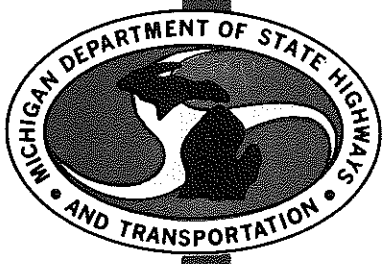
RAISED PAVEMENT MARKERS



TESTING AND RESEARCH DIVISION
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RAISED PAVEMENT MARKERS

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In response to a request by R. J. Kuzma, acting for D. E. Orne, Engineer of Traffic and Safety, dated December 2, 1976, the Research Laboratory has photometrically evaluated raised pavement markers manufactured by the Signal Products Division of Amerace Corp., Niles, Illinois (Fig. 1).

The request asked that every three months we measure the reflectivity of 66 raised pavement markers installed on the eastbound and westbound lanes of temporary I 69 just east of the Hagadorn Rd intersection, City of East Lansing. Visual inspections of the markers were accomplished but nighttime on-site photometric measurements proved to be too hazardous and, because of the necessary traffic control measures, too costly.

Therefore, at our request N. H. Alshari, Traffic and Safety, furnished the Research Laboratory with reflectors from four raised pavement markers on March 10, 1977. The reflectors represented four different lengths of service on a roadway. One of the four reflectors had not been installed and, therefore, was considered new. The remaining three reflectors had been in service for 5 months, 12 months, and 18 months, respectively (Fig. 2). The 5-month old service reflector was removed from I 75 in Oakland County; the 12 and 18-month old service reflectors were removed from temporary I 69 at Hagadorn Rd.

The reflectors lost 80 to 90 percent of their specific luminance after 5 months, and 95 to 99 percent after 12 months depending on the testing geometry. In a new condition the reflector was approximately 20 times brighter than a newly painted centerline stripe, but after 12 months both were approximately equal in brightness. This comparison is valid only under dry pavement or dry paint stripe conditions.

Photometric Testing

The specific luminance values were obtained in the laboratory. The values were obtained at various combinations of vertical and horizontal angles to approximate either a driver viewing condition at 150 ft, or to duplicate the manufacturer's testing geometry.

Table 1 gives reflector specific luminance values at 0.5° divergence angle, 1° entrance angle with a horizontal driver displacement of 0° (driver above the line of markers), 2° (driver in the passing lane), and 6° (driver in the traffic lane). Values are also shown for the 0.2° divergence and 0° entrance angle test geometries used by the manufacturer. Values for the new reflector are shown along with the values for the reflectors that had been in service.

