



Project Summary Report O-4471-S

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Project O-4471: Evaluation of Horizontal Signing Applications

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## Research Recommendations for Pavement Marking Words and Symbols

Pavement markings are an effective way to convey information alongside the roadway to motorists. Common uses of horizontal signing are lane assignment arrows at intersections and advanced warning for stop-controlled intersections and school speed zones.

Research has illustrated the following facts about horizontal signing:

- Drivers spend most of their time focusing on the roadway in front of them, and any object or sign that appears in this region is more likely to be observed than a sign that appears in their peripheral vision.
- Drivers can miss roadside signs because of visual clutter (billboards, etc.) or other traffic (heavy trucks, etc.). A redundant method of information dissemination increases the likelihood of the message getting to drivers.
- Any symbols developed for use on horizontal signs should have large simple components and should be visually unique to the highest possible degree.
- When drivers experience driving situations that require a great deal of attention, they focus on the more important tasks of control and guidance and will look more at the road and less at side- or overhead-mounted signing.

The proper application of horizontal signing messages using either text or symbols can be achieved through:

- minimizing the use of abbreviations,
- keeping symbols simple and legible, and
- limiting application to critical locations where drivers will recognize them as an added warning or caution.

Two key issues have prevented the wide-scale adoption of horizontal signing by transportation agencies around the world. The first issue is the *visibility* of the markings. The second issue is the overall *durability* of materials placed in the travel lane.

### Visibility

In order for any markings to be seen in the daytime they must contrast with the road surface. A white marking may not provide adequate contrast for symbol recognition or word legibility when viewed against a concrete or worn asphalt surface. Nighttime visibility is affected by the durability of the optical elements present in the marking material, typically glass beads. Traffic congestion and location of other vehicles affect visibility. In dense traffic, headways may not be sufficient for drivers to see the full horizontal sign application ahead of them.

### Durability

A variety of pavement marking materials are available to agencies today that vary in cost, ease of application, and durability. Some vendors supply preformed symbols, made either from thermoplastic or rubber, which can be used for horizontal signing. Because horizontal signing applications are largely directly in the path of traveling vehicles, the number of hits on these materials is markedly higher than on long-line pavement markings.

### What We Did...

The team focused on three main tasks in the evaluation of pavement markings: a field study of various horizontal applications for curve advisories, a field study of a two-way arrow treatment, and durability testing. Report O-4471-3 details the procedures and findings of the durability study.

### Field Study: Curve Advisories

Four treatments to reduce speed on horizontal curves were evaluated. These treatments included:

- transverse lines,
- CURVE AHEAD text,
- CURVE 55 MPH text on rural curve, and
- CURVE 50 MPH text on urban curve.

*Transverse Lines:* The northbound direction of FM 707



in the Abilene District received a treatment of simple transverse lines (see Figure 1). This treatment was selected to represent the lowest-cost minimal treatment. The treatments applied here attempted to provide a visual warning, a “visual rumble strip” of sorts, to alert drivers to some upcoming change or hazard.

**CURVE AHEAD Text:** The southbound direction of FM 707 received a treatment of the text message CURVE AHEAD. The text consisted of 8-ft letters as shown in Figure 2.

**CURVE 55 MPH Text on Rural Curve:** The treatment consisted of the words CURVE 55 MPH. The treatment began approximately 400 ft after the standard curve warning sign (see Figure 3).

**CURVE 50 MPH Text on Urban Curve:** An urban curve location was selected on US 77 near Robstown in the Corpus Christi District. This location, on a divided four-lane highway, was selected based on a high number of truck rollover accidents in the area as reported by the TxDOT district engineer. Directional curve arrows and a 50 mph advisory speed were placed on the pavement as shown in Figure 4.

### Field Study: Two-Way Frontage Road Directional Arrows

Use of the frontage road system is widespread in Texas, and it is common for urban frontage roads to operate as

one-way roadways, while rural areas tend to have two-way frontage roads. The presence of both one-way and two-way frontage roads in a given area may create increased potential for wrong-way movements. The location selected for the field evaluation was a short section of two-way frontage road on the fringe of the College Station, Texas, urban area. The diagram in Figure 5 shows the ramp configuration and adjoining frontage road.

The pavement marking treatment was a pair of standard 9-ft white retroreflective thermoplastic pavement marking arrows defined in the *Manual on Uniform Traffic Control Devices (MUTCD)* as a “Through Lane-Use Arrow.” Typical cost for such an installation is in the range of \$300.

## What We Found...

### Field Study: Curve Advisories

**Transverse Lines:** The transverse line treatment at the study location did not appear to have a measurable effect on speed. The results indicate that the materials did not provide a sufficient cue to drivers that they should slow for the approaching curve.

**CURVE AHEAD Text:** The CURVE AHEAD treatment at this location did not have the expected effect on speed selection. The number of observations for this site was smaller than the number for other sites, but still of

sufficient size to draw the conclusion that the CURVE AHEAD text treatment did not succeed in changing driver behavior.

