Executive Summary

Evaluation Of Delineation Systems For Temporary Traffic Barriers In Work Zones

WA-RD 115.2

Washington State Department of Transportation
in cooperation with the
United States Department of Transportation
Federal Highway Administration

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.
WA-RD-115.2

2. GOVERNMENT ACCESSION NO.

3. RECIPIENT'S CATALOG NO.

4. TITLE AND SUBTITLE
EXECUTIVE SUMMARY
EVALUATION OF DELINEATION SYSTEMS FOR TEMPORARY TRAFFIC BARRIERS

5. REPORT DATE
May 1987

6. PERFORMING ORGANIZATION CODE

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10. WORK UNIT NO.

11. CONTRACT OR GRANT NO.
DOT-FH-11-8007, Task 17

12. SPONSORING AGENCY NAME AND ADDRESS
Federal Highway Administration
400 7th St. S.W.
Washington, D.C. 20590

13. TYPE OF REPORT AND PERIOD COVERED
Executive Summary

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
This study was conducted in cooperation with the U.S. Department of Transportation

16. ABSTRACT

This study investigated the effectiveness of various barrier-mounted reflectors. Barrier delineators come in different shapes and sizes, and their materials and installation labor costs also differ. They can be mounted on the barrier top, the barrier face or even on the pavement. A delineator's level of effectiveness depends on the type of delineator as well as its placement.

This study evaluated the effectiveness of seven concrete barriers delineators: Astro-optics on the barrier top, Reflexite on the barrier top, reflective cylinders on the barrier top, hazard panels, raised pavement markers on the barrier face, Astro-optics on the barrier face, and Davidson markers on the edge line.

The study included a literature review, observations of the delineators at a test site, and having motorists drive by the delineators and rate them.

The study concluded that drivers need the guidance of delineators most when they are confronted with opposing traffic headlight glare. Devices placed on top of teh barrier are washed out by headlight glare and therefore are not effective. The best placement of concrete barriers is on the barrier face. A delineator loses more than half of its reflectiveness in a short period due to dirt accumulation.

The study recommended that the Manual on Uniform Traffic Control Devices make note of the effect of opposing traffic headlight glare on delineators' effectiveness, that delineators be placed on the top of concrete barriers, that prism-lensed devices are the most effective, and that delineators should be cleaned regularly.

17. KEY WORDS
concrete median barriers, traffic barriers
reflector
delineator

18. DISTRIBUTION STATEMENT

19. SECURITY CLASSIF. (of this report)
Unclassified

20. SECURITY CLASSIF. (of this page)
Unclassified

21. NO. OF PAGES
18

22. PRICE

DOT FORM 310-022 (11-86) -1216

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Final Report
DOT-FH-11-8007
Task Order No. 17

Prepared for

U.S. Department of Transportation
Federal Highway Administration

May 1987

EXECUTIVE SUMMARY

INTRODUCTION

Concrete median barriers are often used in construction zones to keep traffic from entering a work area or from hitting an exposed object or excavation, to protect workers, to separate two-way traffic and to protect construction such as false work for bridges. In some construction zones, especially on interim roadways, concrete barriers are installed where the roadways are not only substandard but also lack adequate illumination. In these cases, barrier-mounted reflectors are commonly used as aids to nighttime visibility.

This study was sponsored by the Federal Highway Administration to investigate the effectiveness of various barrier-mounted reflectors. Barrier delineators come in different shapes and sizes, and their materials and installation labor costs also differ. They can be mounted on the barrier top, the barrier face or even on the pavement. A delineator's level of effectiveness depends on the type of delineator installed as well as its placement.

