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The Division of Highways of the State of California investigated a wide spectrum of coatings for the protection of steel from corrosion in an aggressive marine environment for 16 years in the period 1952-1968. Evaluation of test sections of two bridges on the coast to which the coatings were applied showed the best system after a 10-year exposure was an inorganic post cure zinc pigmented sodium silicate primer having a vinyl finish coat. This system was rated 9+, 10 being perfect. Evaluation of inorganic self cure zinc pigmented silicate primers will not be available for another 6-10 years. All other systems provided definitely inferior protection, the next best being an all vinyl type.

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HIGHWAY RESEARCH REPORT

EVALUATION OF COATINGS ON COASTAL STEEL BRIDGES 16 Year Period

INTERIM REPORT 70-17

January 1969

STATE OF CALIFORNIA

BUSINESS & TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

NO. M & R 645135

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STATE OF CALIFORNIA—TRANSPORTATION AGENCY

RONALD REAGAN, Governor

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT
5900 FOLSOM BLVD., SACRAMENTO 95819

January, 1969

Research Project No. 645135
Interim Report

Mr. J. A. Legarra
State Highway Engineer

Dear Sir:

Submitted herewith is a research report titled:

Evaluation of Coatings on

Coastal Steel Bridges

16 Year Period

Herbert A. Rooney and Albert L. Woods
Principal Investigators

Thomas L. Shelly
Co-Investigator

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

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ABSTRACT : The Division of Highways of the State of California investigated a wide spectrum of coatings for the protection of steel from corrosion in an aggressive marine environment for 16 years in the period 1952-1968. Evaluation of test sections of two bridges on the coast to which the coatings were applied showed the best system after a 10 year exposure was an inorganic post cure zinc pigmented sodium silicate primer having a vinyl finish coat. This system was rated 9+, 10 being perfect. Evaluation of the inorganic self cure zinc pigmented silicate primers will not be available for another 6-10 years. All other systems provided definitely inferior protection, the next best being an all vinyl type.

KEY WORDS: Protective coatings, marine atmospheres, corrosive environments, corrosion, steels, paints, zinc, primers, vinyl plastics.

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ACKNOWLEDGMENT

The research project described in this report was initiated in 1952 by the late E. D. Botts, Ph.D., formerly Senior Chemical Testing Engineer for the Materials and Research Department of the California Division of Highways and Dale F. Downing[1] and I. O. Jahlstrom,[2] both former engineers for the Bridge Department of the Division of Highways.

The authors who worked on the project with the above individuals and shared responsibility for its direction before and subsequent to the retirement of Dr. Botts and Mr. Jahlstrom, are indebted to Paul Jurach, B. F. Deason and L. R. Brush, Resident Engineers for much of the work done on the bridges described in this report, for their dedicated service.

[1]Presently Maintenance Engineer - Division of Highways.

[2]Retired.

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INTRODUCTION

The search for a satisfactory paint system for the protection of exposed structural steel members of State bridges in a corrosive marine environment has been conducted intensively by the Bridge Department and the Materials and Research Department of the California Division of Highways in the 16 year interval since 1952.

Properly formulated and applied conventional state and federal specification primers and proprietary primers containing various drying oils, alkyd resins and phenolic resins in the non volatile vehicle and the well known red lead, basic lead silicochromate and zinc chromate rust inhibitive pigments will normally protect steel from corrosion in inland areas (non-marine) for 25-30 years if used in conjunction with suitable finish coats.

The above coating systems have been found to have a maximum life of 4-6 years when used on the bridges located in a severely corrosive marine environment as described in this report.

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CONCLUSIONS

A 10 year study of coatings applied in 1958 shows that a post cure inorganic zinc silicate primer with vinyl finish coats has provided almost perfect corrosion protection and that no organic vehicle system tested with or without rust inhibitive pigments, will provide equal protection. Studies are continuing in the evaluation of the self-cure inorganic zinc silicate primers, results of which will not be available for 6 - 10 years.

The formulation data for the coating systems described in this report, where such are available, together with pictures of the coatings at the completion of their respective test periods, are shown in the Appendix. In some cases the photographs do not indicate the severity of the corrosion reported in the text of this report, especially where the corrosion was pronounced on the bottoms of the lower flanges and on the braces which are not shown in all of the pictures.

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DISCUSSION

Although a few other bridges were involved, this report is confined to coatings applied to the bridges spanning the Leffingwell and San Simeon Creeks on a section of State Sign Route 1 in the vicinity of the town of San Simeon. Both bridges are close to the shoreline of the ocean, presenting an ideal location where protective coatings could be applied and tested in a very corrosive salt air environment.

These steel bridges were constructed in 1932 when the Coast State Sign Route 1 was first opened to traffic. The paint systems applied prior to the start of this research project in 1952 had an average life of 3 to 4 years on these bridges whereas the same paint systems applied on inland structures removed from salt air corrosion had a life of 25 - 30 years.

The following table shows the year each of these bridges was repainted subsequent to 1932. The year shown does not necessarily mean that repainting should not have been done earlier.

San Simeon Creek: 1932, 1936, 1938, 1943, 1946, 1949 1953, 1959 and 1964.

Leffingwell Creek: 1932, 1936, 1938, 1943, 1946, 1949 1952 and 1958.

Prior to 1953, contracts for repainting specified the number of coats of primer and finish coat, but no thickness of coatings. At the commencement of the paint research project in 1952, State forces from the Division of Bay Toll Crossings did the painting of Leffingwell Bridge. Although no advance requirement for film thickness was required, each coat of paint was heavily applied to the degree of no sag, and subsequent dry film thickness readings were taken by the Resident Engineer of the Bridge Department. Beginning in 1953 all State highway painting contracts specified the mil thickness of primers and finish coats.

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LEFFINGWELL CREEK BRIDGE, 1952 REPAINTING

This was the first bridge in the coastal area near San Simeon of the two bridges previously described which was repainted under the research project of the Materials and Research Department and the Bridge Department. Prior to 1952 it had been painted 6 times since 1932. It is a low level structure containing eight steel stringer spans with a concrete deck supported on concrete piers and abutments. The 24-foot wide concrete deck of this bridge as well as that on San Simeon Creek shields the steel girders to a limited extend from rain thereby allowing salt to accumulate in heavier deposits than would occur if the steel were more exposed as in a superstructure.

Prior to painting, the steel on both bridges was sandblasted to the appearance of cast aluminum which is essentially equal to a Steel Structures Painting Council "White Metal Blast".

In the 1952 repainting research project, the stringers of the Leffingwell Bridge were divided into 48 strips, each of which was used as a separate test panel for the application of the experimental coatings. The length of the panels varied between 4 and 7 feet and the area varied between 150 and 240 square feet.

Seven different primer paints and two different finish coats were used. The primers used were as follows:

System 1 A Semi-Quick Drying Red Lead Primer. The non volatile vehicle was approximately 1:1 by weight of raw linseed oil and alkyd solids conforming to Federal Specification TT-R-266, Type III.

System 2 A Zinc Chromate Primer. The non volatile vehicle was an alkyd similar to the present specification 681-80-430.

System 3 Red Lead and Oil. The non volatile vehicle was raw linseed oil. This paint was used as a primer on State bridges prior to 1953.

System 4 A Red Lead - Phenolic Varnish Primer.

System 5 A Red Lead - Linseed Oil - Phenolic Varnish based on the San Francisco - Oakland Bay Bridge Formula X-6.

System 6 Red Lead - Vinyl Resin Vehicle Primer.

System 7 Red Lead - Epoxy Ester - Vinyl Resin Vehicle Primer.

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The finish coats on the 1952 painting of Leffingwell Creek Bridge were as follows:

a. Vinyl Aluminum. A vinyl resin vehicle.

b. No. 5, Aluminum Finish Coat from the 1949 Standard Specifications. The vehicle for this finish coat was a phenolic - china wood oil varnish.

The vinyl aluminum was applied over the vinyl red lead and vinyl-epoxy-red lead primers. The No. 5 Aluminum Finish Coat was applied over all other paint systems. Selected test panels were first coated with Vinyl Wash Primer, Federal Specification MIL-P-15328 and compared with other panels of the same paint system without the Vinyl Wash Primer.

Critical examination of this bridge in 1958 prior to repainting shows that certain of the above paint systems were better than others, but as the pictures in the appendix show, corrosion was severe enough after 6 years in all systems to require repainting.

The formulas for some of the paint systems used in the 1952 repainting, as given in the Appendix, are considered as equal to the best of the well known primers and finish coats and will give 25-30 years service in an inland location.

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SAN SIMEON CREEK BRIDGE, 1953 REPAINTING

The San Simeon Creek Bridge was painted in 1953 for the seventh time in 21 years for an average paint coat life of 3½ years and a maximum time between painting of 5 years. Its record is one of rapid and consistent failure of all varieties of paints used. Rusting and consequent paint failures have generally occured at the same locations after every painting as was the case of Leffingwell Creek Bridge. At the time of repainting of San Simeon Creek Bridge in 1953, the previous asphaltic mastic coating was a complete failure. In the corrosion process, up to 1/8" deep pits were formed on the bottom flange.

In the 1953 repainting, the surface was sandblasted to the appearance of cast aluminum as described in the Standard Specifications. All sandblasted surfaces, except those specifically omitted, received a first coat of Vinyl Wash Primer, Federal Specification MIL-P-15328. The paint systems were as follows on the test sections:

System 8 About 4 mils of a highly recommended brand name alkyd red lead primer applied. No vinyl wash primer applied at the request of the commercial supplier of the coating system. About 2 mils of an aluminum finish coat supplied by the manufacturer was applied over the prime coat.

System 9 The "so-called" Harvey System, whereby a barrier coat is applied over a first coat to prevent subsequent paint coats lifting the first coat. Sections of the bridge were coated with two distinct "Harvey Systems", each containing a different inhibitive primer. Total dry coating thickness was approximately 4½ mils in each system.

"Harvey System" I

a. One coat of an alkyd-linseed oil-red lead primer, State Specification 52-G-53. No vinyl wash primer used.

b. A barrier coating of white traffic line paint State Division of Highways Type IV containing a china wood oil oleoresinous varnish vehicle and chlorinated rubber and a highly aromatic solvent.

c. Vinyl aluminum finish coat, State Specification T53-G-49.

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"Harvey System" II

Same as Harvey System I except the primer was a zinc chromate type, State Specification 52-G-51.

System 10 Metalizing system. No Vinyl Wash Primer on sandblasted steel. Aluminum and zinc metal coating sprayed in molten state onto sandblasted steel. Application was approximately 5 mils. Half of each of the aluminum and zinc coated test panels were coated with 3 mils of a vinyl aluminum coating applied over a vinyl wash primer.

System 11 Linseed Oil-Alkyd-Red Lead Primer, State Specification 52-G-53. One section was coated with 3 mils of the primer and 2 mils of No. 5 aluminum finish coat containing a china wood oil-phenolic varnish. Another section had 4.5 mils of the primer and 3.5 mils of the finish coat.

System 12 A two component epoxy-red lead primer applied 4 mils thick followed by 2 mils of aluminum vinyl finish coat.

System 13 An all vinyl paint system, with one section 5 mils and the other section 8 mils in thickness. The vinyl primers were State Specifications T53-G-40 and T53-G-41 applied in alternating coats. The T53-G-49 vinyl aluminum finish was applied in one coat.

Inspection of the San Simeon Creek Bridge in 1959 prior to repainting showed varying degrees of breakdown of the experimental coatings applied in 1953 with resultant corrosion of the steel. The all vinyl system (No. 13) appeared to give the best protection, although not as good as the post cure inorganic zinc silicate and vinyl finish coat system applied to the Leffingwell Creek Bridge in 1958 which will be discussed in the 1968 evaluation of the Leffingwell Bridge.

The aluminum and zinc metallizing coatings system (No. 10) were very porous and there was much underfilm corrosion. However, where vinyl finish coats were applied to the metallizing, results were very satisfactory. Better protection of steel and easier application can be achieved by the inorganic zinc silicate coatings with vinyl finish coats.

