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A Report on the Investigation of Median Strip Glare Shield for the Santa Monica Freeway

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16. ABSTRACT
During the design stages of the Santa Monica Viaduct Project, approval was granted by Mr. G.T. McCoy in his letter dated July 20, 1956, and by Mr. J.C. Young in his letter of January 15, 1957, to incorporate a headlight glare shield with the median barrier rail at two locations on the viaduct: 5700 linear feet of glare shield on type M-16 rail between Hooper Street and the A.T. & S.F. Railway, and 9000 feet of glare shield between Hoover and Hooper Streets.

A drawing STUDY 4-5.1, TYPE M-16 RAILING, was submitted by the Bridge Department to the Materials and Research Department on May 9, 1958, with a request (see Exhibit 1, Appendix) that tests of physical properties be performed upon the several corrugated plastic sheeting types which were being considered for a glare shield.

Those mechanical properties which were considered of most concern were: sheer strength at the supports, beam strength, fatigue, and brittleness. Such factors were considered significant because in highway installations the material will be subject to wind loading, aging by sunlight and weather, vibration, and occasional impact.

Information was also desired on color fastness, light transmission, light reflectance, sun glare, and the effects of sound or vibration in relation to the sheeting.

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STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

A REPORT ON

THE INVESTIGATION OF MEDIAN STRIP GLARE SHIELD FOR THE SANTA MONICA FREEWAY

September 1958

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT

Median Strip
Glare Shield Investigation
Santa Monica Freeway
VII-LA-173-LA

88--R--6147

Mr. A. L. Elliott
Bridge Department
Division of Highways
Sacramento, California

Dear Sir:

Submitted for your consideration is:

A REPORT ON

THE INVESTIGATION OF MEDIAN STRIP GLARE SHIELD

FOR THE SANTA MONICA FREEWAY

Study made by . . . . Structural Materials Section
Under general direction of . . . . J. L. Beaton
Under general supervision of . . . . L. S. Hannibal
Work supervised and report prepared by . . . . L. S. Hannibal
With assistance of . . . . H. F. Kuhlman and R. Watkins

Very truly yours,

F. N. Hveem
Materials and Research Engineer

By [signature]
A. W. Root
Supv. Mtls. and Research Engineer

LSH:mw
cc: JWTrask
FEBaxter

58-24

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I. INTRODUCTION

During the design stages of the Santa Monica Viaduct Project, approval was granted by Mr. G. T. McCoy in his letter dated July 20, 1956, and by Mr. J. C. Young in his letter of January 15, 1957, to incorporate a headlight glare shield with the median barrier rail at two locations on the viaduct: 5700 linear feet of glare shield on type M-16 rail between Hooper Street and the A. T. & S. F. Railway, and 9000 feet of glare shield between Hoover and Hooper Streets.

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Those mechanical properties which were considered of most concern were: sheer strength at the supports, beam strength, fatigue, and brittleness. Such factors were considered significant because in highway installations the material will be subject to wind loading, aging by sunlight and weather, vibration, and occasional impact.

Information was also desired on color fastness, light transmission, light reflectance, sun glare, and the effects of sound or vibration in relation to the sheeting.

Work Order 88-R-6147 was established by the Materials and Research Department to undertake this investigation. Descriptions and results of short-range tests on products initially available are reported in the following text. A supplementary report will be prepared at a later date to include results of longer-range tests, such as accelerated aging or fatigue tests, and to report test results for additional products submitted by manufacturers who did not participate in the initial selection of material to be tested.

II. SUMMARY AND CONCLUSIONS

There are a number of fiberglass reinforced plastic materials on the market such as polyesters, acrylic resins, and methyl methacrylate. All are available in flat or corrugated panels such as employed in residential or commercial structures. The lasting qualities of the better grades of plastics are good--as these materials withstand sunlight, moisture, and fumes without detrimental effects.

The normal surface treatment or finishes in the trade are smooth, granitized, pebblized, and raised crinkling. However, in our investigation it was found that high gloss surfaces of any type are subject to excessive reflected sunlight which produces a serious sun glare condition whenever employed on an east-west axis. Experimental sand blasted surfaces showed a major improvement in the reduction of this glare and a subsequent sample panel with a chemically dulled surface was found particularly satisfactory, even to the point that one material has poor wetting qualities such that rain or dew will not adhere sufficiently to permit much opportunity for wet surface sunglare.

As a result of this study gloss surface corrugated panelings are permissible for use on a north-south axis (see Exhibit 6) but surface dulled material is mandatory due to sunglare on any east-west installations. As a consequence the latter should be employed in all installations. In some respects the dull surfaces may lack some of the esthetic value of the gloss, but the reduction of glare from both reflected and transmitted light is particularly gratifying as sunglare would otherwise make the employment of plastic paneling impractical.

Sheets 21" x 12'-0" are recommended, with a thickness of .09 inches or more, three ounces of glass fiber per square foot, and a 4.2" pitch by 1 1/16" corrugation depth. The above 21" panel width takes advantage of splitting the 42" wide sheet which is standard in the industry.

Lack of uniformity in the distribution of the glass fibers in the reinforcing mats, yellowing of these fibers due to aging of the chemical wetting or bonding agents, variations in sheet thicknesses, and variations in light absorbing qualities are objectionable visible physical defects which need close control.

Fading of colors during long exposure tests or by fadeometer tests, or chalking or discoloring of any of the ingredients in the latter fadeometer test are likewise objectionable.

Tensile tests have not been consistent enough to properly evaluate the products. The 3/4" width type of test strip which is standard in A.S.T.M. tests for unreinforced plastics is not suitable for glass reinforced plastics. Load tests have shown that failure is more prone to occur under compression than in tension, thus the A.S.T.M. beam type quarter point load test is recommended for corrugated plastics with the loading carried to the failure point.

Shattering due to impact from flying rocks is likewise of concern. Lacking equipment for an Izod test, a drop weight test was investigated in order to employ equipment available at the laboratory. Unfortunately, the results have been far from conclusive and further investigation is desirable.

Fatigue tests have not been performed due to the limited time permitted to conduct the initial investigation. However, it is to be noted that most manufacturers report a greater flexural strength than tensile strength. Usually this is of a magnitude of 50% or more. Consequently, fatigue properties of the plastics should be relatively favorable, particularly with fresh materials. A similar examination of artificially aged material from the fadeometer is considered worth investigating, but such data will not be available until a subsequent date.

Light transmission, as noted, is of considerable importance. A 35% transmission factor is probably the maximum permissible in order to avoid glare from sunlight conducted through the panel and not have the green pigment wash out under headlights since headlights predominate in the yellow part of the spectrum and tend to kill the green color.

Hetron plastic, which is a fire retardant type of polyester material, is not considered essential for a light barrier installation. Its structural strength is similar to that of the other types examined. Hetron turns brown with age.

The methyl methacrylate plastics have the advantage that differences in the index of refraction of fiber glass and the plastic are slight, and thus under actual headlight conditions the fiberglass mat does not give the dirty blotching or smearing appearance with transmitted light as occurs with polyester plastics. This plastic is also poorly wetted with water, thus reflected glare is not a problem in wet weather. The methacrylate plastics have much in their favor for glare shields. Ten years of use of this plastic in highway reflector buttons has shown that the material is exceptionally weather resistant.

Load tests have shown that unsupported spans of 8 feet or greater are impractical due to excessive deflection. Each span should carry a 30# per square foot wind loading factor. Six foot spacing is recommended particularly in view of some evidence that plastic and glass reinforcement may weaken materially after 10 years or more of use. Thus 12 foot lengths of sheeting are recommended with the suggestion that brackets of the type shown in the Appendix be placed at six foot intervals, and that properly cut wiggle-mold be employed to hold the plastic sheets securely.

An investigation of the United States Department of Commerce voluntary standards CS214-57 for Glass-fiber Reinforced Polyester Corrugated Structural Plastics Panels has disclosed that these standards with certain modifications and additions are adaptable to our purposes. The pertinent sections are reproduced in the Appendix. The proposed specifications are given under Chapter V.

Vertical baffles or louvers were assembled which employed small solid panels of plywood or aluminum coated in a diagonal manner. Samples of these units were quite effective in eliminating headlight glare. The general design is shown in Exhibit 7 in the Appendix. A 30° cant is employed, and the distance between the baffles is twice the width. Wind resistance is not a problem with this type of glare shield.

III. DISCUSSION

Poor correlation has been encountered between the tests of mechanical properties conducted in our laboratory and the published data on these properties furnished by several of the manufacturers. These tests were conducted on actual corrugated materials taken from general production, whereas in the plastic industry flat samples of sheeting are batch-prepared for such tests. It can be assumed that this accounts in part for the lack of close confirmation of test results between the two sources. Corrugated grips and saddles were prepared in our laboratory to support the materials during tests, but warpage of the corrugated surfaces under stress introduces secondary factors which alter the values for over-all comparative results.

Glass fiber is known to deteriorate with age and become brittle. No recognized method is immediately at hand to accelerate this condition. Allowances should be made for such deterioration, which may take 10 to 15 years.

In addition to the translucent plastics several opaque materials have been furnished, both in corrugated plastic and in dense plywood. Various properties of these materials are being examined. A set of plywood baffles has also been examined.

