FHWA/NJ-87-001-4706

FIELD EVALUATION OF A FUSION-BONDED WHITE POLYESTER COATED GUIDERAIL

Initial Report

August, 1986

by

Kathleen T. Diringer

Principal Engineer

KTDAN

New Jersey Department of Transportation

Bureau of Transportation Structures Research

NOTICE

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of New Jersey or the Federal Highway Administration.

This report does not constitute a standard, specification, or regulation.

The citation of trade names used here does not constitute an official endorsement or recommendation of the use of any commercial products and is, therefore, provided strictly for informational and not promotional uses.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/NJ-87-001-4706		

4. Title and Subtitle	5. Report Date
Field Evaluation of a Fusion-Bonded White Polyester Coated Guiderail - Initial Report	August, 1986
	6. Performing Organization Code: N.A.
7. Author(s): Kathleen T. Diringer	8. Performing Organization Report No.: FHWA/NJ-87-001-4706
9. Performing Organization Name and Address: New Jersey Department of Transportation, Division of Research and Demonstration, 1035 Parkway Avenue, Trenton, NJ 08625	10. Work Unit No. (TRAIS): N.A.
	11. Contract or Grant No.: FHWA Grant Study 4706
	13. Type of Report and Period Covered: Initial Report
12. Sponsoring Agency Name and Address: New Jersey Department of Transportation, 1035 Parkway Avenue, Trenton, NJ 08625	14. Sponsoring Agency Code

15. Supplementary Notes

This study was conducted in cooperation with the Federal Highway Administration, U.S. Department of Transportation, Washington, D.C. as part of Demonstration Project No. 57, "Powder Coatings for Safety Appurtenances".

16. Abstract

This report documents the installation and performance after nine months of a white polyester coated guiderail in Seaside Heights, New Jersey. Included is information on site location, materials used, handling problems, and a preliminary evaluation of polyester coating relative to galvanized rail. Initial results suggest that due to the high cost, handling problems, and the availability of alternate systems, the use of polyester coated guiderail in New Jersey may not be cost effective. However, the final determination will not be made until the three-year evaluation is completed.

17. Key Words	18. Distribution Statement
Powder coating, guiderail, polyester powder	No restrictions.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

ACKNOWLEDGMENTS

The author would like to express her appreciation to Mr. Bernie Olzanowski and to Mr. Jay Walker of the Bureau of Maintenance for their vigilance, which helped to ensure the quality of the materials under study, promoting a fair evaluation.

TABLE OF CONTENTS

LIST OF FIGURES

1.0 OBJECTIVE

The objective of this study is to evaluate the performance and cost-effectiveness of a white polyester coated guiderail relative to that of galvanized guiderail.

2.0 BACKGROUND AND SCOPE

Galvanized guiderail is used almost exclusively in New Jersey. For the most part, New Jersey is satisfied with the performance of galvanized rail, although in some instances, white or aluminum paint has been applied over old, weathered galvanized rail for aesthetics and additional corrosion protection. An interest was expressed by Department representatives in polyester coated guiderail, due to its purported high corrosion resistance, especially for use in corrosive atmospheres, such as the New Jersey Coastal Region.

The increasing availability of high corrosion-resistant powder coatings, such as polyester, prompted the Federal Highway Administration in 1981 to sponsor Demonstration Project No. 57, "Powder Coatings for Safety Appurtenances". At that time, manufacturers' claims were that powder coatings on guiderails would increase durability, at the same time increasing visibility.[1] The New Jersey Department of Transportation expressed interest in evaluating a highly corrosion-resistant coating for guiderail. Increased visibility was of secondary interest, but since white polyester coating was available, it was selected for its high visibility. Since the cost of polyester coated guiderail was expected to be higher than galvanized, its use was anticipated to be limited to highly corrosive environments and high safety risk areas.

This research project is to serve as a demonstration of this alternative coating system. The original intent of this project was to install a substantial

length (approximately 6000 ft.) of a white polyester coated guiderail, and a substantial length of galvanized rail, to be evaluated over a three-year period. However, due to limitations on the quantity of rail permitted to be installed by New Jersey Maintenance forces, the installation was restricted to approximately 600 ft. of experimental rail.

