of the additional retroreflective material is a supplementary treatment to existing chevron posts. The addition of retroreflective sheeting material to existing posts is just one low-cost treatment that has been used to provide additional delineation. The treatment provides vertical delineation and is likely to be most effective at night when it is more visible to drivers.

Supplementary post-mounted retroreflective material on County Road Y-52

Site Selection

The team compiled a list of high-crash horizontal curves (five or more crashes within five years) on rural two-lane paved roadways in Iowa. The researchers reviewed the sites using aerial imagery and site visits. The team selected the final sites using the following criteria:

- No major access points present within the curve (i.e., railroad, intersection)
- Posted speed limit on tangent section of 50 mph or higher
- Demonstrated speeding problem (determined during site visit and defined as a mean or 85th percentile speed that was 5 or more mph over the posted or advisory curve speed)
- No unusual features that would make certain types of treatment or speed data collection difficult
- No major maintenance or safety improvements over the three years prior to the study and no plans for major maintenance or safety improvements within the next three years

The team then selected four of the final sites for the installation of supplementary retroreflective treatments on the posts of the existing chevrons.

Test site details

Site	AADT (vpd)	Posted Speed Limit	Curve Advisory Speed
US 52	2,280	50	40
CR Y52	1,710	55	40
221st Street	2,410	55	50
IA 141	830	55	35

AADT = average annual daily traffic
vpd = vehicles per day

Data Collection and Reduction

The researchers collected speed and volume data at each test location using the pneumatic road tubes. Data were collected about one month before the treatment installation (referred to as before data) and at one month after installation for all sites. The team also collected data 12 months after installation for one site (County Road Y-52) where the post treatments were installed in 2010.

The researchers used the following speed metrics to determine the effectiveness of the treatments: change in mean and 85th percentile speeds and number of vehicles exceeding the advisory speed, if present, or the posted speed (if not present) by a set amount.

The researchers assessed changes in mean speed using a t-test, assuming unequal variances, and compared the percentage of vehicles exceeding the posted or advisory speed using a test of proportions.

The researchers compared change in the percentage of vehicles exceeding a certain speed threshold by subtracting the percentage of vehicles exceeding that threshold in the before period from the percentage exceeding that threshold in the after period.

For instance, if 45 percent of vehicles were exceeding the advisory speed in the before period and 20 percent of vehicles were exceeding that threshold in the after period, the change would be 25 percent.

When feasible, the researchers disaggregated data by time of day for the retroreflective chevron post treatments. The researchers felt that the treatment was more likely to be effective at night, given the treatments would be more highly visible then.

Findings

US 52 Retroreflective Post Treatments

Retroreflective strips were added to the front and back of existing chevron posts on US 52 facing both directions of travel in May 2011.

The team collected data at the north and south point of curvature (PC). The team also collected data at the center of the curve, but experienced issues with the counter, and, due to the significant distance to the site, didn't find it feasible to recollect data.

Data were evaluated for northbound vehicles at the south PC and for southbound vehicles at the north PC.

The researchers reduced the data for the nighttime and daytime periods. Mean and 85th percentile speeds decreased by 1 mph for the north PC during the daytime. Speeds did not decrease for the north PC during the nighttime. Average speeds decreased by 0.6 mph for the south PC during the daytime while 85th percentile speeds remained constant. Mean speeds increased slightly for the south PC during the nighttime while the 85th percentile speed decreased by 1 mph.

The percentage of vehicles exceeding the advisory speed by 5, 10, or 15 mph decreased by up to 5 percent at the both the north and south PC during the daytime. Both the north and south PC experienced increases in the nighttime percentage of vehicles exceeding the advisory speed (5 percent for north and 13 percent for south).

The north PC experienced a 4 percent decrease in vehicles exceeding the advisory speed by 10 or more mph during the nighttime, while a 3 percent increase resulted at the south PC. Decreases of 5 and 6 percent were found for vehicles exceeding the advisory speed by 15 or more mph at the north and south PC, respectively.

County Road Y-52 Retroreflective Post Treatments

Retroreflective post treatments were applied to existing chevron posts on CR Y52 in July 2010. A 60 in. polypropylene tube coated with yellow high-intensity sheeting was wrapped around the existing Telspar chevron post.

The researchers collected data on CR Y52 at the north PC, center of curve, and south PC. Data were evaluated for northbound vehicles at the south PC and for southbound vehicles at the north PC. Data were evaluated for both directions of travel at the center of curve, given the retroreflective treatment was visible for drivers in both directions.

Results were similar for both day and nighttime, so the researchers combined the results. Mean speeds decreased by up to 2.2 mph at all locations.

