# FHWA Bridge Coatings Technical Note: Overcoating (Maintenance Painting)

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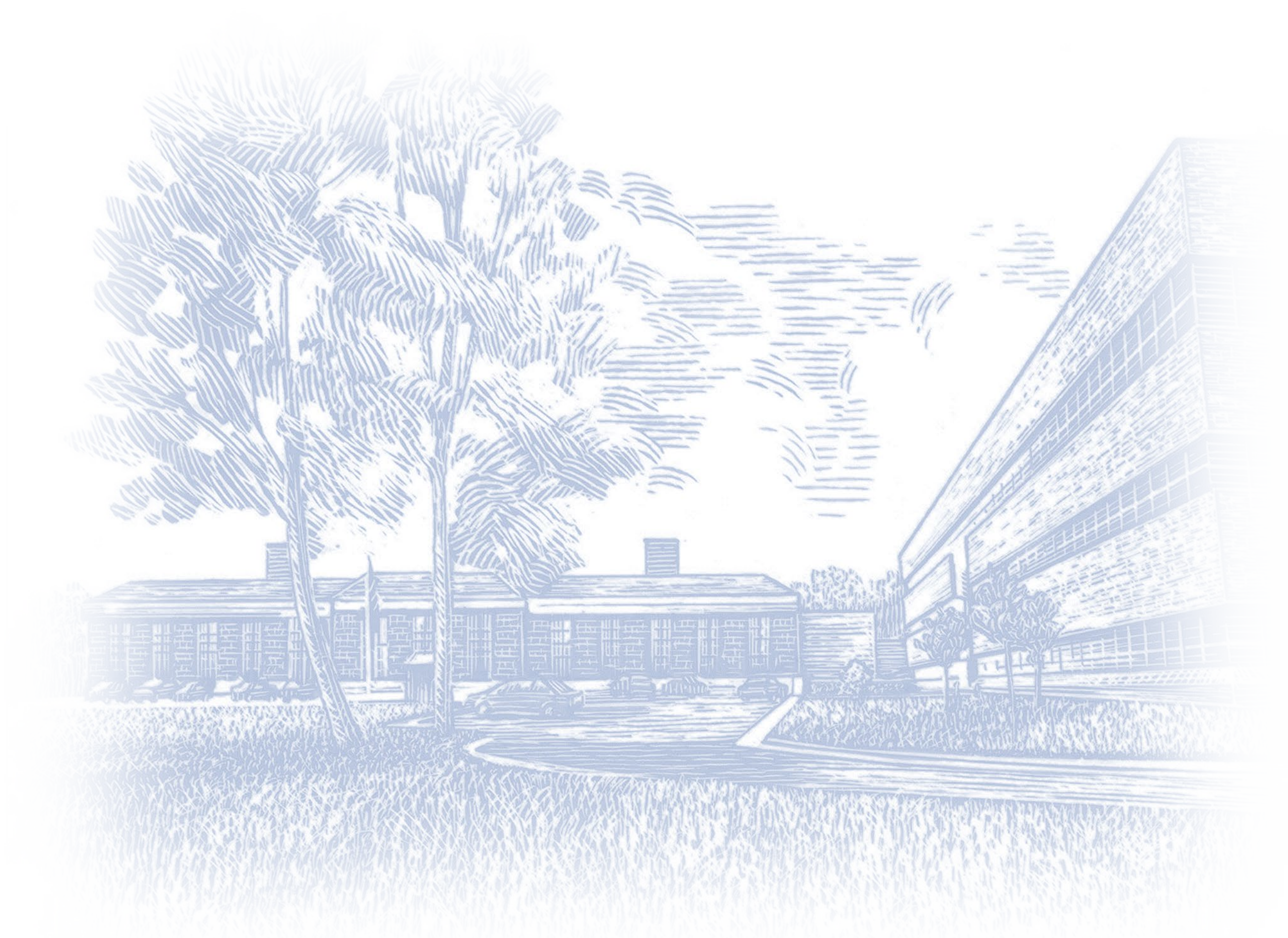

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**From: Bridge Coatings Technology Outreach Team**