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LEFFINGWELL CREEK BRIDGE, 1958 REPAINTING

The following coatings were applied to this bridge in the 1958 repainting. Vinyl wash primer was applied to the sandblasted steel unless otherwise noted:

System 14 No vinyl wash primer on sandblasted steel. 3 mils of inorganic zinc pigmented sodium silicate primer applied and subsequently cured with a spray application of a phosphoric acid solution curing agent. The reaction products of the curing agent and zinc-silicate primer were scrubbed off the coated steel with water and stiff brushes. Vinyl wash primer, Federal Specification MIL-P-15328A applied followed by 2 mils of Vinyls, State Specification T58-G-40 and T58-G-41 in alternating coats and a final coat of 1 mil of State Specification T58-G-49, Vinyl paint, Aluminum Finish Coat. Total film thickness, 6 mils.

System 15 3 Mils of Semi-Quick Drying Red Lead Primer, State Specification 58-G-53; 2 mils of White Traffic Paint, State Specification 55-G-95; 2 mils of Vinyl Paints, State Specification T58-G-40 and T58-G-41 in alternating coats; 1 mil of State Specification T58-G-49, Vinyl Paint, Aluminum Finish Coat. Total film thickness, 8 mils.

System 16 Epoxy Paint, 100 percent solids, made with an epoxy resin of viscosity 40-100 poise at 25°C and an epoxide equivalent of 180-195, 20 percent TiO_2 and 5 percent Cr_2O_3 cured with an epoxy amine adduct Shell Epon Curing Agent U, and applied by hot spray 15-20 mils thick.

System 17 4 mils of Vinyl Paints, State Specifications T58-G-40 and T58-G-41 in alternating coats; 2 mils of Vinyl Paint, Aluminum Finish Coat, State Specification T58-G-49. Total film thickness, 6 mils.

System 18 4 mils of Semi-Quick Drying Red Lead Primer, State Specification 58-G-53; 2 mils of Phenolic Iridescent Green, State Specification 58-G-79. Total film thickness, 6 mils.

System No. 16, the 100% solids epoxy coating on Span 3 was replaced by a Laboratory Formulated zinc silicate paint and vinyl green finish coat, State Specification 61-G-75 in June, 1964. The original epoxy system deteriorated so rapidly that severe corrosion was noted within one year of its application.

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Photographs of the above test sections taken in March, 1968 after 10 years exposure are shown in the appendix.

The following visual ratings of these test sections were made on October 24, 1968 on a scale of 0 to 10, 10 being perfect condition:

System 14 The post cure inorganic zinc silicate-vinyl finish coat type. Average rating of all test sections about 9+. Of all systems tried since 1932 this is the best as of the date of this report.

System 15 Average rating of all test sections about 4.5.

System 16 Rating of 0 after 1 year in 1959. The replacement post cure type Laboratory formula 1R-310, System 23, with a green vinyl finish coat applied in June, 1964 had a rating of 8. However, this rating of 8 must be qualified because of the extremely adverse conditions at the time the zinc silicate coating was applied. In scrubbing off the excess curing agent, some of the inorganic zinc silicate primer was removed from the steel because it did not have sufficient time to cure properly in the foggy weather.

System 17 Average rating of about 7.0 for all test sections.

System 18 Average rating 4 to 5.

As will be noted in the above ratings after a 10 year exposure, the post cure type inorganic zinc silicate coating with vinyl finish coats is by a good margin the best coating system tested to date and should provide excellent protection for an additional 10-20 years. The all vinyl system, which ranks second in this series of tests, shows some breakdown on the sharp edges of the upper and lower flanges and appears to be the best of the organic vehicle systems tested.

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SAN SIMEON CREEK BRIDGE, 1959 REPAINTING

The following coatings were applied to this bridge in the 1959 repainting. All sandblasted surfaces received a first coat of Vinyl Wash Primer, Federal Specification MIL-P-15328.

System 19 Basic Lead Silico Chromate Primer, 4 mils dry film thickness in not less than 3 applications followed by 2 mil dry film thickness in not less than 2 applications of Phenolic Iridescent Green, State Specification 58-G-79. This system was applied to the three south spans of the bridge.

System 20 Semi-Quick Drying Red Lead Primer, State Specification 58-G-53, 3 mils dry film thickness in not less than 2 applications over spot blasted areas followed by 1 mil dry film thickness over entire area followed by 2 mils dry film thickness in not less than 2 applications of Phenolic Iridescent Green, State Specification 58-G-79. This system was applied to all spans north of the three southern spans.

Final inspection in 1964 before reapinting this bridge showed both of the above systems were equivalent in corrosion prevention and were rated about 5 on a scale of 0-10, 10 being perfect. It confirmed previously noted observations that the conventional organic vehicles with inhibitive pigments will not provide the protection afforded by certain inorganic zinc silicate primers in aggressive marine environments.

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SAN SIMEON CREEK BRIDGE, 1964 REPAINTING

As has been noted previously in this report, the post cure type inorganic zinc silicate primer with a vinyl finish coat provided excellent corrosion protection to the steel sections of the Leffingwell Creek Bridge to which this coating system was applied in the 1958 repainting.

In the post cure type inorganic zinc silicate coating, zinc dust is dispersed in an aqueous sodium silicate vehicle just before use. The zinc-sodium silicate vehicle is sprayed on the sandblasted steel to provide about a 3 mil dry film thickness coating. After an initial drying period of approximately 1/2 hour, a solution of phosphoric acid in isopropyl alcohol is sprayed on the coating to "cure" it. The cure period normally requires about 24 hours, after which the coating becomes very hard and the vehicle insoluble in water.

The curing process results in the deposition of a white salt on the zinc-silicate film which must be removed prior to the application of finish coats. The film deposit is very difficult to remove and requires intense scrubbing with brushes and water. On large complicated steel structures the removal of this film is difficult and therefore costly to achieve by hand scrubbing.

Self cure zinc-silicate coatings, which do not require the removal of a film of curing solution products prior to the application of subsequent paint coats, were known only a few years prior to the repainting of the San Simeon Creek Bridge in 1964. None of the self cure systems have been exposed to aggressive atmospheres long enough to draw valid conclusions relative to their performance compared to the post cure type. The latter have had service histories in various parts of the world approximating 25-30 years.

In 1964, the Materials and Research Department wrote a specification, 64-G-55, for a self cure zinc silicate paint containing a lithium-sodium silicate vehicle as a result of very successful salt spray tests in the laboratory.

In the 1964 repainting of the San Simeon Creek Bridge it was decided to use this material as a primer on the three south spans of this bridge as part of the following system:

<u>System 21</u> Three mils dry film thickness of State Specification 64-G-55, Self Cure Zinc Silicate primer. Following a cure of 48 hours Vinyl Wash primer, Federal Specification MIL-P-15328A was applied following by 3 mils dry film thickness of State Specification Vinyls 63-G-40, 63-G-41 and 61-G-75. No Vinyl Wash Primer on sandblasted steel.

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System 22 The remaining spans of the bridge were coated with 6 mils dry film thickness of the all vinyl system described in the above paragraph.

When these coatings were evaluated on October 24, 1968 the self-cure inorganic zinc silicate - vinyl system and the all vinyl system were rated as 8.0. The lower rating of the self-cure inorganic zinc silicate - vinyl system after four years compared to the 9+ rating of the post cure inorganic zinc silicate - vinyl system after 10 years on the Leffingwell Creek Bridge may be attributed to the following adverse factors present at the time the San Simeon Creek Bridge was repainted in 1964:

1. No agitated spray pot was used. This is absolutely essential for maintaining complete dispersion of the zinc dust pigment at all times.

2. The spray hose was 150 feet long, which was excessive and may have resulted in the settlement of some zinc pigment in the spray hose.

3. The weather was cloudy and misty during application and a heavy rain occurred immediately after application of the self-cure inorganic zinc silicate primer which would have inhibited the curing process.

No photographs are available showing the present condition of the all vinyl system applied to the northern spans of San Simeon Creek Bridge in the 1964 repainting.

LEFFINGWELL CREEK BRIDGE, 1964 REPAINTING OF SPAN 3,

To Replace Severely Deteriorated 100% Solids Epoxy Coating Applied in 1958.

System 23 A post-cure type inorganic zinc silicate paint prepared in the Materials and Research Department of the Division of Highways as Laboratory Formula 1R310 and applied to the sandblasted steel. Subsequent coats of paint consisted of Vinyl Wash Primer, Federal Specification MIL-P-15328A and Vinyl Finish Coat, State Specification 61-G-75.

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NEW DEVELOPMENTS IN THE INORGANIC ZINC SILICATE PRIMERS

Subsequent to the 1964 repainting of the San Simeon Creek Bridge, research work was done in the Laboratory on the modified ethyl silicate vehicles for use in inorganic zinc silicate coatings. Based upon the great promise shown by the above ethyl silicate type vehicle in extensive salt spray tests, a new specification was written in 1965 which included two types of self-cure inorganic zinc silicate coatings:

Type I, a Lithium-Sodium Silicate Vehicle
Type II, a Modified Ethyl Silicate Vehicle.

Type I cures best in a drier atmosphere than is normally experienced on the coast. The cure of Type II, however, is accelerated by high humidities because wet air speeds the hydrolysis of the ethyl silicate vehicle in the curing process. In dry arid areas it would be mandatory to artifically cure a Type II system by the periodic application of a water spray for 24 - 48 hours.

Mud Creek Bridge, about 30 miles north of San Simeon, on Coast Sign Route 1, was coated with the Type II system with vinyl finish coats in 1967. This bridge and other bridges in the coastal zone coated with the Type I and Type II systems will be periodically evaluated in the coming years.

Final conclusions as to the merits of the self-cure and post cure inorganic zinc silicate systems cannot be made until we have sufficient exposure time with the self cure systems.

About three years ago experiments using high pressure water jets in the range of 2,000 - 6,000 psi showed that the post cure reaction products of the post cure inorganic zinc silicate coating could be removed efficiently by this procedure. Adoption of this procedure will depend upon whether the self cure systems provide the corrosion protection of the post cure type.

NOTE:

The solvents in many of the paint systems described in this report do not comply with the air pollution control regulations which first became effective in July, 1967 in the County of Los Angeles and January, 1968 in the Bay Area Counties Air Pollution Control District. A research program initiated in 1966 and completed prior to July 1, 1967 enabled the Division of Highways to reformulate all its specification paints to comply with these regulations. The revised formulas for the paints are shown in the January, 1969 California Standard Specifications of the Division of Highways.

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APPENDIX

Formulas for paints used on Leffingwell Creek and San Simeon Creek Bridges as described in this Research Report.

Photographs of exposed test sections of Leffingwell and San Simeon Creek Bridges coated with paints investigated in this Research Report.

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1952 LEFFINGWELL CREEK BRIDGE REPAINTING

PRIMERS AND FINISH COATS USED ON TEST SECTIONS

SYSTEM 1 SEMI-QUICK DRYING RED LEAD PRIMER

	Pounds
97% Sublimed Red Lead	131
Talc	23
Aluminum Stearate	.25
Raw Linseed Oil	20
TT-R-266, Type 3 at 60% non-volatile Alkyd	31
Mineral Spirits	10
24% Lead Naphthenate	1
6% Cobalt Naphthenate	.2

Weight per gallon 20.43 pounds
Viscosity 98 KU

SYSTEM 2 80% ZINC CHROMATE

Zinc Chromate	41 pounds
Zinc Oxide	6 pounds
Yellow Oxide	1.5 pounds
Talc	6 pounds
Aluminum Stearate	13 ounces
Alkyd Resin TT-R-266, Type III, 60% N.V.	40 pounds
Dipentene	2 pounds
SoCal #2	17 pounds
6% Manganese Naphthenate	2 ounces
6% Cobalt Naphthenate	2 ounces
24% Lead Naphthenate	1 pound

Weight per gallon 11.5 pounds
Viscosity 75 KU

SYSTEM 3 RED LEAD AND OIL (#3 PRIMER)

	Pounds
97% Sublimed Red Lead	398
Metal Lead Powder	52
Raw Linseed Oil	87
Mineral Spirits	6
6% Cobalt Naphthenate	.25
6% Manganese Naphthenate	.25
24% Lead Naphthenate	1

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1952 LEFFINGWELL CREEK BRIDGE REPAINTING

PRIMERS USED ON TEST SECTIONS

SYSTEM 4 RED LEAD PHENOLIC

97% Sublimed Red Lead	63 pounds
Zinc Chromate	10 pounds
Zinc Oxide	5 pounds
Mica	11 pounds
Talc	15.5 pounds
Aluminum Stearate	.5 pound
*Bakelite Varnish	7 gallons
Mineral Spirits	2.375 gallons
Dipentene	1 gallon
Anti-Skin	.375 pound
6% Cobalt Naphthenate	50 grams

Weight per gallon 14.78 pounds
Viscosity 83 KU

*150 lbs. of Bakelite BR 4036, 293.6 lbs. China Wood Oil, 42 gallons of mineral spirits.