Actual visual tests conducted under night conditions such as existing on a freeway have disclosed certain undesirable esthetic features which should be considered in the final selection of a glare shield product, i.e., some green colors appear yellow to angular transmitted light, particularly to headlights, whereas the glass fibers add a grimy brown appearance. These are features which particularly need to be avoided by proper selection of colors, opacity, and actual test.

However, the major objection found with plastic headlight glare shields is that reflected sunlight creates an intense reflectance during the early morning or late afternoon hours from those shields with glossy surfaces which are installed in an east-west direction. Exhibit 6 shows those directions where this sunlight glare can be anticipated. Granitized or pebblized surface textures are not effective in reducing this particular difficulty, but sandblasted or chemically dulled surfaces are pleasingly effective except when the plastic sheeting is actually wet with rain or dew. Installing the plastic with the corrugations in the vertical position is only partially effective, since glare at sunrise or sunset will occur when the sun is on the level of the driver's line of vision. Glare shields placed on the north-south axis create no problem with the sun.

Based on visual observations by several observers, the light transmission value probably should not exceed 35%

IV. INVESTIGATION

1. Materials Investigated

Several types of glass fiber reinforced corrugated plastics are employed in the industry. Each manufacturer is equipped to produce two or more specific types of plastic formulation, depending upon fire retardance or other factors which may be desired in his particular products. The color pigments employed also vary widely. It is difficult to obtain a fast non-fading green and consequently the color materials employed generally remain a trade secret.

The means of making up the glass reinforced mat also differs considerably: fiber sizes, orientation and uniformity of distribution vary appreciably from one grade to another. Fraying of glass fibers, which occurs with poorly prepared mats, is a factor to consider in a permanent installation.

The following plastics have been investigated:

Filon: trade name for a nylon reinforced glass fiber. The plastic employed is a polyester. Formulation can vary widely. The polyesters are resistant to mildew, low temperatures, and sunlight. Unreinforced material has an appreciable elastic recovery. The melting point ranges from 480° to 600° F. for semi-inflammable polyester and 800° F. for the Hetron fire retardant types. The fiber glass reinforcement matting is spread upon longitudinal nylon threads, hence the name.

Examination of Filon sheeting showed acceptable uniformity in sheet thickness. Fadeometer tests made at 102° F. temperature showed a marked tendency for the Hetron plastic to turn brown on the surface and on the contact faces between the plastic and glass fibers. Their regular polyester plastic browned slightly. All material furnished was of smooth surface since granitized sheets were not immediately available.

Two types were purchased:

#900 fire retardant "Hetron" of .06" thickness.

#350 semi fire-retardant Polyester, which was .09" thick

Material with 4.2" pitch was available only in the 900 series. Material with 2.66" pitch was obtained in both the 350 and 900 series to permit aging studies of both products.

This material is manufactured in El Segundo, California.

Alsynite: consists of a catalyzed polyester resin. Formulation can be varied appreciably depending on the desired use. An improved type of laminated fiber glass mat is employed for reinforcement wherein a finer glass mat .006" thick is used in the exterior laminates. This prevents the heavier fibers which are within the core of the material from spalling out through the surface of the sheet, should the surface be damaged. Spalling of the coarse glass fibers is likewise held to a minimum when the plastic sheets are cut by saw. Considerable variation in sheet thickness was encountered.

Smooth surfaces and crinkled surfaces are available. The latter is obtained by dipping the finished sheet into a plastic bath and developing a raised ribbing or crazing on the surface during the final curing operation.

Two thicknesses of sheets were obtained: #200 which is .06" thick and #300 which is .09" thick. Samples of both 2.66" and 4.2" pitch were obtained for examination.

The product is manufactured in San Diego, California.

Corrulux: no technical information was received regarding the nature of this plastic or the glass mat. It is a polyester resin type of plastic.

Smooth and granitized surfaces are available.

Material of both .06" and .09" thickness of 4.2" pitch were obtained.

A sample of opaque white Corrulux dating back to 1952 was submitted by the writer. This earlier material suggested some evidence of embrittlement with age, both for the glass fibers and the plastic. A distinct crackling is evident when the sample is flexed. However, comparisons to early initial productions are none too significant due to recent process modifications in manufacture.

Corrulux is manufactured in Texas.

Structoglas: an acrylic polymer plastic.

Smooth and pebblized surfaces are commercially available; however, the pebblized treatment is available only on a single side of the panel in the 4.2" x 1 pitch series. A sample with a chemically dulled surface was furnished which reduced sunglare to an insignificant value.

Samples were submitted at too late a date to perform all tests for this report, but in comparison to the previously described plastics the material is apparently quite uniform in thickness and has a better plastic wetting or bonding effect on the glass fibers. Glass fibers are not apparent when inspected with transmitted light and do not cast the grimy appearing shadows which are so typical of the polyester plastics.

Methacrylate plastics are used in reflector buttons and samples of the latter have been in state service for 10 years or more without appreciable deterioration. This plastic is poorly wet with water which assures little difficulty with reflectance glare from wet surfaces.

2. Weight and Thickness Test

Plastics are graded according to weight in ounces per square foot. The following evaluations were made employing full length sheets to obtain an average value per sheet.

Sample No.		Type	Corru-gation	Rated Wt. in oz/ft.	Actual Weight	Range of Thickness
Filon	1	900*	4.2"	8	7.82	.052"
	2	900*	4.2"	8	7.69	.051-.061"
	3	900*	4.2"	8	7.60	.048-.055"
	4	900*	4.2"	8	7.45	.043-.052"
	5	900*	2.5"	8	8.20	.050-.060"
	6	900*	2.5"	8	8.48	.050-.060"
	7	350	2.5"	12	11.03	.087-.095"
	8	350	2.5"	12	11.40	.092-.100"
	9	350	2.5"	12	13.05	.100-.105"
Alsynite	1	300	4.2"	12	12.28	.048-.135"
	2	300	4.2"	12	12.72	.074-.134"
	3	200	4.2"	8	8.25	.050-.093"
	4	300	4.2"	12	12.72	.050-.116"
	5	200	4.2"	8	8.48	.062-.077"
	6	200	4.2"	8	8.54	.070-.105"
Corrulux	1		4.2"	12	10.94	.090-.104"
	2		4.2"	12	11.20	.085-.105"
	3		4.2"	8	7.74	.050-.058"
Structo-glass	1		4.2"	8	7.50	.048-.057"
	2		2.5	8	-	- - -

* Fire Retardant Type Hetron
8 oz. material is approximately .06" thick
12 oz. material is approximately .09" thick

The weight variations were not seriously out of line as 10% variation is permissible, but the thickness variations for Alsynite as shown is unacceptable. It is understood that Alysnite sheets are cured in groups of 10 or more with corrugated aluminum roofing sheets sandwiched between each raw plastic sheet. This permits wide variations in thickness from corrugation to corrugation. Such a production technique of sandwich construction lowers labor and equipment costs in the production of the material but gives a product with definite variations in light transmission and thin areas of structural weakness.

3. Glass Fiber Content

Corrugated plastics presumably contain 2 oz. of glass fiber per square foot for .06" thick materials, and 3 oz./sq. ft. for .09" thick material.

Chemical analysis gave the following results:

Sample	No.	Type	Thickness	Glass Fiber oz./sq. ft.	Fiber Content
Corrulux	1		.09"	3 oz.	3.06
	3		.06"	2 oz.	2.30
Alsynite	1	300	.09"	3 oz.	2.70
	2	300	.09"	3 oz.	2.68
	6	200	.06"	2 oz.	1.79
Filon	1	900	.06"	2 oz.	2.19
	5	900	.06"	2 oz.	2.42
	9	350	.09"	3 oz.	2.83

Structoglass - No test conducted.

The method employed was by ignition of an average sample. The test discloses that relatively wide variations exist in the weight distribution of the glass matting. No standard limitation on glass fiber content has been established by the Department of Commerce Standards. However, a 10% deviation should be considered as a limit on permissible variations.

4. Light Transmission Test, Close, and Color of Material

This test is defined as a close light transmission test since the photo cell was placed near the plastic panel, whereas in the following Test #5 the light cell was 10 feet from the plastic panel. This close test gives the rated transmission value of the plastic.

The corrugated panels were placed 10 inches in front of the photo cell. Distance from light source to photo cell was 50 feet. Munsell color book was employed to establish colors.

