CYCOLAC PLASTIC FOR NON-REFLECTORIZED SIGNS

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

CYCOLAC PLASTIC FOR NON-REFLECTORIZED SIGNS

J. T. Ellis

Research Laboratory Section
Testing and Research Division
Research Project 68 NM-203
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Michigan State Highway Commission
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INTRODUCTION

An evaluation of Borg-Warner Co.'s "Cycolac" as a material for small signs was requested by P. H. DeCamp in a letter to H. H. Cooper dated May 27, 1968. Subsequent correspondence between H. H. Cooper, R. L. Greenman, and L. T. Oehler transmitted the request and authorized the evaluation. It was learned from the manufacturer's literature that Cycolac was an ABS-type of plastic. A previous evaluation of ABS plastic signs, Research Project 64 NM-127 (Research Report No. R-514), concluded that ABS had good physical properties such as high impact strength, high tensile strength, high resistance to deformation under flexural load and weathered well compared to other plastics. Mr. DeCamp noted in his letter that Cycolac was compatible with production procedures of Michigan State Industries and might offer an economic advantage over metal signs.

A three-phase outline for Cycolac sign evaluation proposed by L. T. Oehler in a July 11, 1968 memorandum to R. L. Greenman follows:

A. Cost

1. Michigan State Industries was contacted to determine the material and processing costs of both aluminum and Cycolac signs.

2. Traffic and Safety Division was contacted to determine the average cost for labor and equipment to install one sign.

3. Traffic and Sign Shop personnel from Districts 6 and 7 were contacted for information on the service life of aluminum signs and cost information on the installation and replacement of the signs.

B. Performance Evaluation (Cycolac signs)

1. Four newly fabricated Cycolac signs were obtained from the Traffic and Safety Division, and color and gloss were measured on each sign.

2. Two, sign test installations of 50 signs each of Cycolac were installed at different locations in the Lansing area.

3. The test installations were inspected twice at approximately yearly intervals.

4. Representative signs were returned to the laboratory for color and gloss measurements following each inspection.

C. Control Sign Evaluation (aluminum signs)

1. Five newly fabricated aluminum signs were obtained from the MDSH Sign Shop and color and gloss were measured on each sign.

2. The areas adjacent to Cycolac test installations were signed with new aluminum signs.

3. The aluminum sign installations were inspected twice and at the same time as the Cycolac signs.

4. Representative aluminum signs were returned to the laboratory for color and gloss measurements following each inspection.

COST

P. H. Chase of the Department of Corrections, Michigan State Industries, was contacted to determine the material and processing costs of 12 in. by 18-in. signs of both aluminum and Cycolac. In his June 24, 1971 memo to J. T. Ellis, Mr. Chase showed that aluminum signs cost $0.96 and Cycolac signs $0.75 up to the point of silk screening the legend on the white background. It was learned from the MDSH Sign Shop that the silk screening operation costs about $0.08 per sign, thus the total cost per sign is approximately $1.04 for aluminum and $0.83 for Cycolac.

R. E. Addy of the Traffic and Safety Division, and Traffic and Sign Shop personnel from Districts 6 and 7, were contacted for information on the service life of aluminum signs and cost information on the installation and replacement of the signs. Estimates of service life vary from three to five years and estimates of installation and replacement costs vary from 7 to 12 dollars per sign. Assuming the maximum estimated service life (5 years) and the minimum installation and replacement cost (7 dollars) the total cost per sign is $8.04 for aluminum and $7.83 for Cycolac. A Cycolac sign would thus need a service life of $7.83/$8.04 x 60 months (5 years) or 58 months to be competitive with aluminum.

PERFORMANCE AND CONTROL SIGN EVALUATION

Four 12 in. by 18-in. Cycolac signs with the legend "No Parking At Any Time" were received by the Research Laboratory from P. H. DeCamp on June 25, 1968. The signs had been newly fabricated by Michigan State Industries using normal production procedures. Five new aluminum signs of the same size with the same legend were obtained from the MDSH Sign

Shop. Color measurements were performed on the white background and the red legend of both types of signs. Gloss of the background was also measured. These measurements were performed to show a comparison between new signs and weathered signs after one to two years service. The signs were returned to P. H. DeCamp on July 3, 1968. Test Installation of 50 Cycolac "No Parking At Any Time" signs on US 27 from Sheridan Rd north to Stoll Rd in Clinton County was completed on October 26, 1968. Test Installation of 50 "No Stopping, Standing or Parking" signs on M 99 from Jolly Rd north to Rundle St in Lansing was completed on February 7, 1969. The test signs were installed consecutively in the test area. Test signs at each location were placed on both sides of the street so that directional weathering effects could be examined. The areas adjacent to the test Cycolac signs were signed with aluminum signs at approximately the same time.

VISUAL INSPECTION

Two inspections of the test installations were performed. Inspection 1 was completed in April, 1970 and Inspection 2 in April, 1971. It was found that several Cycolac signs were missing or had been replaced with aluminum signs. No information was available as to the reason for the missing or replaced signs. It was learned that both District Maintenance personnel and Sign Shop personnel in a roving sign truck install and replace signs. Each of the signs remaining in service was visually examined in detail for general appearance and for such defects as:

1. Discoloration (a change from the initial white color).
2. Dirtiness (soiled with removable dust, dirt, road grime, etc.).
3. Crazing (fine cracks at or under the surface). Figure 1.
4. Chalking (a dry chalk-like powdery deposit on the surface).
5. Cracking (fractures).
6. Breakage (broken or shattered into more than one piece). Figure 2.
7. Scratches (surface gouges or marks). Figure 3.
8. Warping (bent from it's normal plane). Figure 4.
9. Vandalism (deliberate malicious damage).