STUDY OBJECTIVES

This study evaluated the effectiveness of seven of the concrete barrier delineators currently on the market (Figures 1 through 7):

- Astro-optics placed on the barrier top,
- Reflexite placed on the barrier top,
- reflective cylinders placed on the barrier top,
- hazard panels,
- raised pavement markers placed on the barrier face,

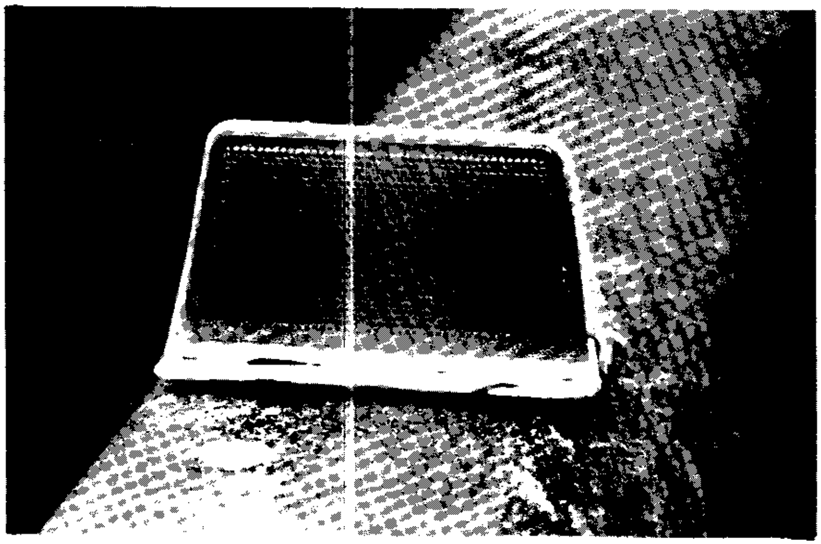

Figure 1

Astro-optics on Barrier Top

Dimensions (inches)

Overall: Width = 4.60, Height = 2.80, Thickness = 0.45
Reflective Surface: Width = 4.5, Height = 2.60
Spacing = 40 ft., Length of Section = 1,000 ft.

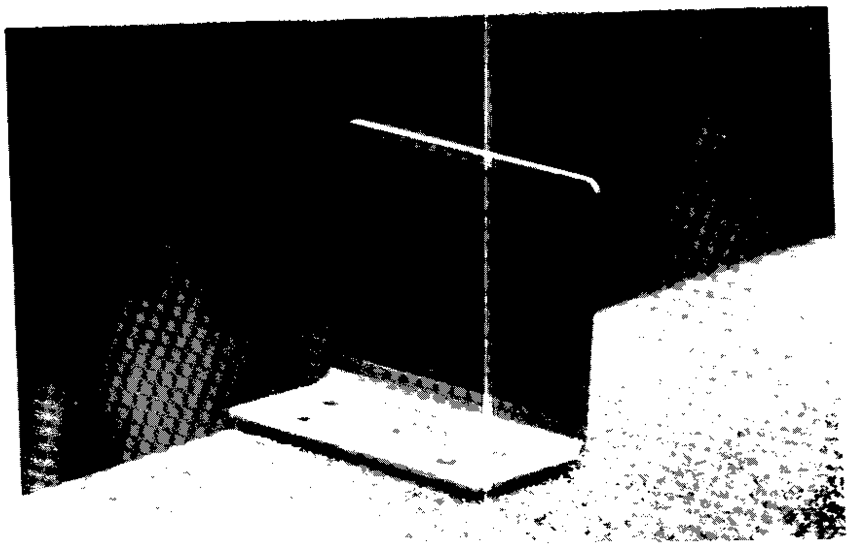

Figure 2

Reflexite on Barrier Top

Dimensions (inches)

Overall: Width = 4.50, Height = 3.50, Thickness = 0.10
Reflective Surface: Width = 4.25, Height = 3.00
Spacing = 40 ft., Length of Section = 1,000 ft.

