EDGE MARKING CRITERIA FROM CONTRAST RATIOS

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The Engineer of Traffic and Safety, requested the assistance of the Research Laboratory in establishing quantitative criteria on which to base the need for the edgeline marking of pavement (letter to R. L. Greenman, Engineer of Testing and Research, October 23, 1968).

In a meeting March 11, 1968, attended by W. Savage and J. Kineman of the Traffic and Safety Division, and M. H. Janson and G. M. Smith of the Research Laboratory, it was agreed that the Research Laboratory would determine the brightness contrast between the pavement and shoulder, and that the contrast level would be the criterion by which the Traffic and Safety Division would determine what roads should be edgestriped on a priority basis. Priorities became necessary since funds were not available to edgeline all roads. The measurement would be confined to the driving lane, low beam illumination, and to a uniform grade with no horizontal curves. The pavement would be portland cement concrete only.

The recommendations based on this study are that, based on need, roadways with bituminous shoulders older than three years should be edgestriped first; followed by roads with new bituminous, gravel, and lastly seal coat shoulders.

The 1973 Michigan Manual of Uniform Traffic Control Devices, Section 3B-6 requires that all Interstate roadways have pavement edge marking; optional on other roadways.

Since funds became available soon after this study began and since all state trunklines are edgelined now there is no need for a priority ranking of shoulder materials except for edgestripe maintenance purposes.

Beginning in June 1969, measurements of the brightness or luminance of shoulders and concrete lanes for roadways selected by the Traffic and Safety Division and by the Research Laboratory were made in order to determine a rank order of need for edgestriping for the various ages and types of shoulder materials in widespread use. Table 1 lists the location, the type, and approximate age of the shoulder materials.

In addition, the luminances of a fresh paint stripe at the No. 3 location and of an older paint stripe at the No. 4 location were measured.

A set of headlamps, shown in Figure 1 provided the pavement and shoulder illumination at the chosen sites. Also depicted in Figure 1 is the Pritchard Telephotometer placed at the driver's eyes position for measuring brightness. The set of headlamps used was constructed with typical

TABLE 1
SHOULDER/PAVEMENT TEST SITES

Site No. and Location	Shoulder Material	Approximate Age of Shoulder, years
1. US 127 northbound, 1,500 ft north of the M 36 Interchange	Bituminous	6
2. US 127 southbound, 1,000 ft north of Barnes Rd Interchange	Gravel	11
3. I 496 westbound, 1,000 ft east of the Waverly Rd Interchange	Bituminous	3
4. M 78 eastbound, one mile east of the M 47 Intersection	Seal Coat	8

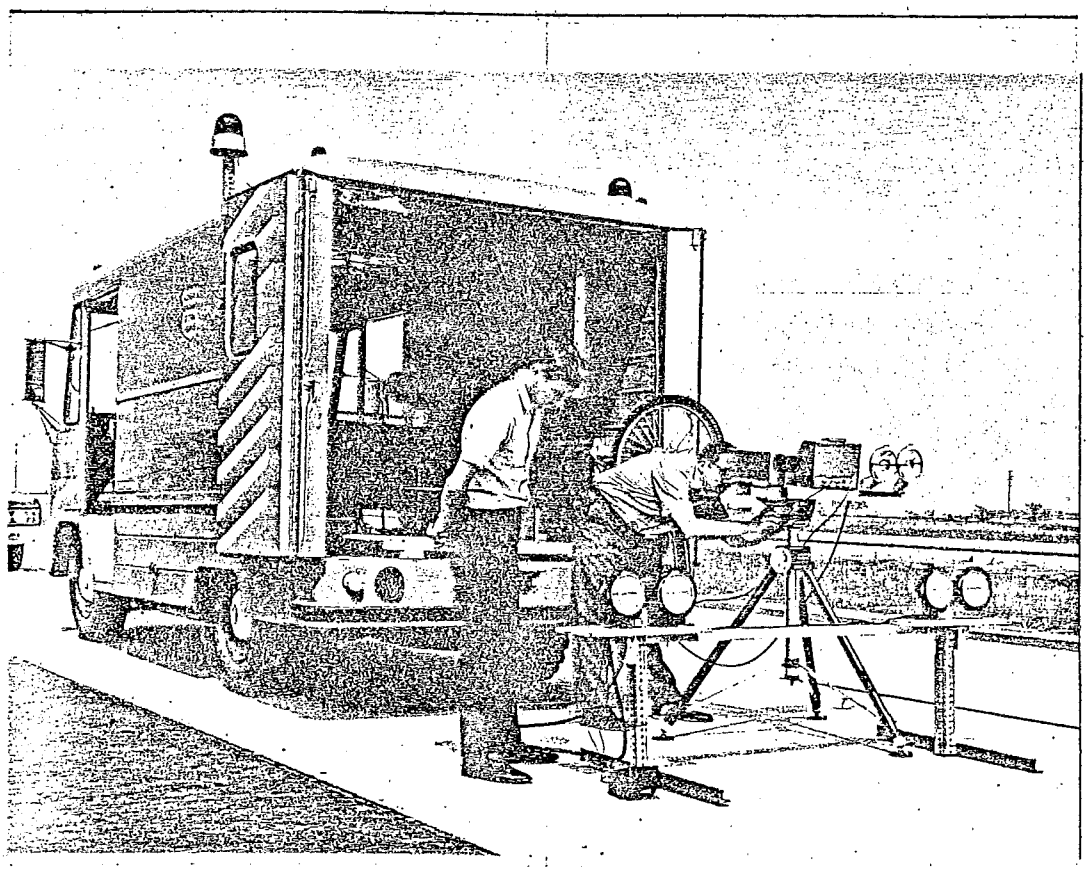

Figure 1. Headlamps, spotlamps, and Pritchard Telephotometer array.

