COMPARATIVE TESTS OF BEADED PAINT AND SHEET MATERIALS FOR SIGN REFLECTORIZATION

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On October 30, 1957, a meeting was held to discuss the merits of new sign making materials being produced by the Flex-O-Lite Company, with the thought that the beads-on-paint type of reflectorization might prove to be an economical and effective substitute for sheet reflectorized material for certain kinds of signs. Present at this meeting were the following representatives of the Flex-O-Lite Company and Michigan State Highway Department:

Flex-O-Lite

C. R. Dernbach
G. B. Kelch

Michigan State Highway Department

H. G. Bauerle
L. J. Doyle
M. R. Hoffman
E. F. Gervais
R. L. Rigotti
V. G. Burgess
C. C. Rhodes

At this meeting, and at a later one of the Department's Traffic Sign Committee on November 12, 1957, procedures were discussed for carrying out field and laboratory tests to evaluate the various materials to be included in the study. At the November 12 meeting C. C. Rhodes was in-

structed to prepare an outline of the tests. This was done and the outline submitted to W. W. McLaughlin, H. G. Bauerle, and E. D. Suino on November 25, 1957 (Appendix A).

Materials

As indicated in the outline, the products of four manufacturers were included in the tests: bead and paint materials from the Prismo, Cataphote, and Flex-O-Lite companies; and two types of reflective sheeting, No. 241 Wide-angle white and Flat-top silver, from the Minnesota Mining and Manufacturing Company. Oversize M route markers, 18 by 18 in., white background with black legend, were used in the tests. Two markers of each proprietary product were made by the manufacturer and two by the Michigan Prison Industries, except the Scotchlite specimens which were made up by the Michigan State Highway Department sign shop from sheeting on hand. All specimens were made according to the manufacturers' recommendations including the application of Storm-Coat on Flex-O-Lite specimens. Four plain panels, 2-7/8 by 5-7/8 in., were also made from each production of sign specimens for optical and accelerated weathering tests in the laboratory.

Test Methods

On March 28, 1958, the completed signs were installed on M 78 about 3 miles east of East Lansing at the locations shown in Figure 1. Two signs were mounted side by side on a single post with posts about

500 ft apart. Company-prepared signs were mounted alongside their prison-prepared counterparts on the south side of the road, while the duplicate panels were mounted in random pairs on the north side. This arrangement permitted comparison of the different sign materials as well as different preparation of panels made with the same materials.

The signs were rated by four observers on daytime appearance, background brightness (night visibility), and night legibility. Night ratings were made by the observers in a car driven along the shoulder toward the signs using high beam illumination. Comparative background brightness was rated at a distance of 400 to 300 ft from the signs, and legend legibility was rated, again comparatively, by determining which legend first became distinctly readable. This distance was about 300 ft from the sign.

Rating of each quality was on the basis of 10 to 0, with 10 indicating optimum or perfect condition, as in the traffic paint performance tests. The signs were rated three times, the last on November 19, 1959, when the signs had been out about 20 months.

Photometric and accelerated weathering tests were made in the laboratory on the 2-7/8 in. by 5-7/8 in. panels to determine optical properties and relative durability of the various systems. At the time these tests were started, the goniometer of the photometric apparatus could not accommodate an 18 in. sign, so it was necessary to rely on the smaller

panels prepared in the same way and at the same time as the signs themselves for initial photometric data. The apparatus has since been modified to hold specimens of this size, so the signs were tested photometrically after they were brought in from the field. Accelerated weathering tests were also performed on the plain panels by subjecting them to 90 cycles of exposure in the Atlas twin-arc weatherometer. During these tests, observations and photometric measurements were made at the end of 30, 60, and 90 cycles. Twenty-four cycles are ordinarily considered equivalent to one year of outside weathering.

Results

Data from both the field and laboratory tests are given in Table 1. For the accelerated weathering tests, only the data obtained at 60 cycles are included, since this treatment is the one next higher in severity over the minimum corresponding to 20 months outdoors.

