AMERICAN DECAL REFLECTIVE SHEETING

TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

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Summary

Adcolite reflective sheeting has been considered an approved material, but the sheeting had not been tested for a number of years. Samples of white, yellow, orange, green, and red—both pressure sensitive and heat activated—were requested from the manufacturer. Tests applicable to Type 2 reflective sheeting in the 1979 MDOT Standard Specifications were performed, and the results are discussed in this report and presented in tabular form. Testing showed some discrepancies, but the manufacturer can produce sheeting conforming with specification requirements and it is recommended that they continue to be approved as a source of reflective sheeting.

Introduction

The Department has a policy of approving reflective sheeting products from manufacturers that can demonstrate an ability to conform with various specifications. Since American Decal's "Adcolite" reflective sheeting had not been tested for a number of years, samples were requested and received on February 28, 1980. Two sheets each of white, yellow, orange, green, and red with pressure sensitive and heat activated adhesive were received. Tests applicable to Type 2 reflective sheeting in the 1979 Standard Specifications were performed including the artificial weathering tests. Results of tests for adhesion, cold shock, liner removal, luminance wet, impact, shrinkage, solvent, peeling, initial luminance, and initial reflectance showed compliance with specification requirements by all samples.

On some samples, results of the tests for color, flexibility, specific luminance, water immersion, and artificial weathering showed discrepancies. Color test results, specific luminance, and flexibility test results are described below along with observations on post-water immersion and post-weathering surface appearance. Results of all tests are summarized in Table 1.

Color Test

Spectrophotometric evaluation of the samples before and after weathering gave the following results:

1) Yellow samples with pressure sensitive adhesive had a hue more green than the green limit and a lightness that was satisfactory before and after weathering. On samples with heat activated adhesive the hue was satisfactory before weathering but became more green than the green limit after weathering. Lightness was satisfactory before and after weathering.

2) Red samples with pressure sensitive and with heat activated adhesives had hues that were more yellow than the yellow limit before weathering. After weathering the sample with pressure sensitive adhesive was more gray than the gray limit and the heat activated sample remained too yellow. Lightness on each sample was satisfactory before and after weathering.

3) Orange samples with each adhesive had a satisfactory hue and lightness both before and after artificial weathering.

4) Green samples with each adhesive had a satisfactory hue and lightness both before and after artificial weathering.

5) White samples with both adhesives had a satisfactory hue before weathering but were more yellow than the yellow limit after weathering.

Specific Luminance

Specific luminance test values showed that all samples conformed to the requirements before artificial weathering (Table 2). After 1,200 hours of weathering all samples except red, yellow, and white with pressure sensitive adhesive and white with heat activated adhesive conformed with specification requirements (Table 3).

Flexibility Test

Orange and green sheeting samples with heat activated adhesive, cracked when bent around a 3/4-in. mandrel. White sheeting with pressure sensitive adhesive also cracked. All other samples passed as shown in Table 1.

Surface Appearance

After 1,200 hours of artificial weathering all samples showed slight water spotting but all samples were considered satisfactory.

Water Immersion

After water immersion all of the colors except red had darkened on at least one of the adhesive substrates. Both samples of the orange darkened.

Discussion

Color discrepancies noted on the red, yellow, and white Adcolite samples have been observed on samplings from other sources.

Red colors that are more yellow than the yellow limit before and after artificial weathering are typical of reds supplied by other manufacturers. Manufacturers of Fasign, Kiwilite, and Scotchlite produce yellows that are more green than the green limit before and after artificial weathering. Whites that become too yellow during artificial weathering are common. The Adcolite colors appear typical of colors supplied by others.

The slightly low specific luminance results on red and yellow samples after artificial weathering could be considered acceptable. Results on these sheetings with a pressure sensitive adhesive were satisfactory. American Decal has submitted test data showing compliance with MDOT requirements and has submitted additional samples for testing.

Darkening during water immersion is not readily related to field performance, but darkened sheeting has been noted on numerous signs in the field. In an effort to determine whether the darkening was related to the optical (bead) system or to the colorant system, specific luminance and color were measured on the immersed samples. Comparing the results with measurements from control samples it was concluded that water immersion affected the optical system. The specific luminance results showed the greatest change. Tables 4 and 5 show the measurements obtained.

The effects of water immersion are probably related to loss of the reflector coating. American Decal forwarded samples on May 1, 1980 (80 RD-100 through 103) that had been tested in their laboratory. Darkening was observed. American Decal has indicated that processing changes have been made.

Recommendations

Since the Department has adopted a policy of approving reflective sheeting products from a manufacturer that can demonstrate an ability to conform with various specifications, it is recommended that American Decal be continued as an approved source of reflective sheeting. Results of these tests have been discussed with American Decal and the company is aware that shipments will be tested to determine consistency of conformance.