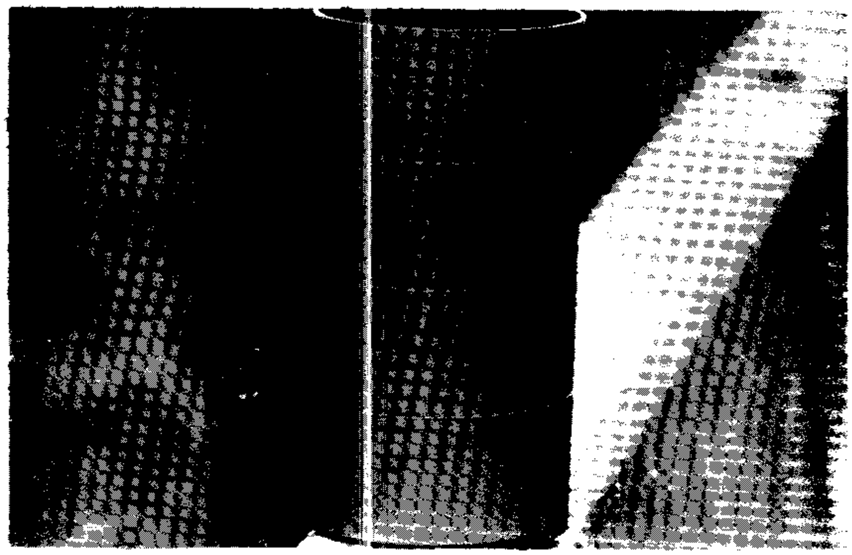

Figure 3

Reflective Cylinders on Barrier Top

Dimensions (inches)

Overall: Height = 12, Diameter = 6
Reflective Surface: Height = 12, Diameter = 6 (Three 4-inch wide stripes of high intensity sheeting)
Spacing = 100 ft., Length of Section = 1,000 ft.

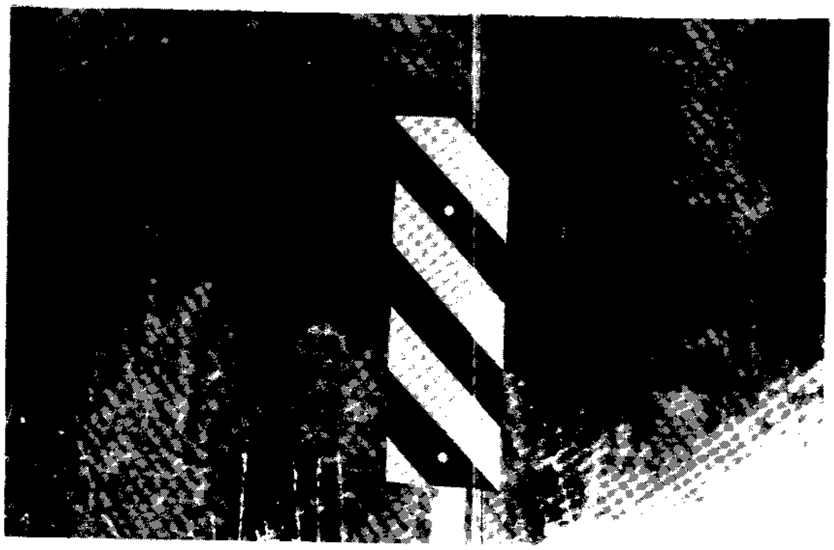

Figure 4

Hazard Panel on Barrier Top

Dimensions (inches)

Overall: Height = 24, Width = 8
Reflective Surface: Three 3-inch-wide stripes of high intensity sheeting
Spacing = 100 ft., Length of Section = 1,000 ft.