General Appearance. There was little difference in the original daytime appearance of the various products. All were neat, pleasing, and legible. After 20 months in service, however, the signs of producers C and D had weathered more uniformly than the others, some of which showed occasional spots of thin paint film. The two signs from Producer A made with steel panels rusted badly on the back and rust was also beginning to encroach seriously on the front.

Background Brightness. The smooth-surface silver reflective sheeting exhibited the highest initial background brightness by a wide margin and this brightness suffered no loss during the field service tests. The beaded paints and wide-angle white reflective sheeting were originally about equal in brightness, but the sheeting maintained a higher, more uniform brightness on weathering. The signs from Producer D were lowest in brightness and the beads looked cloudy under the microscope.

Night Legibility. Products A and B were rated the most legible at night after 20-months' exposure, with values slightly above those of Product D and wide-angle white sheeting. In spite of their background brightness, or rather because of it, signs made with the smooth-surface silver material were rated lowest in night legibility.

Durability. As mentioned previously, the reflective sheeting withstood the weather much better than the bead-paint systems; loss of reflection was less and uniformity of appearance better. Unfortunately, the signs were brought in at a time (20 mo) when the paint-bead systems were apparently just beginning to fail, thus forestalling a widening of the gap between these materials and the reflective sheeting in service performance.

Uniformity of Production. One of the most noticeable shortcomings of the beaded paint signs was their lack of uniformity. In some cases the signs made by the company were brighter than their prison-made

counterparts; in others, the reverse was true. Also, for some unaccountable reason, there was a wide difference in brightness between the two signs made from Producer B's materials at the Jackson prison. The results obtained on beaded-paint signs apparently depend as much on production control as they do on the materials used, and this is difficult in a relatively limited operation. Control of binder wet film thickness is especially troublesome and this is a critical factor in subsequent optical performance.

Cost. According to figures recently submitted by Flex-O-Lite, smooth-surface reflective sheeting costs about four times as much as beaded paint. They give the cost of Flat-top as 81 cents per sq ft and beaded paint as 15 cents for materials and 5 cents for application. V. G. Burgess does not agree with this cost estimate and says that the 5 cents per sq ft processing cost is too low for beaded paint signs. While Mr. Burgess was not able to say what the difference in labor cost might be, it seems reasonable to assume that the cost of reflective sheeting, installed on the sign, would amount to about three times that of beaded paint.

To offset this difference in cost, there are several other factors entering into the comparison. First, the service life of the reflective sheeting is about twice that of beaded paint (5-6 years against 2-3 years). Second, the visibility of beaded paint signs is seriously reduced by fog, rain, dew, and frost. Third, production time is a great deal longer for

the bead-paint signs, thus restricting capacity of the sign shop. Fourth, the rough surface of exposed beads is more destructive to the silk screens used to apply the legend.

Summary and Conclusion

The one disadvantage of the smooth-surface sheeting in the M 78 tests was the decreased legibility occasioned by apparently excessive background brightness. This seeming disadvantage can be overcome in two ways. Either the legend design can be modified by an increase in stroke width to reduce the "halo" effect, or a sheet material of slightly lower brightness can be specified. Photometric data in Table 1 show that the silver sheeting had a specific intensity of around 60 candlepower per foot-candle per square foot, while that of beaded paint under similar conditions was approximately 8 to 10. From these results an intelligent guess would put optimum background brightness for existing legend design somewhere in the specific intensity range of 20 to 40. It should be remembered, too, that upper beam illumination was used in the tests reported here. With present median widths and traffic volumes most driving, by far, is done with low beam illumination, and under this condition the reflective sheeting shows up to considerably better advantage.

In fairness to the bead producers, it should be said that it is now possible to make beaded paint signs with specific intensities of 15 to 20 cp per fc per sq ft. This may be bright enough for the purpose; only further tests would tell. However, this improvement does not solve the basic problems of durability, uniformity, and visibility under adverse weather conditions that are associated with the use of beaded paint signs.