SYSTEM 5 RED LEAD PHENOLIC (SFOBB FORMULATION X-6)

Red Lead Paste Federal Spec. TT-R-191, Type II	100 pounds
**Aluminum Vehicle	5 gallons
Mineral Spirits	1 pint

**Composition: This vehicle shall be an oil varnish, the resinous portion of which shall be 100 percent phenol-formaldehyde type. The resin shall be BR 254 or BR 9432 or equal corresponding to Federal Specifications MIL-R-15184 or MIL-R-15189. The varnish shall be 33 gals. in oil length, 30 gals. of which shall be tung oil TT-0-395, and three gallons of which shall be alkali refined linseed oil, MIL-0-15180A.

The volatile portion of this varnish, which shall not exceed 50% of the total weight of the varnish, shall consist of 90% mineral spirits and 10 percent turpentine or xylol. The drier content shall consist of the naphthenates of lead, cobalt and manganese in such proportion as required, provided however, that based on oil content, the total amount of lead shall not exceed 0.3 percent, the cobalt shall not exceed 0.03 percent and the manganese shall not exceed 0.015 percent.

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SYSTEM 6 VINYL RED LEAD

	Pounds
97% Sublimed Red Lead	85
Tribase	1
Vinyl VAGH, Bakelite	12
G 60, Rohm and Haas Plasticizer	8
Methyl Isobutyl Ketone	20
Toluol	20
Butanol	3.5
Cellosolve Acetate	8.5
Xylol	8

SYSTEM 7 VINYL-EPON RED LEAD

	Pounds
97% Sublimed Red Lead	50
Tribase	.5
Epitex 120, Jones Dabney Epoxy Ester	10
Vinyl VAGH, Bakelite	6
G 60, Rohm and Haas Plasticizer	2
Methyl Isobutyl Ketone	10
Toluol	10
Butanol	2
Cellosolve Acetate	4
Xylol	4

FINISH COATS

(a) Finish coat used in Systems 1, 2, 3, 4 and 5 contained 2¼ pounds of leafing aluminum paste, TT-A-468a, Type II, Class B, per gallon of vehicle. The vehicle is described under footnote **, Aluminum Vehicle, of System 5.

(b) Finish coat of Systems 6 and 7 was as follows:

Vinyl Aluminum	Pounds
Vinyl, Bakelite VYHH	14
Standard Lining Aluminum Powder	8
G 60, Rohm and Haas Plasticizer	1.5
Methyl Isobutyl Ketone	27
Toluol	27
Butanol	4
Cellosolve Acetate	11
Xylol	11

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1953 SAN SIMEON CREEK BRIDGE REPAINTING

PRIMERS AND FINISH COATS USED ON TEST SECTIONS

SYSTEM 8 A PROPRIETARY ALKYD RED LEAD PRIMER AND ALUMINUM FINISH COAT

SYSTEM 9 HARVEY SYSTEM NO. 1

(a) Primer, State Specification 52-G-53

PAINT, PRIMER, RED LEAD, SEMI-QUICK DRYING (STATE SPECIFICATION 52-G-53)

This specification covers a ready-mixed priming paint for use on structural steel where rapid drying is required. It is recommended for general use in locations where the wet paint film is subject to early contamination. Careful surface preparation is essential.

Composition:

Pigment Ingredients	Lbs./100 Gals.
Red Lead, TT-R-191a, Class C	1,566
Aluminum Stearate, MIL-A-15206	6
Vehicle Ingredients	
Raw Linseed Oil, TT-O-369	160
*Alkyd Solution	307
Drier, Lead, TT-D-643	16
Drier, Cobalt, TT-D-643	6
Thinner, TT-T-291a, Grade 1	92

*Federal Specification TT-R-266, Type III, except that the oil content shall be linseed oil fatty acids.

(b) Barier Coat, Type IV White Traffic Paint.

This specification is intended to cover a ready-mixed white paint of a consistency suitable for spray application on highway pavements of concrete or bitumen. It is required that the paint furnished shall bind glass beads in such manner as to provide satisfactory lines in all respects as determined by the Materials and Research Department.

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Pigment 46% to 49%
Vehicle 51% to 54%

Pigment: Pigment shall have the following composition for approximately 100 gallons of paint:

	Pounds
Rutile Titanium Dioxide, TT-T-425, Type III	144
Magnesium Silicate, TT-M-90	60
Celite 281 (or equal)	84
Mica D 607-42 ASTM	60
Whiting, Water Ground, non-caking, not more than 0.5% retained on 325 mesh sieve	210

Vehicle: Vehicle composition for approximately 100 gallons of paint:

	Pounds
Varnish (50% solids)	220
40% Chlorinated Paraffin (Chlorowax 40 or equal)	33
Parlon, (10 cps. or equal)	77
Propylene Oxide	2
V.M. & P. Naphtha, Boiling Range 200° - 300°F.	44
Toluol	115
SoCal #2	120-155
6% Cobalt Naphthenate	1.5

Soya Lecithin and Aluminum Stearate shall be incorporated in quantities sufficient to insure against caking and excessive settling of the pigment in package. Approximate requirements are 4 and 1 pounds respectively.

The varnish shall consist of a 25 gallon tung oil product, the resin of which shall be Pentalyn 802A or equal. These ingredients shall be cooked together in such manner as to produce a varnish which shall show no gas checking (bell jar) and a viscosity of A-E, Gardner, at 50% total solids.

(c) Vinyl Finish Coat. Same as State Specification T-53-G-49 except methyl normal amyl ketone used in lieu of ethyl amyl ketone in the solvent.

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FINISH, ALUMINUM - VINYL
(STATE SPECIFICATION T53-G-49)

This specification is intended to cover an aluminum vinyl type paint for use on structural steel as a finish coat over a vinyl or epoxy system undercoating. It is required that the vehicle when mixed with aluminum powder shall be suitable for immediate spray application and shall have proper flow, leafing, drying time and suspension of pigment as determined by the Engineer.

This paint shall be furnished in two compartment containers and mixed fresh each day.

Composition:

Pigment Ingredients
(To be packaged separate from the vehicle)

	Lbs./100 Gals.
Aluminum powder (Reynolds 30XD-Powder or equal) per 100 gallons of vehicle	54.0

Vehicle Ingredients

Bakelite Vinyl Resin VAGH or equal	62.4
Bakelite Vinyl Resin VMCH or equal	62.4
Methyl Isobutyl Ketone TT-M-268	159.4
Ethyl Amyl Ketone, Shell Chemical Corp. Grade or equal	158.1
Toluene TT-T-548	158.0
Xylene TT-X-916	158.0
"Flexol" Plasticizer DOP or equal	31.7
Shell Chemical Corp. Epon Resin 828 or equal	0.6

The components of the vehicle shall be mixed and ground as required to produce a uniform solution.

Characteristics of Vehicle:

Volatile, percent by weight	80.2 maximum
Non-volatile, percent by weight	19.8 minimum
Viscosity at 77°F	57.0 KU
Weight per gallon	7.5 pounds
Dry to touch	1/2 hr. maximum

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HARVEY SYSTEM NO. 2

(a) Primer, State Specification 52-G-51.

ZINC CHROMATE PRIMER FOR METAL
(State Specification 52-G-51)

This specification covers a ready mixed fast drying primer paint for use on carefully sand blasted metal surfaces or galvanized surfaces which have been pre-treated. (Pre-treatment Acid Wash 52-I-05). It is not desirable for use on metal surfaces which cannot be prepared as outlined. This paint is to be made available in two types, one for shop application and one for field application. When ordering the type shall be specified either as "shop" or "field".

Composition:

Pigment Ingredients	Lbs./100 Gals.
Zinc Yellow, TT-Z-415, Type I	405
Zinc Oxide, TT-Z-301, acicular	60
Sienna, TT-S-346	25
Magnesium Silicate, TT-M-90	50
Aluminum Stearate, MIL-A-15206	6
Vehicle Ingredients	
Alkyd Resin Solution	483
Dipentene, TT-D-376	22
Thinner, TT-N-97, Type II	97
Drier, Lead, TT-D-643	12
Drier, Cobalt, TT-D-643	1.2
Drier, Manganese, TT-D-643	1.2

Alkyd Resin Solution Ingredients

Phthalic anhydride	29%
Drying oil acids	48%
Polyhydric alcohols (equimolecular quantities of pentaerythritol and glycerine)	23%

The resin shall then be reduced to 50 percent non-volatile content with thinner (2/3 TT-T-291a, Grade I, 1/3 thinner Federal Specification TT-N-97, Type II. For fast drying shop coat substitute thinner State Specification 53-I-12 for the TT-T-291a).

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Characteristics of Resin Solution:

Non-volatile	50%
Weight per gallon	7.9 pounds
Viscosity	Z to Z_3, Gardner
Acid No.	10-20 based on solids

(b) Barier Coat. Same as in Harvey System No. 1 (b)

(c) Vinyl Finish Coat. Same as in Harvey System No. 1 (c)

SYSTEM 10 METALIZING SYSTEM

(a) Metalizing Primer System

(b) Finish Coat (where applied) consisted of Vinyl Wash Primer, Federal Specification MIL-P-15328A followed by vinyl finish coat T53-G-49 as described in System 9.

SYSTEM 11

(a) Primer, State Specification 52-G-53 as described in System 9.

(b) Aluminum Finish coat as described under Finish Coats (a) on the 1952 Leffingwell Bridge Repainting.

SYSTEM 12 PRIMER, STATE SPECIFICATION T53-G-42

SPECIFICATION FOR STRUCTURAL STEEL PAINT
EPON-RED LEAD PRIMER
(State Specification T53-G-42)

This specification is intended to cover a ready-mixed paint, Epoxy-Red Lead Primer, for use on structural steel over a system consisting of Pre-treatment Wash Primer, MIL-P-15328A. A curing agent, packaged in separate glass containers, shall be part of this specification and shall be added to the finished paint in the manner specified immediately prior to application. No paint which has been mixed with the curing agent for more than 8 hours shall be used. It is required that the paint furnished shall be suitable for spray application on steel bridges and shall have proper flow, drying time and suspension of pigment as determined by the Engineer.

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Composition:

Pigment Ingredients	Lbs./100 Gals.
Red Lead TT-R-191a, Dry, Class C, 97%	902
Celite 110 or equal	83.2
Magnesium Silicate TT-M-90	67.9
Aluminum Stearate MIL-A-15206	4.3
Vehicle Ingredients	
Shell Chemical Corp. Epon Resin 1001 or equal	256.2
American Cyanamid Beetle 216-8 or equal	13.3
Methyl Normal Amyl Ketone, Shell Chemical Corp., Grade or equal	120.5
Butyl Cellosolve, Carbide and Carbon or equal	13.3
Xylene TT-X-916	90.0
Normal Butanol TT-B-846	74.7
Toluene TT-T-548	74.7

Curing Agent

The curing agent shall be packaged in glass containers, one container for each five gallons of paint. The size of the container shall be sufficient to contain 1.6 lbs. of the material. The full contents of one package of curing agent shall be added to each five gallons of the finished paint and thoroughly mixed immediately prior to application. The curing agent shall have the following percentage composition by weight.

Ethylene Diamine (Technical Grade 77%) Carbide and Carbon or equal	65%
Secondary Butyl Alcohol TT-B-848	20%
Methyl Ethyl Ketone TT-M-261	15%

The components of the vehicle shall be mixed and ground as required to produce a uniform solution. The pigment when ground into the vehicle shall not settle to such extent upon standing that it cannot be readily dispersed by a paddle.

(b) Vinyl Finish Coat. Same as Vinyl Finish Coat formula given in Harvey System No. 1 (c) in Coating System No. 2.

SYSTEM 13 ALL VINYL SYSTEM

Same as State Specification T53-G-40 and T53-G-41 except methyl normal amyl ketone used in lieu of ethyl amyl ketone in the solvent.