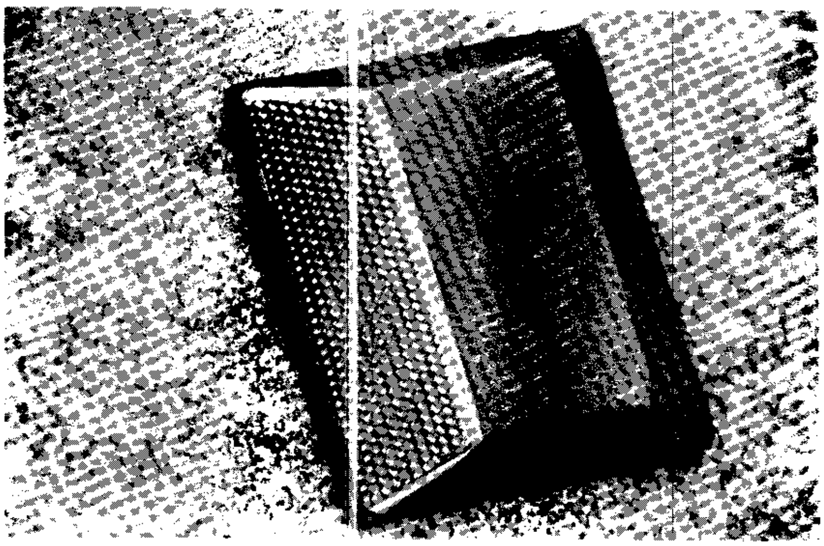

Figure 5

Raised Pavement Marker on Barrier Face

Dimensions (inches)

Overall: Length = 4, Width = 4, Height = 0.60
Reflective Surface: Length = 4, Slant Height = 1.20
Spacing = 40 ft., Length of Section = 1,000 ft.

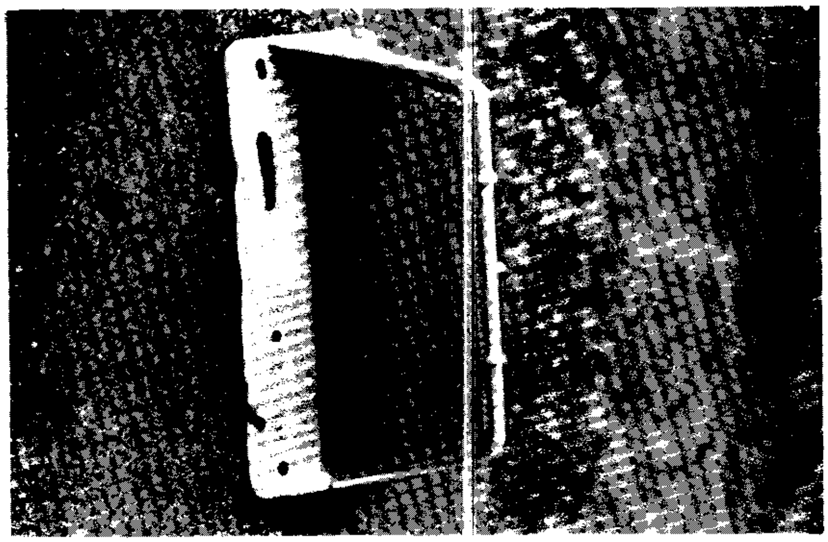

Figure 6

Astro-optics on Barrier Face

Dimensions (inches)

Overall: Length = 4.60, Width = 2.80, Thickness = 0.45
Reflective Surface: Length = 4.5, Width = 2.60
Spacing = 40 ft., Length of Section = 1,000 ft.

