TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

Project Summary Report 0-1796-S

Project 0-1796: Impacts of Retroreflectivity on Sign Management, Maintenance, and Design

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PROJECT SUMMARY REPORT

Traffic Sign Retroreflectivity Issues

Traffic signs provide an important means of communicating information to road users, and they need to be visible to be effective. At night, sign visibility is provided through the use of retroreflective sign sheeting materials. Retroreflective sheeting redirects the light from a vehicle's headlamps back toward the vehicle. Without retroreflective properties, traffic control devices would be largely ineffective at night.

The retroreflective performance characteristics of signs have become increasingly significant in recent years because of a dramatic increase in the choices of retroreflective material products with a range of performance levels and because of national efforts to develop guidelines for minimum levels of retroreflectivity for traffic signs.

This project evaluated several different issues related to traffic sign retroreflectivity and used the information to help the Texas Department of Transportation (TxDOT) address several different aspects of signing operations.

What We Did ...

Several distinct efforts were undertaken as part of this research project.

District Visits

Between January 2000 and April 2001, a team of Texas Transportation Institute (TTI) researchers and TxDOT Traffic Operations Division staff visited all 25 districts, plus the TxDOT regional warehouse in Athens and the Texas prison sign shop at the Beto Unit, to review TxDOT signing operations practices. At each district, the team members met individually with sign crews and maintenance supervisors, sign shop staff, area engineers, district maintenance staff, district traffic staff, and the district engineer. Each visit lasted a full day, and during the visit team members discussed a wide variety of signing issues of concern to each group. The team members used the comments received from TxDOT staff to identify the findings and recommendations that were of department-wide interest.

Sign Crew Workshops

An important element of maintaining traffic sign retroreflectivity is the effectiveness of TxDOT sign crews in conducting nighttime sign inspections. Between May 2000 and March 2002, TTI researchers, working with TxDOT Traffic Operations staff, conducted seven Sign Crew Workshops. These workshops started in the afternoon, included a nighttime sign inspection on a closed course, and concluded the next morning. Over 300 TxDOT field staff participated in the workshops.

During the afternoon session, TxDOT staff updated participants on current issues related to signing, including discussions on recently implemented sign hardware. After dark, all participants drove through a 5-mile course at the Texas A&M Riverside Campus, where about 45 signs had been installed. These signs represented various levels of sign retroreflectivity, and the participants were told to visually inspect each sign in the same manner they would conduct a nighttime sign inspection. The results of the sign inspections were presented the next morning, along with a comparison of how the sign inspections compared to the application of federal research findings for minimum levels of sign retroreflectivity.

Comparative Legibility of Sign Sheeting Materials

Sign sheeting performance has improved dramatically over the last 50 years. However, the basic design or layout of signs has not changed as the retroreflective performance of sign materials has increased. In this task, the researchers compared the legibility of similar signs made from different sheeting materials and also evaluated the legibility of using alternative fonts (alphabets) for the sign legend.

A total of 24 participants viewed 48 signs representing various combinations of sheeting materials, four background colors, and three alphabets with 6-inch letters. Figure 1 provides examples of the signs used in the evaluation. Subjects were instructed to read the sign legend while driving the test vehicle. A

researcher recorded the distance when the subject correctly read the sign.

Evaluation of Headlamp Performance

The amount of light directed toward a sign by a vehicle's headlamps is one of the factors that impact the brightness of a sign. The computer modeling that is used to assess and compare sign sheeting performance is based on illumination provided by new headlamps that are properly aimed. However, general observations of vehicle headlamps in actual use indicate that a noticeable proportion of them have improperly aimed headlamps. Furthermore, headlamps are no longer inspected as part of the annual vehicle inspection process. In this part of the project, researchers measured the headlamp performance of vehicles to evaluate real-world conditions. For each vehicle, illumination was measured for the individual headlamps at specified points that represent typical sign locations. The vehicles included 25 passenger cars and 21 light trucks. Vehicles were measured without aiming, but after cleaning the headlamps.

Evaluation of Microprismatic Legend on High Intensity Background

The basic objective of this research was to compare the legibility of guide signs using combinations of microprismatic and beaded sheeting. A secondary objective was to evaluate the Clearview fonts for guide signs as compared to the standard highway fonts. The research focused on destination/distance signs and shoulder-mounted guide signs but also included a small sample of Texas county road name signs. The 30 individuals that participated in the study drove an instrumented vehicle past 11 sign installations, reading the sign messages at the furthest possible distance. Researchers recorded the legibility distance and analyzed the data to assess the impacts of: retroreflective material combinations used for the legend and background, the type of legend font, and the spacing of letters.