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VINYL - RED IRON OXIDE TYPE
(STATE SPECIFICATION T53-G-40)

This specification is intended to cover a ready-mixed paint, vinyl - red iron oxide type, for use on carefully sand-blasted structural steel which has been treated with Vinyl Wash Primer Specification MIL-P-15328A. When applied on structural steel, the paint shall level properly to a smooth surface before setting and have a satisfactory drying time and suspension of pigment as determined by the Engineer.

Composition:

Pigment Ingredients	Lbs./100 Gals.
Red Iron Oxide Williams R-3098 or equal	51.2
Magnesium Silicate TT-M-90	7.2
Vehicle Ingredients	
Bakelite Vinyl Resin VAGH or equal	87.2
Bakelite Vinyl Resin VMCH or equal	82.8
Methyl Isobutyl Ketone TT-M-268	148.0
Ethyl Amyl Ketone, Shell Chemical Corp. Grade or equal	147.2
Toluene TT-T-548	147.2
Xylene TT-X-916	147.2
"Flexol" Plasticizer DOP or equal	28.8
Soya Lecithin	7.2
Shell Chemical Corp. Epon Resin 828 or equal	0.6

VINYL - RED IRON OXIDE - TITANIUM DIOXIDE TYPE
(STATE SPECIFICATION T53-G-41)

This specification is intended to cover a ready-mixed paint, vinyl - red iron oxide - titanium dioxide type, for use as a second coat on structural steel over a vinyl system consisting of pretreatment with wash primer and one coat of red oxide vinyl. It is required that the paint furnished shall be suitable for spray application on steel bridges and shall have proper flow, drying time and suspension of pigment as determined by the Engineer.

Composition:

Pigment Ingredients	Lbs./100 Gals.
Red Iron Oxide Williams R-3098 or equal	19.2
Titanium Dioxide TT-T-425, a Type III	39.2

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Vehicle Ingredients	Lbs./100 Gals.
Bakelite Vinyl Resin VAGH or equal	87.2
Bakelite Vinyl Resin VMCH or equal	28.8
Methyl Isobutyl Ketone TT-M-268	148.0
Ethyl Amyl Ketone, Shell Chemical Corp. Grade or equal	
Toluene TT-T-548	147.2
Xylene TT-X-916	147.2
"Flexol" Plasticizer DOP or equal	147.2
Soya Lecithin	28.8
Shell Chemical Corp. Epon Resin 828 or equal	7.2
	0.6

(b) Vinyl Finish Coat. Same as Vinyl Finish Coat formula given in State Specification T53-G-49 shown in Harvey System No. 1(c) in Coating System 9.

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1958 LEFFINGWELL CREEK BRIDGE REPAINTING

PRIMERS AND FINISH COATS USED ON TEST SECTIONS

SYSTEM 14

(a) Primer, a proprietary post cure inorganic zinc silicate.

(b) Vinyl Wash Primer, Federal Specification MIL-P-15328A.

(c) Vinyl Primers

VINYL PRIMER, TITANIUM DIOXIDE TYPE
(STATE SPECIFICATION T58-G-40)

This specification is intended to cover a ready-mixed paint, vinyl - titanium dioxide type, for use on carefully blast cleaned structural steel which has been treated with Vinyl Wash Primer MIL-P-15328A. When applied on structural steel, the paint shall level properly to a smooth surface before setting and have a satisfactory drying time and suspension of pigment.

Composition:

Pigment Ingredients	Lbs./100 Gals.
Titanium Dioxide, TT-T-425, Type III	38.7
Magnesium Silicate, TT-M-90	7.2
Vehicle Ingredients	
Vinyl Resin, Bakelite VAGH	87.2
Vinyl Resin, Bakelite VMCH	28.8
Methyl Isobutyl Ketone, TT-M-268	148.0
Ethyl Amyl Ketone	147.2
Toluene, TT-T-548	147.2
Xylene, TT-X-916	147.2
Di-(2-ethylhexyl) phthalate	28.8
Soya Lecithin	7.2
Epoxy Resin, Shell Epon 828	0.6

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VINYL PRIMER, RED IRON OXIDE - TITANIUM DIOXIDE TYPE
(STATE SPECIFICATION T58-G-41)

This specification is intended to cover a ready-mixed paint, vinyl-red iron oxide-titanium dioxide type, for use as a second coat on structural steel over a vinyl system consisting of pre-treatment with wash primer and one coat of titanium dioxide vinyl. It is required that the paint furnished shall be suitable for spray application on steel structures and shall have proper flow, drying time and suspension of pigment.

Composition:

Pigment Ingredients	Lbs./100 Gals.
Red Iron Oxide, Williams 3098	19.2
Titanium Dioxide, TT-T-425, Type III	39.2
Vehicle Ingredients	
Vinyl Resin, Bakelite VAGH	87.2
Vinyl Resin, Bakelite VMCH	28.8
Methyl Isobutyl Ketone, TT-M-268	148.0
Ethyl Amyl Ketone	147.2
Toluene, TT-T-548	147.2
Xylene, TT-X-916	147.2
Di-(2-ethylhexyl)phthalate	28.8
Soya Lecithin	7.2
Epoxy Resin, Shell Epon 828	0.6

(d) Vinyl Finish Coat

VINYL PAINT, ALUMINUM FINISH COAT
(STATE SPECIFICATION T58-G-49)

This specification is intended to cover an aluminum vinyl type paint for use on structural steel as a finish coat over a vinyl system undercoating. It is required that the vehicle when mixed with aluminum powder shall be suitable for immediate spray application and shall have proper flow, leafing, drying time, and suspension of pigment.

This paint shall be furnished in two compartment containers and mixed fresh each day.

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Composition:

Pigment Ingredients (To be packaged separate from Vehicle)	Lbs./100 Gals.
Aluminum Powder, TT-A-468a, Type I, Class B	54.0
Vehicle Ingredients	
Vinyl Resin, Bakelite VAGH	62.4
Vinyl Resin, Bakelite VMCH	62.4
Methyl Isobutyl Ketone, TT-M-268	159.4
Ethyl Amyl Ketone	158.1
Toluene, TT-T-548	158.0
Xylene, TT-X-916	158.0
Di-(2-ethylhexyl) phthalate	31.7
Epoxy Resin, Shell Epon 828	0.6

SYSTEM 15

(a) Primer, State Specification 58-G-53

PAINT, PRIMER, RED LEAD, SEMI-QUICK DRYING (STATE SPECIFICATION 58-G-53)

This specification covers a ready-mixed priming paint for use on structural steel where rapid drying is required. It combines the desirable characteristics of the straight oil primers with those of the synthetic resins. It is recommended for general use in locations where the wet paint film is subject to early contamination.

When this paint is used for second coat, 0.25 pound lamp-black, TT-L-70, per gallon of paint shall be added.

Composition:

Pigment Ingredients	Lbs./100 Gals.
Red Lead (97 percent Grade) TT-R-191, Type I	1,568
Aluminum Stearate, MIL-A-15206	6
Diatomaceous Silica, MIL-S-15191A	25
Vehicle Ingredients	
Linseed Oil (Raw) TT-O-369	150
Alkyd Resin Solution, State Spec. 56-I-30	307
Thinner, TT-T-291, Grade I } Driers, TT-D-643 }	114

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(b) Barrier Coat, State Specification 55-G-95

WHITE TRAFFIC LINE PAINT
(STATE SPECIFICATION 55-G-95)

Pigment: Pigment shall have the following composition for approximately 100 gallons of paint:

	Lbs./100 Gals.
Ti-Cal R-27, R-25, or RCHT	300
Rutile Titanium Dioxide, TT-T-425, Type III	60
Magnesium Silicate TT-M-90	54
Diatomaceous Silica Celite 281 or 110	84
Mica D-607-42 (ASTM)(without water grind)	60

(50% TiO_2 pigment may be blended with 30% material to get proper weight and TiO_2 content.)

Vehicle: Vehicle composition for approximately 100 gallons of paint:

	Lbs./100 Gals.
Varnish (50% non-volatile, 1/2 SoCal #1, 1/2 V.M. & P. naphtha distilling range 200-300°F	220
40% Chlorinated Paraffin (Chlorowax, or Chlorafin)	37
Parlon, 10 cps	77
Propylene Oxide	2
V.M. & P. Naptha, Distillation 200-300°F	44
Toluol	115
SoCal #1	110-120
6% Cobalt Naphthenate	1.5

Varnish: The varnish shall consist of a 25 gallon, 100% tung oil, TT-O-395 product. The resin shall consist of pentaerythritol-rosin ester, 80%, and phenolic (BR 9400) 20%. The rosin from which the ester is derived shall be WW grade. These ingredients shall be cooked and processed in such manner as to yield a varnish, which at 50% non-volatile content and 77°F temperature, shall have the following characteristics:

Gas check (TT-P-141-b with Drier)	None
Weight per gallon	7.4-7.6 pounds
Saponification No., TT-P-141-b	78 maximum
Acid No., TT-P-141-b	7 maximum
Aromatic content of volatile	40% minimum
Viscosity, Gardner	A, maximum

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1959 SAN SIMEON CREEK BRIDGE REPAINTING

PRIMERS AND FINISH COATS USED ON TEST SECTIONS

SYSTEM 19

(a) Primer

ORANGE PRIMER
(SIMILAR TO FEDERAL SPEC. TT-P-615b, TYPE I)

Pigment	Pounds
Basic Lead Silico Chromate M50	1000.0
Bentone 34	6.0
Vehicle	
Raw Linseed Oil	309.0
Alkyd Resin (70% Solids) Federal Spec. TT-R-266, Type I	112.0
Mineral Spirits, Heavy	87.0
Lead Naphthenate (24%)	4.0
Manganese Naphthenate (6%)	1.9

MAROON INTERMEDIATE COAT

Pigment	Pounds
Basic Lead Silico Chromate M50	650.0
Red Iron Oxide (Siliceous, 85% Fe_2O_3 min)	350.0
Bentone 34	6.0
Vehicle	
Raw Linseed Oil	290.0
Alkyd Resin (70% solids) Federal Spec. TT-R-266, Type I	210.0
Mineral Spirits, Heavy	91.8
Lead Naphthenate (24%)	4.5
Manganese Naphthenate (6%)	2.2
Anti-Skinning Agent	1.0

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(b) Finish Coat. State Specification 58-G-79. See System 18 (b).

SYSTEM 20

(a) Primer. State Specification 58-G-53. See System 15 (a).

(b) Finish Coat. State Specification 58-G-79. See System 18 (b).

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1964 SAN SIMEON CREEK BRIDGE REPAINTING

PRIMERS AND FINISH COATS USED ON TEST SECTIONS

SYSTEM 21

(a) Primer, State Specification 64-G-55

INORGANIC ZINC SILICATE PAINT

The inorganic zinc silicate paint shall be a two component self-curing type which when mixed and applied in accordance with specification requirements shall cure without the use of a separate curing solution to a coating having the properties described herein.

Pigment

The pigment shall consist of two ingredients, Pigment A and Pigment B, combined in the ratio 98 percent by weight of A and two percent by weight of B.

Pigment A shall consist of a finely divided zinc powder having at least 96 percent metallic zinc by weight and having a particle size not exceeding 5.5 microns. The zinc powder shall have a specific gravity of 7.09 to 7.14 as determined using the procedures set forth in ASTM Designation: C 128.

Pigment B shall be synthetic Red Iron Oxide. The oxide shall disperse so that there are no coarse particles in the sprayed film.

Vehicle

The vehicle component shall consist primarily of a water solution of lithium and sodium silicates.

The ratio of silicon dioxide to alkali metals expressed as moles of lithium oxide and sodium oxide shall be between 3.5 to 5.0 to one.

Total solids in the vehicle shall not be more than 25 percent nor less than 21%. Solids shall be determined by ashing the sample for 1 hour at 900°C.

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Viscosity of the vehicle shall be between 30 and 40 cps, Brookfield viscosity with No. 1 spindle at 100 rpm.

The mole ratio of lithium oxide to sodium oxide shall be between 2.8 and 3.3 to one.

Mixed Paint

The ratio of the pigment component to the vehicle component shall be between 3.2 and 3.5 to one by weight.

Viscosity of the mixed paint shall be between 350 and 650 cps. Brookfield viscosity, with No. 3 spindle at 100 rpm. The weight per gallon shall not be less than 26.5.