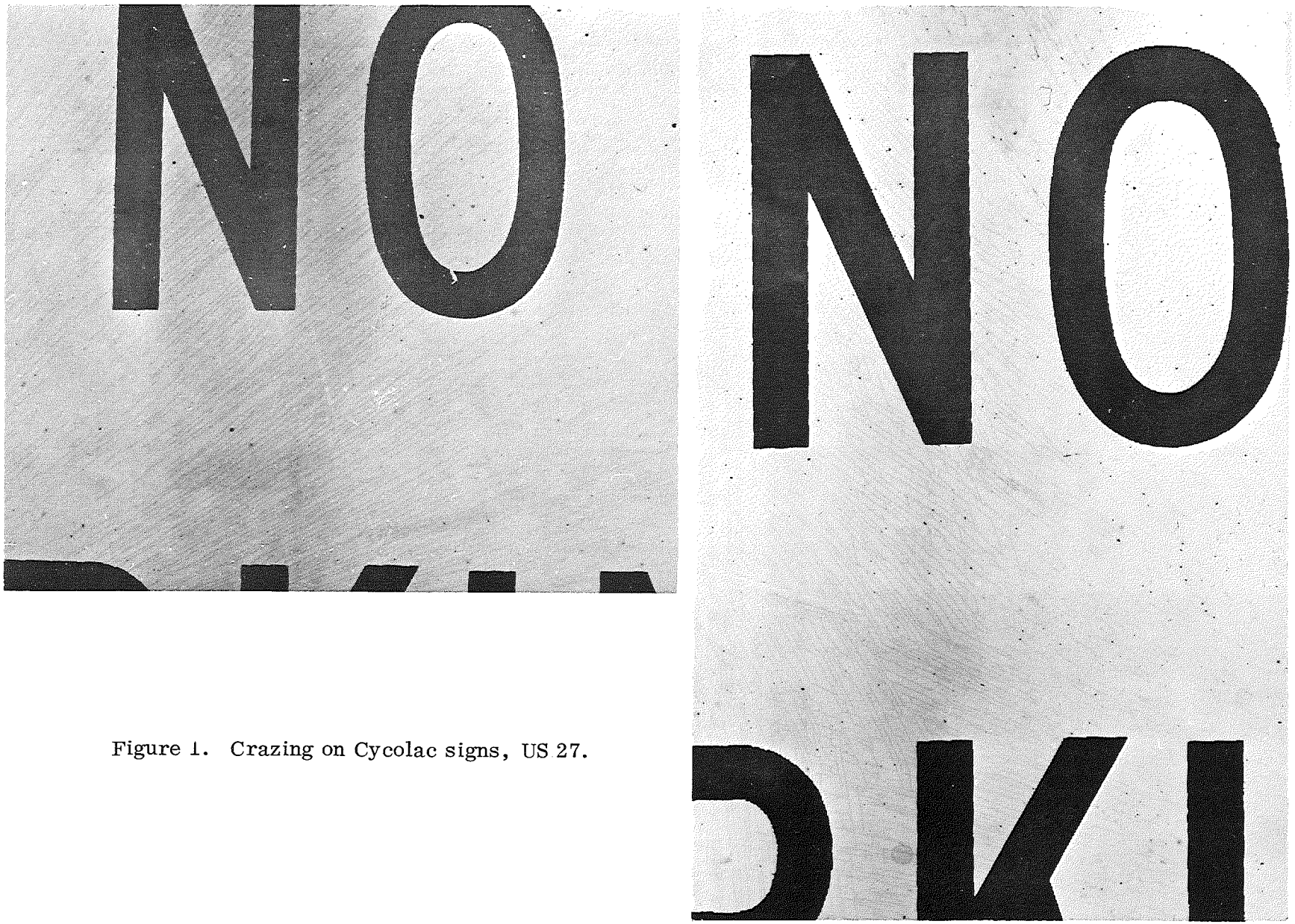

Figure 1. Crazing on Cycolac signs, US 27.

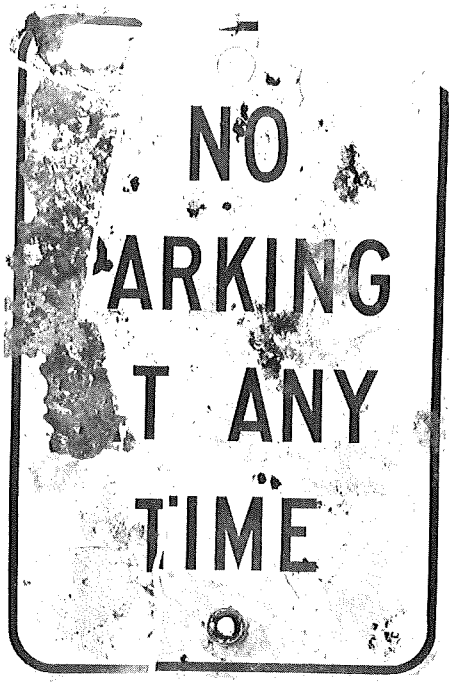

Figure 2. Broken Cycolac signs, US 27. Sign at right was still bolted to post but pieces were scattered over several square feet.