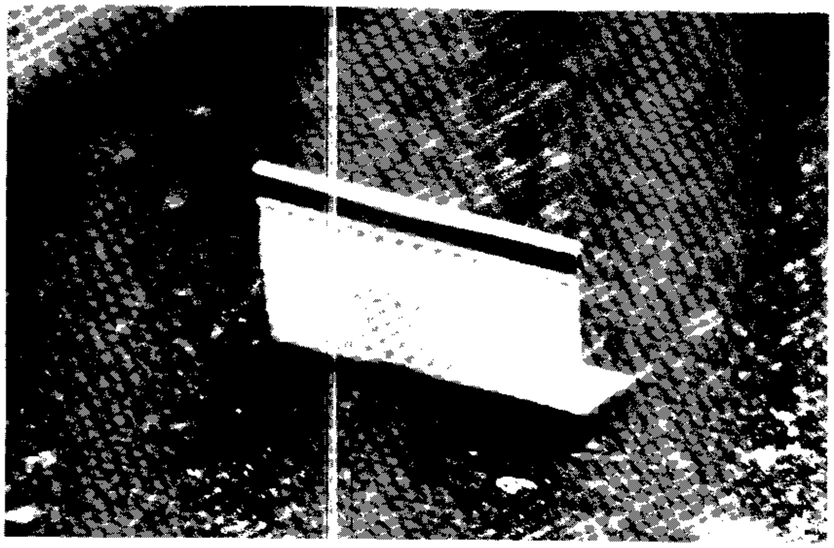

Figure 7

Davidson Markers on Edge Line

Dimensions (inches)
Overall: Length = 3.50, Height = 2.00, Thickness = 0.05
Reflective Surface: Length = 3.50, Width = 0.25
Spacing = 16 ft., Length of Section = 1,000 ft.

- Astro-optics placed on the barrier face, and
- Davidson markers placed on the edge line.

The delineators were compared among each other and with the Washington State Department of Transportation's (WSDOT) current delineation system, raised pavement markers placed on the the barrier side of the edge line.

STUDY PLAN

A literature review proved to be inconclusive about the effectiveness of various delineators. Therefore, the study team installed the delineators on a test site on Interstate 90 near Seattle (Figure 8) to make observations, measurements, and to allow drivers to compare and rate the various delineators. The study team observed and measured luminance, the effects of dirt and moisture on the devices, the effects of snow, and the relationship between placement of the devices and the amount of dirt that accumulated on them. The team also observed the effects of wind and gravity and noted whether the devices could be used again, how easy they were to vandalize, and how long it took to install them.

Motorists drove over the test course and answered a questionnaire designed to test their perception of the delineators' brightness, their comfort with the roadways' alignment, the effects of opposing traffic headlight glare on the delineators' effectiveness, at what distance from the barrier the drivers felt most comfortable, how fast they felt comfortable driving, and how they liked the delineators in general. In the first stage of the tests, drivers compared the seven delineators described above, and then in the second stage drivers compared the best of the seven with WSDOT's current delineation system.