Material	Sample No.	Rated Thick-ness	Pitch	Texture	ASTM Color	Light trans-mission
Corrulux	1	.09"	4.2"	Granitized	Green 6/6	33.3%
"	2	.09"	4.2"	"	Green 6/6	32.7%
"	3	.06"	4.2"	"	Green 6/6	41.6%
Structoglass	1	.05"	4.2"	"	Bluish-Green 6/6	-
Alsynite	1	.09"	4.2"	Smooth	Green 7/4	45.0%
"	2	.09"	4.2"	"	Green 7/4	48.0%
"	3	.06"	4.2"	"	Green 7/4	68.0%
"	4	.09"	4.2"	"	Green 7/4	-
"	5	.06"	4.2"	"	Green 7/4	-
"	6	.06"	4.2"	"	Green 7/4	58.0%
Filon	1	.06"	4.2"	"	Yellow-Green 7/6	62.0%
"	2	.06"	4.2"	"	Yellow-Green 7/6	66.0%
"	3	.06"	4.2"	"	Yellow-Green 7/6	-
"	4	.06"	4.2"	"	Yellow-Green 7/6	-
"	5	.06"	2.66"	"	Yellow-Green 7/6	-
"	6	.06"	2.66"	"	Yellow-Green 7/6	62.0%
"	7	.09"	2.66"	"	Yellow-Green 7/6	48.0%
"	8	.09"	2.66"	"	Yellow-Green 7/6	-
"	9	.09"	2.66"	"	Yellow-Green 7/6	-

The dark-color heavy-granitized surface of Corrulux samples #1 and #2 reduced light transmission materially.

All materials were close to their published values for light conductance.

5. Angular Transmission of Light

Whereas light transmission measurements conducted within a few inches of the plastic sheeting gives a good measurement of the actual light transmission values for the plastic sheets, any measurements made at 10 feet or more from the plastic sheets simulates actual road conditions because much of the defracted light which passes through the sheet is scattered and dispersed before reaching the photo-electric recording cell. To further simulate road conditions the plastic sheets were rotated at right angles to the light beam to duplicate the angular transmission of headlights through the sheeting. Rotational readings were taken at 10° intervals from 0° to 80°. A rapid fall off of transmitted light occurs as the angle of incidence approaches 80°. Readings above 80° were not considered of importance. Exhibit 2 is a graphic illustration of the results.

ANGULAR TRANSMISSION OF LIGHT

Sample	No.	0°	10°	20°	30°	40°	50°	60°	70°	80°
		Percent Light Passed at Various Angles								
Filon	1	29.0	28.9	28.2	26.6	24.1	20.5	16.5	10.8	3.2
"	2	31.0	31.0	29.8	28.2	26.0	22.8	19.0	12.2	4.8
"	6	23.8	23.6	23.0	21.6	19.7	17.0	12.4	8.8	3.4
"	7	13.8	13.6	13.0	12.1	10.8	9.0	6.9	4.1	1.4
Alsynite	1	9.5	9.5	8.8	8.2	7.2	5.9	4.6	3.7	1.0
"	2	9.4	9.4	8.8	8.1	7.1	5.9	4.4	3.6	0.8
"	3	17.2	17.0	16.4	15.3	13.9	11.7	9.0	5.4	1.7
"	6	14.6	14.6	13.7	12.9	11.9	9.9	7.5	4.6	1.4
Corrulux	1	6.8	6.7	6.1	5.5	4.5	3.1	2.1	1.0	0.2
"	2	12.6	12.3	11.6	10.7	9.3	7.2	6.4	3.2	1.0
"	3	14.0	14.0	13.7	12.5	11.0	9.1	6.9	4.1	1.4

Structoglas: No measurements taken, but inspection showed no discoloration due to refraction shadows created by the fiber glass. These shadows were particularly noticeable in the Filon, Alsynite, and Corrulux samples which are composed of polyesters in lieu of acrylic polmers, and under auto headlights appeared as grease or grime spots.

The granitized surface textures, when compared to smooth, showed no modification in the amount of angular light transmitted through the panels. The graphic illustration, Exhibit 2, confirms this.

No light conductance tests were made on samples after sandblasting.

Samples sufficiently large with chemically dulled non-glass surfaces were not available for this test. Both this type and the sandblasted surfaces would show a lower angular transmission of light due to higher light scattering properties.

6. <u>Angular Reflectance Tests</u>

In this test the photocells were placed 7.5 feet from the reflectance point on the plastic sheet. A constant light source was set at 40 feet from the plastic sheet. The reflectance incidence angle is that angle established between the plastic sheet and light source, or plastic sheet and photocell.

Sample	No.	Thickness	Reflectance Angle * 10°	20°	30°	40°
Corrulux	1	.09"	9.9%	3.3%	1.3%	0.83%
"	2	.09"	10.2%	3.1%	1.3%	0.83%
"	3	.06"	13.7%	3.8%	1.47%	0.98%
Alsynite	1	.09"	15.0%	4.0%	1.77%	1.2%
"	2	.09"	16.0%	4.7%	2.0%	1.25%
"	3	.06"	19.0%	4.8%	2.07%	1.23%
"	6	.06"	14.7%	4.4%	2.08%	1.22%
Filon	1	.06"	16.0%	5.2%	2.0%	1.25%
"	2	.06"	18.0%	5.0%	2.0%	1.25%
"	6	.06"	16.5%	3.5%	1.5%	0.87%
"	7	.09"	15.7%	4.3%	1.8%	0.85%

Structoglass - Not Measured

* In this instance defined as the angle between the panel and the light rays.

The Alsynite and Filon being of smooth finish had a higher reflectance value. The Corrulux samples had a granitized surface, and the above data confirms that a granitized surface is somewhat beneficial in reducing reflectances.

In reference to the sunglare type of reflectance, any reflectance greater than a fraction of a percent can become quite serious. This factor definitely curbs the use of gloss material in any direction where the sun can have a low angle of incidence reflection, which eliminates the use of such panels in an east-west installation. Exhibit 6 shows the azimuth angles where sunglare can be most prevalent.

The chemical treatment of plastic panels to produce a non-gloss or flat surface is possible, and a value of 1.5% or less as measured on the Bureau of Standards Gloss Meter is recommended. Such a value eliminates sun glare by reflectance except when the panels are wet with rain or dew. However, this latter difficulty can be eliminated to some extent by the use of methacrylate plastics which are poorly wet with water.

7. <u>Fadeometer Test</u>

Samples placed in the Atlas FDAR Fade-Ometer were examined on several occasions. All samples showed good resistance to the ultraviolet light exposure except the Filon. The Filon fire retardant Hetron browned badly on the surface and at the contact faces between the plastic and fiberglass. The pigments faded slightly.

The Filon #350 also showed a slight browning. These experiments were conducted at 90° - 100° F. to simulate Central Valley conditions.

The Fade-Ometer test is recommended as a means of control to discourage those plastic manufacturers who may produce inferior products.

8. Tensile Tests

Tensile tests were performed in accordance with A.S.T.M. specifications D638 - 46T, Page 366, 1957.

Results are as follows:

Material	Sample	Type	Size, Thickness	Area	Actual Ultimate	psi Ultimate
Corrulux	1	12 oz.	.500" x .081"	.0405	254 lbs.	6,300
"	1	12 oz.	.500" x .080"	.040	396 lbs.	9,900
"	2	12 oz.	.500" x .084"	.042	277 lbs.	6,600
"	2	12 oz.	.500" x .110"	.055	328 lbs.	5,980
Alsynite	1	12 oz.	.50" x .116"	.058	424 lbs.	7,300
"	1	12 oz.	.50" x .121"	.0605	397 lbs.	6,600
"	3	8 oz.	.50" x .070"	.035	240 lbs.	6,900
"	3	8 oz.	.50" x .060"	.030	258 lbs.	8,600
"	4	12 oz.	.500" x .082"	.041	525 lbs.	12,800
"	4	12 oz.	.500" x .088"	.044	479 lbs.	10,900
Filon #900	1	8 oz.	.500" x .051"	.029	397 lbs.	15,900
" #900	1	8 oz.	.500" x .051"	.025	366 lbs.	14,600
" #900	3	8 oz.	.500" x .048"	.024	362 lbs.	15,100
" #900	3	8 oz.	.500" x .043"	.0215	371 lbs.	17,300
" #350	6	8 oz.	.500" x .098"	.049	589 lbs.	12,000
" #350	6	8 oz.	.500" x -	-	-	-
Structoglass #1		8 oz.	No tests			

The standard A.S.T.M. sample cut to 3/4" width did not give a satisfactory tensile test due to the random arrangement of the glass fibers. Wider samples are recommended.

Published data for Alsynite #200 and #300 are 15,000 psi tensile strength and 24,000 psi flexural strength.

Published data on Filon gives the tensile strength as 17,000 to 18,000 psi and flexural as 33,000 to 35,000 psi.

Tensile tests are not recognized as practical in the U. S. Department of Commerce Commercial Standards #CS 214-57 for corrugated plastic panels. Beam loading tests are considered of more significance.

Special grips to fit the contour of the corrugations will be required if tensile tests should become standard.

9. Full Length Beam Loading Tests (Wind Loading)

To determine wind loading capacity of the various corrugated plastics, it was proposed that beam loading tests of full sheets be performed. In this instance the ends of the corrugated sheet were clamped horizontally to two saw horses, and 10-lb. canvas sacks of sand were distributed uniformly over the face of the sheet. See Exhibit 5. The contemplated loading of 30-lbs. per square foot was found impossible for spans exceeding 8 feet. However, as a matter of information some initial data taken with 9 and 10 foot spans is included. Deflection was measured at the mid-point. Breakage, as noted, occurred with several sheets. This was due to compression failure and not to tensile weakness.