Figure 3. Scratched Cycolac signs; M 99 (above) and US 27 (below).

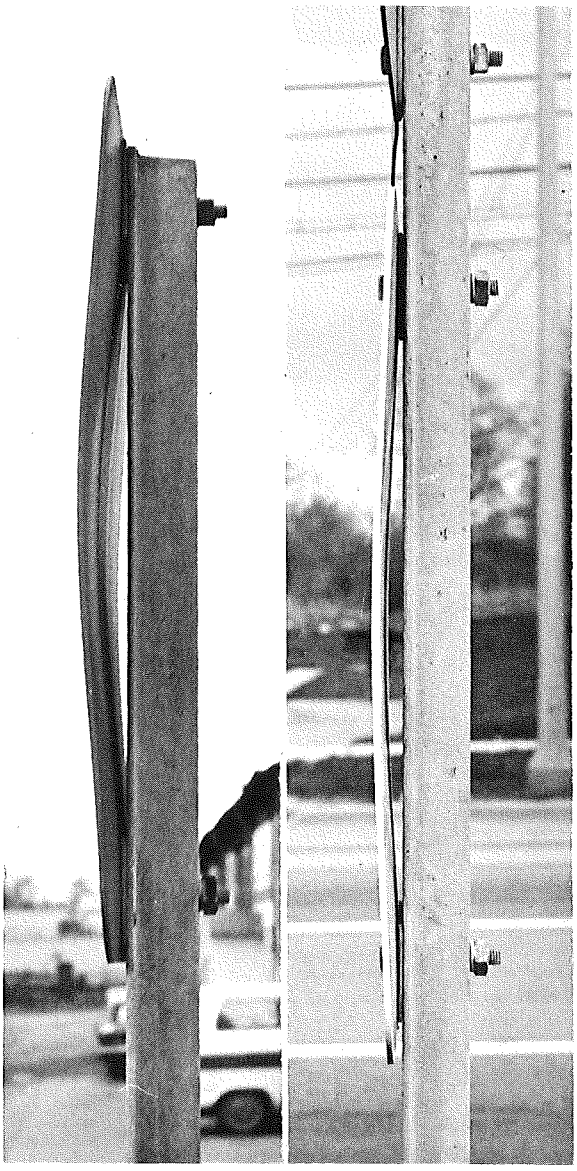

Figure 4. Warped Cycolac sign, M 99.

Also considered in the visual inspection was:

1. Direction of the sign face (north or south).

2. Sign enviroment (shade, open, roadside, shopping center, etc.).

3. Sign mount type (post or street light).

Following each visual inspection 20 Cycolac signs from each test area and five aluminum signs from each of the adjacent areas were returned to the laboratory for color and gloss measurements. The measurements were first performed in the sign's field condition (dirty) and again after the sign had been cleaned employing a standard scrub cycle (Appendix). A standard scrub cycle was used to ensure that all signs had precisely the same amount of cleaning before remeasuring the color and gloss. When the measurements were completed (two days) the signs were returned to their respective test field locations for further service. The findings of the two visual inspections are reported below.

Inspection 1
Test Site 1 (M 99)

Cycolac - 44 remaining signs of 50 installed

1. All signs were quite dirty and slightly discolored (yellowed).
2. Three signs were very discolored (brown-yellow color).
3. Twenty-seven signs were warped or bent from the vertical up to about 5/8 in. (Most signs were bent less than 1/2 in.)
4. Three signs were cracked.
5. Two signs were scratched or gouged.

Aluminum - 5 signs

1. All signs were quite dirty but not visibly discolored.
2. One sign was badly spotted with asphalt.
3. Three signs had chipped paint, usually at the edges.

Inspection 1
Test Site 2 (US 27)

Cycolac - 35 remaining signs of 50 installed

1. All signs were quite dirty and slightly discolored (yellowed).
2. Twenty-seven signs were warped or bent from the vertical up to about 3/4 in. (Most signs were bent less than 1/2 in.)

3. Seven signs showed crazing.
4. Two signs were cracked.
5. Two signs were broken into several pieces.

Aluminum - 5 signs

1. All signs were quite dirty but not visibly discolored.
2. Three signs had chipped paint usually at the edges or near the bolt holes.
3. One sign was badly scratched through the paint in several areas.

Inspection 2
Test Site 1

Cycolac - 43 signs remaining of 50 installed

1. All signs were quite dirty and slightly discolored (yellowed).
2. Three signs were very discolored (brown-yellow color).
3. Twenty-three signs were warped or bent from the vertical up to 3/4 in. (Most signs were bent less than 1/2 in.)
4. Seventeen signs showed crazing.
5. Six signs were cracked.
6. Three signs were scratched.

Aluminum - 15 signs

1. All signs were quite dirty but not visibly discolored.
2. One sign was badly spotted with asphalt.
3. Five signs had chipped paint.
4. One sign was scratched.