Total solids when heated at 110°C for 3 hours shall not be less than 81.0 percent by weight.

Resistance to cracking and flaking shall be such that the coating, when applied to a dry film thickness of seven mils at 70 to 80°F at 65 to 70 percent relative humidity in still air (no air movement over the surface), shall not develop cracking or flaking.

Pencil hardness of the coating when applied to a dry film thickness of four mils with 24 hours drying time at 70 to 80°F and at 65 to 70 percent relative humidity in still air shall not be less than 5H.

The usable pot life of the coating after mixing the components shall not be less than 48 hours at 77°F. There shall be no hard settling which cannot be easily redispersed during this period.

(b) Intermediate Coat, Vinyl Wash Primer, Federal Specification MIL-P-15328A.

(c) Vinyl Primers, State Specification 63-G-40 and 63-G-41

VINYL PRIMER, RED IRON OXIDE TYPE
(STATE SPECIFICATION 63-G-40)

Composition:

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Pigment Ingredients	Lbs./100 Gals.
Red Iron Oxide[1]	51.2
Magnesium Silicate, TT-M-90*	7.2

*Chemical requirements only.

[1] Fe_2O_3, 98.5% minimum; oil absorption, 21; fineness through 325 mesh screen, 99% minimum; and specific gravity, 5.15.

Vehicle Ingredients	
Vinyl Resin[2]	87.2
Vinyl Resin[3]	28.8
Methyl Isobutyl Ketone, TT-M-268	148.0
Ethyl Amyl Ketone	147.2
Toluene, TT-T-00548	147.2
Xylene, TT-X-916, Grade A	147.2
Di-(2-ethylhexyl) phthalate	28.8
Soya Lecithin	7.2
Epoxy Resin[4]	0.6

[2] A vinyl chloride-vinyl acetate copolymer resin, 1.39 specific gravity, containing 91% vinyl chloride, 3% vinyl acetate and 6% vinyl alcohol with an intrinsic viscosity of 0.57 poise at 20°C. in cyclohexanone.

[3] A vinyl chloride-vinyl acetate copolymer resin, 1.35 specific gravity containing 86% vinyl chloride, 13% vinyl acetate and 1% interpolymerized dibasic acid (0.7 to 0.8 carboxyl) with an intrinsic viscosity of 0.53 poise at 20°C in cyclohexanone.

[4] Liquid, color 5 max. (Gardner), 100-160 poise viscosity at 25°C, 180-195 epoxide equivalent.

The preparation of this paint in steel ball mills is not acceptable.

VINYL PRIMER, RED IRON OXIDE - TITANIUM DIOXIDE TYPE (STATE SPECIFICATION 63-G-41)

Composition:

Pigment Ingredients	Lbs./100 Gals.
Red Iron Oxide[1]	19.2
Titanium Dioxide, TT-T-425, Type III	39.2

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[1]Fe_2O_3, 98.5% minimum; oil absorption 21; fineness through 325 mesh screen, 99% minimum; and specific gravity, 5.15.

Vehicle Ingredients	Lbs./100 Gals.
Vinyl Resin[2]	87.2
Vinyl Resin[3]	28.8
Methyl Isobutyl Ketone, TT-M-268	148.0
Ethyl Amyl Ketone	147.2
Toluene, TT-T-00548	147.2
Xylene, TT-X-916, Grade A	147.2
Di-(2-ethylhexyl) Phthalate	28.8
Soya Lecithin	7.2
Epoxy Resin[4]	0.6

[2]A vinyl chloride-vinyl acetate copolymer resin, 1.39 specific gravity, containing 91% vinyl chloride, 3% vinyl acetate and 6% vinyl alcohol with an intrinsic viscosity of 0.57 poise at 20°C in cyclohexanone.

[3]A vinyl chloride-vinyl acetate copolymer resin, 1.35 specific gravity, containing 86% vinyl chloride, 13% vinyl acetate and 1% interpolymerized dibasic acid (0.7 to 0.8 carboxyl) with an intrinsic viscosity of 0.53 poise at 20°C in cyclohexanone.

[4]Liquid, color 5 max. (Gardner), 100-160 poise viscosity at 25°C, 180-195 epoxide equivalent.

The preparation of this paint in steel ball mills is not acceptable.

(d) Vinyl Finish Coat. State Specification 61-G-75.

VINYL FINISH COAT; GREEN

Composition:

Pigment Ingredients	Lbs./100 Gals.
Titanium Dioxide, TT-T-425, Type III	8.6
Phthalocyanine Green	5.0
Chrome Oxide Green, TT-P-347	40.4

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Vehicle Ingredients	Lbs./100 Gals.
Vinyl Resin[1]	87.2
Vinyl Resin[2]	28.8
Methyl Isobutyl Ketone, TT-M-268	148.0
Ethyl Amyl Ketone	147.2
Toluene, TT-T-548	147.2
Xylene, TT-X-916, Grade A	147.2
Di-(2-ethylhexyl) Phthalate	28.8
Soya Lecithin	7.2
Epoxy Resin[3]	0.6

[1]A vinyl chloride-vinyl acetate copolymer resin, 1.39 specific gravity, containing 91% vinyl chloride, 3% vinyl acetate and 6% vinyl alcohol with an intrinsic viscosity of 0.57 poise at 20°C in cyclohexanone.

[2]A vinyl chloride-vinyl acetate copolymer resin, 1.35 specific gravity, containing 86% vinyl chloride, 13% vinyl acetate and 1% interpolymerized dibasic acid (0.7 to 0.8 carboxyl) with an intrinsic viscosity of 0.53 poise at 20°C in cyclohexanone.

[3]Liquid, color 5 max. (Gardner), 100-160 poise viscosity at 25°C, 180-195 epoxide equivalent.

SYSTEM 22

All Vinyl System. See Specification 63-G-40, 63-G-41 and 61-G-75 under System 21 (c) and (d).

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1964 REPAINTING OF SPAN 3 ON LEFFINGWELL CREEK BRIDGE TO REPLACE SEVERELY DETERIORATED 100% SOLIDS EPOXY COATING APPLIED IN 1958

SYSTEM 23

(a) Primer, Laboratory Formula 1R310

INORGANIC ZINC SILICATE
(LABORATORY FORMULA 1R310)

Vehicle

Water Glass, 41° Baume	8.5 pounds
Water	2.3 pounds
Tamol 731, Rohm and Haas	0.065 pounds

Pigment

New Jersey Zinc Co., Zinc Dust No. 44	16.3 pounds
Red Lead, 97% grade	1.8 pounds

After the above components were mixed on the jobsite, strained through two layers of cheesecloth and sprayed onto the steel, a curing solution of the following composition was applied. This curing solution is allowed to remain on the coating for at least 24 hours before scrubbing it off and applying the Vinyl Wash Primer, Federal Specification MIL-P-15328A

Curing Solution

Phosphoric Acid, 85% grade	25% by weight
Isopropyl Alcohol	75% by weight

(b) Intermediate Coat, Vinyl Wash Primer, Federal Specification MIL-P-15328A.

(c) Vinyl Finish Coat, State Specification 61-G-75. For formula, see System No. 21 (d), Finish Coat.

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PHOTOGRAPHS TAKEN IN 1958 OF THE EXPERIMENTAL

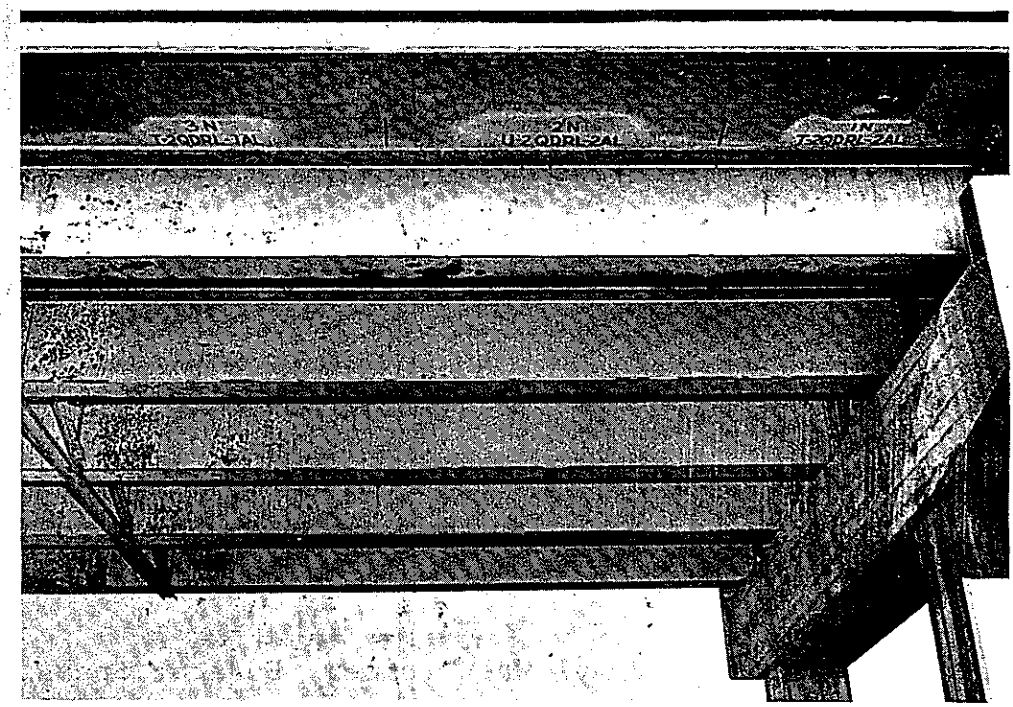
PAINT PANELS OF LEFFINGWELL CREEK BRIDGE

COATED IN 1952

NOTE: "T" on panel legend indicates Vinyl Wash Primer pretreatment of sandblasted steel.

"U" on panel legend indicates no Vinyl Wash Primer pretreatment of sandblasted steel.

Number of coats indicated on panel legend by "1" and "2". System "No." beneath photographs indicates system number in text.



System 1. Red Lead, Linseed Oil, Alkyd Primer and No. 5 Aluminum Finish Coat. Panels 1N, 2N, 3N.

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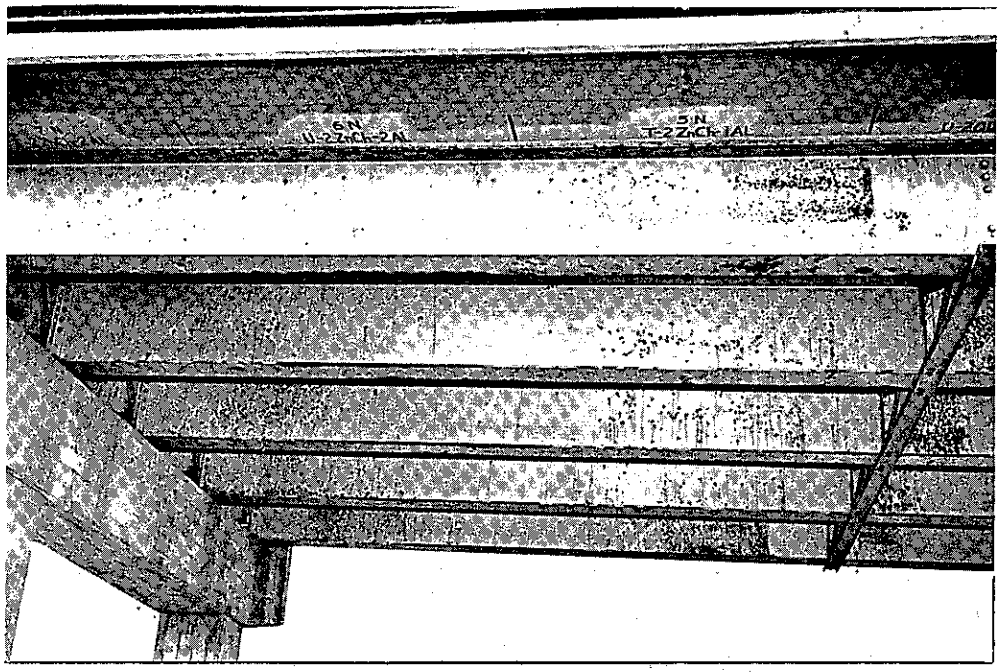
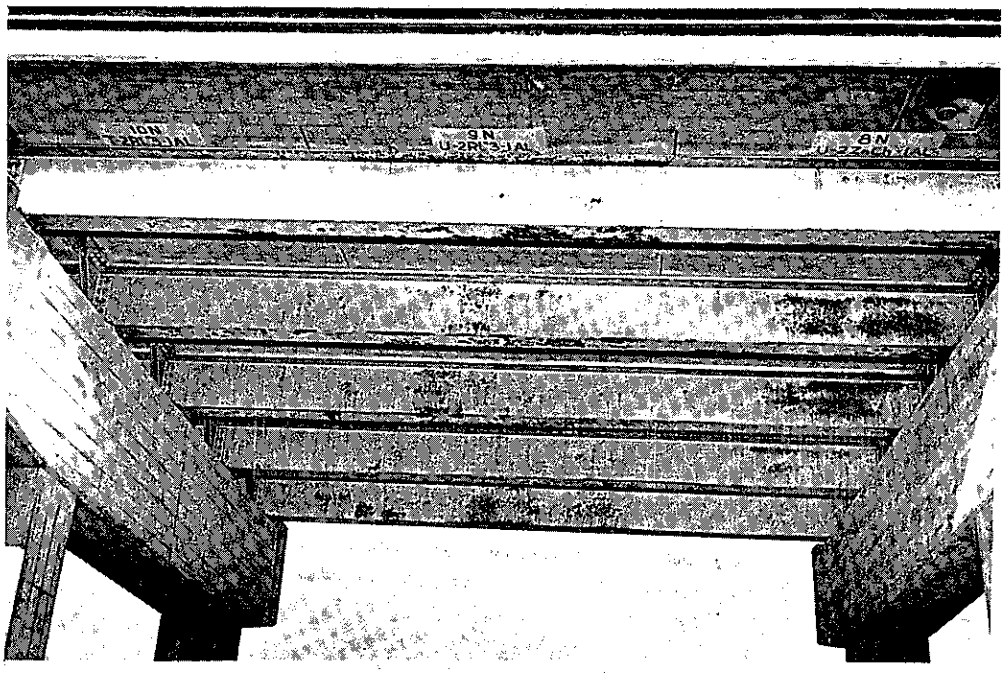


