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"OVERCOATING STRUCTURAL STEEL CONTAINING LEAD BASED PAINTS - AN ECONOMICAL ALTERNATIVE TO TOTAL REMOVAL AND CONTAINMENT"

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OVERCOATING STRUCTURAL STEEL CONTAINING LEAD BASED PAINTS - AN ECONOMICAL ALTERNATIVE TO TOTAL REMOVAL AND CONTAINMENT

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It is estimated that 35-40% of existing bridges and industrial steel structures are coated with lead-containing paint. On a bridge where a maximum of 20-25% of its surface is corroded, use of the "overcoat" method is an alternate to full removal and containment.

Tight maintenance budgets can be stretched by utilizing the overcoat technology for repainting steel structures originally coated with lead based paint.

It is estimated that 35-40% of all existing bridges and industrial steel structures are coated with lead-containing paint. These structures are coated with hundreds of millions of pounds of lead that represents a potential imminent danger to the environment and worker health upon removal.

Total removal is a difficult and expensive proposition. It involves containing and collecting the old paint along with abrasive and other material used in the process, and proper disposal.

These costs have increased so much that on some projects, the facility owner can no longer afford to paint. Thus, some owners have postponed maintenance painting projects indefinitely, anticipating a time when the process is more affordable. However, postponing coating work may take its toll on many structures because significant steel section loss may result from inadequate corrosion protection (1).

The economics and environmental realities of maintaining today's structures is forcing many decision makers to consider marginal surface preparation prior to maintenance painting of steel structures. Power tool cleaning (SP-3 and SP-11)and hand tool cleaning (SP-2) may be the only option available to owners and maintenance personnel responsible for painting programs (2).

OVERCOAT CONCEPT

On a structure where a maximum of 20-25% of its surface is corroded, use of the "overcoat" method is an alternate to full removal and containment. An alternative to total blasting and containment, the overcoat painting technology can be a dramatically cost-effective, as well as environmentally sensitive means of refinishing steel surfaces originally coated with lead-based paints.

The overcoat system is defined as the process of applying a surface tolerant coating to a minimally prepared surface and existing layer of a lead containing coating. It is not implied that lead particles are neutralized, totally surrounded by or otherwise rendered harmless.

This paper describes materials and methods to be used for recoating steel structures which have suffered minor to moderate damage due to corrosion or weather.

THE OVERCOAT PAINT PROCESS

There are several strategies that can be used in overcoating steel structures.

1. Spot Repair and Full Topcoating

   For this option, the entire steel structure is power washed and those areas exhibiting paint deterioration or steel corrosion are prepared to the specified SSPC standards. The spot repaired areas are primed and receive a spot or full intermediate coating (optional depending on exposure environment). The entire structure is then topcoated.

   The areas of loose paint and the cleaning of rusted steel shall comply with SSPC standards: SSPC-SP1 for Solvent Cleaning, SP 2 for hand tool cleaning, SP 3 for conventional power tool cleaning, and/or SP 11 for special power tool cleaning. A bare metal profile may be cleaned by the use of needle guns and rotary peening tools to SSPC-SP 11. The bare steel areas shall have an ideal surface profile of 1 mil (25 microns) to 3 mils (76 microns). However, corroded areas will generally be rougher than this, which must be considered to prevent early rust-through at the profile peaks. Surface preparation procedures may need to be modified to prevent early rust breakthrough. The surface of each coat to receive a subsequent coating shall be clean, dry and prepared in accordance with the manufacturer's recommendations (4).

   Overcoating eliminates open air blasting so pollution containment and waste disposal costs are reduced. In addition, non-corroded lead-containing paints are left intact after water-blasting. This reduces surface preparation costs and allows for these paints to continue to provide protection.

   Project plans must provide for containment and disposal of all generated waste and debris in compliance with applicable environmental regulations.

2. Spot Repair

   For this option, cleaning and painting are limited to those areas exhibiting paint deterioration and/or steel corrosion. It is necessary to specify degree of cleanliness for the corroded areas and areas adjacent to or surrounding the corroded areas in accordance with paragraph (1). Areas to be cleaned should be power washed prior to performing any work.