Inspection 2
Test Site 2

Cycolac - 20 signs remaining of 50 installed

1. All signs were quite dirty and slightly discolored (yellowed).
2. Twenty signs were warped or bent from the vertical up to about 3/4 in. (Most signs were bent less than 1/2 in.)
4. Seven signs were cracked.
5. Three signs were scratched or gouged.
6. Six signs were broken.

Aluminum - 15 signs

1. All signs were quite dirty but not visibly discolored.
2. Four signs were scratched.
3. Eleven signs had chipped paint.
4. One sign was bent

Discussion - Visual Inspection

Cycolac

Some of the test signs had multiple minor defects such as dirtiness, discoloration, crazing, scratches and cracks so in the tabulations are counted more than once. The dirt on the signs was usually just dust, mud, road grime, etc. and was easily removed by washing with a detergent solution. The slight discoloration (yellowing) of all signs could not be readily removed by washing, but on most signs the discoloration was slight and did not seriously detract from the sign's legibility. The three signs on M 99 described as very discolored are in front of, or across from, a drop-forge plant. The immediate drop-forge area (sidewalks, street, signs, etc.) is covered with a reddish brown material, probably iron rust, discharged during production. Although the legibility of the three signs was reduced considerably by the discoloration they were still legible. The warping or bending condition observed on many signs at both test sites is not readily explained. No hole spacing differences were noted between aluminum and cycolac signs or in the mounts (post or street light). This warping condition does not affect the sign's legibility or function. The crazing or surface cracking observed on many signs at both test sites probably resulted from the almost constant flexing from the wind and/or backwash from fast moving traffic, particularly large trucks. This crazing condition did not significantly reduce the legibility or otherwise impair the function of the signs. The cracked, broken, and missing signs, noted at both test sites, but primarily at Test Site 2, probably resulted from a combination of errant motorists and the careless use of heavy construction equipment. Utility and curb and gutter construction occurred on Test Site 2 between Inspections 1 and 2 and it was in the immediate construction area where most of the badly cracked and broken signs were found. This was also the area where several signs and posts were missing. Several of the test signs were lying on the ground shattered into several pieces (Fig. 2). In some instances the posts were not damaged and in other cases they were badly bent and twisted. Neither the sign environment (shade, open, roadside, driveway, etc.) nor the sign mount type (post or street light) had any significant effect on the sign's condition. The direction of the sign face appeared to have some ef-

fect on the number of signs that showed crazing. Of the number of signs still in serviceable condition at the time of Inspection 2, 15 signs or 68 percent on northbound M 99 (sign facing south) showed some degree of crazing while only two signs or 10 percent on the southbound side showed this condition. On northbound US 27, 14 signs or 93 percent were crazed while only one sign, 20 percent on the southbound side showed this condition.

Of the original 50 test signs at each test site 43 signs or 86 percent at Test Site 1 and 20 signs or 40 percent at Test Site 2 for a total of 63 signs or 63 percent were still in legible, serviceable condition at the time of Inspection 2.

Aluminum

The chipped paint reported on many of the signs usually occurred on the sign edges and in areas surrounding the bolts. Aside from the chipped paint, the dirty condition of most signs, and a few minor scratches the aluminum signs at both test sites do not appear to have been significantly affected by weathering (service in the field) and are generally in very good condition.

Color and Gloss Measurements

Experimental

The measurements were performed with a Photovolt colorimeter and a Multi-Angle Glossmeter. Four areas were measured for color on the white background and two areas measured for color on the red legend. Four 60-degree gloss measurements were performed on the white background of each sign. The measurements were first performed in the field condition (dirty), then again after being cleaned in a standardized scrub cycle (Appendix). The color measurements on the white background were converted into CIE chromaticity or color coordinates x and y in daylight and into reflectivity (R_S) values. A Yellowness Index YI = 100 (A-B/G) was also calculated in accordance with ASTM E 313-67. YI values are numbers which correlate with visual ratings of yellowness and whiteness of certain white and near-white surfaces. The measurements on the red legend were also converted into CIE color values.

Discussion of Color and Gloss

Table 1 shows YI, R_S and gloss values for the white background of both aluminum and Cycolac test signs for the two inspections at both test sites.

Also included are YI, R_S and gloss values for new signs of each type. Table 1 shows the range of the values obtained and the final average values.

Examination of the average data in Table 1 shows the following:

1. YI values for both types of signs (aluminum and Cycolac) are consistently higher while R_S and gloss values are consistently lower for the dirty (before washing) than the clean (after washing) signs. This indicates that the signs in the field when dirty appear more yellow with lower reflectivity and gloss than the signs after cleaning.

2. Cycolac signs become yellow at a faster rate than aluminum signs. The YI of clean Cycolac signs changed from -5.6 to 20.9 in 26 months at Test Site 1 and to 22.1 in 30 months at Test Site 2 during the same test period. While the YI of the aluminum reference signs changed from 0.8 to 5.7 at Test Site 1 and to 2.3 at Test Site 2. Figures 5 and 6 show the change in the YI of the Cycolac signs with service time at both test sites in both the dirty and clean condition. The change in the YI for both the northbound and southbound signs at both test sites is also included.

3. The reflectivity (R_S) of both the clean Cycolac and the aluminum reference signs did not change significantly.

4. The Cycolac signs lost their gloss at a faster rate than the aluminum signs. The average gloss of clean signs changed from 34.4 to 14.8 in 26 months at Test Site 1 and to 21.4 in 30 months at Test Site 2, while the gloss of the aluminum signs changed from 98.0 to 95.4 at Test Site 1 and to 94.0 at Test Site 2 during the same test period.