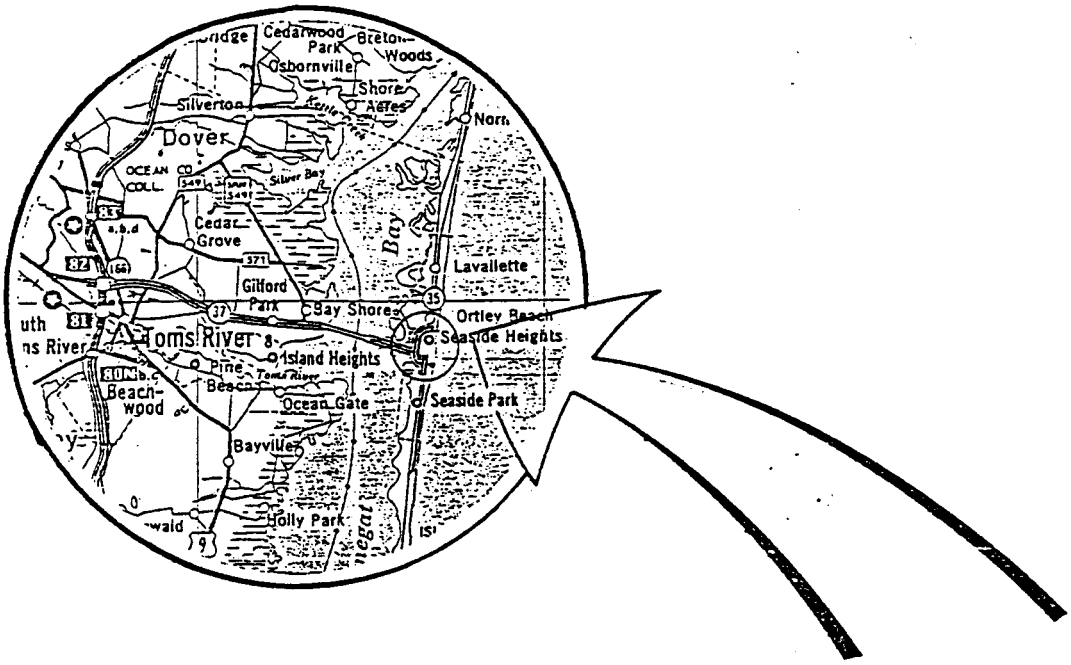
The evaluation of this coating system is primarily subjective. The analysis will consist of a comparison of the following factors for polyester versus galvanized coated guiderail: maintenance costs, aesthetic benefits, accident rate, day and night visibility, durability and cost-effectiveness. As an adjunct to this study, the corrosive properties of the guiderail coatings will be evaluated using the laboratory's salt spray (fog) chamber. This initial report consists of a description of the site location and accident history, material costs, material handling and installation problems, information on the coating, manufacturer and applicator, and briefly presents the results of the evaluations conducted to date.

2.1 Test Location

The test site chosen for this study is the New Jersey Route 37-35 interchange in the shore resort community of Seaside Heights, New Jersey. This interchange is adjacent to Barnegat Bay, east of Pelican Island and is subject to salt spray exposure. The polyester coated guiderail was installed on the Route 37 eastbound overpass; the galvanized guiderail (control) is located on the eastbound ramp to Route 35 southbound. See Figure 1.

The estimated traffic in this area is 28,400 vehicles per day. This location historically has a low accident rate (less than five accidents per million vehicle-miles). Therefore, damage to these guiderail sections was expected to be due more to corrosion than to vehicular impact. In the past, this location has had white painted galvanized guiderail, and as can be seen in Figures 2 and 3, corrosion of the rail is extensive.