DEFLECTION TEST

(See page 15 for Deflection Test Chart)

All samples which collapsed failed under compression. The Corrulux was badly damaged. The Alsynite when unloaded sprung back into place and showed a minimum of damage. Lack of uniformity in the load test for Alsynite was partially due to the extreme variations in the thickness of this material. Alsynite sample #1, for example, varied from .048" to .135" in thickness.

The nature of the failures suggested that a small beam load testing device with two symmetrically concentrated loads should be employed as a standard test procedure. The subsequent test procedure was therefore undertaken, which is in line with the A.S.T.M. test D1502-57T.

Tests were also conducted with one edge of the panel supported. This obviously produced a warped contour for the plastic sheet.

Deflections were as follows:

DEFLECTION TEST

			Load per Square Foot					
Sample	No.	Weight	5 lbs.	10 lbs.	15 lbs.	20 lbs.	25 lbs.	30 lbs.
Alsynite	4	.09"	7/8"	2"	3 3/8"	4 3/8"	5 7/8"	7 1/4"
Filon	3	.06"	1 5/8"	3"	4 5/8"	5 7/8"	7 1/2"	-

Deflection was greater for the unsupported edge in the above test wherein the opposite edge was supported than in the previous tests where neither edge was supported. Supporting a single edge does not permit the use of a greater span.

DEFLECTION TEST

Sample	No.	Thickness	Span	Load Per Square Foot: 5 lbs.	10 lbs.	15 lbs.	20 lbs.	25 lbs.	30 lbs.
Corrulux	1	.09"	8 ft.	11/16"	1 1/2"	2 5/16"	3 5/16"	4 3/4"	6"
"	2	.09"	8 ft.	7/8"	1 13/16"	2 13/16"	3 13/16"	4 3/4"	5 13/16"
"	3	.06"	8 ft.	1"	1 13/16"	3"	4"	5"	Collapsed
"	1	.09"	9 ft.	-	2 3/4"	-	-	-	-
"	2	.09"	10 ft.	-	4 3/4"	8 1/2"	-	-	-
Filon	1	.06"	8 ft.	1 1/4"	2 13/16"	4 3/8"	6 3/16"	-	-
"	2	.06"	8 ft.	1 1/4"	2 3/8"	2 7/16"	4 13/16"	Collapsed	
"	8	.09"	8 ft.	2 15/16"	6 7/16"	9 3/4"	-	-	-
"	2	.06"	10 ft.	3 1/4"	2 1/2"	(9 1/4" with 12#/square foot)			
Alsynite	1	.09"	8 ft.	1 1/16"	2"	3 1/16"	4 1/8"	5 3/16"	6 5/16"
"	4	.09"	8 ft.	7/8"	1 7/8"	2 3/16"	4 13/16"	4 13/16"	5 13/16"
"	4	.09"	10 ft.	2 3/8"	4 3/4"	7 3/4"	-	-	-
"	5	.06"	8 ft.	1 1/4"	2 1/2"	3 3/4"	4 1/2"	5 5/8"	6 5/8"
"	6	.06"	8 ft.	1 1/8"	2 7/16"	3 3/4"	5 7/16"	Collapsed	
3/8" Dense Plywood		-	8 ft.	1 11/16"	3 1/4"	4 7/8"	6 7/16"	8 1/4"	-
Structoglass	1	.05"	8 ft.	1 1/4"	3 1/4"	5 1/4"	7 1/4"	-	-

* Filon #8 represents a 2.33" pitch x 9/16" gauge.

10. A.S.T.M. Standard Beam Load Test

The preceding load test which was conducted on full length sheets suggested that the newly established standard beam load test, A.S.T.M. D1502-57T, is a practical means of evaluating corrugated plastic sheeting. Unstressed 8 1/2" wide sections were initially employed for this test. However, by the use of wiggle molds for bearing saddles and load distribution pads, these samples (which were only two corrugations wide) could be loaded without distorting the sheets unduly and give close approximations to standard 24" wide samples.

Tests were conducted employing third point loading:

Sample	No.	Thickness	Max. Load in lbs.	Max. Deflection (inches)	Wt./Ft. Width
Filon	1	.06"	320	2"	451
"	2	.06"	440	1 1/2"	620
"	3	.06"	480	1 3/4"	678
"	4	.06"	430	1 1/2"	608
Corrulux	1	.09"	530	1 1/4"	747
"	2	.09"	470	1"	663
"	3	.06"	300	3/4"	423
Alsynite	1	.09"	430	1"	602
"	2	.09"	620	1 1/2"	876
"	3	.06"	310	1"	438
"	4	.09"	620	1 1/4"	875
"	5	.06"	400	1 1/4"	565
"	6	.06"	420	1"	590
Structoglass	1	.05"	400	1"	565
	1a	.05"	430	1 1/4"	605

A recommended minimum average traverse strength of 650 pounds per foot of width is recommended for .09" plastic sheeting having 3 oz./sq. ft. of fiber glass reinforcement.

11. Extreme Fiber Stress

Although the corrugated plastic simulates a sine curve with a pitch of 4.2 inches and amplitude of 1 1/16", it is easier to compute the moment of inertia by empirical means. Such calculations give a value of I/C of .216 per foot width for .06" thick material and .325 for .09" thick material. Thus from the preceding test #10, "Standard Beam Load Tests", the following extreme fiber stresses are derived. Moments are given for 8 1/2" samples per foot of width, thusly:

$$1/2\ Wa = 1/2\ W\ 8\ (12/8.5) = 5.67\ W$$

Sample	No.	Thickness	Max. Load in lbs.	Moment inch lbs.	I/C	Fiber stress lbs/sq. in.
Filon	1	.06"	320	1840	.216	8,540
"	2	.06"	440	2530	.216	11,700
"	3	.06"	480	2760	.216	12,800
"	4	.06"	430	2470	.216	11,450
Corrulux	1	.09"	530	3050	.325	9,600
"	2	.09"	470	2700	.325	8,300
"	3	.06"	300	1730	.216	8,000
Alsynite	1	.09"	430	2480	.325	7,600
"	2	.09"	620	3580	.325	11,000
"	3	.06"	310	1790	.216	8,300
"	4	.09"	620	3580	.325	11,000
"	5	.06"	400	2300	.216	10,700
"	6	.06"	420	2420	.216	11,200
Structoglass	1	.05"	400	2260	.180	12,500
	1a	.05"	430	2430	.180	13,500

Failures occurred to both compression and tension. The load tests disclose that the extreme fiber stress is considerably less than the rated tensile tests as published by the manufacturers. However, values do not digress too seriously from the actual tensile tests performed in #8 when allowances are made for those obviously defective samples which failed prematurely due to notching effects or other secondary difficulties. Such deviations would be less likely to occur with full width samples in both the tensile and beam tests.

12. Sound or Noise Factors

A corrugated surface tends to reflect sound in much the same manner as a frosted surface scatters light, giving a wide degree of sound dispersion, particularly in the higher frequencies. Likewise, since the plastic sheets are not held rigidly over the full length, they tend to dampen low frequency sound. Therefore, over the general acoustical range the reflectance of sound from the plastic sheeting will not be as pronounced or intense as that reflected from a smooth concrete surface. However, there may be a tendency to accentuate tire noises slightly in the frequency range of 2100-2300 cycles during wet weather due to a sound spectral grating effect caused by reflectance from the parallel corrugations.

13. Baffle Designs

Several arrangements of light baffles were prepared for examination.

The first consisted of quarter inch weatherproof plyboard pieces cut 6" x 22" and supported vertically between two 2" x 4" OP rails. The baffles were canted at 60° to the rails and placed on rails. The baffles were canted at 60° to the rails and placed on

12" centers, thus offering a right angle restriction to a beam of light crossing the median strip at a 30° angle, and preventing all light from crossing the barrier at angles less than 30°. See Exhibit 7.

This unit is particularly effective and offers no wind resistance. However, the top rail has been declared as undesirable.

As a consequence a sample baffle was prepared using 4 1/2" wide light weight aluminum awning strips supported on a single rail by means of brackets. Like the plyboard baffles these aluminum baffles were canted 30° toward the traffic. This arrangement is equally as effective as a light barrier, but it is suggested that a light weight cable with spacers be run along the top to the baffles so as to reduce bending or damage to the baffles.

14. Visual Inspection of Plastics

A night test conducted with automobile headlights after dark on the various samples of plastic sheeting showed that the deeper jade green coloration of the Corrulux had much to be preferred. A light transmission factor of 37% which would be approximately intermediate between the two Corrulux samples submitted appears to be the maximum permissible light transmission value; 35% was decided by general approval to be the most acceptable.

The lighter green shades of the Filon and Alsynite samples under the action of seal beam headlights bleached out to a dirty yellow color blotched with yellow-brown fibrillous patches. These latter blotches (actually shadows) were caused by the differences in index of refraction between the glass fiber and polyester resins. The Corrulux also showed these dark patches on account of the glass fibers, but the blotches appeared as dark green shadows in lieu of dirty brown and thus were not so objectionable.

Samples of Structoglass when exposed to headlights did not show evidence of discoloration or blotching due to the fiberglass mat since the index of refraction of the glass fiber and alkyd-methyl-methacrylate complex are quite similar and do not defract the light to give the defraction shadows experienced with the other plastic materials.