Examination of the color data on the red legends of the test signs showed no measurable changes upon weathering in the field for either type of sign (Cycolac and aluminum) during the test period.

OTHER INFORMATION

In addition to the economic and performance evaluation reported above literature references were checked for recent developments in ABS plastic technology and several people knowledgeable in traffic control and signing were contacted for information on the performance of small aluminum and plastic signs. The following summarizes the findings:

Literature References

Since the inception of this study almost five years ago, developments in plastics technology have produced significant improvements in several

TABLE 1
COLOR DATA ON CYCOLAC & ALUMINUM SIGNS

	New Signs			M 99												US 27											
				Inspection No. 1						Inspection No. 2						Inspection No. 1						Inspection No. 2					
				Before Washing			After Washing			Before Washing			After Washing			Before Washing			After Washing			Before Washing			After Washing		
	YI	R_s	60° gloss	YI	R_s	60° gloss	YI	R_s	60° gloss	YI	R_s	60° gloss	YI	R_s	60° gloss	YI	R_s	60° gloss	YI	R_s	60° gloss	YI	R_s	60° gloss	YI	R_s	60° gloss
CYCOLAC	-5.2	77.8	31.2	8.4	69.8	21.5	5.3	76.2	32.2	15.9	71.0	8.5	15.2	77.8	11.3	10.5	70.9	3.5	7.1	76.3	5.2	23.2	69.7	3.5	25.0	75.3	8.5
	-6.3	78.0	35.7	18.6	55.9	16.7	17.5	60.5	27.1	23.8	65.7	10.3	22.2	72.5	16.5	12.7	70.1	5.7	9.3	72.8	9.5	24.5	71.0	20.3	22.8	77.6	3.3
	-5.0	78.0	36.7	16.0	64.4	11.8	14.4	70.3	15.9	29.2	56.3	8.5	27.2	65.3	18.5	12.8	69.2	8.2	10.1	74.2	10.8	30.2	66.4	11.0	25.1	75.8	26.3
	-5.7	77.7	33.8	27.6	54.7	10.9	21.9	63.0	18.7	45.6	44.1	13.3	43.7	50.8	37.0	11.0	71.6	26.3	9.3	75.6	35.6	31.2	64.4	4.8	18.6	79.5	38.3
				33.0	49.2	11.6	28.0	57.3	36.4	20.6	67.3	4.4	18.7	76.7	8.6	13.7	69.1	9.1	10.7	74.7	14.1	28.0	64.4	3.3	21.9	77.1	36.5
				13.8	65.4	8.2	12.3	73.9	11.5	19.0	70.4	3.5	16.0	79.8	4.0	6.9	74.0	4.1	6.6	77.8	4.4	23.7	68.8	9.0	18.8	78.3	16.5
				8.1	69.1	2.6	6.3	77.9	3.4	20.3	71.9	5.5	18.0	78.8	5.8	15.9	68.1	24.2	12.8	74.5	38.5	24.5	67.8	9.0	19.0	77.8	22.3
				12.9	66.6	5.5	10.2	75.1	7.1	19.3	71.1	5.3	16.4	79.0	7.2	15.3	66.6	5.8	11.5	74.1	8.9	23.4	68.4	16.2	20.9	76.2	35.3
				13.2	66.0	8.0	10.8	74.7	12.1	17.5	72.4	4.5	14.8	80.6	4.8	15.3	66.8	9.4	13.2	73.7	14.3	21.4	69.2	10.6	19.3	78.1	23.3
				8.8	68.3	3.8	6.7	77.2	5.8	18.6	70.9	4.3	15.3	79.8	4.8	14.4	68.5	12.4	9.7	75.8	18.1	21.6	69.5	11.4	20.2	77.2	25.8
				16.0	68.3	16.1	12.9	75.8	36.3	31.8	57.2	18.8	20.3	75.7	--	19.0	64.4	11.4	11.5	76.2	48.0	26.4	69.5	12.3	20.2	77.9	24.3