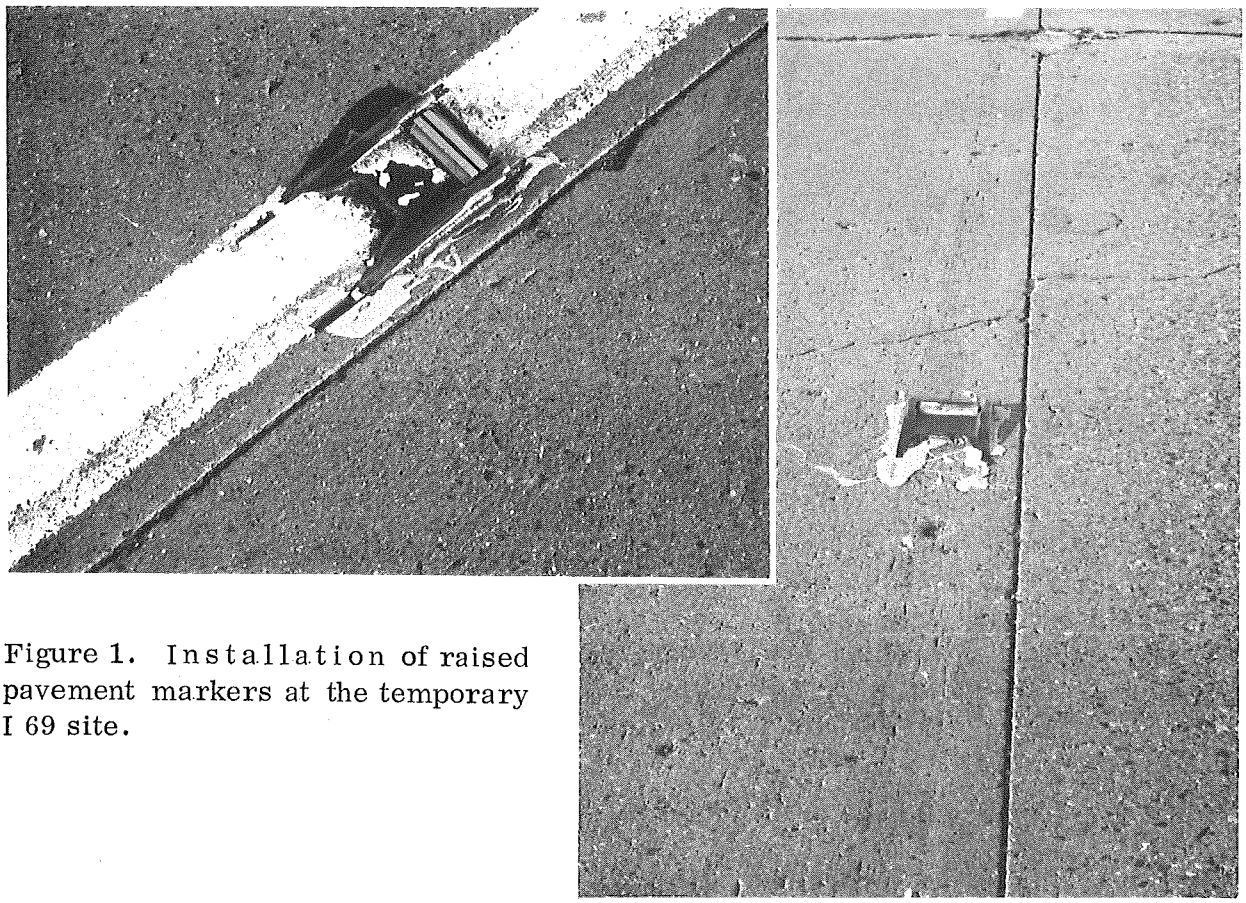

Figure 1. Installation of raised pavement markers at the temporary I 69 site.