A daylight test with the sun at a low angle showed that the darker colors of the Corrulux produced considerably less light transmission glare than the samples having the higher light transmission properties. This factor also justifies the use of deep colors.

However, the major difficulty is sun reflectance from both the smooth and granitized surfaces of any glare shield erected in an east-west direction. A reflectance from any plane up to an incidence angle of 30 degrees is objectionable. Test #6 shows the intensity of reflectance at angles normal to the length of the sheet and Exhibit 6 shows those azimuth angles where corrugated gloss material will reflect sunlight producing excessive glare.

Plastic samples whose surfaces were sandblasted to reduce the glare reflectance are quite acceptable for east-west installation purposes, but the final acceptance resolves around (1) the esthetic appearance of plastic sheeting with a non-glass flat or sandblasted surface and (2) whether occasional glare is permissible on those instances when the plastic is wet with rain or dew.

A Structoglass sample with a chemically dulled non-glass surface showed very poor wetting qualities even when the surface was treated with soap. If this condition is permanent, then there is little concern for hazards developing due to sun glare from wet surfaces.

By actual test a glass meter reading not exceeding 1.5% should be established to assure the prevention of sun glare reflectance from chemically dulled or non-glass "flat" surfaces.

V. PROPOSED SPECIFICATIONS

Corrugated plastic panels for headlight barrier purposes shall conform to the U. S. Department of Commerce Commercial Standards CS214-57 for corrugated structural plastic panels, but with the following modification and special provisions:

The material shall be of 12 ounce per square foot weight and contain a 3 ounce per square foot fiber glass mat.

Nominal weight of the plastic panel and glass mat shall not deviate greater than 10% from the above values. Nominal thickness of the plastic panel shall not exceed +.025" or -.015" from that thickness which is representative of a 12 oz. per square foot standard panel.

The surface of the plastic panel shall either be etched or chemically processed to give a non-gloss sun glare free finish with a gloss value of 1.5% or less as measured by a Bureau of Standards calibrated Glossmeter complying with the requirements A.S.T.M. D523.

The color shall be jade green with a light transmission factor of 30 to 35%.

The traverse load test A.S.T.M. D1502-57T shall be modified by the use of wiggle mold at all quarter points to prevent distortion of the sheet. Samples thirteen inches wide shall be employed. An average minimum transverse strength of 650 pounds per foot width shall be required.

The plastic or pigments shall show no detrimental physical or structural changes when exposed to an accelerated aging in an Atlas #FDAR Fade-Ometer for 1000 hours at 100° F. Significant fading of the colors, chalking, or discoloration of the plastic, either on the surface or about the glass fiber, embrittlement, fraying of glass fibers or other indications of deterioration shall be grounds for rejection.

The plastic sheeting shall not appear yellowish or present a grimy or stained appearance due to light defraction differences existing between the glass fibers and plastic when examined for such light transmission effects by employing an automotive seal beam spotlight GE 4515. In this test the observer shall stand 25 feet from the sheet, and the light source shall be 25 feet. The light shall pass through the panel at a 30° angle as measured from the longitudinal face of the panel.

Prepurchased samples of the plastic paneling are to be submitted for initial testing.

Two tenths of 1% of the sheets from a bulk order shall be examined for structural properties, 0.5% for optical, sun glare, objectionable color, and staining effect under transmitted lighting.

VI. APPENDIX

Exhibit I. Letter of Authorization

II. Graphic Illustration of Angular Light Transmission

III. Design of Corrugated Plastic Support Brackets

IV. Pertinent Portions of U. S. Department of Commerce Commercial Standards CS214-57

V. Photographs of Investigation

- A. Loading Panels
- B. Field Test

VI. Chart: Sun glare vx. Azimuth Angle

VII. Light Baffles

Exhibit 1

C O P Y

CALIFORNIA DIVISION OF HIGHWAYS

B R I D G E   D E P A R T M E N T

Santa Monica Freeway
VII-LA-173-LA

May 19, 1958

Mr. F. N. Hveem

This is to request that the Laboratory study the proposed glare shield shown on the attached sheet titled, "Study 4-5.1, Type M-16 Railing".

The cross section for the Santa Monica Viaduct with a barrier rail and headlight glare shield in the center of the median was approved by Mr. McCoy's letter dated 7-20-56 and J. C. Young's letter of Jan. 15, 1957. There will be 5,700 lineal feet of the Type M-16 Rail in the portion from Hooper to the AT&SF Railway. An additional 9,000 lineal feet will be used to complete the viaduct between Hoover Street and Hooper Street. It therefore becomes obvious that with about 2 1/2 miles of this glare shield to be installed, we should be sure that it is suitable for the purpose intended.

Information is needed on several points. First, are the structural properties of the plastic to be used for the glare shield. These properties are beam strength, shear strength at supports, fatigue or brittleness, and the effect of age on these properties. Other cross sections than those indicated on the plan are available with the same or somewhat less strength. There appears to be a wide variation in strength and other properties between different commercial products.

Information is also needed on the color fastness, light transmission factor, and reflectivity of light.

It is requested that sections of the material be obtained and some experimentation done on full scale models 30 to 40 feet in length. So long as the glare shield is placed at the proper height, the supporting member could be of any convenient material and would of course not have to be concrete. From the full scale test, these questions should be considered:

C O P Y

C O P Y

Mr. F. N. Hveem
Santa Monica Freeway
VII-LA-173-LA

1. Does the glare shield function as anticipated to control headlight glare at night?

2. Is there any undesirable reflection likely from any other external light source such as the sun or illuminated signs during the day or night?

3. Will there be any peculiar sound effects set up by passing vehicles which might prove objectionable? This noise might be caused by vibration of the panels or by the rythmic effect of vehicles passing the panels and posts.

The characteristics of two types of materials have been shown on the sheet, although other satisfactory materials may be available.

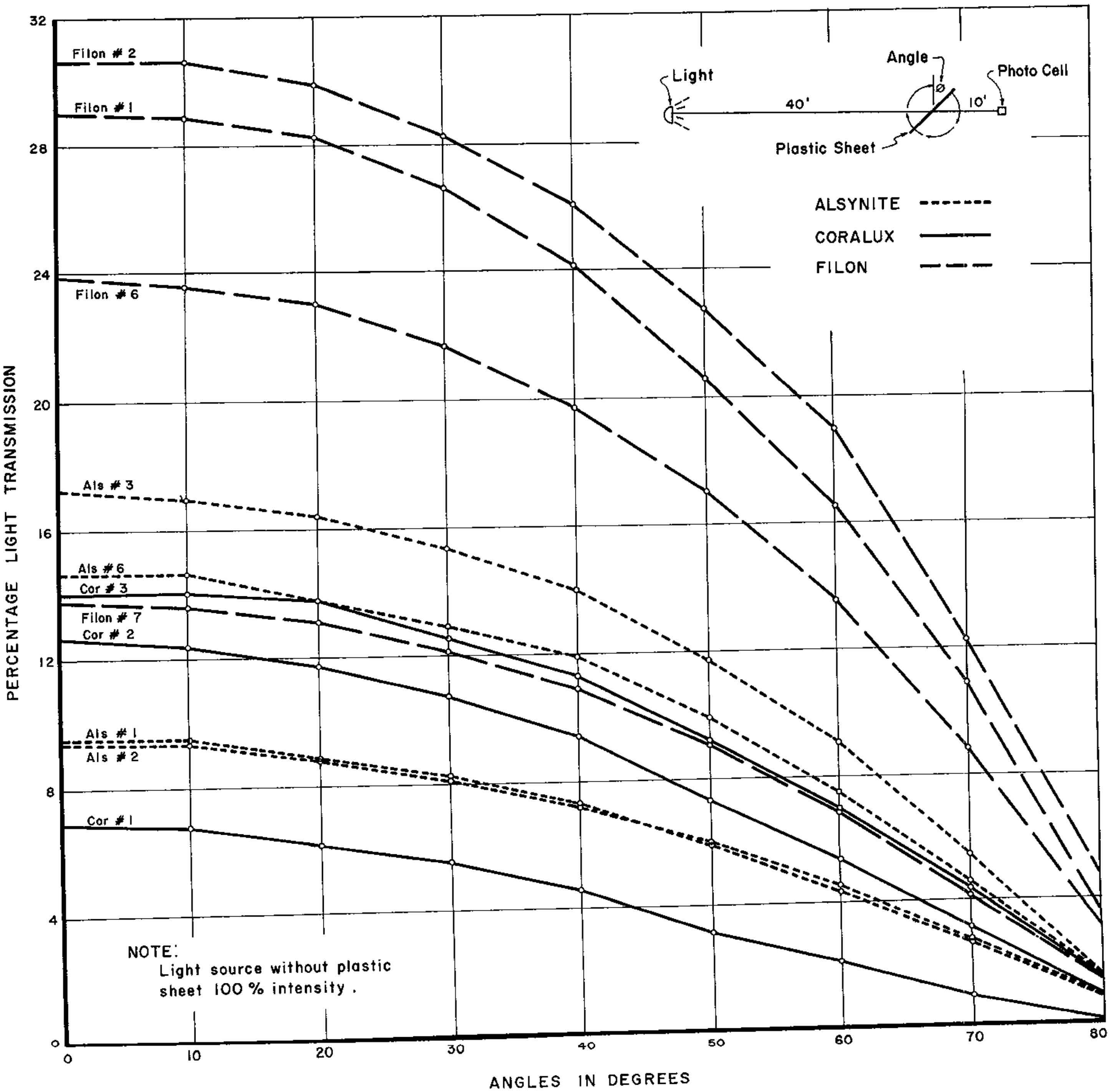
This job is due to have the plans completed by December, 1958, and it is therefore requested that the answers to these experimental questions, as well as any information you may be able to obtain on accelerated weathering tests, be furnished to the Bridge Department not later than October 1, 1958.