3. Zone Painting

   This option involves special treatment of highly vulnerable portions or zones of a structure that may warrant topcoating at more frequent intervals, and possibly before the existing coating has started to deteriorate. Spot repairs, as noted in paragraph (1) above, may also be necessary. Typical vulnerable zones would include up to 5 ft. of the steel beams on each side of deck expansion joints, or up to 10 ft. above the deck, and bottom chords for through truss bridges, splash zones in water and sewerage treatment plants and highly corrosive areas of industrial facilities.

It is estimated that painting costs can be reduced from 30% to 75% using the overcoat method of maintenance painting (Tables 1-5). (5)

PRIMER'S SURFACE WETTING, CURING CAPABILITIES ARE KEY

The Homestead high-level bridge was successfully overcoated with a high-performance, three coat polyurethane system in 1978. Corrosion has occurred in less than five percent of the surfaces.

The spot primer and full intermediate coat were moisture curing polyurethane aluminum technology. The topcoat was a two component polyester aliphatic polyurethane coating.

Important to the success of the overcoat painting method are the special surface wetting, edge sealing and curing capabilities of the moisture-curing polyurethane spot primer.

The low-viscosity characteristic of the primer enables it to penetrate and wet out the old paint and tightly adhering rust. To cure, the

primer scavenges the moisture in the rust, atmosphere and existing paint.

In addition, the excellent wetting ability of the primer allows penetration of the primer under the old paint at the spot-cleaned areas. Upon curing by moisture, this helps seal both the surface and old paint.

The resulting polyurethane primer provides flexibility that helps prevent cracking and stressing of the paint film during freeze-thaw cycles. This important property has contributed to the long-term durability of the coatings used on the Homestead High-Level Bridge. The bridge had many spot-blasted areas that could have been sources of failure if paint lifting or stress cracking had occurred. Instead, the moisture-cured primer has provided a protective barrier.

INTERMEDIATE, TOP COATINGS DELIVER OUTSTANDING PROPERTIES

The intermediate coating must provide excellent adhesion to the primer and remaining lead-containing paint, as well as quick recoat time. It also must reduce the amount of corrosion-inducing oxygen and moisture passing through the paint film. It is very important that the intermediate coat will not attack or lift the existing paint.

A high-performance topcoat must provide superior light stability, weather resistance and chemical resistance. Consideration should be given to formulating a durable topcoat that makes it easy to remove graffiti without degrading the paint finish.

COATING EVALUATION

The most important factor in determining if a structure is a candidate is to determine if the existing coating system can be overcoated. This evaluation is conducted to assess the condition of the coating and the base metal at representative areas of the structure.

The following factors must be evaluated:

1. Approximate percent of rusted areas. At what percentages of rusted areas does owner specify complete removal of coating system?
2. Character of rust areas - light, moderate or severe corrosion.
3. Condition of steel under the coating.
4. Adhesion of existing coating to the steel.
5. Adhesion between layers of the coating system.
6. Serviceability or expected remaining life of the coating and/or repairability of the coating.
7. Determination of paint type and DFT of coating. In the case of aluminum pigmented alkyds, it must be determined whether the existing coating, to be painted over, contains leafing or non-leafing aluminum pigments. It may be difficult to develop proper adhesion between leafing pigmented paints and the new coating system.
8. Compatibility of the existing coating system/systems (test patch areas).

SURFACE PREPARATION

Method A: High Pressure Water Wash

High-pressure water wash can be used to remove dirt and contaminates from existing sound paint surfaces and corroded areas. There is no Steel Structures Painting Council (SSPC) Specification reference.

All exposed areas of existing steel members are cleaned by high-pressure water wash to remove chalking, dirt, dust, oil film or other deleterious material, so that new paint will adhere to the surface. There are several schools of thought regarding water pressure. One calls for hydrant pressures of 80-150 psi with large volumes of water. Another requires higher pressures (500-3,000 psi) and less water. The source and types of contaminates and degree of cleanliness will dictate the specification. Also, a non-sudsing, biodegradable detergent may be added to the water to optimize the cleaning operation. However, a rinse operation must follow and various environmental regulations may apply. In general, the purpose of the water wash is to remove loose chalk, paint, rust and dirt prior to the more extensive final surface

preparation necessary to the painting operation. Slight chalking may remain as evidenced by rubbing a hand over the existing coating surface.