				17.4	68.4	17.7	13.8	75.4	34.4	23.0	74.0	23.3	20.8	75.5	27.8	19.8	62.4	8.7	11.3	76.4	36.2	25.4	70.5	13.8	19.6	78.6	24.3
				19.8	68.4	8.6	12.6	75.4	17.6	24.8	71.4	15.5	20.5	77.6	33.8	18.1	63.8	6.3	11.7	76.0	30.7	26.0	69.4	5.3	20.2	78.9	9.0
				15.1	65.1	3.1	7.3	74.0	4.9	20.5	70.0	2.5	19.9	78.3	10.5	19.0	65.1	16.3	14.1	74.4	46.6	24.1	73.0	10.0	21.0	78.2	14.8
				16.3	66.9	6.7	9.7	75.8	10.9	23.0	70.2	6.3	20.2	77.4	6.0	17.1	67.0	13.1	13.9	74.2	17.5	24.5	71.0	16.0	21.4	77.4	26.3
				15.4	63.9	2.4	8.4	76.4	4.2	19.2	71.5	2.8	16.5	80.4	3.5	22.5	63.4	20.5	18.2	70.8	41.0	24.9	73.2	21.0	25.2	76.8	34.8
				16.8	68.6	17.8	13.4	75.4	30.3	24.6	72.1	19.5	24.3	76.9	27.5	18.7	66.2	10.2	14.4	74.5	14.4	30.9	61.4	4.3	23.7	77.3	6.5
				18.7	58.7	8.5	9.0	75.3	12.5	23.1	66.2	2.8	20.0	76.1	4.3	19.9	65.8	14.9	13.6	73.4	20.8	24.8	66.6	5.5	25.1	76.7	8.3
				17.2	69.3	30.1	13.4	74.9	13.0	25.0	71.8	15.5	23.3	75.5	21.8	19.3	66.6	14.4	14.2	73.6	22.1	21.8	69.9	11.0	23.2	77.6	19.0
				18.4	68.9	14.2	14.1	73.8	13.9	23.6	73.1	15.8	24.0	76.3	24.3	18.2	66.3	6.0	13.0	74.1	8.0	24.1	73.1	10.3	23.8	76.2	13.0
Range High	-5.0	78.0	36.7	33.0	69.8	30.1	28.0	77.9	36.4	45.6	74.0	23.3	43.7	80.6	37.0	22.5	74.0	26.3	18.2	77.8	48.0	31.2	73.2	21.0	25.2	79.5	38.3
Low	-6.3	77.7	31.2	8.1	49.2	2.4	5.3	57.3	3.4	15.9	56.3	2.5	14.8	50.8	3.5	6.9	62.4	3.5	6.6	70.8	4.4	21.4	61.4	3.3	18.6	75.3	3.3
Average	-5.6	77.9	34.4	16.6	64.8	11.3	11.9	72.9	17.4	23.5	67.8	9.5	20.9	75.5	14.8	16.3	67.3	11.6	11.4	74.7	22.2	26.1	68.3	9.8	22.1	77.3	21.4
ALUMINUM	-1.6	88.1	97.9	2.5	79.3	64.9	-2.5	87.3	96.0	11.7	84.4	80.8	6.6	86.6	96.5	4.9	79.3	51.2	-0.9	86.9	95.5	12.2	81.2	53.8	-6.8	82.2	85.0
	1.3	88.7	99.0	2.7	73.8	67.3	-1.8	84.0	94.2	8.2	82.1	67.5	4.2	89.1	90.8	9.2	71.1	28.1	-2.0	85.7	96.3	18.4	73.2	3.5	6.2	79.8	95.8
	1.4	88.1	98.0	2.3	79.6	60.1	-2.5	84.4	93.6	7.5	79.9	67.5	6.0	86.7	90.8	0.8	78.3	51.9	-4.1	82.6	94.9	10.0	70.7	7.5	0.7	86.6	97.3
	2.9	88.6	98.0	6.6	72.9	39.1	-1.1	83.1	84.0	9.9	84.1	75.0	6.1	84.9	100.0	5.2	72.8	29.9	-4.9	84.2	92.5	15.3	78.7	49.2	2.4	83.8	93.5
	0.2	88.7	98.2	5.9	71.7	45.8	-1.1	82.1	90.9	10.0	84.8	82.8	5.8	87.5	98.8	4.6	70.3	31.4	-4.6	80.1	91.8	13.6	71.1	20.8	8.8	83.0	98.5
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Range High	2.9	88.7	99.0	6.6	79.6	67.3	-1.1	87.3	96.0	11.7	84.8	82.8	6.6	89.1	100.0	9.2	79.3	51.9	-0.9	86.9	96.3	18.4	81.2	53.8	-6.8	86.6	98.5
Low	-1.6	83.8	94.5	2.3	71.7	39.1	-2.5	82.1	84.0	7.5	79.9	67.5	4.2	84.9	98.8	0.8	70.3	28.1	-4.9	80.1	91.8	10.0	70.7	3.5	8.8	79.8	85.0
Average	0.8	86.7	98.0	4.0	75.4	57.2	-1.8	84.4	92.3	9.5	83.0	74.7	5.7	87.0	95.4	4.9	73.9	37.2	-3.3	83.7	93.9	13.9	75.0	27.0	2.3	83.1	94.0