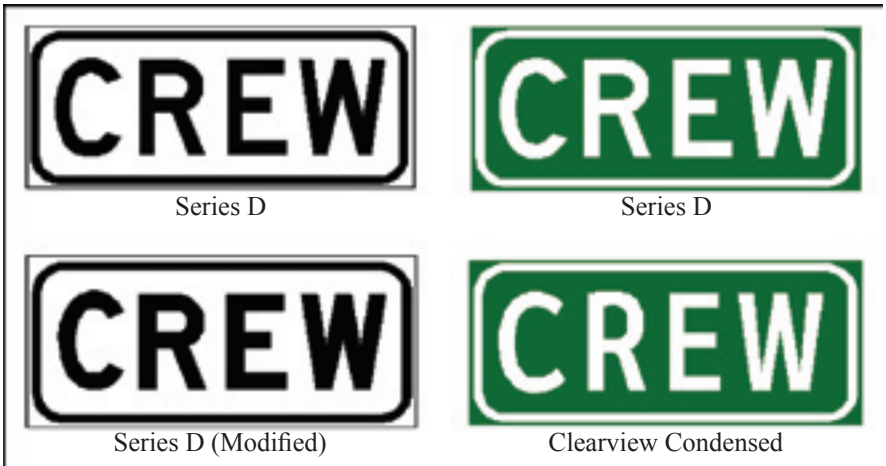

Figure 1. Signs Used in First Legibility Evaluation.

Sign Lighting Guidelines

In the early 1990s, TxDOT changed the policy for overhead signs to use high intensity sheeting for all overhead signs. Since that policy was established, several factors have emerged that affect the visibility of overhead signs. One is the fact that TxDOT is moving to the use of microprismatic materials for all overhead signs. Another is that vehicle headlamps have changed dramatically in the last decade, with a trend toward having less light reaching overhead signs. One of the efforts of this project was to develop a procedure that TxDOT staff can use to determine whether sign lighting is needed at a given location.

What We Found ...

District Visits

The discussions with district personnel led to numerous findings, including the following key findings:

- there is uncertainty among some districts over the intent of guidance provided by Austin leadership,
- there are some differences of opinion within some districts on the emphasis that signing should receive,
- there are significant variations in signing practices between the districts (in many cases these variations are necessary and appropriate),
- the three-year sign upgrade initiative has been embraced by many districts as a long overdue emphasis on signing,
- the value of the upgrade could have been improved with some advance strategic planning,
- the quality of contractor-installed signs often is not consistent with the quality of sign installations performed by TxDOT personnel, and
- sign crews would benefit from improved equipment.

Sign Crew Workshops

The results of the sign inspections revealed two important findings:

- TxDOT sign crews provide a higher level of maintenance than would be achieved through the application of federal minimum levels of retroreflectivity (TxDOT crews replace more signs than would be replaced according to the federal minimum retroreflectivity levels).
- There was significant variability in the level of illumination provided by the TxDOT vehicles used to conduct inspections in the workshop. These vehicles are of the same type used to conduct nighttime sign inspections.

Comparative Legibility of Sign Sheeting Materials

The evaluation found that the overall legibility indices for all of the signs used in the evaluations ranged between 24 and 34 feet per inch of letter height. The type of

retroreflective sheeting was a significant factor in the legibility of the signs, with specific differences in legibility being dependent upon the sign color. White and yellow signs produced the longest legibility distances, due to the higher retroreflectivity levels of these colors. The current standard alphabet (Series D) was more legible than the two alternative alphabets.

Evaluation of Headlamp Performance

The headlamp measurements indicated that, based on the small sample of vehicles tested, there is no evidence to suggest that headlamp performance of real-world vehicles is significantly different from that used in computer models to predict sign brightness. Figure 2 illustrates the headlamp distribution patterns for two of the vehicles in the sample. The findings also found that the illuminance levels provided by the vehicles in the sample support the use of Type C (high intensity) sheeting for ground-mounted signs located close to the shoulder. For overhead signs or signs located farther from the shoulder, Type C sheeting does not provide sufficient luminance levels.

Evaluation of Microprismatic Legend on High Intensity Background

The assessment of sign sheeting materials found that the combination of microprismatic legend on high intensity background provided greater legibility than the high intensity on high intensity combination, but not always as good as the microprismatic on microprismatic combination. For shoulder-mounted guide signs, the Clearview font produced longer legibility distances than the current standard. The research also found that a 2-inch increase in the legend size of distance/destination signs (to 8-inch legend) improves legibility compared to the 6-inch standard legend size.

Sign Lighting Guidelines

The researchers developed a flowchart-based procedure that indicates the need for sign lighting. The flowchart identifies several factors that affect the legibility of overhead signs. The flowchart has been incorporated into the *Freeway Signing Handbook*, which was developed as part of a different TxDOT research project (0-4170).

The Researchers Recommend ...

District Visits

The findings from the district visits were used to develop a list of 42 recommendations. Report 1796-1 contains the full list of 42 recommendations.