FIGURE 1: LOCATION OF TEST SITE



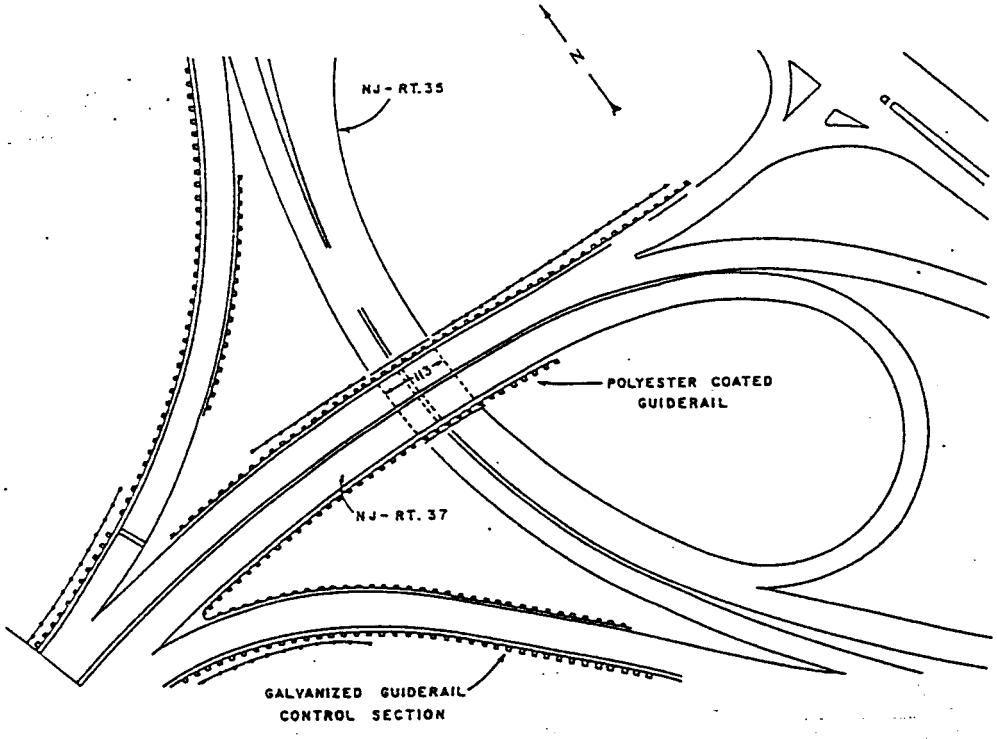


Figure 2: White Painted Guiderail

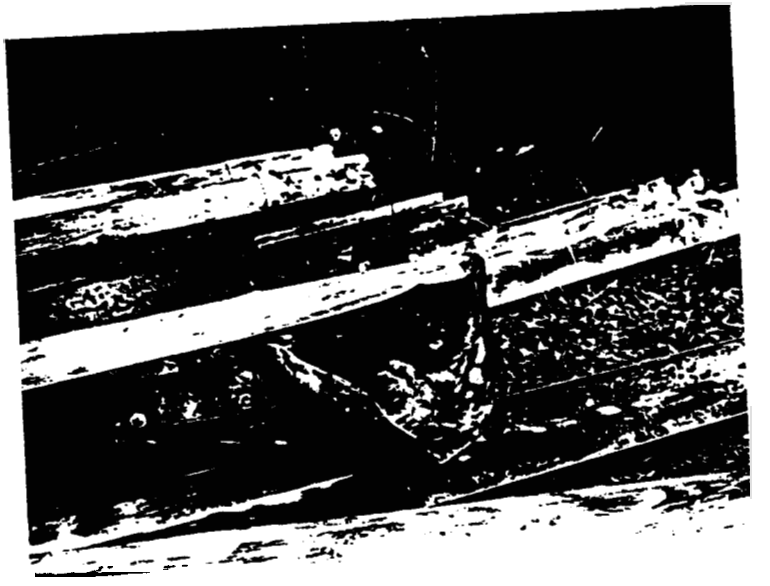


Figure 3: White Painted Guiderail Removed at Site

2.2 Materials in Test

White polyester coated guiderail was obtained by contract through the competitive bidding procedure to meet the specification for Type V fusion bonded powder coated guiderail presented in Appendix A. Galvanized rail from NJDOT stock was available for use as a control.

The contractor who supplied the polyester coated guiderail was Allan E. Brown, Inc. of Exton, Pennsylvania. The coating used was Corflex CF 2201, manufactured by Carboline/Ferro Powder Coating Company. See Appendix B for material data sheet. The powder coating was applied to the steel guiderail by Industrial Coatings Inc. of Baltimore, Maryland.

2.2.1 Powder Coating Process

The powder coating process consists of electrostatic spraying of polyester powder to near-white blasted and primered steel. The powder is pressure-fed through an applicator nozzle, charging the particles and directing the spray to the steel; electrostatically inducing initial adhesion. Final adhesion, called fusion bonding, occurs in an oven, "flowing" the powder into a film of specified thickness (6 +/- 2 mils).

2.2.2 Material Handling

Special material handling requirements were specified for the polyester coated guiderail to prohibit damage to the coating during transport. These requirements are detailed in Appendix A. Also, installation of these sections was required to be accomplished with hand tools; no impact tools were permitted. Neoprene washers were to be placed under the bolt heads to further protect the coating from damage.

2.3 Evaluation Method

Condition survey forms have been prepared to record all guiderail damage, including scratches and rust. In addition, visibility is monitored at regular intervals using a Gardner Colorgard portable reflectometer.[2] Night visibility of the guiderail sections is to be checked and documented with photographs. Also, number of hits sustained by each section and accident rate will be monitored. In addition, the corrosion resistance of the guiderail coatings will be checked in a salt spray (fog) chamber.

3.0 PROBLEMS WITH TRANSPORT OF POLYESTER COATED GUIDERAIL

Although this research project was approved by the Federal Highway Administration in March, 1982, installation of the experimental guiderail sections was delayed until January, 1985 due to material problems. The first shipment was refused delivery at the NJDOT Toms River Maintenance Yard in May, 1983. The guiderail was transported "in a closed type box trailer, the packing had been removed and strewn through the trailer and the materials had been scratched and the powder coating was severely scratched."[3] The second shipment was delivered in April, 1984. The polyester coated guiderail was found to be in satisfactory condition, padded and bound in accordance with the specifications. See Figures 4 and 5.

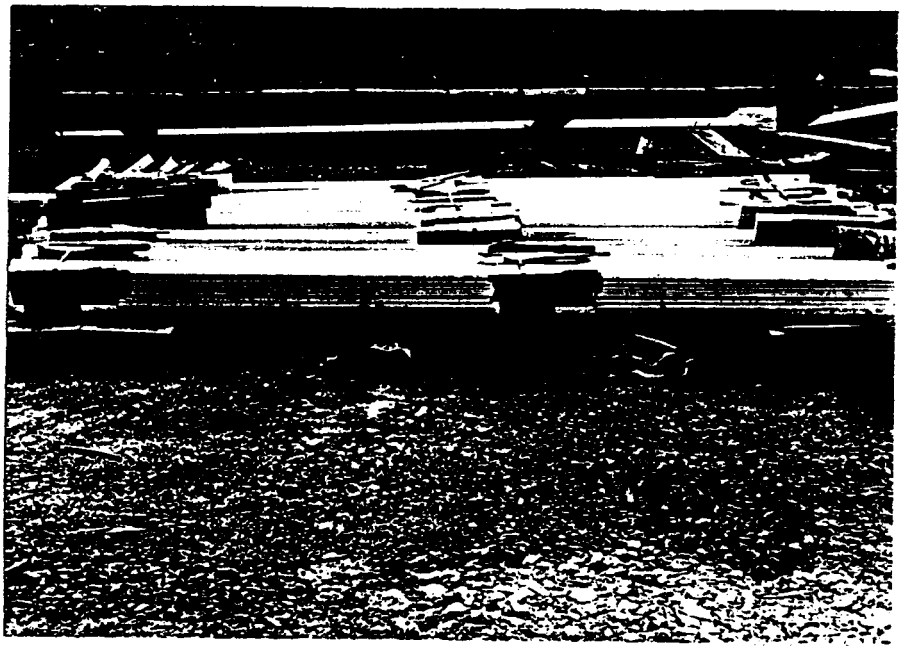


Figure 4: Polyester Coated Guiderail as Delivered

Figure 5: Padding Required for Polyester Coated Guiderail

4.0 INSTALLATION

The polyester coated guiderail was installed in January, 1985. The galvanized guiderail section was existing, installed approximately one year earlier. The experimental sections were off-loaded by hand and bolted together using hand tools. Much care was taken to avoid damaging the polyester coating. Neoprene washers were placed under the galvanized bolt heads. See Figures 6 and 7. Even so, some damage was inflicted, since pry bars were needed to line up the holes in the guiderail elements.