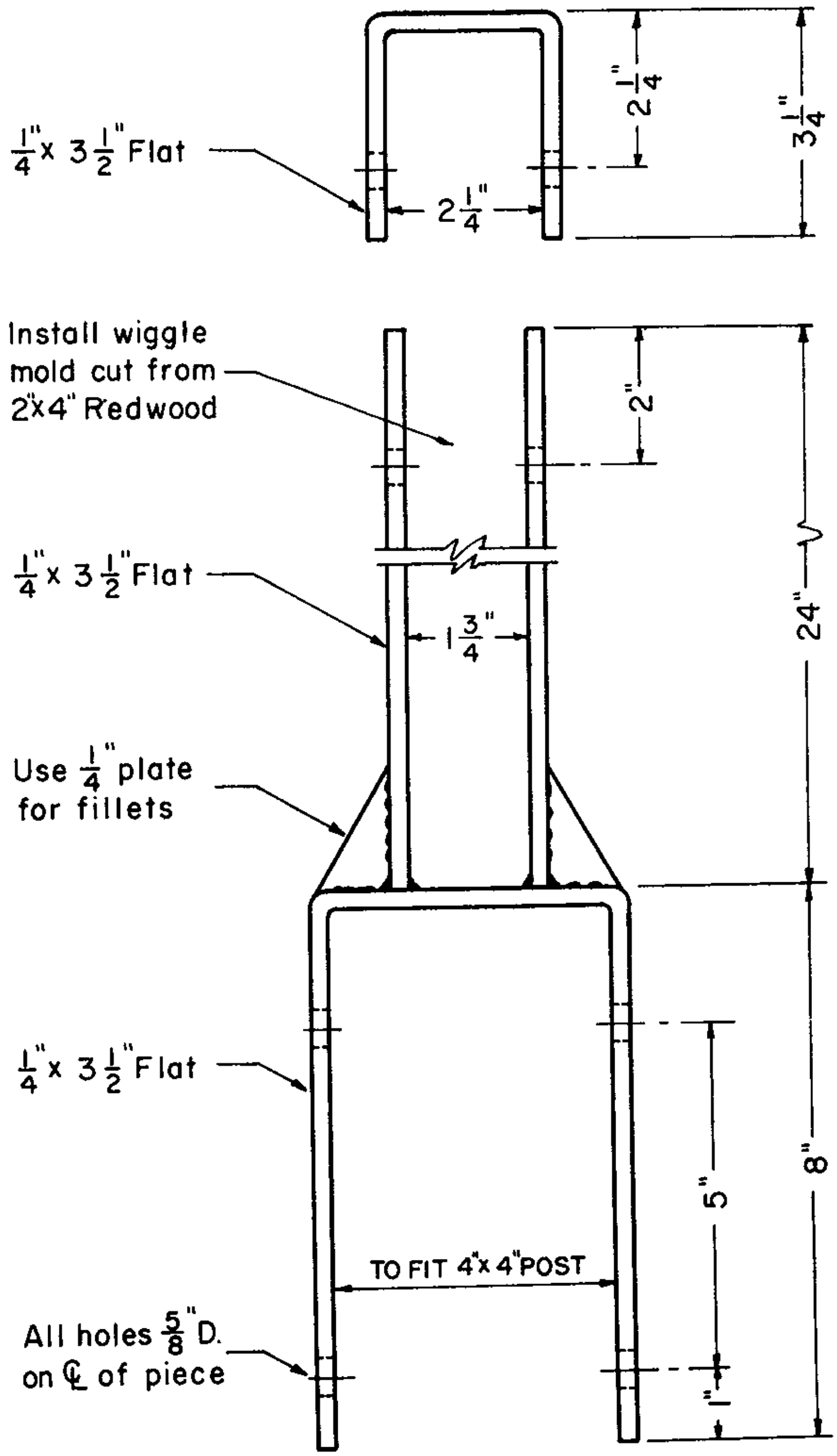
A. L. Elliott

ALE vs
Attach

C O P Y

PERCENTAGE LIGHT TRANSMISSION AT VARIOUS ANGLES
CLOCKWISE ROTATION





SUPPORT BRACKETS
FOR CORRUGATED PLASTIC
MEDIAN STRIP LIGHT
BARRIER TESTS

Materials & Research Department

4. TYPES

4.1 The corrugated plastics panels covered by this standard shall be the following types:

Type I—General Purpose.

Type II—Fire Retardant.

The principal difference between the two types of corrugated plastics panels is their resistance to flame and weathering elements. Type I has better weathering properties; Type II has a slower rate of burning. The slower rate of burning is obtained at some sacrifice in resistance to weathering. Type II may cost more than Type I.

5. DIMENSIONAL REQUIREMENTS

5.1 *Sizes.*—Panels are supplied is a variety of widths and lengths (see appendix). The tolerance on specified lengths and widths shall be ±1/4 inch when measured in accordance with paragraph 7.2.

5.2 *Weight.*—The weight in ounces per square foot shall be 8 oz./ft.[2] ±10 percent when measured in accordance with paragraph 7.3.

5.3 *Corrugations.*—The pitch of the corrugations shall be 2.67 inches[2] +0.010 and −0.015 inch, and the depth of corrugations shall be 0.50 inch ±0.100 inch when measured in accordance with paragraph 7.4.

5.4 *Thickness.*—The thickness shall be 0.062 inch +0.025 and −0.015 inch when measured in accordance with paragraph 7.5.

5.5 *Squareness.*—Panels 27½ inches or less in width shall be within 1/16 inch of square and those wider than 27½ inches within 1/8 inch of square when measured in accordance with paragraph 7.6.

6. INTRINSIC QUALITY REQUIREMENTS

6.1 *Appearance.*—The panel shall be as free as commercially practicable from visual defects such as foreign inclusions, cracks, crazing, die lines, pinholes, and striations.

6.2 *Color.*—The panels shall be essentially uniform in color when determined in accordance with paragraph 7.7.

6.3 *Light transmission.*—The light transmission shall be within ±5 percent of the designated light transmission value when determined in accordance with paragraph 7.8.

6.4 *Transverse load.*—The transverse load of each specimen shall be not less than 225 pounds per foot of width when tested in accordance with paragraph 7.9.

6.5 *Bearing load.*—The average bearing load shall be not less than 225 pounds, and the bearing load of each individual specimen shall be not less than 175 pounds when tested in accordance with paragraph 7.10.

6.6 *Flammability.*—The rate of burning for Type I panels shall be less than 2.0 inches per minute, and the rate of burning for Type II panels shall be less than 0.2 inch per minute when tested in accordance with paragraph 7.11.

[2] Galvanized steel corrugated panels with an actual pitch of 2.67 inches are designated as having a pitch of 2½ inches in the trade.

NOTE.—*Aging.*—The Society of the Plastics Industry (SPI) Committee that prepared this Commercial Standard recognized the value and need of an aging test during the course of their work. However, after years of work by the SPI group which was assigned the problem of selecting or developing a suitable method of test for aging, as well as by the American Society for Testing Materials, and various governmental agencies, such as the National Bureau of Standards, no suitable method has been found or developed. Two major difficulties have been encountered: (1) The poor degree of reproducibility between different pieces of apparatus of the same type; and (2) the poor degree of correlation between laboratory aging tests and service behavior.

The SPI group working on aging hopes to have a reasonably satisfactory method in a year or two. It was the opinion of the committee recommending this specification for promulgation as a Commercial Standard that it would be more of a detriment to the corrugated panel industry than a benefit to wait for another 2 years to issue this standard because of the lack of this one test. When a suitable test method is developed, the Commercial Standard will be revised. Any help which anyone can offer to the SPI group will be appreciated.

7. TEST METHODS

7.1 *Conditioning.*—The test specimens shall be conditioned in accordance with Procedure A in ASTM D618–54, Methods of Conditioning Plastics and Electrical Insulating Materials for Testing, and tested under these conditions for those tests where conditioning is required.

7.2 *Sizes.*—The panel specimen shall be laid on a flat smooth surface and measured with a steel tape. The length shall be measured on the top of the two sides and the center corrugations to the nearest 1/32 inch, and the three measurements averaged. The width shall be measured on the projected width at each end and in the center to the nearest 1/32 inch, and the three measurements averaged.

7.3 *Weight.*—Ten panels shall be weighed individually on a balance or scale accurate to ±1 percent. The area shall be calculated on the basis of length and width measurements made in accordance with paragraph 7.2. The weight of each panel in ounces per square foot shall be calculated, and the ten results averaged.