Method B: Hand And Power Tool Cleaning

Another method of surface cleaning is Solvent (SSPC-SP 1), Hand Tool (SSPC-SP 2), and Power Tool (SSPC-SP 3) and Power Tool Cleaning to Bare Metal Cleaning (SSPC-SP 11). All exposed areas of existing steel members (the entire exposed steel structure) are cleaned by approved methods, in accordance with SSPC-SP 1, to remove dirt, dust, oil film, or other deleterious material, so that new paint will adhere to the surface. Solvent cleaning may be supplemented by scrubbing with water and mild detergent. Small areas of the structure that show pin-hole corrosion, stone damage from traffic or minor scratches are cleaned in accordance with SSPC-SP 2, SSPC-SP 3 or SSPC-SP 11.

Smaller surface areas where the topcoats are peeling or are badly deteriorated are scraped and cleaned by these methods. It is not the intent that large surfaces of corroded metal be prepared by SP 2 or SP 3 cleaning. Small containment areas may be more economical that utilize abrasive blasting.

COATING TEST METHODS AND PROCEDURES

The following test methods may be used to evaluate the coating:

1. Adhesion Testing of Coating to the Steel

   The adhesion test may consist of one or more of the following:

   a. SSPC Steel Structures Painting Manual, Vol. 1, Chapter 6, Inspection: Pen knife subjective coating adhesion evaluation (3).

   b. ASTM D-4541: Standard method for pull-off strength of coatings using portable adhesion testers. Test for adhesion of organic coatings. Elcometer adhesion test. Instrumentation testing of the tensile adhesion strength (psi) of coatings to the substrate. Location and frequency of testing is determined by the inspector.

   c. ASTM D-3359: Standard methods for measuring adhesion by tape test.

      Method A - X-Cut Tape Test

      Method B - Cross-Cut Tape Test

      Shear Adhesion Test, measuring adhesion by tape test. Location and frequency of testing is determined by the inspector.

2. Coating Cohesion and Adhesion Test

   Evaluation of coating cohesion and adhesion between coats is accomplished as outlined in Section 1.

3. Substrate Examination and Evaluation. The Test Methods Are As Described In the Steel Structures Painting Council Manual

   a. SSPC, Steel Structures Painting Manual, Vol. 1, Chapter 6, Inspection: Tooke gage examination through a 50x internal microscope.

   b. SSPC, Steel Structures Painting Manual, Vol. 1, Chapter 6, Inspection: Coating Inspection requirements specify use of a minimum 30x power pocket-sized microscope to examine the coating in field evaluations.

4. Dry Film Thickness Testing

   The gages which may be employed are:

   a. SSPC, PA2, SSPC Method for Measurement of Dry Film Thickness with Magnetic Gages, Type 1 gages.

   b. SSPC, PA2, Type 2 gage, fixed probe magnetic flux gages.

5. Coatings Cure Evaluation

   ASTM D-1640: Coating Cure Evaluation is specified as a recommended field method. Field evaluation of coating cure is generally difficult because there are no universally

reliable field tests for such purposes. Solvent rub tests, sandpaper test and microscopic examination can be utilized in field testing. If field testing results are inconclusive, coating samples can be taken for extensive laboratory analysis.

PROJECT SUCCESS

A painting project has more variables that are critical to its success than most construction projects. Improper surface preparation, inclement weather and the wrong choice of materials for that particular application can have catastrophic results.

There are six steps to obtaining the best possible paint system on a bridge:

1. Choose the best paint system available to achieve maximum performance.

2. Write a specification that is understandable and enforceable.

3. Design maintenance free structural steel details that won't collect debris and moisture. Eliminate weld spatter and provide access for future cleaning and painting.

4. Choose a qualified reputable painting contractor.

5. Provide good construction inspection that is both fair and consistent.

6. Follow-up with a routine and sound maintenance program to eliminate corrosion problems at the earliest stage in their development.

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(1) K. A. Trimber, Industrial Lead Paint Removal Handbook, 1991, SSPC Publication 91-18.