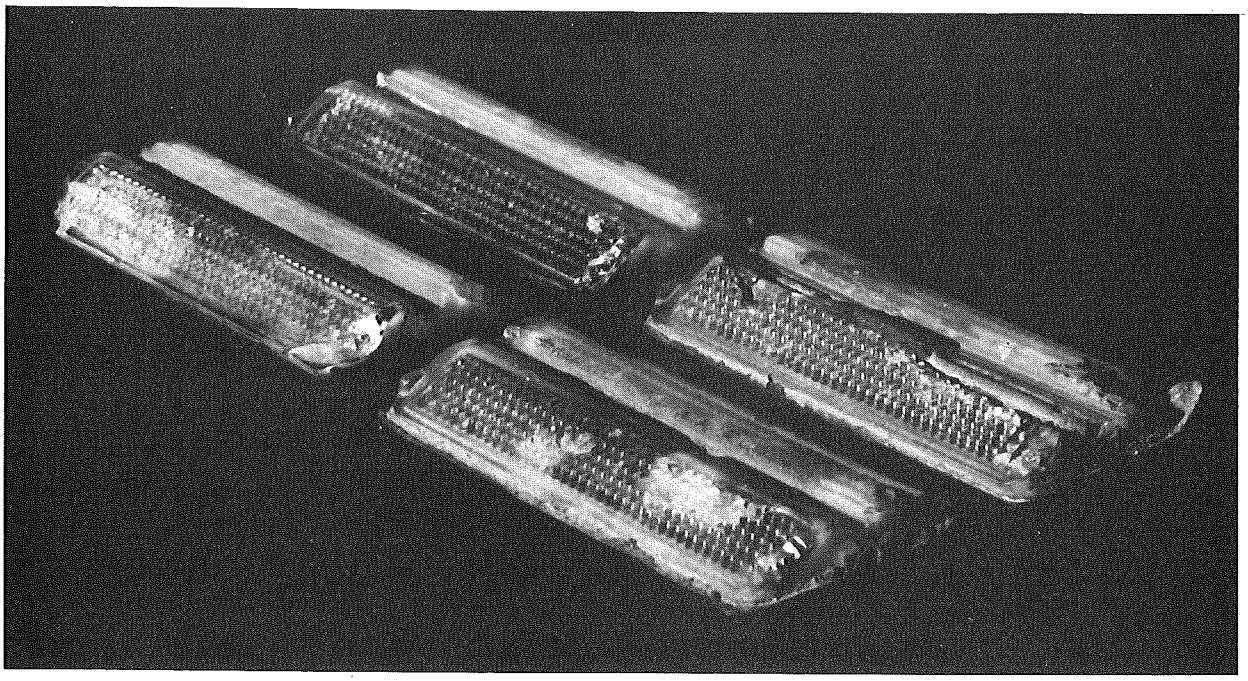

Figure 2. Raised pavement marker reflectors at various stages of service; new reflector (top), 5-month old reflector (left), 12-month old reflector (right), and 18-month old reflector (bottom). Light spots indicate damaged cube corners.

TABLE 1
REFLECTOR SPECIFIC LUMINANCE
(All measurements at 1° vertical)

Months in Service	0.5° Divergence			0.2° Divergence
	0° Horizontal (Marker Line)	2° Horizontal (Passing Lane)	6° Horizontal (Traffic Lane)	0° Horizontal
0	2.20	2.20	1.90	5.60
5	0.30	0.32	0.25	0.62
12	0.06	0.05	0.06	0.06
18	0.02	0.02	0.02	0.03

TABLE 2
EFFECTIVE REFLECTOR AREA

Months in Service	Effective Area, sq in.	Percent of Original Area Remaining
0	1.002	100.0
5	0.787	78.5
12	0.738	73.7
18	0.749	74.7

It should be noted that the above values of effective reflector area are the projected areas on a plane perpendicular to the driver's line of sight. The true plane of the reflector is at a 60° angle with the projected plane. The approximate area of the new reflector in its true plane was 2 sq in.

At the 0.2° divergence angle the reflector had lost nearly 90 percent of its specific luminance after 5 months, and 99 percent after 12 months service.

Specific luminance is defined as:

$$\frac{\text{Intensity (candela)}}{\text{Area (sq in.) x incident illumination (foot candles)}}$$

The effective area of the reflectors varied with time in service because of damage to the reflector (Fig. 2). The values of reflective area employed in the computation of specific luminance are listed in Table 2.

Comparison of Marker and Paint Stripe

The luminance of the new raised pavement marker and of a freshly painted lane marking stripe were measured at 100 ft from a standardized set of headlamps. The 4-in. wide paint stripe had been prepared in the field by Department striping equipment.

A Pritchard telephotometer (Model 1980) placed at a typical driver's eye height, measured the luminance of the marker and stripe. The luminance values were as follows:

1. Raised pavement marker (new)	9.8 ft-L
2. Paint stripe (new)	0.50 ft-L
3. Raised pavement marker (5 months service)	1-2 ft-L (calculated)
4. Raised pavement marker (12 months service)	0.1-0.5 ft-L (calculated)
5. Paint stripe (12 months service)	0.2-0.45 ft-L (calculated)

Visual Evaluations of Raised Pavement Markers

The visual evaluations of markers installed at 50-ft intervals on centerlines for eastbound and westbound traffic on I 69 are summarized as follows:

	Eastbound	Westbound
October 1975	33 reflectors installed	33 reflectors installed
October 1976	33 replaced	no evaluation
February 1, 1977	22 remaining: 18 broken, cracked or chipped; 4 in good condition	33 remaining, but most had extensive physical damage, with very few in good condition; 7 covered with centerlining paint
March 1, 1977	16 remaining: 13 broken, cracked or chipped; 3 in good condition	33 remaining, condition had deteriorated slightly
March 24, 1977	14 remaining: 2, only pieces remaining; 9 broken, cracked or chipped; 3 in good condition	32 remaining: 1 removed by Traffic and Safety for testing; 4 in good condition

As part of the evaluation, photographs were taken of each eastbound installation and of representative marker installations in the westbound traffic lanes. The photographs are on file in the laboratory.