5.0 PRELIMINARY EVALUATION

The evaluation of the polyester coated guiderail is scheduled for three years, through January, 1988. However, some preliminary statements may be made at this time.

5.1 Durability

To date, two condition surveys have been conducted — the first in February, 1985 and the second in July, 1985. Every scratch, nick and rust spot was recorded on survey forms. The general condition of the polyester coated guiderail is good. Most rust spotting is localized around the bolt heads and on the edges where the coating was inadvertently crushed during installation. See Figure 8.

One impact has occurred on the experimental section, inflicting a long, semi-continuous scratch on approximately 20 of the 42 guiderail elements. The accident occurred within days of the installation. The damage was immediately touched-up per manufacturer's instructions. See Figure 9.

The galvanized control section exhibits no damage to date. No impacts have occurred and no rust is evident. See Figure 10.

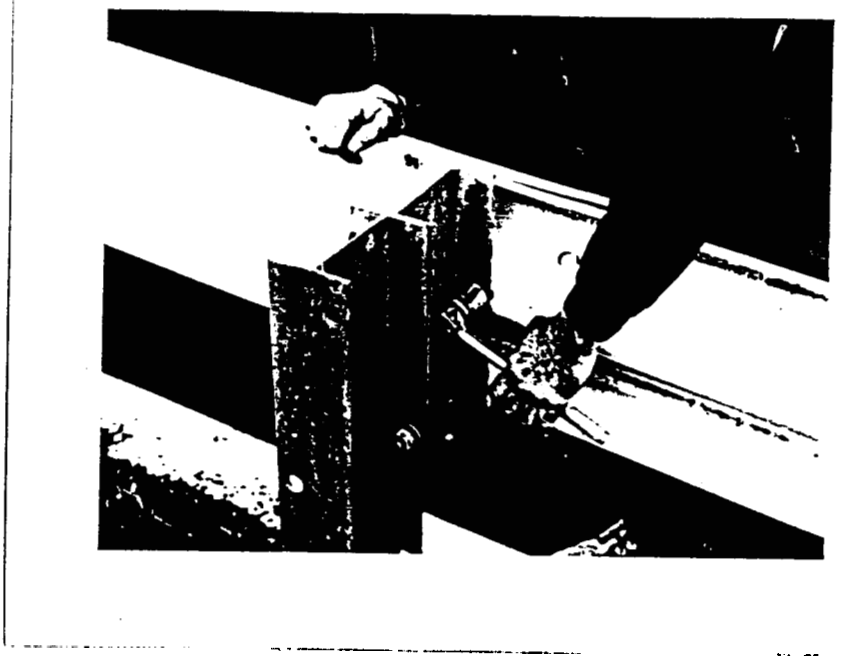