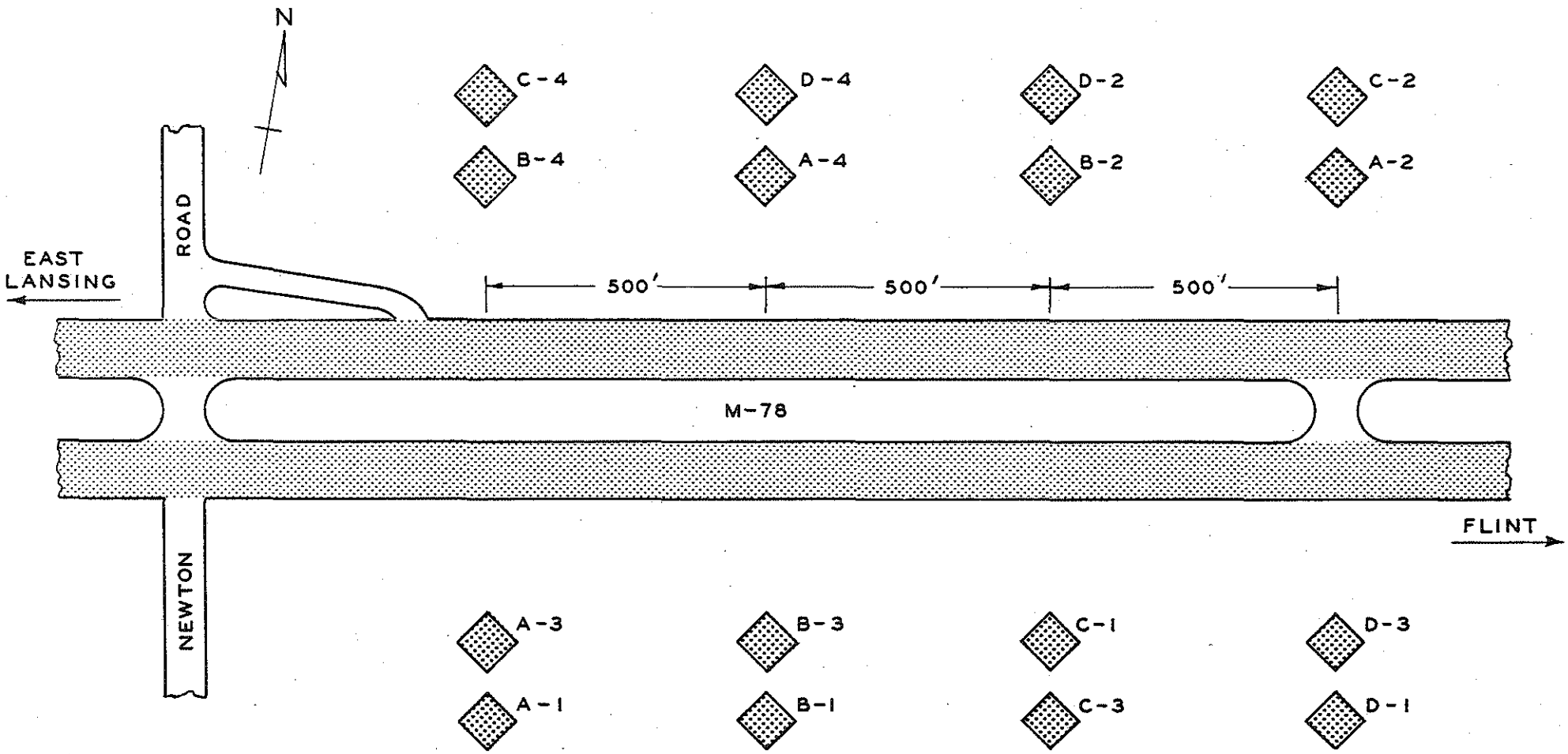

Figure 1. Location of Test Signs on M 78.