System 2. Zinc Chromate Primer and No. 5 Aluminum Finish Coat. Panels 5N, 6N, 7N.



System 2. Zinc Chromate Primer and No. 5 Aluminum Finish Coat. Panel 8N.

System 3. Red Lead and Oil Primer and No. 5 Aluminum Finish Coat. Panel 9N. Red Lead and Oil and Aluminum Finish Coat. Panel 10N.

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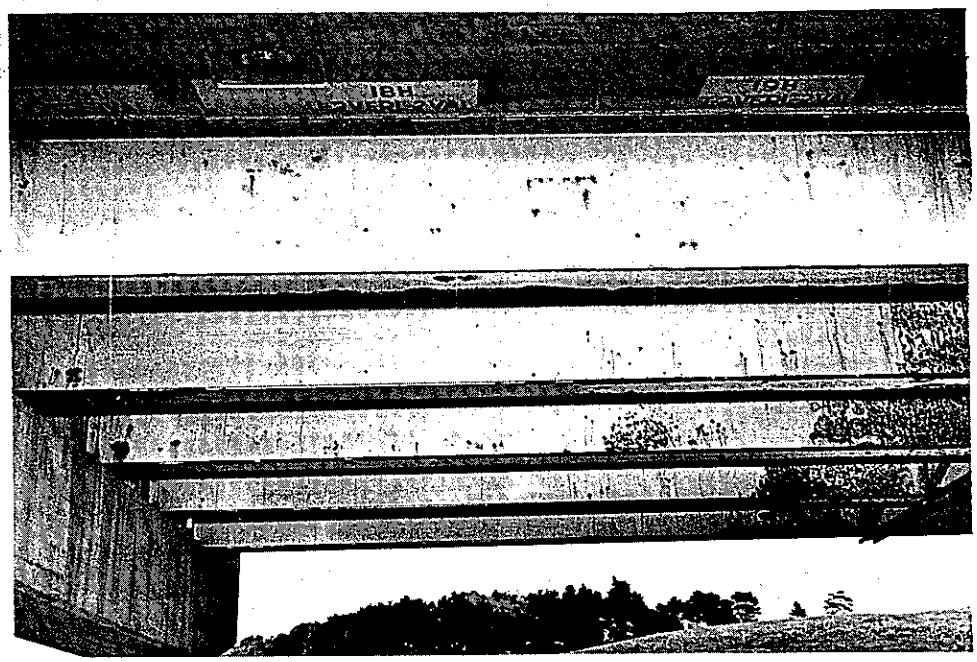
System 6. Red Lead Vinyl Resin Primer and Vinyl Aluminum Finish Coat. Panels 14N, 15N, 16N.



System 7. Red Lead, Epoxy Ester, Vinyl Resin Primer and Vinyl Aluminum Finish Coat. Panels 17H, 18H, 19H.

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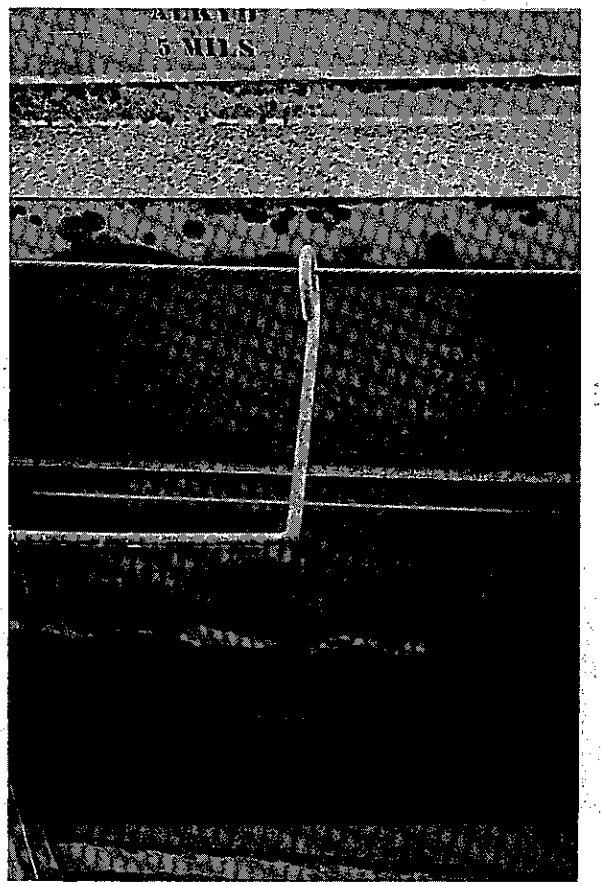
PHOTOGRAPHS TAKEN IN 1959 OF THE EXPERIMENTAL PAINT PANELS OF SAN SIMEON CREEK BRIDGE COATED IN 1953



System 8 Proprietary Alkyd - Red Lead Primer and Proprietary Aluminum Finish Coat.

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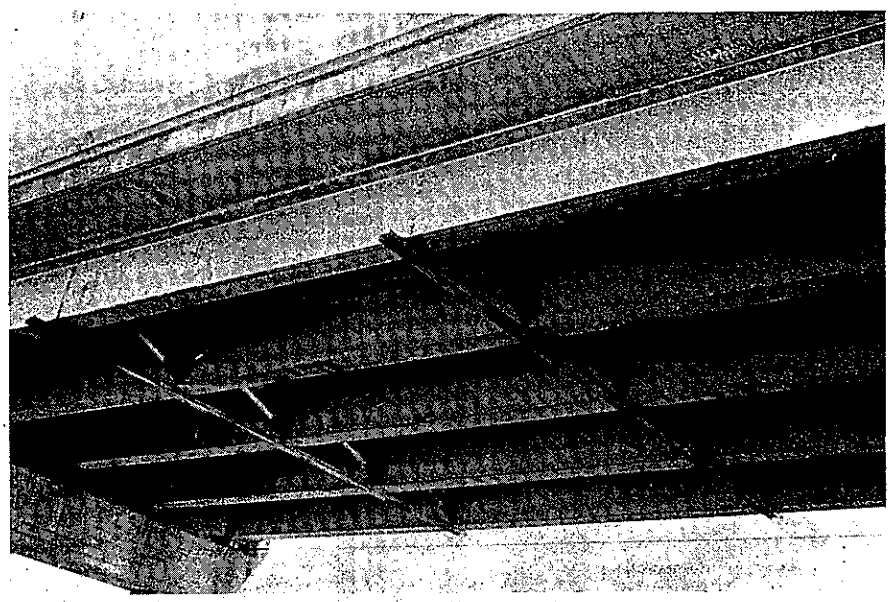
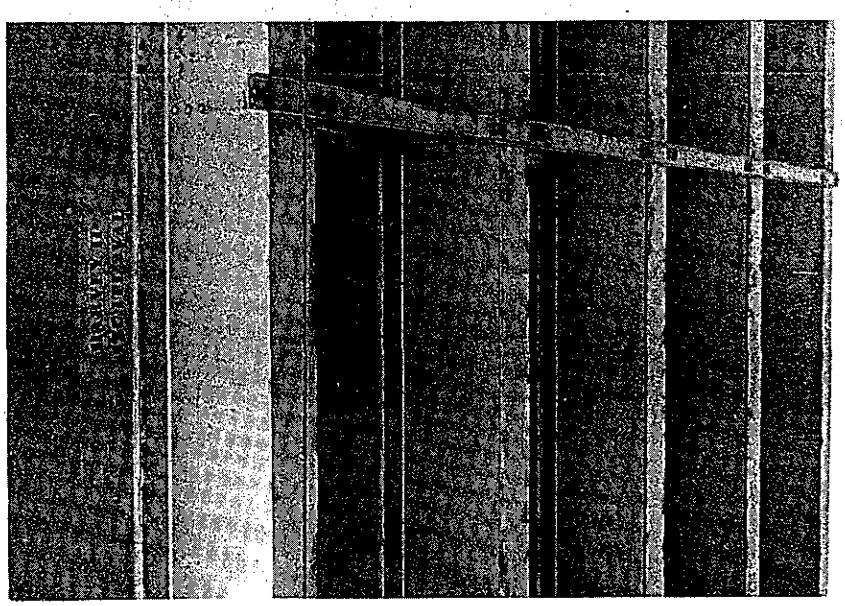


System 9. and 13 Harvey System I, Left third section of Span. Vinyl System, 8 mils middle section of span, Vinyl System, 5 mils, right section of span.