Amerace Concepts of Test

Larry Smith, an Amerace Corp. representative, was contacted by phone, March 17, 1977, and was questioned concerning his concepts of the raised pavement marker test installation on temporary I 69. He replied that the markers were a new product being tested in Michigan and that Amerace was interested in an evaluation of the adhesive. He noted that at the time of installing replacement markers in 1976, corporation representatives were not aware of the limitations of the pressure sensitive adhesive furnished on the reflectors. For example, the temperature during installation was below the recommended minimum for application and, therefore,

the cast metal housing for the reflectors should have been preheated. In addition, a pickup truck was driven over the reflectors to secure the adhesive, whereas now Amerace recommends a 1,000-lb load for three seconds.

On June 8, 1977, J. Steiner, Regional Sales representative for Amerace Corp., restated the above limitations and also reviewed the Amerace concepts of the test installation. Mr. Steiner stated that Amerace, in cooperation with the Department, was studying the field serviceability of three types of pavement markers. The markers were described as follows:

1) Model 944, with hardcoat - 17 units were installed on eastbound temporary I 69 in October 1976. Hardcoating consists of a glass veneer on the plastic reflector surface to provide protection from traffic abrasion.

2) Model 944, without hardcoat - two units were installed on eastbound temporary I 69 in October 1976; 33 units were installed on westbound temporary I 69 in October 1975.

3) Model 945, with hardcoat - 14 units were installed on eastbound temporary I 69 in October 1976. This model unit can be identified by protective ridges which protrude between cells in the reflector. The unit contained an epoxy filler to replace the cube-corner airspace. Amerace has found that the epoxy ingredients attacked the reflector and efforts to retard the corrosion with an aluminum film led to another problem of reduced reflectivity.

Amerace has recognized the need for improving their markers and also was aware of the adhesive failure on units installed on eastbound temporary I 69. Therefore, on June 7, 1977 revised Model 944 units were installed (33 units) on eastbound temporary I 69. The revised 944 unit is claimed to have improved cube corners which yield approximately twice the reflectivity of the older 944 and has a lower profile because it does not contain a baseplate. The unit is hardcoated. Mr. Steiner also noted that the raised markers do perform under wet pavement conditions and are expected to have a two-year service life. Castings for the markers are usually replaced at the rate of 1/2 percent per year.

Summary

Three different models of raised pavement markers were installed on temporary I 69. Markers for westbound traffic showed good retention of the reflector but only 4 of 33 were considered in good performance condition after 18 months service. On the basis of a reflector removed, measured brightness was about the same as the brightness of a traffic paint stripe. The reflector lost approximately 99 percent of its original specific luminance during 18 months of service. Reflectors of the type installed are no longer available; replacement of the reflectors is indicated.

Markers for eastbound traffic showed poor retention. The method of installation was probably responsible for the early loss of reflectors. Comparison photometric performance of the two models of reflectors installed could not be measured because of the loss of reflectors. Markers on the eastbound traffic lanes have been replaced.

An on-site photometric evaluation of raised pavement markers could not be made for this test area. However, the influence of improper installation methods and substantiating evidence of an expected two-year service life were noted from visual observations.

On June 29, 1977 photometric tests were completed on samples representing the June 7, 1977 replacement reflectors. The specific luminance was 5.2 at 0.2° divergence angle, 0° horizontal entrance angle and 1° vertical entrance angle. When compared with the results shown in Table 1, the results do not verify the photometric claims for the revised model 944 markers.