TABLE 1
COMPARATIVE TESTS OF BEADED PAINT AND SHEET MATERIALS FOR SIGN REFLECTORIZATION
RESEARCH PROJECT 51 G-54(1)

Date installed.....March 26, 1958
1st Evaluation.....April 7, 1958
2nd Evaluation.....May 10, 1959
3rd Evaluation.....November 19, 1959

Sign Designation	Prepared By	Location	Day			Night						Refractive Index Glass Beads	Specific Intensity, cp per fc per sq ft (2)						General Condition After 20 Months Exposure
			Gen. Appearance			Background Brightness			Legibility				Laboratory Panels, 3- by 6 in.				Field Signs, After 20 Mo.		
													Original		After 60 Cycles				
			1	2	3	1	2	3	1	2	3		0	10	0	10	0	10	
A-1	Company	S1R(1)	6.0	4.7	4.7	6.0	6.7	5.2	7.0	7.2	6.7	1.91+	8.4	8.3	4.0	4.0	8.3	8.4	Thin paint film; some rust on steel panel
A-2	Company	N1L	6.0	4.7	5.5	6.0	5.7	4.5	7.0	7.0	5.0	1.91+					7.2	7.2	Thin paint film; some rust on steel panel
A-3	Prison Ind.	S1L	8.0	8.5	9.5	8.0	8.2	7.2	7.0	7.7	7.2	1.91+	10.5	10.5	7.2	8.1	6.2	6.2	Light yellow staining
A-4	Prison Ind.	N3L	8.0	8.2	8.0	7.0	6.2	6.7	7.0	7.0	7.2	1.91+					7.5	7.4	Good
	Avg		7.0	6.5	6.9	6.8	6.7	5.9	7.0	7.2	6.5	1.91+	9.5	9.4	5.6	6.1	7.3	9.1	
B-1	Company	S2R	7.0	8.5	9.2	6.0	5.7	6.2	7.0	7.2	7.0	1.91+	8.2	7.9	5.3	5.2	7.4	7.2	Slight flaking of coating
B-2	Company	N2L	6.0	4.7	4.7	6.0	6.2	7.5	7.0	7.2	6.7	1.91+					8.5	8.2	5 - 10% flaking of coating
B-3	Prison Ind.	S2L	7.0	7.0	7.7	7.0	8.7	7.5	7.0	7.7	7.7	1.90+	9.5	9.5	7.3	7.2	17.7	17.5	Thickest paint film; muitilayer of beads; slight yellowing
B-4	Prison Ind.	N4L	8.0	8.5	8.0	6.0	4.7	4.0	6.0	6.2	5.5	1.91+					4.9	4.7	Monolayer of beads, not deeply imbedded
	Avg		7.0	7.2	7.4	6.3	6.3	7.8	6.8	7.1	6.7	1.91+	8.9	8.7	6.3	6.2	9.6	9.4	
C-1	MSHD Sign Shop	S3L	8.0	8.5	9.0	8.0	5.5	6.5	8.0	7.7	6.0	1.83+	9.2	8.6	5.3	5.0	8.3	8.2	Good
C-2	MSHD Sign Shop	N1R	8.0	8.5	8.5	8.0	7.0	5.5	8.0	7.7	5.7	1.83+					8.8	8.5	Good
	Avg		8.0	8.5	8.8	8.0	6.3	6.0	8.0	7.7	5.9	1.83+	9.2	8.6	5.3	5.0	8.6	8.4	
C-3	MSHD Sign Shop	S3R	7.0	7.0	8.0	9.0	8.5	8.7	7.0	7.0	5.0	-----	56.1	49.4	54.0	47.8	66.3	59.8	Good
C-4	MSHD Sign Shop	N4R	7.0	7.5	8.2	10.0	10.0	9.5	7.0	7.0	5.2	-----					65.6	59.3	Good
	Avg		7.0	7.3	8.1	9.5	9.3	9.1	7.0	7.0	5.1	-----	56.1	49.4	54.0	47.8	66.0	59.6	
D-1	Company	S4R	8.0	8.5	8.5	6.0	5.7	5.7	7.0	6.2	6.2	1.91+	9.3	9.1	7.5	8.5	3.0	2.9	Beads cloudy, slight flaking of coating
D-2	Company	N2R	7.0	7.2	8.0	6.0	5.2	5.7	6.0	6.7	5.5	1.91+					4.2	4.1	Beads cloudy
D-3	Prison Ind.	S4L	7.0	7.5	8.2	7.0	5.7	5.2	7.0	6.2	6.2	1.91+	9.4	9.3	5.5	5.8	3.4	3.4	Beads cloudy; slight yellowing of paint
D-4	Prison Ind.	N3R	7.0	7.5	7.5	6.0	5.0	4.7	6.0	6.5	6.5	1.91+	8.0	8.0	5.4	5.9	4.4	4.2	Beads cloudy
	Avg	N3R	7.3	7.7	8.1	6.3	5.4	5.3	6.5	6.4	6.1	1.91+	8.9	8.8	6.1	6.7	3.8	3.7	