System 9. Harvey System II

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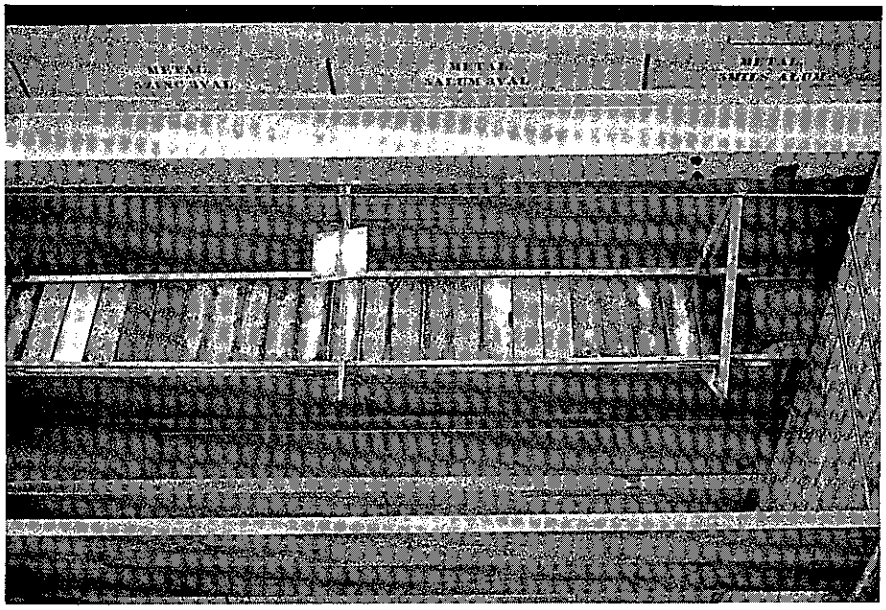
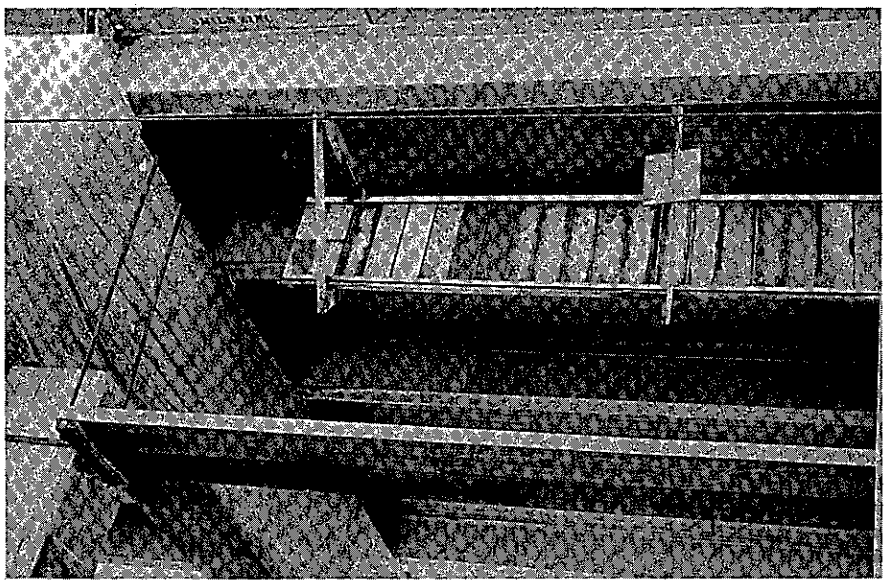


System 10. Zinc Metalizing-Vinyl Aluminum Finish Coat. Left Section of Span. Aluminum Metalizing-Vinyl Aluminum Finish Coat, Middle Section of Span. Aluminum metalizing, Right Section of Span.



System 10. Zinc Metalizing, Left Section of Span.

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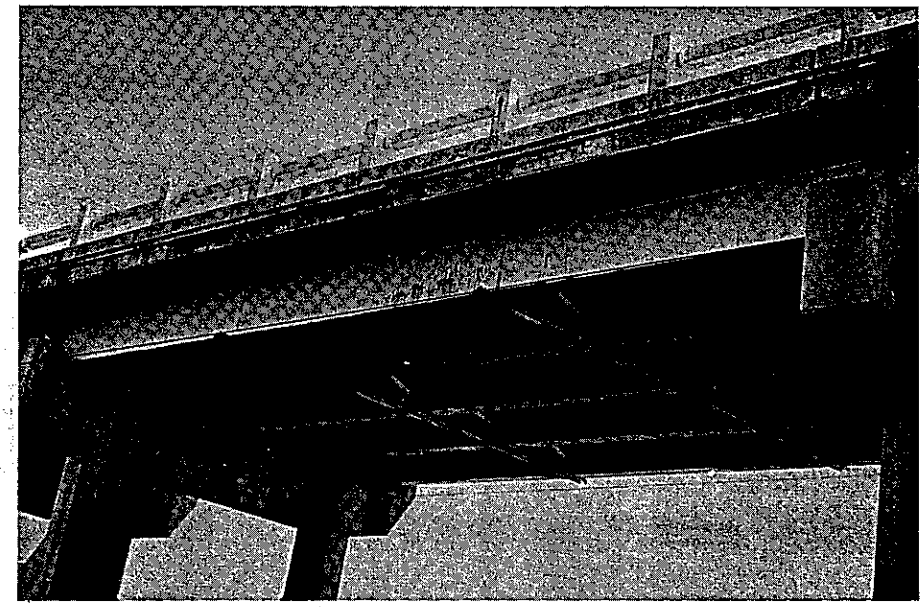
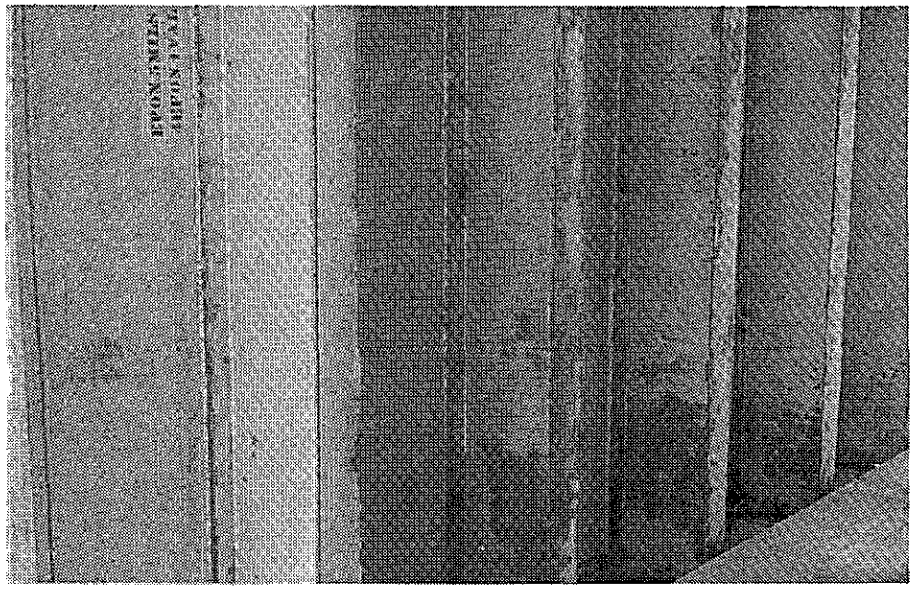


System 11. Linseed Oil-Alkyd-Red Lead Primer and No. 5 Aluminum Finish Coat.



System 12. Epoxy - Red Lead Primer and Vinyl Aluminum Finish Coat.

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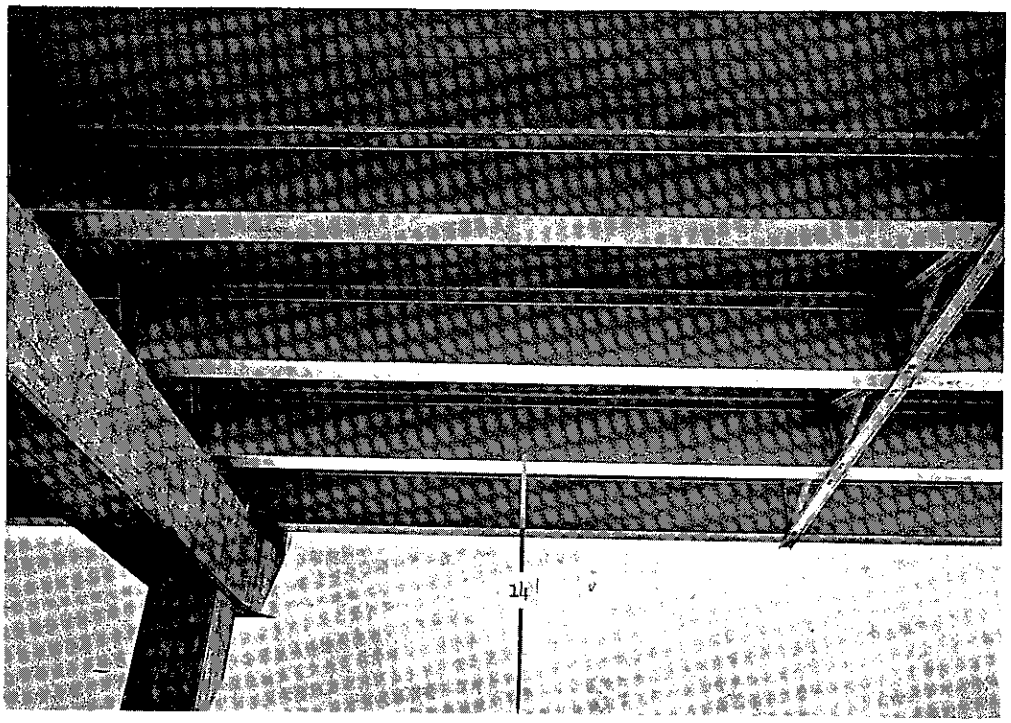
PHOTOGRAPHS TAKEN IN 1968 OF THE EXPERIMENTAL PAINT PANELS OF LEFFINGWELL CREEK BRIDGE COATED IN 1958



System 14. Inorganic Zinc Silicate Primer, Post Cure Type and Vinyl Primers and Vinyl Finish Coat.

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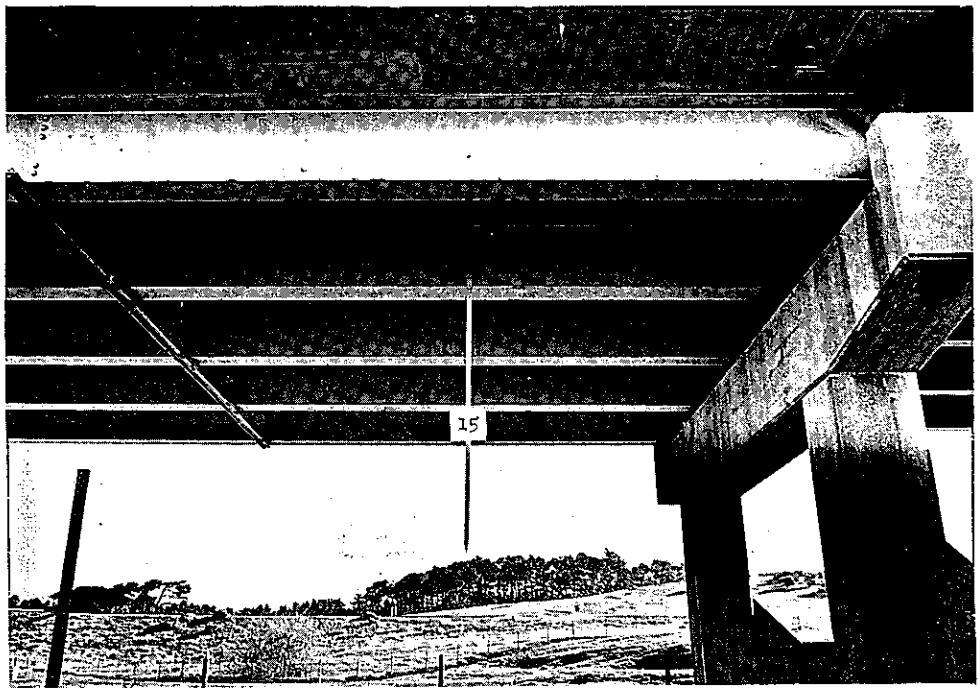
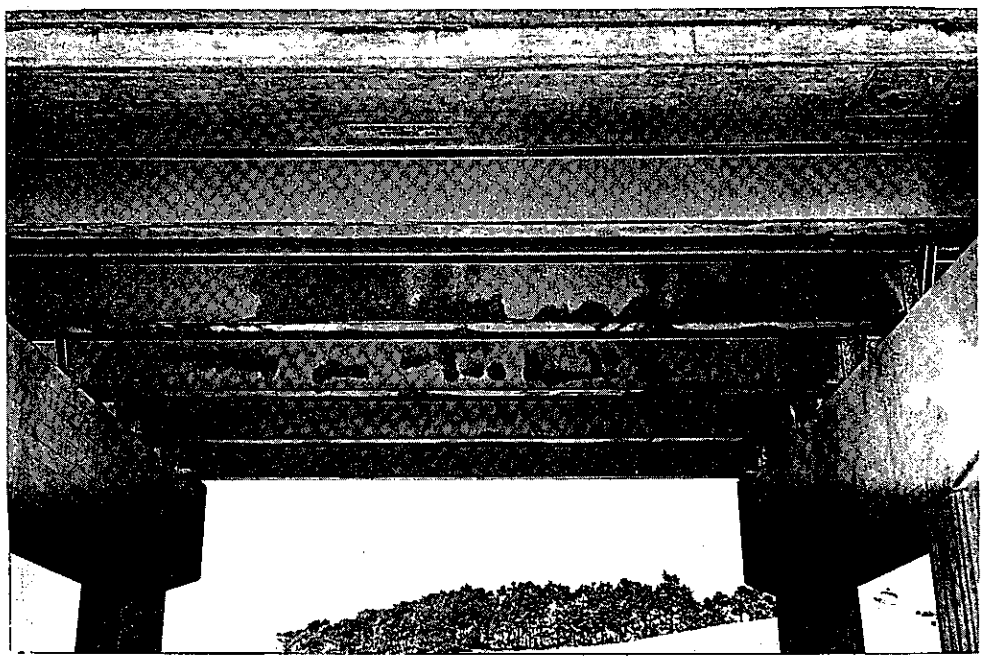


System 15. Linseed Oil-Alkyd Red Lead Primer, Traffic Paint Barrier Coat and Vinyl Primers and Vinyl Finish Coat.