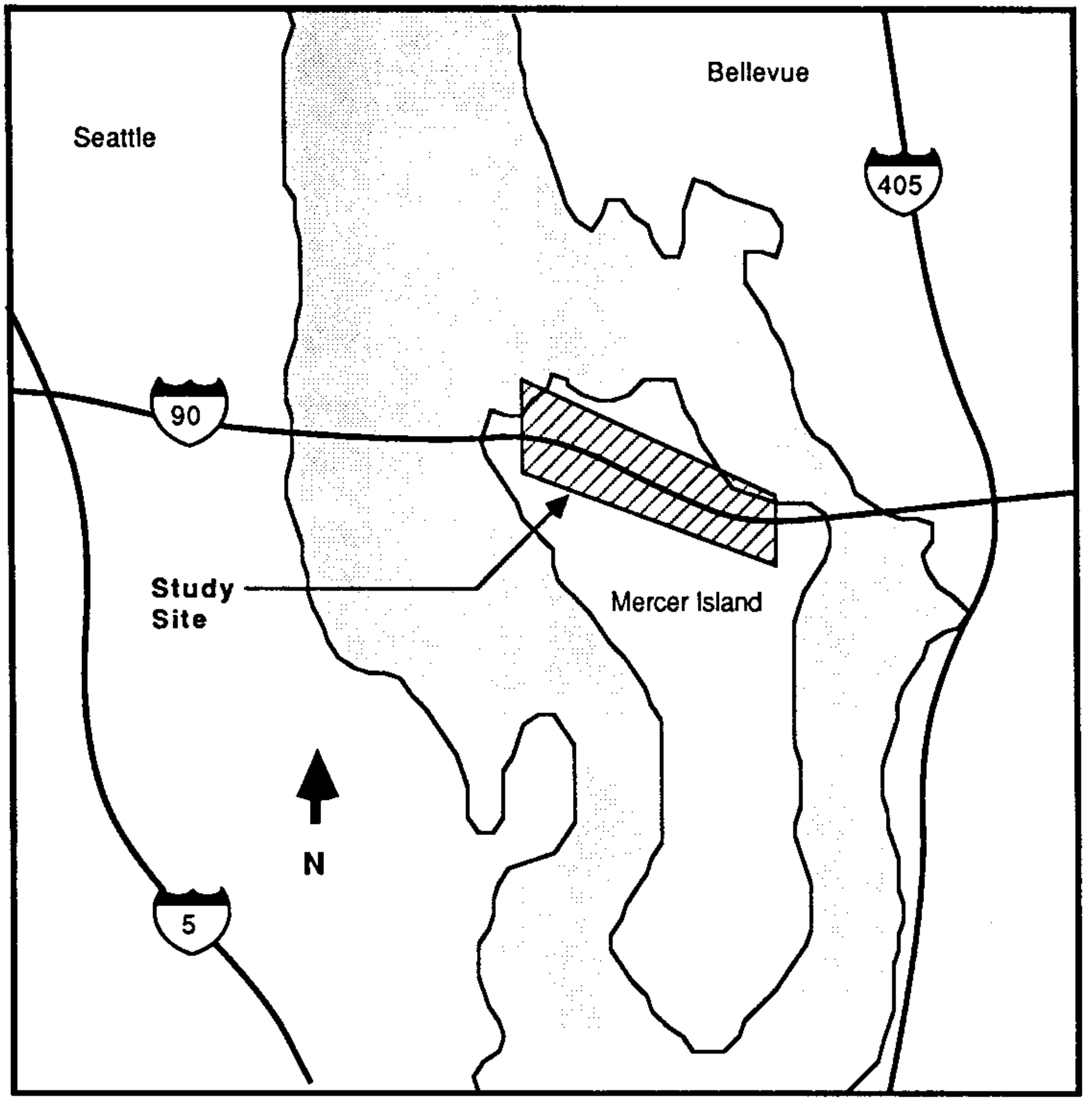

Figure 8. Vicinity Map

RESULTS

Luminance measurements showed that, even when dirty, Astro-optics were the brightest devices (Table 1). However, some of the markers, including the raised pavement markers and the Davidson markers, were not measurable by a retro-Tech instrument because their reflective sheetings were too narrow to measure.

The study team made the following observations:

- moisture rusted the outer edges of the hazard panels and reflective cylinders but did not affect the other delineators;
- snow would have covered the barrier-top mounted devices, the raised pavement markers and the Davidson markers; Astro-optics would have been least prone to snow coverage;
- generally, those devices placed higher up on the barrier collected relatively less dirt;
- wind had no observable effect;
- gravity affected the installation of the barrier-face mounted devices;
- all the devices were reusable except the Davidson markers; and
- Davidson markers took the least amount of time to install; hazard panels the most time. Astro-optics on the barrier face were at the mid-point (Table 2).

As Table 3 indicates, analysis of material and labor installation costs showed that Davidson markers were the least expensive to buy and install, using unit prices for comparison. 3M high intensity sheeting for cylinders was the most expensive. Astro-optics fell at the mid-point.

Analysis of the questionnaire results showed that opposing traffic headlight glare was the most important factor to the drivers in rating their comfort with the roadway's alignment. In other words, those delineators that were still visible

Table 1. Average Luminance Readings for Astro-Optics, Reflexite and Cylinders/Hazard Panels

	Astro-Optic	Reflexite	Cylinders/Hazard Panels
Before Cleaning	256.56	75.40	14.81
After Cleaning	1482.12	377.76	49.54

* Note that the more useful readings are those of the dirty delineators. Because no standard method of cleaning was used, the readings taken after cleaning are secondary and are only good for comparison to dirty reflectors. Most importantly, they emphasize the need to clean the delineators on a regular basis (monthly).