(2) Kline, Eric S. and Corbett, William D., "Beneficial Procrastination: Delaying Lead Paint Removal Projects by Upgrading the Coating System," JPCL, March 1992, pp 48-56.

(3) SSPC, Steel Structures Paint Manual, Vol. 2, 1990, SSPC.

(4) AASHTO, Guide for Painting Steel Structures, 1994.

(5) SSPC, Special Report: Overcoating Lead Paint, JPCL Reprint, November 1993.

Estimated Costs of Overcoating Bridges

Table 1 (5)

	Structure	Area Sq. Ft.	Area Sq. M.	Cost $/Sq. Ft.	Cost $/Sq. M.
1	Bridge over river	40,000	3,716	2.00	22
2	Highway overpass	10,000	929	3.00	32
3	Highway overpass	18,000	1,672	2.75	30
4	Bridge over wharf	20,000	1,858	2.00	22
5	Riveted girder span	8,000	743	3.00	32
6	Rail bridge trusses	300,000	27,871	2.00	22
7	Deck truss	1,000,000	92,903	5.00	54
19	Overpass	10,000	929	1.05	11
21	Girder, double deck	350,000	32,515	4.00	43
	Average			2.76	30
	Median			2.75	30

Estimated Costs of Full Removal for Bridges

Table 2 (5)

	Structure	Area Sq. Ft.	Area Sq. M.	Cost $/Sq. Ft.	Cost $/Sq. M.
13	Girder over river	500,000	46,452	4.00	43
14	Girder overpass	180,000	16,723	6.75	73
15	Tied arch over river	220,900	20,522	11.21	121
16	General, recyclable	N/A	N/A	12.00	129
17	General, disposable	N/A	N/A	10.00	108
18	7 spans over water	100,000	9,290	18.00	194
19	Overpass	10,000	929	3.30	36
20	Overpass	20,000	1,858	8.50	91
21	Girder, double deck	350,000	32,516	8.00	86
22	Suspended cable/river	300,000	27,871	12.00	129
	Average			7.47	80
	Median			7.50	81

Estimated Costs of Full Removal

Table 3 (5)

Structure	Area Sq. Ft.	Cost $/Sq. Ft.
Exterior pipe rack	798	8.00
Brewery pasteurizer	2,000	5.00
Tank at pulp mill	30,000	4.87
600 gal. tank	350	2.50
Elevated water tank	N/A	4.50
Furnace building	120,000	5.00
Galvanizing plant	65,000	9.00
Gasoline storage tank	88,000	4.50
Ship loading wharf	30,000	40.00
Elevated water tank	N/A	11.00
Coal conveyor	380,000	10.00
Hydro dam	11,700	11.96

Estimated Costs of Full Removal

Table 4 (5)

Structure	Area Sq. Ft.	Cost $/Sq. Ft.
Elevated water tank	50,000	9.00
Exterior - stucco cement	8,000	6.00
Electrical substation	200	15.00
Elevated water tank	9,000	9.50
Liquid oxygen tank	257	40.00
Brick office building	600	16.67
Concrete block building	2,400	17.17
Spillway gates	11,000	8.00
Elevated water tank	1,500	20.00
Chemical plant building	87,000	16.67
Galvanizing plant	65,000	9.00
Liquid propane tanks	6,100	3.16
Average		11.94
Median		9.00

Estimated Cost Distribution - Overcoating vs. Full Removal

Table 5 (5)

Cost Factor	Cost Range Per Square Foot * Overcoating	Full Removal
Coatings Materials	$0.25 - $0.55	$0.40 - $0.65
Surface Preparation	0.10 - 0.60	0.75 - 1.30
Application	0.30 - 0.70	0.45 - 1.05
Environmental Monitoring	0.00 - 0.20	0.00 - 2.00
Containment and Disposal	0.50 - 2.00	1.00 - 4.00
Worker Health	0.50 - 2.00	1.00 - 2.00
Overhead/Miscellaneous	0.25 - 1.00	0.40 - 2.00
	$1.90 - $7.05	$4.00 - $13.00

* To convert to cost per square meter, multiply by 10.8