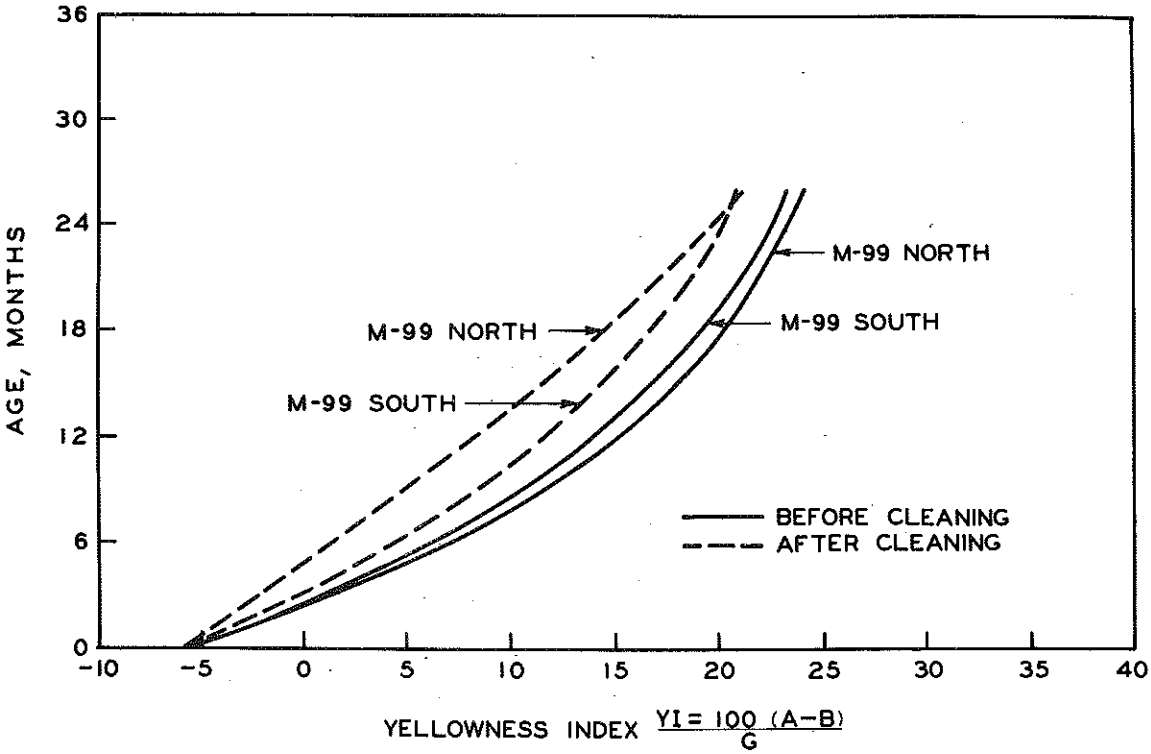

Figure 5. Change of the Yellowness Index (YI) at the M 99 test site with service time.

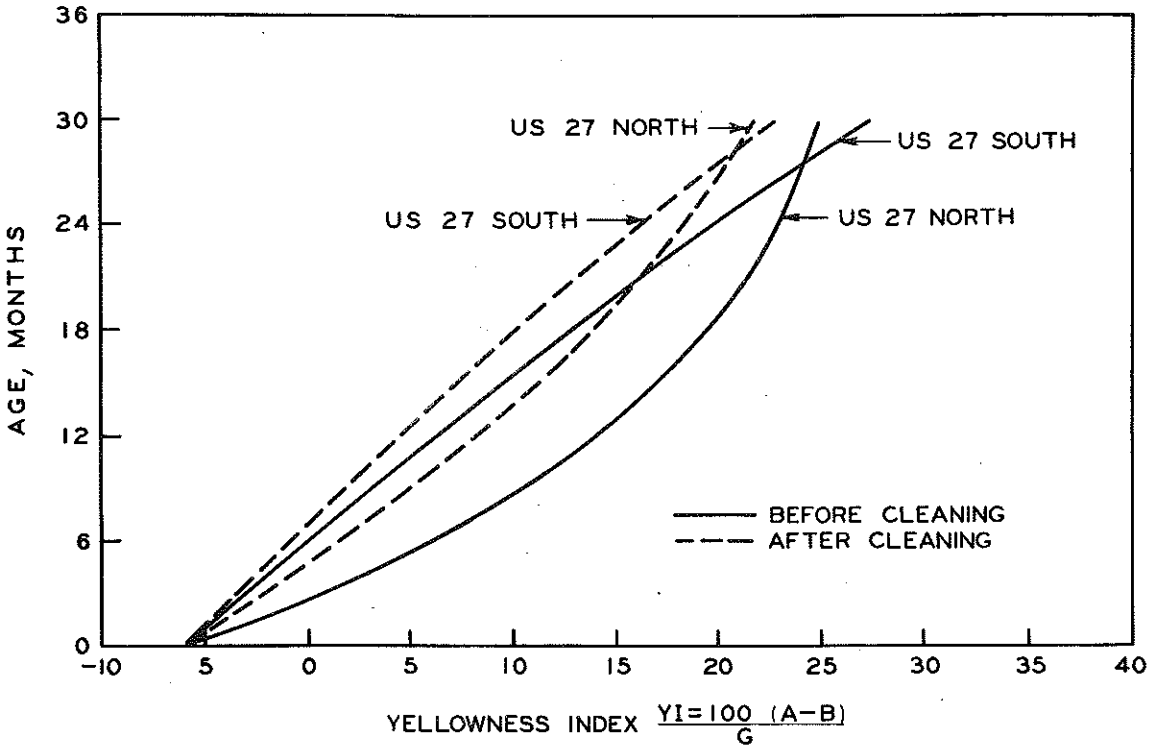

Figure 6. Change of the Yellowness Index (YI) at the US 27 test site with service time.

physical properties of ABS. Table 2 shows that some properties such as the low temperature impact strength of high impact molding grade ABS has been increased up to 60 percent.

TABLE 2

Physical Property	1967[1]		1972[2]	
	Extrusion Grade	High Impact Molding Grade	Extrusion Grade	High Impact Molding Grade
Tensile Strength psi	4000-6000	5000-6000	4000-7000	4500-7500
Flexual Yield Strength psi	5000-8000	7500-9800	6000-14000	6000-11000
Low Temperature Impact Strength, ft lb/in. of Notch	2.5-3.4	1.5-2.5	0.6-4.0	1.5-4.0

[1]1967 Modern Plastics Encyclopedia, p. 30.
[2]1972-73 Modern Plastic Encyclopedia, p. 142.