Figure 6. Installation of Polyester Coated Guiderail

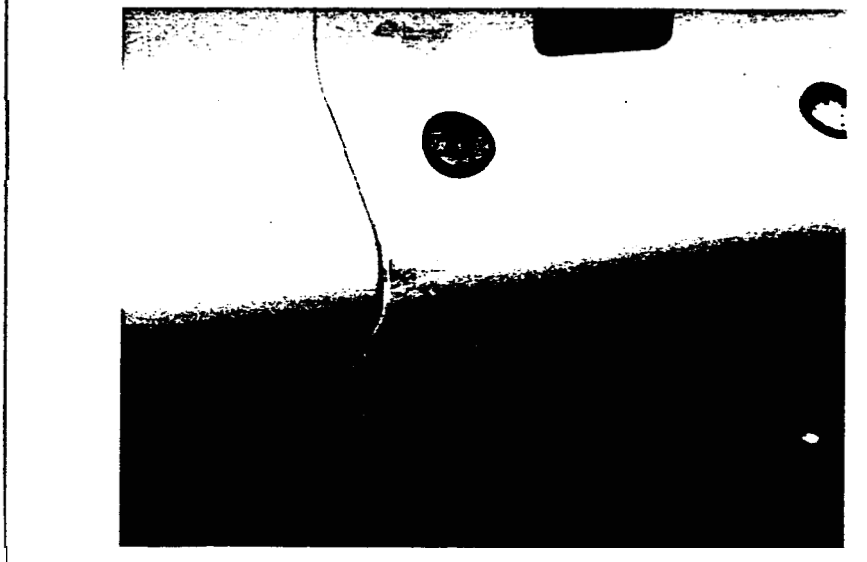


Figure 7: Neoprene Washers Used Under Bolt Heads

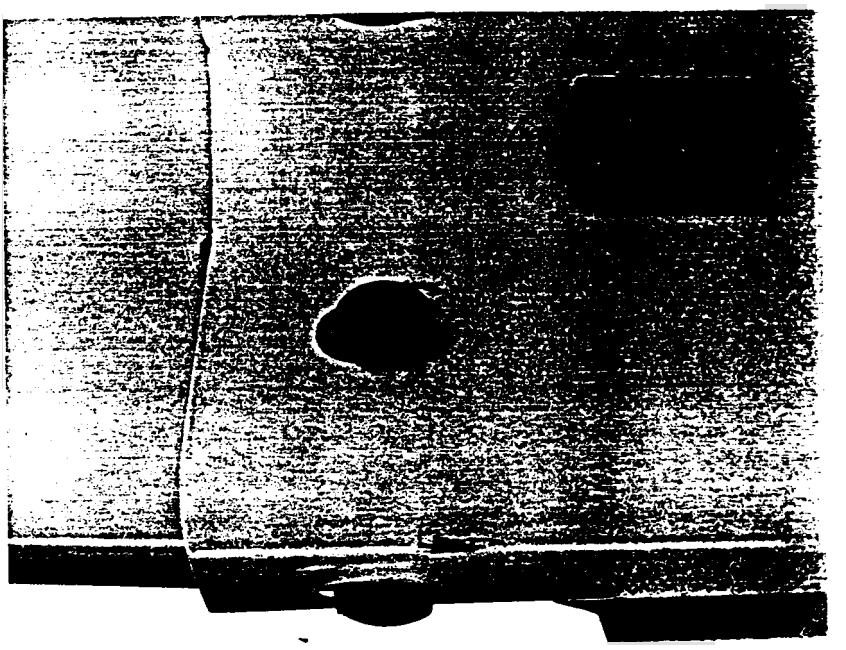


Figure 8: Rusting Around Bolt Heads

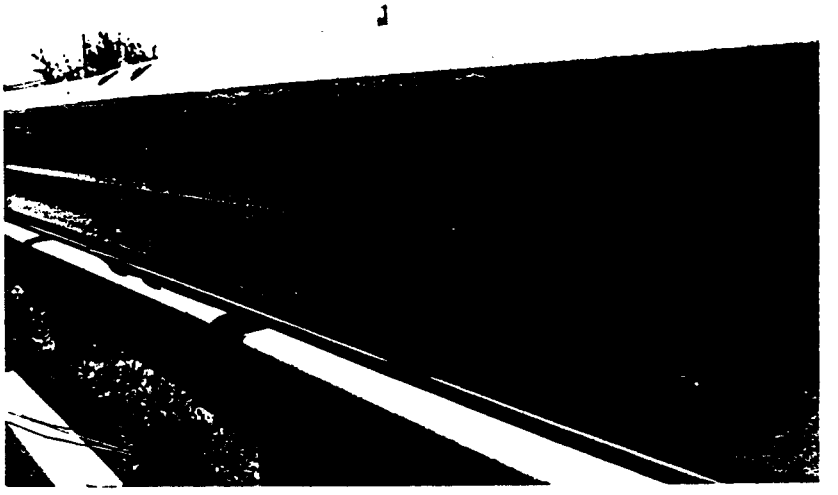


Figure 9: Touched-up Scratch on Polyester Coated Guiderail

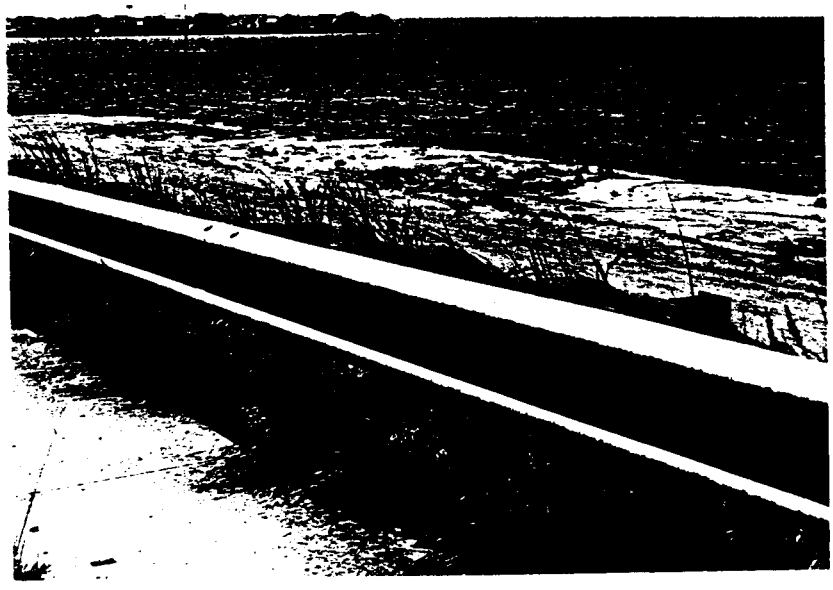


Figure 10: Daytime Appearance of Galvanized Guiderail

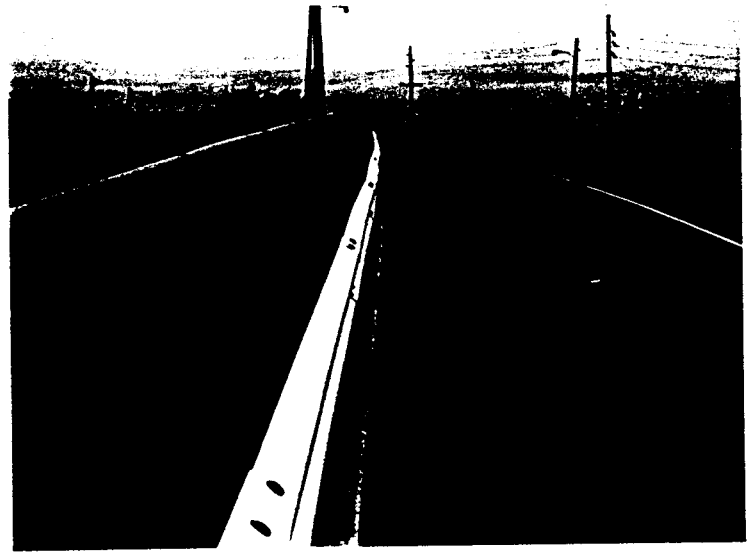


Figure 11: Daytime Appearance of Polyester Coated Guiderail

5.2 Visibility

The white polyester coated guiderail is significantly more visible and clearly delineates the roadside edge better than the galvanized rail. This is apparent in daylight hours (see Figure 11), and it is expected to be even more vivid at night. Night visibility will be checked later in the course of this study. Reflectometer results tabulated below confirm this opinion. These results show that the average reflectance of the galvanized rail is 26.6, while that of the polyester coated rail is 76.2, almost three times brighter.