(1) South side of pvt. 1st pair of signs, sign on right in direction of traffic.
(2) Divergence angle 1/3 degree; entrance angles 0 and 10 degrees as indicated.

APPENDIX A

Outline of Specimens and Tests

I. Materials
   - A. Flex-O-Lite
   - B. Cataphote
   - C. Prismo
   - D. Minnesota Mining and Manufacturing Co.
     1. Wide-angle white
     2. Flat-top silver

II. Specimens
   - A. Field Tests
     1. Type
        - a. Oversize M route markers, 18 by 18 in., white background with black legend.
     2. Number
        - a. Two markers of each proprietary product are to be made by the manufacturer of the material, except Scotchlite specimens which will be made up by the Michigan State Highway Department sign shop from sheeting on hand.
        - b. Two markers of each product are to be made up by the Michigan State Highway Department or its authorized agent, using materials and processes recommended by the manufacturer.
   - B. Laboratory Tests
     1. Type
        - a. Plain white beaded panels, 2-7/8 by 5-7/8 in.
     2. Number
        - a. Four panels are to be made from each production of field specimens, both by the manufacturer and the Michigan State Highway Department.

III. Tests
   - A. Field
     1. One route marker of each production will be installed in each of two test series of markers at locations to be selected on the State trunkline system.
     2. Periodic examinations will be made by a group of observers to determine relative visibility and durability.
   - B. Laboratory
     1. Photometric tests
     2. Accelerated weathering tests

Nov. 25, 1957

MATERIAL CODE

Comparative Tests of Beaded Paint and Sheet Materials for
Sign Reflectorization
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PRISMO

A-1	Prepared by Prismo on steel panels
A-2	Prepared by Prismo on steel panels
A-3	Prepared by Prison Industries on aluminum panels
A-4	Prepared by Prison Industries on aluminum panels

CATAPHOTE

B-1	Prepared by Cataphote on aluminum panels
B-2	Prepared by Cataphote on aluminum panels
B-3	Prepared by Prison Industries on aluminum panels
B-4	Prepared by Prison Industries on aluminum panels

3M

C-1	No. 241 Wide Angle White. Prepared by MSHD Sign Shop on aluminum panels
C-2	No. 241 Wide Angle White. Prepared by MSHD Sign Shop on aluminum panels
C-3	Flat-Top Silver. Prepared by MSHD Sign Shop
C-4	Flat-Top Silver. Prepared by MSHD Sign Shop

FLEX-O-LITE (with Storm-Coat)

D-1	Prepared by Flex-O-Lite on aluminum panels
D-2	Prepared by Flex-O-Lite on aluminum panels
D-3	Prepared by Prison Industries on aluminum panels
D-4	Prepared by Prison Industries on aluminum panels