TABLE 1
TEST RESULT SUMMARY

Test	Green		Orange		Red		Yellow		White	
	80 RD-39 HA	80 RD-40 PS	80 RD-41 HA	80 RD-42 PS	80 RD-43 HA	80 RD-44 PS	80 RD-45 HA	80 RD-46 PS	80 RD-47 HA	80 RD-48 PS
Adhesion	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Cold Shock	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Flexibility	Fail	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Liner Removal	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Luminance Wet	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Impact	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Shrinkage	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Solvent	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Peeling	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Initial Luminance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Initial Color	Pass	Pass	Pass	Pass	Too Yellow	Too Yellow	Pass	Too Green	Pass	On Yellow Limit
Initial Reflectance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	58.4	53.2
1200 Hr. Luminance	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Fail	Fail	Fail
1200 Hr. Color	Pass	Pass	Pass	Pass	Too Gray	Too Yellow	Too Green	Too Green	Too Yellow	Too Yellow
1200 Hr. Reflectance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	55.7	58.1
Water Immersion	Pass	Darkened	Darkened	Darkened	Pass	Pass	Darkened	Pass	No Test	Darkened
Americal Decal (Lot No. 3)	407A	456D	387E	387B	258D	454D	375C	320E	384I	412J

TABLE 2
SPECIFIC LUMINANCE BEFORE WEATHERING
candlepower/ft candle/sq ft

Sample and Specification Minimum Value	Divergence Angle			
	0.2°		0.5°	
	Entrance Angle		Entrance Angle	
	-4°	30°	-4°	30°
80 RD-39 HA Green	20.6	5.14	11.7	3.6
80 RD-40 PS Green	24.9	6.58	14.2	4.69
Green Spec. Value	9	3.5	4.5	2.2
80 RD-41 HA Orange	44.6	16.6	25.6	11.2
80 RD-42 PS Orange	53.3	28.3	29.9	18.1
Orange Spec. Value	20	7	8	3.5
80 RD-43 HA Red	21.4	6.31	12.4	4.40
80 RD-44 PS Red	19.7	11.3	10.3	7.07
Red Spec. Value	14.5	6	7.5	3
80 RD-45 HA Yellow	75.7	23.4	34.0	14.4
80 RD-46 PS Yellow	71.2	30.0	30.0	17.8
Yellow Spec. Value	50	22	25	13
80 RD-47 HA White	134	43.6	53.6	26.8
80 RD-48 PS White	108	47.3	51.6	29.7
White Spec. Value	90	40	40	20

Specific luminance test showed compliance of all samples.

TABLE 3
SPECIFIC LUMINANCE AFTER WEATHERING
candlepower/ft candle/sq ft

Sample and Specification Minimum Value	Divergence Angle			
	0.2°		0.5°	
	Entrance Angle		Entrance Angle	
	-4°	30°	-4°	30°
80 RD-39 HA Green	10.1	3.2	5.81	2.42
80 RD-40 PS Green	12.8	4.25	6.9	3.15
Green Spec. Value	4.5	1.75	2.25	1.1
80 RD-41 HA Orange	30.8	14.0	15.8	9.08
80 RD-42 PS Orange	29.6	17.0	14.7	10.2
Orange Spec. Value	10	3.5	4	1.75
80 RD-43 HA Red	9.24	3.24	5.34	2.38
80 RD-44 PS Red	7.91	4.96	(3.58)	2.84
Red Spec. Value	7.25	3	3.75	1.5
80 RD-45 HA Yellow	48.3	20.2	21.8	13.1
80 RD-46 PS Yellow	(22.8)	14.0	(10.8)	8.62
Yellow Spec. Value	25	11	12.5	6.5
80 RD-47 HA White	(41.9)	22.9	(17.1)	13.5
80 RD-48 PS White	(44.7)	24.5	(19.8)	14.9
White Spec. Value	45	20	20	10

(00) Does not comply with specification.

TABLE 4
SPECIFIC LUMINANCE AFTER WATER IMMERSION
candlepower/ft candle/sq ft

Sample	Divergence Angle			
	0.2°		0.5°	
	Entrance Angle		Entrance Angle	
	-4°	30°	-4°	30°
80 RD-39 HA Green	17.0	6.05	10.2	4.22
80 RD-40 PS Green	16.0	5.75	9.74	4.03
80 RD-41 HA Orange	23.4	9.20	13.7	6.43
80 RD-42 PS Orange	27.4	13.2	16.0	9.12
80 RD-43 HA Red	16.3	5.50	9.70	4.00
80 RD-44 PS Red	10.5	6.11	5.54	3.84
80 RD-45 HA Yellow	53.8	18.1	25.6	11.8
80 RD-46 PS Yellow	54.6	23.6	24.0	14.6
80 RD-47 HA White	NO SAMPLE			
80 RD-48 PS White	75.5	34.7	39.9	22.3

TABLE 5
BEFORE AND AFTER WATER IMMERSION COLOR DATA

Sample	Before Immersion Chromaticity Coordinate			After Immersion Chromaticity Coordinate		
	x	y	Reflectance	x	y	Reflectance
80 RD-39 HA Green	0.145	0.466	12.1	0.134	0.458	10.5
80 RD-40 PS Green	0.143	0.459	12.2	0.138	0.453	10.6
80 RD-41 HA Orange	0.562	0.392	26.0	0.562	0.396	23.9
80 RD-42 PS Orange	0.558	0.392	24.8	0.563	0.396	22.1
80 RD-43 HA Red	0.644	0.331	10.2	0.638	0.329	9.39
80 RD-44 PS Red	0.642	0.330	9.53	0.641	0.333	9.68
80 RD-45 HA Yellow	0.498	0.474	41.6	0.492	0.479	38.6
80 RD-46 PS Yellow	0.495	0.481	43.1	0.489	0.487	42.9
80 RD-47 HA White	0.306	0.319	58.4	NO SAMPLE		
80 RD-48 PS White	0.310	0.321	53.2	0.310	0.320	50.7