7.4 *Corrugations.*—The full size panel specimen shall be laid on a flat, smooth surface and measured.

7.4.1 *Pitch.*—The pitch is the average distance from the crest of one corrugation to the crest of an adjacent corrugation. The crests of the corrugations shall be determined by placing a metal straightedge crosswise on the panel so that it touches the crests. The distance between the crests of the two outer corrugations shall be measured to the nearest 0.01 inch except that no more than 10 corrugations need to be used. This distance shall be divided by the number of valleys included in the measurement to obtain the pitch.

7.4.2 *Depth.*—The depth of the corrugation is the vertical distance between the plane of the crests and the upper side of the sheet at the bottom of the valley. Ten depth measurements, five at each end, shall be made to the nearest 0.03 inch with a depth micrometer on each specimen and the results averaged.

7.5 *Thickness.*—The thickness measurements shall be made perpendicular to the surface at the point of measurement with a thickness gage to an accuracy of 0.002 inch. Ten measurements shall be made on each specimen. Two measurements shall be made near each end and three near each side. Approximately half the measurements shall be made at the crests and half at the bottoms of the valleys. Each measurement shall meet the requirement in paragraph 5.4.

EXHIBIT IV A

7.6 *Squareness.*—The panel shall be laid on a flat, smooth surface and measured. Any type of jig that has two rails at 90° to one another may be used to determine squareness. The panel shall be placed in the jig on the surface so that one edge parallel with the corrugations touches one rail along its entire length and with the corner of the panel in the 90° angle between the rails. The widest gap between the edge of the panel that is perpendicular to the corrugations and the rail shall be measured to the nearest 1/32 inch. The test shall be repeated so that all four corners of each specimen are tested for squareness.

7.7 *Color.*—One panel shall be selected at random and examined from a distance of 10 feet for color uniformity by viewing by reflected light. Apparent minor differences in intensity of the color caused by nonuniform distribution of glass fiber shall not be cause for rejection.

7.8 *Light transmission.*—The light transmission shall be measured in accordance with ASTM D1494-57 T, Method of Test for Diffused Light Transmission.

7.9 *Transverse load.*—The transverse load shall be determined by quarter-point loading in accordance with ASTM D1502-57 T, Method of Test for Transverse Strength of Corrugated Reinforced Plastic Panels. At least three specimens from each sample shall be tested.

7.10 *Bearing load.*—The bearing load shall be determined in accordance with Method 1051, Federal Specification L-P-406.[3] Five specimens from each panel shall be tested. Three specimens shall be cut from the crowns of three different corrugations and two from two different valleys. The specimen shall be wide enough so that bearing and not tensile failures are obtained; this is usually 1⅛ inches or more. The length shall be about 7.5 inches. The bearing hole in the specimen shall be 0.125 inch in diameter with the center 0.750±0.005 inch from one end and equidistant from the sides of the specimen. The bearing load is the maximum load sustained by the specimen during test while the bearing pin moves a distance of 0.25 inch toward the end of the specimen.

7.11 *Flammability.*—The rate of burning shall be determined in accordance with ASTM D635-56 T, Method of Test for Flammability of Plastics Over 0.050 Inch in Thickness, except that six specimens taken from different parts of the panel shall be tested and the results averaged. Two specimens shall be taken from crowns, two from sides of valleys, and two from bottoms of valleys. When Type II panels are found to be self-extinguishing by Method D635-56 T, the rate of burning shall be measured by ASTM D757-49, Method of Test for Flammability of Plastics, Self-Extinguishing Type.

8. IDENTIFICATION

8.1 *Labels and literature.*—In order that purchasers may be assured that the corrugated plastics panels actually comply with all requirements of this Commercial Standard, it is recommended that manufacturers include the following statement with their name and address on labels, invoices, sales literature, etc.:

These (this) (General Purpose, Type I) (Fire Retardant, Type II) glass-fiber reinforced polyester corrugated structural plastics panel(s) comply (complies) with Commercial Standard CS214-57, as developed by the trade, under the procedures of the Commodity Standards Division, and issued by the United States Department of Commerce.

8.1.1 The following abbreviated statement is suggested when available space on labels is insufficient for the full statement:

Complies with CS214-57, as developed by the trade, and issued by the United States Department of Commerce.

8.2 *Hallmark.*—Corrugated plastics panels may carry the hallmarks shown in figure 1 and figure 2 to indicate compliance with this Commercial Standard.[4]

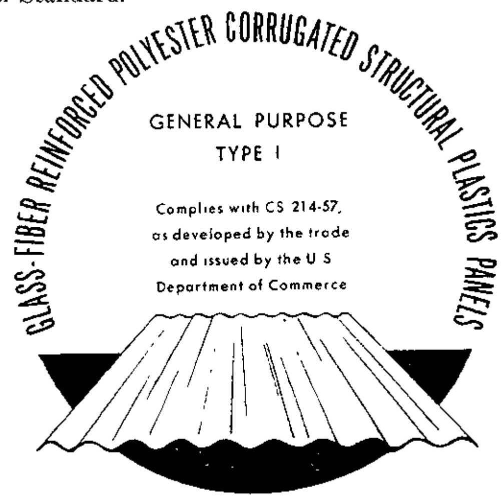


FIGURE 1.—*Hallmark for declaring compliance of Type I panels.*

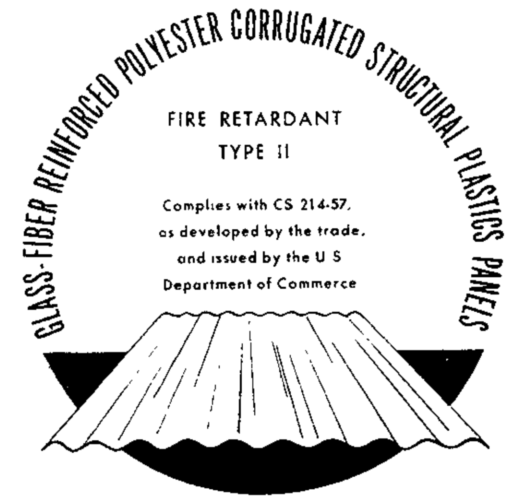
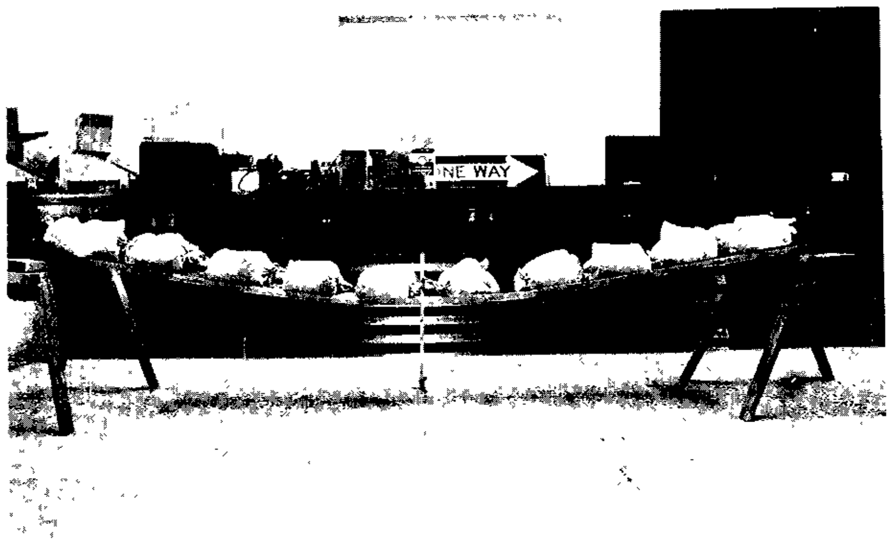


FIGURE 2.—*Hallmark for declaring compliance of Type II panels.*

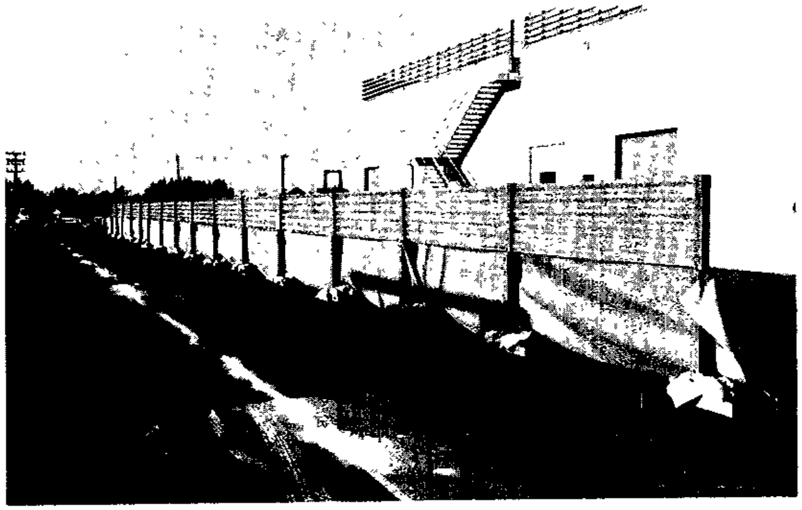
[3] Copies of Fed. Spec. L-P-406, Plastics, Organic; General Specifications, Test Method, are obtainable upon application to Business Service Center, GSA Regional Office Building, 7th and D Streets SW., Washington 25, D. C.