spacing found in a survey of automobiles in 1966. The headlamps were selected for intensity distribution, and were seated and aimed according to SAE recommendations (see SAE J580 and J599a, 1966). Voltage to the lamps was maintained at a constant 12.8 vd.c. monitored by a 1-1/2 percent accuracy volt-ohm-milliammeter and was supplied by a regulated d-c power source. The set of headlamps was centered in the driving lane. Luminance measurements were made at 50-ft intervals from 50 ft to 250 ft from the headlamps. Telephotometer apertures with angular sizes of 30 minutes and 15 minutes were employed such that the area of pavement sampled was an ellipse roughly 1 ft wide and 23 ft long at 100 ft from the vehicle and 2 ft wide, 110 ft long at 200 ft for the 30-minute aperture. The sample dimensions were halved for the 15 minute aperture.

In addition, luminance measurements were made using a pair of high intensity spotlamps, also shown in Figure 1, in order to determine if the same results could be obtained as with the headlamps so that the less cumbersome spotlamps could be used should further measurements of other sites prove necessary. While the spotlamp method yielded luminance contrasts similar to the headlamp method, the luminances obtained by the spotlamp method were greater than those obtained by the headlamp method. The spotlamp method might be employed where pavement reflectances are relatively low resulting in greater accuracy in computing contrast levels.

Table 2 lists luminance measurements of the sites under illumination from the low beam headlamps. Only the luminance values for spots on the roadway at 100 ft and at 200 ft from the headlamps are listed since the values at 40, 150, and 250 ft yield very similar contrast levels.

The apparent visual contrast level (C) is defined as

$$C = \frac{L_t - L_s}{(L_t + L_s)/2}$$

where L_t and L_s are the luminances of the traffic lane and shoulder, respectively.

Table 2 also gives the contrast levels for the sites at the 100 and 200-ft sight distances. A negative number means that the shoulder is brighter than the pavement.

For nearly certain detection (i.e., 99 percent of the time) C (contrast level) must exceed the following approximate values for the referenced distances from the headlamps to the pavement.

TABLE 2
LUMINANCE AND CONTRAST DATA

Distance From Driver, ft	Site No.	Shoulder Material	Age, years	Luminance, Avg ft-L		Contrast Level*	Approximate Minimum Contrast Level For Detection
				Shoulder	Concrete Traffic Lane		
100	1	Bituminous	6	0.078	0.089	0.14	± 0.5
	2	Gravel	11	0.240	0.123	-0.65	± 0.5
	3	Bituminous	3	0.135	0.340	0.86	± 0.5
	4	Seal Coat	8	0.223	0.110	-0.68	± 0.5
200	1	Bituminous	6	0.043	0.043	0.00	± 0.8
	2	Gravel	11	0.030	0.015	-0.67	± 0.8
	3	Bituminous	3	0.021	0.038	0.56	± 0.8
	4	Seal Coat	8	0.125	0.050	-0.86	± 0.8
100, 200		Edgeline Stripe	< 1	0.45 - 1.17		1.2 to 1.3	
100, 200		Edgeline Stripe	> 1	0.20 - 0.45		0.5 to 1.2	

* Negative value indicates that shoulder was brighter than traffic lane.

Distance, ft	Minimum Contrast Required For Certain Detection
100	0.5
200	0.8

The above levels of contrast would allow detection of the edge of the pavement by 95 percent of drivers up to the age of 60 and by the majority over age 60. Note that the minimum contrast level, C, increases with increasing distance from the vehicle. The contrast necessary for detection of the shoulder by the driver increases due to decreasing luminance of the traffic lane with distance from the vehicle.

It can be seen that the six-year old bituminous shoulder (Site No. 1) cannot be detected with certainty at either distance and that even the newer bituminous shoulder (Site No. 3) cannot be easily distinguished from the traffic lane at 200 ft. The gravel (Site No. 2) and the seal coat (Site No. 4) shoulder materials should easily be distinguished at 100 ft. A seal coat shoulder can be seen but a gravel shoulder cannot be easily seen at 200 ft from the headlamps.

It was noted that the older bituminous shoulder at Site No. 1 was covered with concrete dust and thus offered little contrast with the concrete pavement whereas heavily textured shoulder surfaces such as gravel or seal coat reflected more light back to the driver than do the traffic lanes. Note also that the smoother bituminous shoulders, both old and new, lose contrast at the greater distance from the vehicle headlamps whereas the rougher gravel and seal coat shoulders either remain the same or increase in contrast at 200 ft compared with 100 ft.

Paint Stripes

The luminances of a paint stripe less than one year old and of an older paint stripe were measured. The contrast level computed for the newer stripe ranged from 1.2 to 1.3; the contrast level for the older paint stripe ranged from 1.2 downward to less contrast than needed for detection of the paint stripe. It is clear that a much higher contrast is associated with a new paint stripe than with any of the shoulder materials evaluated at the four sites. Old paint stripes may not enhance traffic lane-shoulder contrast.

Recommendations

It was found that old paint stripes may offer no more contrast than the traffic lane and shoulder materials themselves and therefore, it is recommended that concrete roadways with the following shoulder material may be restriped with the priorities as shown ranked in order from foremost preference to least:

1) Bituminous, older (approximately four or more years)
2) Bituminous, newer (approximately three years or less)
3) Gravel
4) Seal Coat