**CURVE 55 MPH Text on Rural Curve:** With only a standard warning sign drivers slowed down approximately 8 mph, while after the installation of the text on the pavement they slowed down 12 mph. This difference was not statistically significant, but it does suggest a benefit of the horizontal signing treatment that is worthy of further exploration.

**CURVE 50 MPH Text on Urban Curve:** The average speed data showed that because of the vertical crest between the control point and the warning sign, vehicles slowed down between the first and second counter locations. After passing the warning sign, vehicles in the before period accelerated as they went down the overpass. In the after condition, vehicles did not accelerate. The percentage of vehicles exceeding the speed limit revealed the effectiveness of this treatment.

The project showed substantial reductions in speed for the multi-lane freeway location marked with a curve arrow and an advisory speed, while the rural curve marked with the word CURVE and the advisory speed showed modest reductions in speed. Both treatments that included a specific advisory speed produced clearer results than the treatments that simply warned



Figure 1. Transverse Line Treatment.



Figure 2. CURVE AHEAD Treatment.



of an upcoming curve through words and transverse lines. In addition, the use of the curve arrow provides drivers with information about the direction of the curve that can be particularly useful on a blind approach like the one created by the vertical crest of the overpass at our test location. Overall, the results of the rural location field studies of speed on horizontal curves were fairly inconclusive.

**Field Study: Two-Way Frontage Road**

Overall, incorrect maneuvers were reduced from 7.4 percent to 0.7 percent, a 90 percent reduction of the number of vehicles driving the wrong way. Stated another way, prior to the installation of the lane direction arrows about 1 out of every 13 vehicles that exited the freeway at this location ended up

driving in the wrong frontage road lane. After the installation of the arrows, this number dropped to about 1 out of every 150 vehicles.

**The Researchers Recommend...**

This research provides an indication of the potential effectiveness of low-cost traffic control improvements such as lane direction arrows to improve safety at locations where wrong-way driving occurs, such as two-way frontage roads and freeway ramp terminals. The field evaluation was not of sufficient depth to justify immediate widespread implementation of lane direction arrows. However, the overwhelming reduction in wrong-way driving indicates that the treatment can have a very beneficial

safety influence on traffic at locations where drivers may be confused about an appropriate lane selection. To that end, the researchers recommend that transportation officials consider this treatment at problem locations.

In summary, treatments that provide a clear message to drivers as to a specific action to take showed the most positive effects in this research. Lane direction arrows clearly indicate to drivers the correct direction of travel for each lane. Speed limits applied in advance of curves inform drivers of the safe advisory speed. Horizontal signing should be used at key locations where a clear message can be transmitted. If horizontal signing is applied broadly with poor or ambiguous messages, the efficacy and safety benefit may be diminished.



Figure 3. CURVE 55 MPH Treatment.



Figure 4. Curve Arrow and Advisory Speed Treatment.

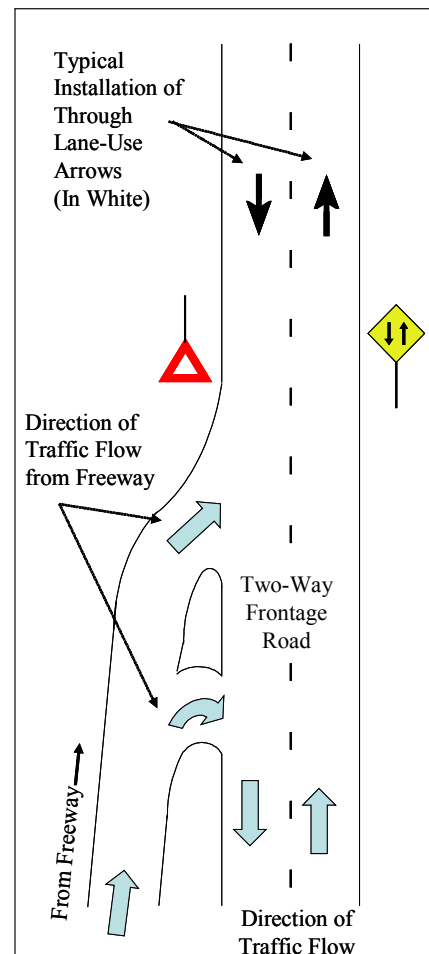


Figure 5. Typical Installation for Directional Arrows on Two-Way Frontage Road to Reduce Wrong-Way Movements.



## For More Details...

The research is documented in:

Report 0-4471-1, *Assessment of Pavement Marking Materials for Horizontal Signing Applications*

Report 0-4471-2, *Field Evaluations and Driver Comprehension Studies of Horizontal Signing*

Report 0-4471-3, *Durability of Preformed Thermoplastic Pavement Markings for Horizontal Signing Applications*

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