Rail No.	Galvanized Rail Avg. Reflectance	Polyester Coated Avg. Reflectance
1	28	76
3	27	77
6	25	76
9	24	77
11	27	—
12	30	81
15	28	77
18	26	77
21	27	76
24	27	78
27	26	—
28	—	75
32	—	73
35	—	75
40	—	72

5.3 Cost

For this demonstration project, the cost of the polyester coated guiderail elements was approximately threee times higher than similar galvanized guiderail elements, $7769 versus $2628. It was anticipated that a higher than normal cost would be incurred, due to the experimental nature of this project and the small quantities involved. The literature suggests that in large scale installations, the cost of polyester guiderail would be twice as high as that of galvanized. Since New Jersey is fairly well satisfied with the performance of galvanized rail, it was expected that this expensive item would be considered only as an exception, in highly corrosive environments and high safety risk areas.

In order for this coating to be considered cost-effective, significant improvements in performance, especially in corrosion resistance, will need to be realized in the course of this study.

Since the beginning of this demonstration project in 1981, other coating and guiderail delineation systems have become available which should be considered in a cost-benefit analysis. For example, a product offered by Duncan Galvanizing called Colorgalv(R) is reported to offer the same visibility as the polyester (white) coating and more durability than galvanized at a cost of only 1.5 times that of galvanized.[4] Reflectors mounted on galvanized rail have been shown to increase visibility for high safety risk areas without sacrificing durability. The final report for this study will include a thorough cost-benefit analysis of the available coating and reflectorized systems.

6.0 PRELIMINARY CONCLUSIONS

Since it is still early in this study, few definitive conclusions can be reached, but a number of preliminary observations can be made.

1. The cost of white polyester powder coated guiderail is very high.
2. Reflectance (visibility) of white polyester powder coated guiderail is very high.
3. Handling of polyester powder coated guiderail is difficult, labor intensive, and prone to inflict coating damage.
4. Other coatings and reflectorized systems may increase visibility and corrosion-resistance more effectively.

Therefore, the cost-effectiveness of this specific guiderail coating system is questionable at this time. Significant improvements in durability/visibility will be necessary in order to offset the high initial cost.

REFERENCES

1. "Powder Coatings for Safety Appurtenances", Demonstration Projects Program Technology Transfer, U.S.D.O.T. Federal Highway Administration flyer, 1981.

2. "Operation and Maintenance Manual Gardner Colorgard Series of Portable Reflectometers", Gardner Laboratory, Inc., 1976.

3. Letter from Bernie Olzanowski, New Jersey Department of Transportation, Bureau of Maintenance to William Husselbaugh, Industrial Coatings, Inc., May 24, 1983.

4. "A Simplified Method for Calculating Cost of Applied Coating Systems", Duncan Galvanizing, 69 Norman Street, Everett, MA, 02149.

TYPE V

FUSION BONDED POWDER COATED GUIDERAIL

I. DESCRIPTION:

This specification includes qualifications and application requirements for fusion bonded powder coated guiderails, in order to provide additional corrosion protection, and where needed, increased guiderail visibility.

II. MATERIALS:

A. Steel rail element for beam guiderail shall comply with Article 8.4.17 of the 1961 New Jersey Standard Specifications for Road and Bridge Construction, except that galvanized coating shall not be applied.

B. The coating material shall be powdered polyester resin of organic composition except that, if a pigment is used, the pigment may be inorganic.

C. A corrosion inhibitive primer, compatible with the coating material, shall be applied and cured per manufacturer's specifications, prior to the powder coating.

D. Patching material compatible with the powder coating shall be applied per manufacturer's specifications. The patching material may be a liquid which hardens to a solid on curing.

E. Except where otherwise specified, all guiderail components shall conform to the requirements of Article 8.4.16 of the 1961 New Jersey Standard Specifications for Road and Bridge Construction and AASHTO Designation M180-78.

III. MATERIALS INFORMATION AND TEST SPECIMENS:

A. The following materials information shall be submitted to the Bureau of Quality Control:

1. The manufacturer shall include the specified actual preparation, coating procedures, and the cure of the coating. The data provided to measure coating quality must be compatible with the actual production tolerances for coatings. Proposed procedures and controls must also be compatible with those described herein.

2. The manufacturer shall specify the material and procedures for maintenance repair and touch up repair due to handling and installation.

B. The following specimens shall be submitted to the Bureau of Quality Control for testing:

1. A one-pound sample of the coating material with its generic description (including percentages of pigments, diluents, fillers, flexibilizers and all other additives) and its infrared fingerprint.

2. One quart of patching material, which shall be compatible with the coating material. The patching material shall be a type suitable for repairing areas of the coated guiderail which were damaged during fabrication or handling.

3. Six steel plates 4" x 4" x 24 gage and 15 flat coupons cut 3" x 6" from approved guiderail stock shall be submitted with the coating to be tested on one side. Both sides and all edges may be coated, but then all surfaces must be to the intended specifications.

The coating must be representative of expected quality of coatings from a production line and must be from an active applicator's production.

4. When requested, the Contractor shall furnish the Bureau of Quality Control with an 8-ounce sample from each batch or lot of the powder coating used in coating the guiderail. The samples shall be packaged in airtight containers and identified by product name and by batch or lot number.