System 16. 100% Solids Epoxy Coating After 3 Years Exposure. Photograph taken in 1961.

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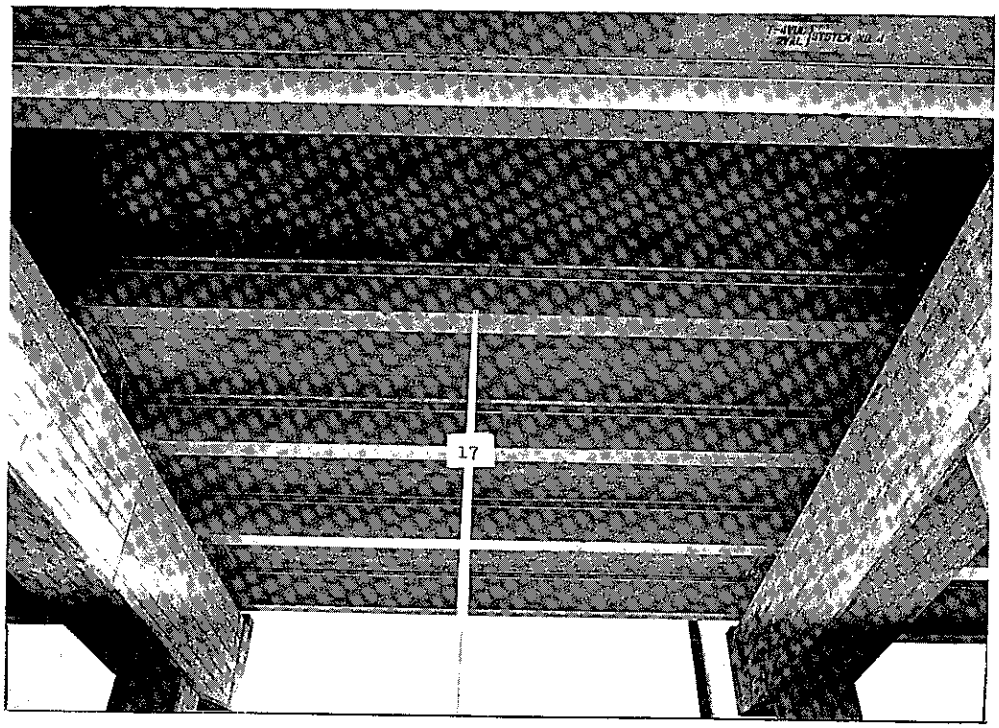
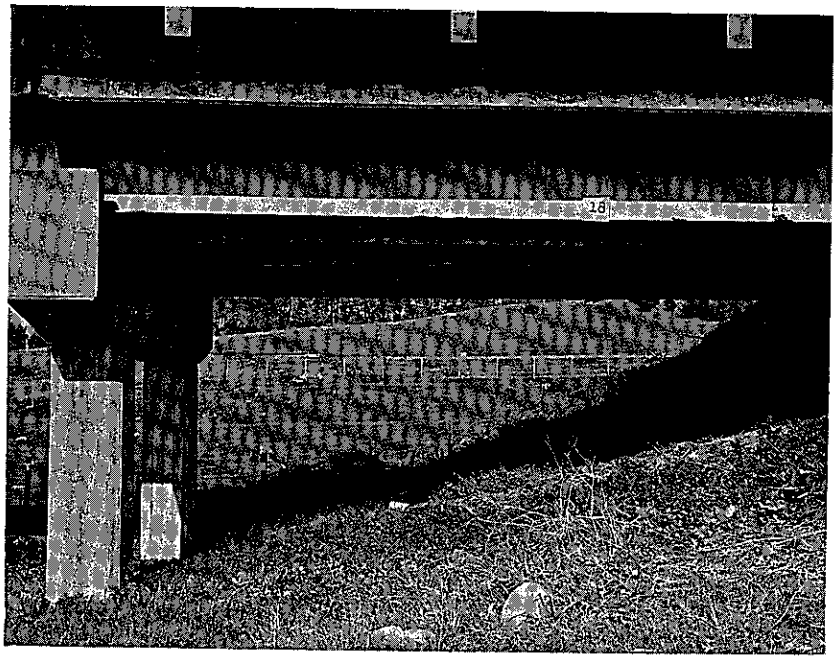


System 17. All Vinyl System



System 18. Linseed Oil - Alkyd - Red Lead Primer and Phenolic Iridescent Green Finish Coat.

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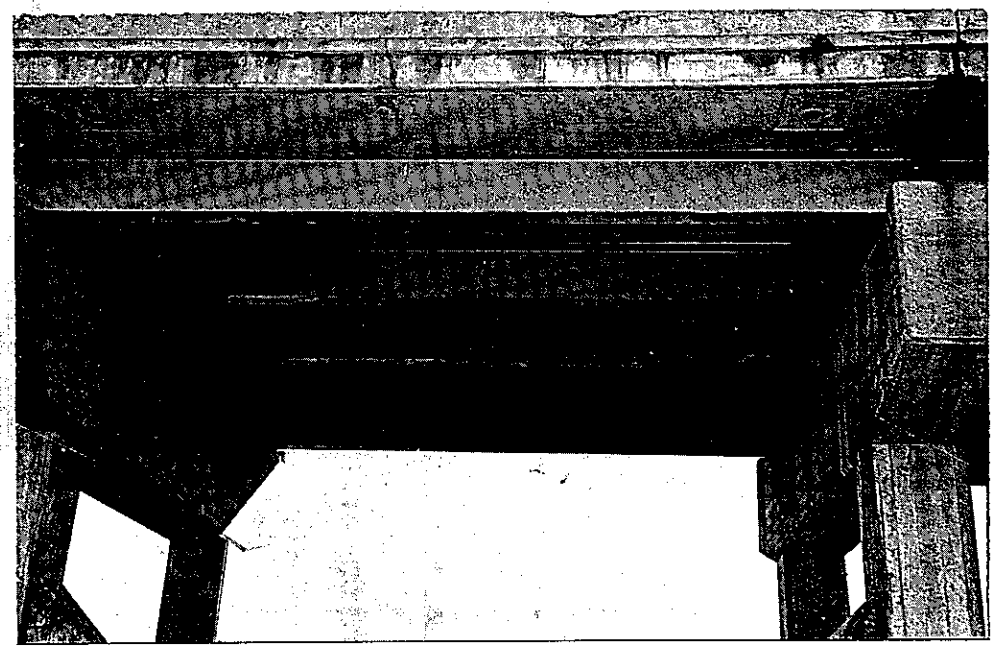
PHOTOGRAPHS TAKEN IN 1964 OF THE EXPERIMENTAL
PAINT PANELS OF SAN SIMEON CREEK BRIDGE
COATED IN 1959



System 19. Basic Lead Silico Chromate and Phenolic Iridescent Green Finish Coat.

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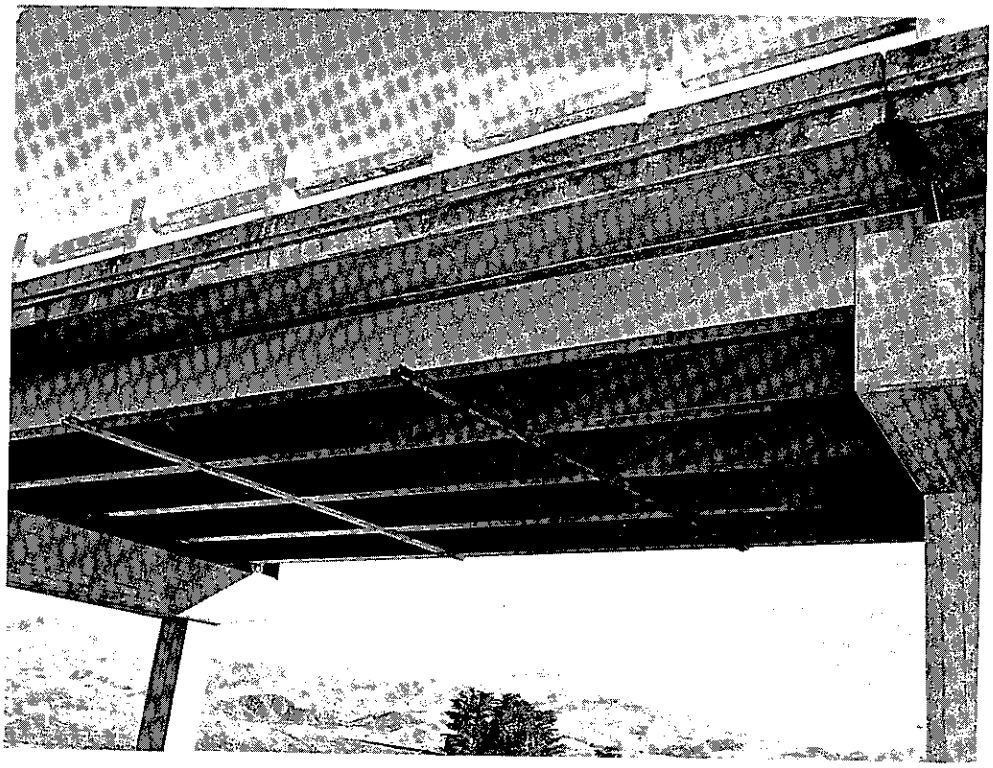

System 20. Linseed Oil-Alkyd-Red Lead Primer, State Specification 58-G-53 and Phenolic Iridescent Green Finish Coat.

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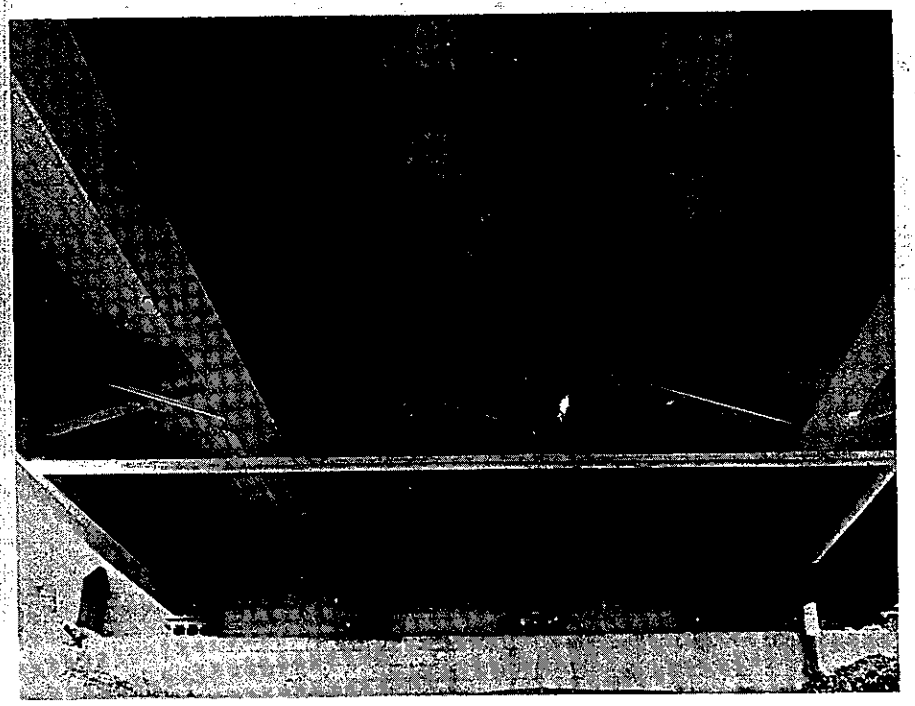
PHOTOGRAPHS TAKEN IN 1968 OF THE EXPERIMENTAL PAINT PANELS OF SAN SIMEON CREEK BRIDGE COATED IN 1964



System 21. Self-Cure Inorganic Zinc Silicate and Vinyl Intermediate and Finish Coats.

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