Table 2. Installation Time Summary

Number of Devices per 1000'	Device Type	Total Installation Time* per 1000'
64	Davidson Markers (on edge line)	128 seconds
26	Astro-optics (on barrier top)	383 "
26	Reflexite (on barrier top)	383 "
26	Raised Pavement Markers (on pavement)	383 "
26	Astro-optics (on barrier face)	539 "
26	Raised Pavement Markers (on barrier face)	539 "
11	Cylinders (on barrier top)	772 "
11	Hazard Panels (on barrier top)	1003 "

* Total installation time does not include the following:

- Travel time from the shop to the field,
- Set up time,
- Travel time between delineators, and
- Time for mixing epoxy.

For hazard panels and cylinders, installation time includes time for preparing these devices for installation (i.e. , punching holes, mounting reflective sheeting, etc.)

Table 3. Material and Installation Time Unit Costs of Reflectors

Reflector	Unit Price
Davidson markers	$ 0.52
Bare Cylinder	0.76
Raised pavement markers	1.20
Reflexite	1.66
Astro-optics	2.45
Hazard panels	8.28
3M High Intensity Sheeting for Panels: 3" wide (per 50 yds.)	132.44
" " " " " Cylinders: 4" wide (per 50 yds.)	176.58

* Prices were obtained from purchase invoices and suppliers.

despite opposing traffic headlight glare were the most effective. Similarly, brightness of the delineators was also important. Drivers also liked a delineator better if it made them feel comfortable going faster. However, where motorists felt comfortable placing their vehicles in relation to the barrier had little effect on their opinions.

Table 4 shows that the drivers rated Astro-optics on the barrier face significantly higher than the other six delineators. Cylinders and hazard panels tied at a distant second, due primarily to the fact that their larger sizes made them partially visible in the presence of opposing traffic glare.

In comparing Astro-optics on the barrier face with WSDOT's current system, raised pavement markers on the inside of the edge line, 88 percent, or 15 out of 17, of the drivers preferred Astro-optics placed on the barrier face.

CONCLUSIONS

The conclusions that can be drawn from the results of this study are as follows:

1. Drivers need the guidance of delineators most when confronted with opposing traffic headlight glare. They, therefore, prefer devices that guide them most effectively under such conditions.
2. Devices placed on top of the barrier are washed out by opposing traffic glare and, therefore, are not effective delineators (especially when they are small).
3. The best placement of concrete barrier delineators is on the barrier face.
4. A delineator loses more than half of its reflective properties in a short period due to dirt accumulation. For the brightest delineator in this study this period was one month.

Table 4. Transformed Total Ranking Frequencies

		Device						
		Astro-Optics (Face)	Cylinder (Top)	Hazard Panel (top)	Astro-Optics (top)	Davidson Markers	Raised Pavement Markers	Reflexite (Top)
Frequency	First	138	21	30	27	30	6	9
	Second	26	42	40	18	20	24	4
	Third	15	23	16	16	1	7	8
Sum		179	86	86	61	52	37	21
Ranking		1	2/3	2/3	4	5	6	7

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. The "Manual on Uniform Traffic Control Devices" calls special attention to the effects of water and snow on delineators. It also needs to call special attention to the effect of opposing traffic headlight glare. This is the condition under which the need for delineators appears to be most critical.
2. For positive guidance, delineators should not be placed on top of concrete barriers.
3. Astro-optics placed on the barrier face was found to be the most effective delineator. Therefore, prism-lensed devices of this type are recommended for use as positive barrier delineators.
4. A delineation system must be maintained (or cleaned) on a regular basis. A dirty delineator reflects no light and is not effective in guiding traffic.