IV. MATERIALS CERTIFICATIONS:

A. The powder coating selected by the Contractor and furnished by the manufacturer shall be of the same material and quality as the coating which has been previously submitted by the manufacturer to the Bureau of Quality Control for testing and evaluation.

B. A written certification from the manufacturer of the powder coating attesting to the sameness of the powder coating shall be furnished with each lot to the Engineer by the Contractor.

V. REQUIREMENTS OF COATINGS:

A. Resistance to Salt Spray ASTM B117: Using six coupons, follow ASTM B-117. Scribe three of the coupons per ASTM D-1654. The scribed coupons should be tested for 400 hours; the unscribed, for 1000 hours. Scribed coupons should be rated per Table 7, unscribed coupons should be rated per Table 2 of ASTM D-1654. The average rating of the three unscribed coupons shall be a minimum of 9, while the average rating of the three scribed coupons shall be a minimum of 6.

B. Weather Resistance: Using six coupons, follow ASTM G-53. The cycles shall be 8 hours consisting of 4 hours condensation and 4 hours light and shall run for 1000 hours. There shall be no film failures including blisters, delamination, cracking, or softening. Also, a minimum of 85% of the initial gloss shall be retained per ASTM D-523 and adhesion shall be rated a minimum of 5A or 5B per ASTM D-3359.

C. Abrasion Resistance: Test the resistance to abrasion of coatings on each of the steel plates by a taber abraser or its equivalent. Using CS-10 wheels and a 1000 gram load, the average weight loss shall not exceed 80 mg. per 1000 cycles.

D. Film Hardness: Using ASTM D-3363 and three coupons, determine pencil hardness of coatings. Coatings must withstand 2H pencil without cutting into or gouging the film.

E. Adhesion: Using coupons used in D, follow ASTM D-3359 Method B for 1000 hours. Coatings must meet the requirements of 5B.

F. Edge Coverage: Per ASTM D-2967, edge coverage must be at least 2 mil depth.

G. Film Thickness: The thickness of the coating on guiderail shall be determined following ASTM G-12. All coupons must meet the requirements of 6 mils ± 2 mils.

H. Coating Quality: Use three coupons. The coupons shall be bent 180 degrees around a ½-inch diameter mandrel. They shall be at 24°C ± 2°C and bent into a uniform radius at a uniform rate within 10 seconds. It is to be bent parallel to its longitudinal axis with

the coating to be tested on the convex side of the bend. There shall be no breaks, flaking, or cracks in the coating visible to normal, corrected vision.

I. Identity: Infrared fingerprint of powder coating used in production must match that supplied originally.

J. Color: Color must meet standard specifications for NJDOT Type IV white paint.

K. Color Change: After 500 hours in the weatherometer, measure color change of the six coupons using Gardner colorimeter. Per ASTM D-2244, color change must be limited to ΔE of 2.5 maximum.

VI. APPLICATION PROCEDURES:

A. All rail shall be free of any oil or grease. All rail edges shall be radiused. Rail shall be blast-cleaned to near white per SSPC-SP-10. The guiderail shall not be allowed to flash rust before priming. The blast profile shall be 1 to 1.5 mils, as specified by the powder manufacturer. Allowances shall be made for retaining an adequate anchor pattern after priming.

B. The rail shall be heated, after priming, prior to coating, per manufacturer specifications. The coating shall be applied as an electrostatically charged dry powder sprayed onto a grounded rail using an electrostatic spray system. The coated rail must be subjected to a time-temperature cure, in accordance with manufacturer specifications.

(2) The Contractor shall furnish a Certificate of Compliance from the coating applicator with each shipment of coated guiderail. The Certificate of Compliance shall (a) verify that the coated guiderail and coating material have been tested in accordance with the requirements of this specification; (b) state the actual test results for each requirement; and (c) state that the test results comply with the requirements.

(3) The Department inspector shall have free access to the plant of the coating applicator and shall be permitted, at his option, to have any or all of the work specified above performed in his presence. The inspector shall be furnished with check samples of the coated guiderail on a random basis as he deems necessary for testing by the Bureau of Quality Control.

IX. ACCESSORIES:

All guiderail end sections, bolts and washers, when specified to be coated, shall be coated using the same procedure as for guiderail beams.

X. HANDLING OF COATED GUIDERAIL AND CONSTRUCTION METHODS:

All systems for handling coated guiderail shall have padded contact areas wherever possible. All bundling bands shall be padded and all bundles shall be lifted and lowered so as to prevent abrasion between adjacent guiderails. Individual panels shall be removed from the bundles and placed on the ground by hand and shall be stacked to prevent coating

damage using padding if necessary. The coated guiderail shall not be dropped or dragged. Any coated hardware shall be handled to prevent marring. Hardware which is damaged so as to prevent its intended function shall not be used. Extra handling precautions are expected to limit any major touch-up by the coater, contractor, or shipper.

XI. MEASUREMENT:

The accepted coated guiderail will be measured in linear feet and will include terminal sections, when installed. Measurements, however, will not include guiderail anchorage assembly.

XII. PAYMENT:

Powder coated guiderail, complete in place, including posts, will be paid for at the contract price per linear foot.

carboline/FERRO
POWDER COATINGS COMPANY

CORFLEX CF 2201
Federal Highway White

350 HANLEY INDUSTRIAL CT., ST. LOUIS, MO 63144

FUSION BONDED COATINGS

GENERIC TYPE: Thermosetting, Polyester Powder Coating.