Technology for enhancing the weatherability of ABS has also been developed by laminating with a thin layer of more ultra-violet resistant materials. With these advances in ABS plastic technology we expect the present Cycolac to be a better sign material than the material used for the study.

Comments of Traffic Control and Signing Personnel

The red legend on aluminum signs often fades seriously sometimes requiring replacement in three to five years. The estimated maximum service life of aluminum signs is about five years. Two 36-in. test Cycolac construction warning signs (men working) are being used in District 7. The legibility of the 36-in. Cycolac sign is satisfactory, but one of the signs developed a crack for unknown reasons.

The City of Saginaw is using small 12 in. by 18-in. Cycolac parking restriction signs quite extensively. Saginaw's Traffic Engineer, Mr. R. Meredith stated that they have had 2,000 to 3,000 Cycolac signs in service

since 1968 and are very favorably impressed with their performance. Mr. Meredith said he particularly liked the Cycolac signs because: 1) Cycolac sign blanks are slightly cheaper than aluminum, the holes are prepunched and the backing does not require painting (legend painted directly on the backing). 2) Cycolac signs are easier to recycle than aluminum signs since they can be reversed and the legend can be repainted on the back. 3) They have experienced only a few minor problems with the Cycolac signs (a small number of cracked and broken signs but no noticeable yellowing, crazing or chalking). Mr. Meredith indicated that Saginaw will probably extend their use of Cycolac signs.

SUMMARY

The following statements summarize the findings of this study:

1. Cycolac has a $0.21 per sign cost advantage over aluminum.

2. A slight tendency for Cycolac signs to warp, craze, become discolored (yellowed) and lose gloss with service life was noted; however, these defects are considered minor and do not seriously impair the signs legibility.

3. More (south facing) Cycolac signs were affected by crazing than north facing signs.

4. The Cycolac signs at Test Site 2 were in much worse condition than at Test Site 1. The relatively large number of broken and missing signs at Test Site 2 is considered due to an abnormal service condition (construction area). We believe that such large incidence of failure would not occur in normal service conditions.

5. The white background paint on aluminum signs tends to chip slightly at edges and around bolt holes.

6. Recent developments in plastic technology have improved the physical properties of some ABS plastics.

7. Reports from the field (Districts) indicate that the red legend on aluminum signs fades seriously affecting sign legibility and, often limiting the service life to three to five years.

8. Cycolac signs apparently perform satisfactorily on many city streets as indicated by their successful performance over a three-year period in the City of Saginaw.

RECOMMENDATION

In consideration of the above findings it is recommended that Cycolac be considered a suitable alternate material to aluminum for small signs.

APPENDIX

Standard Scrub Cycle

1. Position the sign on the scrub machine sign holder (Fig. 7) and apply a 500 gm weight to the sponge scrubber.

2. Wet the sponge scrubber with water and place several drops of a 2 percent liquid detergent solution to the sign in the path of the scrubber.

3. Turn on the scrub machine and scrub the sign 100 times at the rate of 40 cycles per minute.

4. Remove the sign from the scrub machine sign holder, rinse with distilled water and air dry.

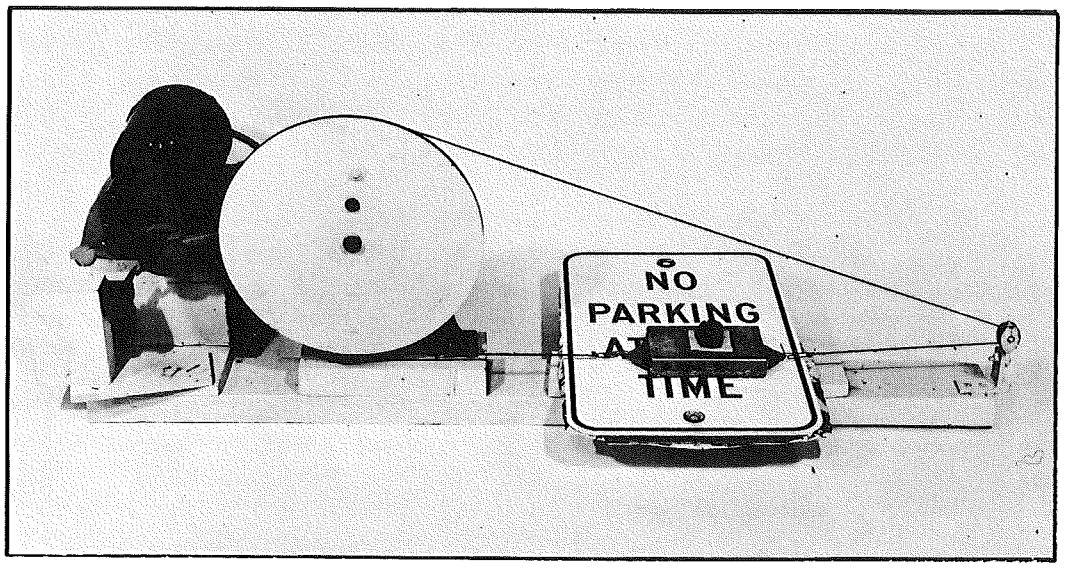

Figure 7. Sign Scrubber