[4] When used on labels, the hallmark shown in figure 1 should be printed in black on a white background; the hallmark shown in figure 2 should be printed in red on a white background.

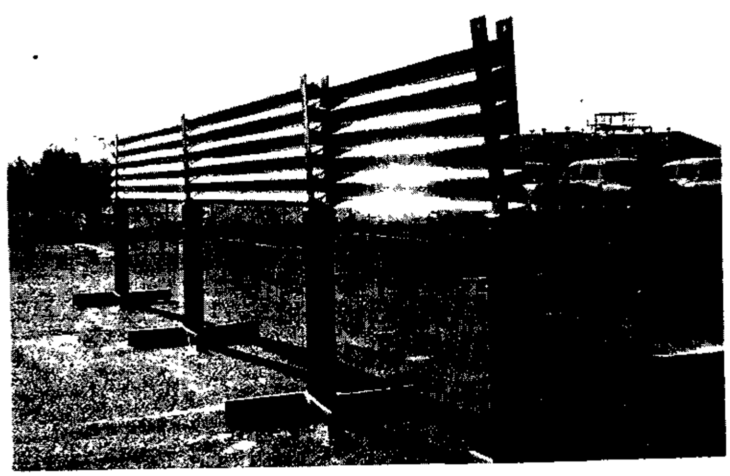


Load Test, 8 foot span, 15 lbs. per square foot

Load Test. Note warping of the panel edge.



Corrugated plastic panel glare shield test installation.



Example of reflected sunlight.

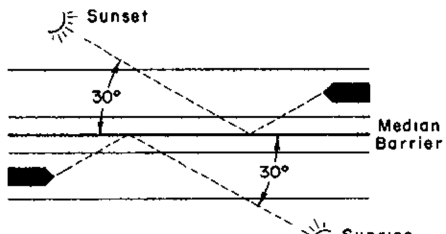
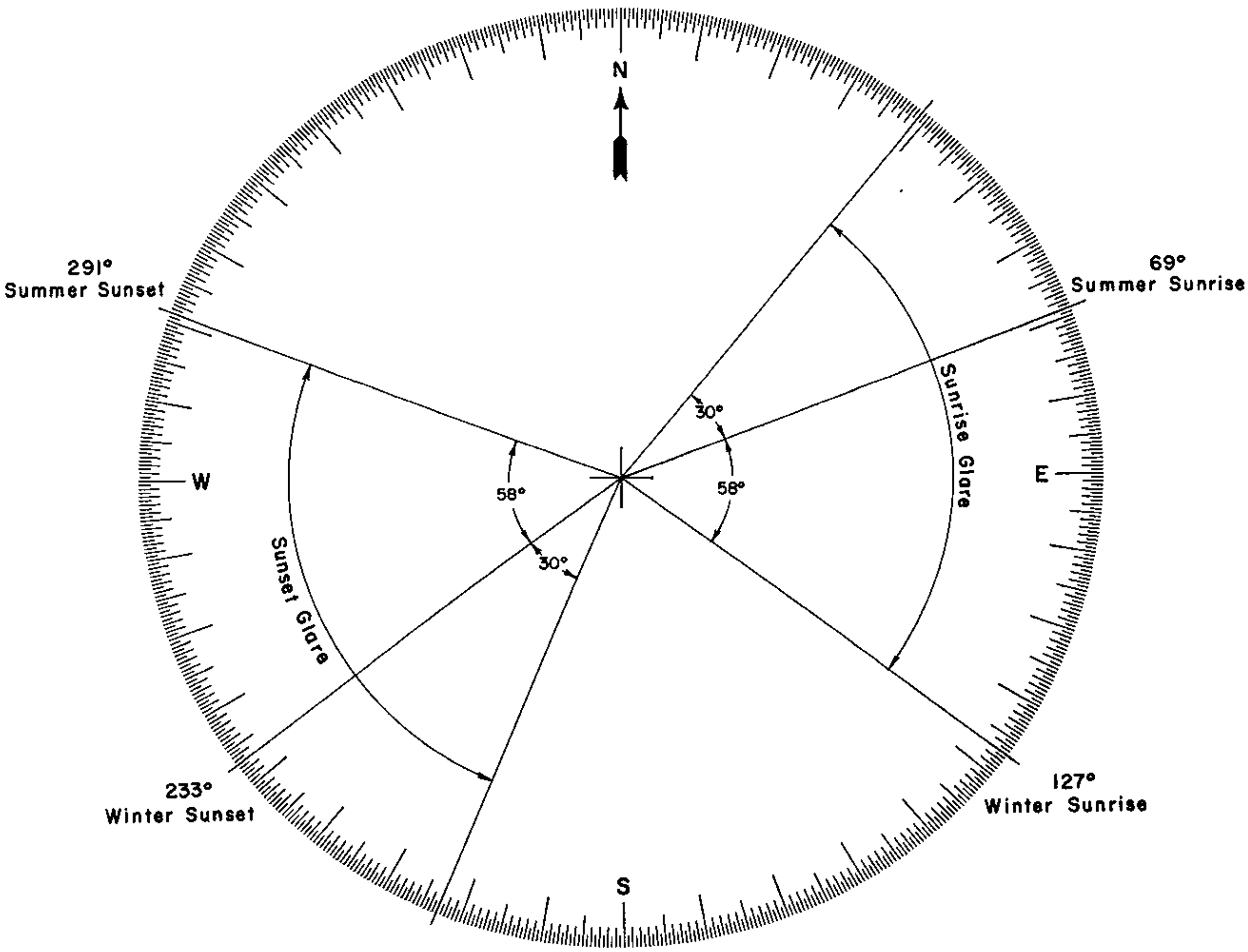


Illustration:
REFLECTIVE GLARE

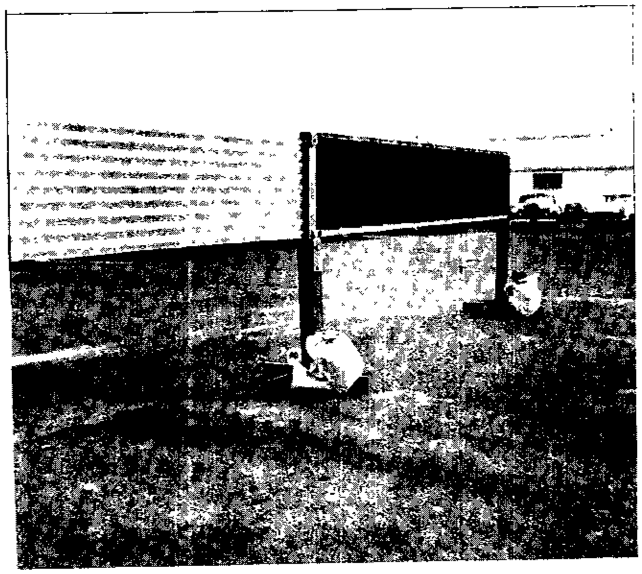


SUN GLARE VS AZIMUTH ANGLE

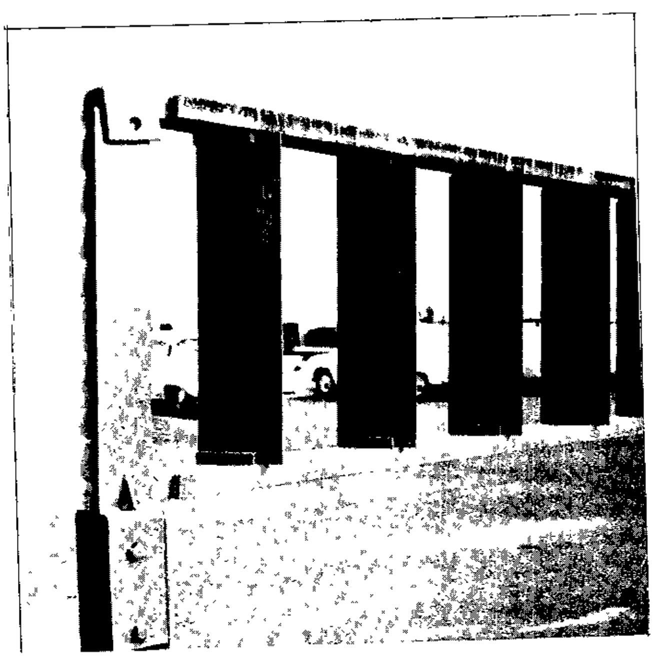
30° to 40° Latitude

NOTE:
The above chart shows those azimuth positions wherein objectionable sunglare caused by reflection will occur from smooth or high gloss surfaces. This assumes that glare 30° or more out of the line of vision is not objectionable.

MEDIAN STRIP GLARE SHIELD INVES.
STATE OF CALIFORNIA-DIVISION OF HIGHWAYS
MATERIALS & RESEARCH DEPARTMENT



Glare shield of 30^{o} baffles and corrugated plastic.



Close-up of baffles viewed at 45^{o}.