RECOMMENDED USES: Corflex CF 2201 is well suited for architectural and transportation related applications. Corflex CF 2201 has been applied successfully to highway guardrails, sign and fence posts, mile markers, aluminum lighting poles, and architectural fascia.

NOT RECOMMENDED FOR: Application directly over galvanized steel or unprepared metal surfaces.

TYPICAL POWDER PROPERTIES:

Specific Gravity	1.60 ± .05
Melting Point	180°F (82°C)
Volatiles (at full bake)	1-2%
Coverage	121 mil sq. ft./lb.
	24 sq. ft./lb. @ 5 mils
Particle Size	48-52% through 425 mesh

COLORS AVAILABLE: CF 2201 Federal Highway White.

RECOMMENDED FILM THICKNESS: 4-6 mils.

SUBSTRATES: Cold or hot rolled steel, aluminum.

SURFACE PREPARATION: Grit blast to a Near White Metal finish in accordance with SSPC-SP 10-63. On surfaces with minimal, tight, or no mill scale (e.g. cold rolled steel) a three or five stage iron phosphate conversion coating may be used. For application to aluminum substrates, consult Carboline/FERRO Technical Service for specific recommendations. Properly treated non-passivated galvanized substrates may be coated with Corflex powder coatings. Carboline/FERRO Technical Service should be consulted for recommendations.

COMPATIBILITY WITH OTHER COATINGS: Repair and touch-up coating is available from Carboline/FERRO. Use medium grit sandpaper to roughen the existing coating, and remove any dust from surface. Apply Carboline 134 Aliphatic Polyurethane by spray or brush.

CURE CONDITIONS:
20-25 minutes @ 350°F (177°C)
15 minutes @ 400°F (204°C)

Do not apply when the surface temperature is less than 5°F (2°C) above the dew point.

APPROXIMATE SHIPPING WEIGHT: 45 lbs. box.

STORAGE CONDITIONS: Store at temperatures below 80°F (27°C) and at 0-90% relative humidity. Avoid moisture contamination.

SHELF LIFE: 12 months minimum when recommended storage conditions are observed.

ORDERING INFORMATION

Consult your local Carboline/FERRO Sales Representative for pricing information.

TYPICAL CURED FILM CHARACTERISTICS

(at recommended film thickness)

PHYSICAL PROPERTIES:

Test	Method	Result
Pencil Hardness	Eagle Pencil	2-3H
Abrasion Resistance	Taber CS-10 Wheel, 1000 cycles @ 1000 gram load	65 mg weight loss
Impact Resistance	Gardner ASTM D-2794	
	Direct	>80 inch lbs.
	Reverse	>80 inch lbs.
Wedge Bend (Conical Mandrel)	ASTM D-522-68	Pass 1/8 inch flex, no cracking
Adhesion	ASTM D-3359	5B
	ASTM 8449 (cross hatch)	100% pass
Gloss	ASTM D-523 60°	
	Initial	75 minimum
	1000 hours	55 minimum
Operating Temperatures		
Maximum		300°F (149°C)
Minimum		−40°F (−40°C)

ENVIRONMENTAL RESISTANCE:

Test	Method	Result
Stain Resistance	ASTM D-1308 (72 hours)	
Clorox Water 1:1		Slight stain
Pine Oil Water 1:1		No effect
Aging	7 days @ 150°F (66°C)	
Color (visual change)		No change
Flexibility (film removal)		No effect
Adhesion Loss		No loss
Humidity		
100°F (38°C) @ 100% R.H. for 720 hours (Cleveland Condensing)		No film failure
100°F (38°C) @ 100% R.H. for 1000 hours		
Blister		None
Gloss Change		None
Salt Spray Resistance	ASTM B-117	
1000 hours, unscribed		Less than 1/8 inch creepage
500 hours, scribed		Less than 1/16 inch creepage
	ASTM D-1654	
1000 hours, unscribed, Table 2		Minimum 9
400 hours, scribed, Table 2		Minimum 6
Weather Resistance	ASTM G-23	
1000 hours (18 minutes water spray, 102 minutes light)		No failures
Color Change	ASTM D-2244	
500 hours		ΔE Less than 2.0
Edge Coverage	ASTM 2907	15% minimum

CHEMICAL RESISTANCE: 72 hours covered at 80°F (27°C)

Isopropyl Alcohol	No effect
Acetic Acid (5%)	No effect
Ammonium Hydroxide (5%)	No effect
Sodium Hydroxide (2%)	No effect

CAUTION: SPECIAL SAFETY PRACTICES SHOULD BE FOLLOWED WHEN USING ANY POWDER COATING. WORKERS SHOULD USE AN OSHA APPROVED DUST MASK WHEN APPLYING OR LOADING POWDER MATERIALS. POWDER, LIKE ANY NUISANCE DUST, CAN BE IRRITATING TO LUNGS AND MUCOUS MEMBRANES IN NOSE AND WINDPIPE. ORGANIC POWDERS ARE HYGROSCOPIC IN NATURE, AND CAN CAUSE CONTACT DERMATITIS ON HANDS AND ARMS. WORKERS SHOULD WEAR GLOVES AND PROTECTIVE CLOTHING WHEN HANDLING DRY POWDER. CLEAN-UP IS EASILY ACCOMPLISHED WITH SOAP AND WATER. WORKERS SHOULD AVOID BLOWING POWDER OFF SKIN WITH AN AIR HOSE, AS THIS PRACTICE MAY DRIVE POWDER PARTICLES DEEPLY INTO PORES, CAUSING SKIN IRRITATION.

Carboline FERRO powder coatings are free of lead, chrome or other heavy metal pigments, and do not contain TMA or MDA curing agents.