The 85th percentile speeds stayed consistent for the 1 month after period at the north PC and decreased by 2 mph for the 12 month after period. The 85th percentile speeds were unchanged at the center of the curve for the northbound direction of travel for both the 1 and 12 month after periods. The 85th percentile speeds decreased at all other locations by up to 3 mph.

At the north PC, the results showed little change for either the 1 or 12 month after period for vehicles traveling 5 or more mph or 10 mph over the advisory speed, while decreases up to 9 percent occurred for vehicles traveling 15 or 20 mph over the advisory speed.

At the center of the curve, little change occurred for 5 or more mph over the advisory speed. The researchers found moderate decreases for all time periods for both directions of travel for the center of curve (up to 5 percent).

At the south PC, little change occurred for vehicles traveling 5 or mph over the advisory speed. The results showed moderate decreases (up to 6 percent) for vehicles traveling 10, 15, and 20 or more mph over the advisory speed for the 1 month after period, while significant decreases occurred for the 12 month after period (up to 21 percent).

Retroreflective chevron post treatments on US 52 at night

221st Street Retroreflective Post Treatments

Retroreflective strips were added to the front and back of existing chevron posts on 221st Street facing both directions of travel in July 2011.

The team collected data at 221st Street at the north PC, center of curve, and south PC. Data were evaluated for northbound vehicles at the south PC and for southbound vehicles at the north PC and for both directions of travel at the center of curve. Speeds were evaluated separately for nighttime and daytime.

At the north PC, a 2 mph decrease in both mean and 85th percentile speeds resulted for both daytime and nighttime.

At the center of the curve, the mean speed decreased by 1.4 mph and the 85th percentile speed decreased by 2 mph for the daytime period, while the mean speed stayed constant for the nighttime period. The nighttime 85th percentile speed increased by 1 mph.

At the south PC, 85th percentile speeds were unchanged for both the daytime and nighttime periods. Mean speeds increased by 0.5 mph for daytime and decreased by 1.2 mph for nighttime.

At the north PC, significant decreases were noted in the percentage of vehicles traveling 5, 10, 15, and 20 mph over the advisory speed. Reductions over 30 percent were noted for vehicles traveling 5 or more mph over the advisory speed for both daytime and nighttime, while reductions of 50 and 41 percent were noted for vehicles traveling 10 or more mph over for the daytime and nighttime, respectively.

Significant decreases (33 percent for daytime and 22 percent for nighttime) were noted for vehicles traveling 15 or more mph over and up to 8 percent decreases occurred for vehicles traveling 20 or more mph over.

At the center of the curve, significant reductions in vehicles traveling over the advisory speed also resulted with decreases up to 34 percent for vehicles traveling 5 or more mph over and up to 43 percent for vehicles traveling 10 or more mph over.

A reduction of 24 percent occurred for vehicles traveling 15 or more mph over during the daytime with a decrease of 12 percent for nighttime. Vehicles traveling 20 or more mph over decreased by up to 6 percent.

At the south PC, the percentage of vehicles traveling 5 or more mph over the advisory speed increased for the daytime period by 7 percent and decreased for the nighttime period by 2 percent. All other speed thresholds for the south PC showed little change.

IA 141 Retroreflective Post Treatments

Retroreflective strips were added to the front and back of existing chevron posts on IA 141 facing both directions of travel in August 2011. The site has two closely-spaced curves, so the treatments were applied through both curves.

The team collected data at the center of both curves (north and south) and at the south PC of the north curve.

Speeds were relatively unchanged at the center of the north curve for the daytime period with a 1.9 mph decrease in mean speed and a 1 mph decrease in 85th percentile speed for the nighttime period.

The researchers found similar results for the southern PC of the north curve with little change in daytime speeds and about a 1 mph decrease for mean and 85th percentile speeds for the nighttime period.

Daytime and nighttime speeds at the center of the south curve remained relatively consistent.

The percentage of vehicles traveling over the advisory speed by 5 and 10 or more mph increased slightly for all locations for the daytime period, while the percentage of vehicles traveling 15 or 20 mph over decreased for all locations.

The percentage of vehicles traveling over the advisory speed during the nighttime period decreased significantly for all locations and for all thresholds with the exception of the south center of the curve, which experienced an increase in vehicles traveling 10 or more mph over the advisory speed limit. However, this result is somewhat inconsistent with the other thresholds for the same location.

Conclusions

The study showed that the addition of retroreflective material to existing chevron posts as a supplementary treatment was moderately effective in most cases. The treatment had the greatest impact in decreasing the percent of vehicles traveling 5, 10, 15, or 20 mph or more over the advisory speed.

Implementation Readiness and Benefits

Given these treatments are relatively low cost, they show promise in reducing speeds on rural two-lane curves. While reducing speeds on curves is assumed to result in a reduction in crashes, the relationship is not known.