Sign Crew Workshops

Based on the findings of the workshops, the researchers recommend that TxDOT continue to use annual nighttime inspections to assess sign retroreflectivity, that sign crews receive training on conducting nighttime sign inspections, and that vehicle headlamps be properly aimed prior to conducting the nighttime inspections.

Comparative Legibility of Sign Sheeting Materials

The researchers found no evidence to adopt any of the alternative alphabets evaluated in this part of the research effort. The microprismatic materials provided greater legibility in some cases, but not consistently across the board, except for the orange material. The most significant recommendation is that a legibility index of 30 to 35 feet/inch should be used for designing signs, indicating a potential need for larger letters in signs.

Evaluation of Headlamp Performance

Sign visibility at night is a function of the amount of light provided by a vehicle, the retroreflective properties of the sign, and the relative location of the two. The evaluation of headlamps indicated that Type C sheeting (high intensity) is sufficient for ground-mounted signs near the shoulder to meet the luminance needs for most drivers based on the sample of vehicles tested. Type D sheeting (microprismatic) should be used for the legend of overhead signs and large guide signs located farther from the shoulder. Since the vehicle sample was not chosen randomly, it may not be representative of headlamp performance of all vehicles on the roadway. The research findings reemphasized the need to properly aim the headlamps of TxDOT vehicles used for nighttime sign inspections.

Evaluation of Microprismatic Legend on High Intensity Background

Based on the results, the researchers recommend that TxDOT begin using a Type D (microprismatic) legend in combination with a Type C (high intensity) background on all new shoulder-mounted guide signs. These signs should be fabricated using the Clearview 5W font (without reduced spacing). For distance/destination signs, the researchers recommend that TxDOT use a Type D legend in combination with a Type C background. The legend should be fabricated using an 8-inch upper/lowercase Clearview 3W font. The researchers also recommend that county road signs be fabricated using a Type D legend on a Type C background.

Sign Lighting Guidelines

The guidelines that will be a part of the *Freeway Signing Handbook* should be considered in determining the need for sign lighting for overhead freeway signs.

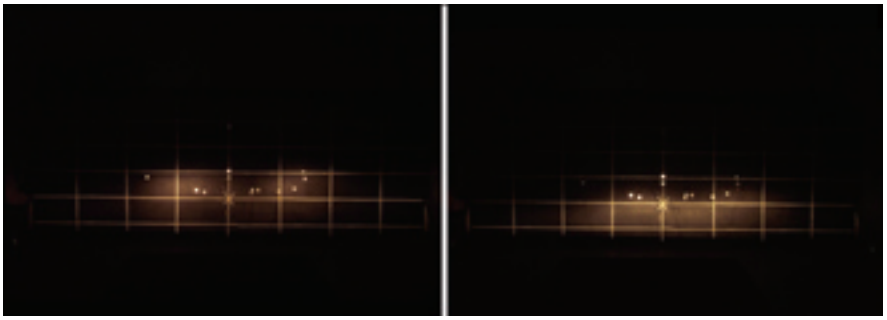

Figure 2. Comparison of Headlamp Patterns for Two Vehicles.

For More Details . . .

The research is documented in four research reports:

- Report 0-1796-1, *A Review of TxDOT Signing Operations*
- Report 0-1796-2, *Nighttime Legibility of Ground-Mounted Traffic Signs as a Function of Font, Color, and Retroreflective Sheeting Type*
- Report 0-1796-3, *Headlamp Illumination Provided to Sign Positions by Passenger Vehicles*
- Report 0-1796-4, *Nighttime Guide Sign Legibility for Microprismatic Clearview Legend on High Intensity Background*

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To obtain copies of the report, contact Dolores Hott, Texas Transportation Institute, TTI Communications, (979) 845-4853, or e-mail d-hott@tamu.edu. See our online catalog at http://tti.tamu.edu.

TxDOT Implementation Status
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This research project examined the impacts of retroreflectivity on sign visibility and legibility, which included the evaluation of retroreflective properties of various sign sheeting materials on ground-mounted and overhead signs. Four products were required for this project: 1) guidelines for sign design as a function of the type of sign sheeting; 2) guidelines for determining the need for overhead sign lighting; 3) guidelines for selection of sign material based on headlamp performance; and 4) a synthesis of TxDOT signing practices. Products 1 and 3 are incorporated in the findings of research reports 0-1796-2 and 0-1796-3, respectively, and have been implemented in current design and fabrication practices. Product 2 is incorporated for implementation in the *Freeway Signing Handbook*, a product of Project 0-4170, "Improved Signing for Urban Freeway Conditions." As Project 0-1796 progressed, it was determined that Product 4 was no longer needed for this project. The information gathered from this project – in particular, the effectiveness of Clearview font – may serve as an aid for further research into signing technologies.

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