**Topic: Overcoating (Maintenance Painting)**

## Description

Over the past several years, "overcoating" has become the common term used to describe bridge maintenance painting operations which only partially remove existing paint and apply new coatings over a mixed substrate of existing paint, bare steel, and rusted surfaces. The practice of overcoating encompasses and is very similar to traditional maintenance and touch-up painting that has been conducted for many years. Overcoating differs from traditional maintenance painting in the following ways:

- Traditionally, maintenance painting was either accomplished as part of routine lifecycle maintenance (for larger bridges) or in conjunction with other maintenance activities (e.g., steel component replacement, etc.). Overcoating is now viewed as an "alternative" to full removal and replacement of a failed existing paint system.
- Due to increasing cost constraints, overcoating is now being viewed by some bridge owners as a primary bridge rehabilitation option. That is, a reasonable substitute for abrasive blasting and application of a full paint system.
- Maintenance painting has generally involved the application of coatings similar to those already applied (e.g., lead-containing alkyd over existing lead-containing alkyd). Overcoating, as currently practiced, may involve the application of materials vastly different from those previously applied.

Overcoating operations vary widely depending on the condition of the existing steel and paint system and the specified surface preparation and new coating system, but generally these operations have the following components:

1. **Washing** - bridge areas to be cleaned and repainted must be washed to remove dirt, bird litter, grease and soot. Washing is generally accomplished using a pressure washer or steam cleaner. Sometimes detergents are specified and various pressures and volumes of water may be used. Some type of washing step should be included in all maintenance painting operations as the removal of contaminants from the surface has a significant effect on the performance life of any applied coating system. The goal is to remove surface contaminants and not the existing coating system per se; however, some loose paint and rust will be removed by most washing operations.
2. **Mechanical surface preparation** - mechanical removal of loose paint and rust generally follows washing. This operation may vary from light hand tool cleaning with scrappers or wire brushes, to removal of all visible rust and loose paint with vacuum shrouded power tools or vacuum blasting machines. The level of cleaning specified is dependent upon the severity of the environment, the extent of paint failure and the degree of corrosion of the steel in the area of failed paint, the expected life of the applied maintenance system, and the budget for the operation. The goal of this step is to remove rust and non-adherent paint while leaving as much of the intact existing coating system as possible.
3. **Overcoat system application** - there are currently many different paint systems sold as "overcoating" or "surface tolerant" coatings. These vary from high-build, single coat systems to multiple coat systems with sacrificial or inhibitive pigments in the primer coats. In general, multicoat systems are intended for spot primer application over the bare steel areas with full overcoating of the structure with one or two additional coats.

## Key Variables for Overcoating Success

Several variables have a significant effect on overcoating risk for bridges. These factors are described in detail below:

- **Condition of Existing Coating** - The most commonly used coatings during original construction of highway system bridges were single component oil-alkyds containing lead or lead/chromate pigmentation. These coatings were generally applied in multiple thin coats totaling 6 to 12 mils. After many years of exposure to the environment, these alkyds have become brittle and inflexible, and heavily chalked in areas exposed to sunlight. This aging and deterioration of the coating film has, in most cases, severely reduced both the cohesive and adhesive strength of the coating system. In overcoating maintenance, the existing coating which remains after cleaning and minor surface preparation of the structure will serve as the chemical and mechanical basis for adhesion of any new applied coatings. If the existing coating has lost the majority of its cohesive and adhesive properties, an applied overcoating will be at the mercy of the disbonding of the original poor coating. In large part, the degree of risk associated with overcoating is directly related to the remaining adhesion and cohesion of the original coating. Measurement of adhesion of the existing coating by methods ASTM D4541 or ASTM D3359 (or by cutting to existing coating to the substrate and attempting to lift with a knife blade), is an important step in determining the acceptability of an existing system for overcoating.
- **Millscale** - Prior to 20 to 25 years ago, most highway bridges were fabricated from steel members covered with intact millscale. Most painting was accomplished directly over the millscale. Millscale is a relatively poor surface for coating adhesion and performance. Intact millscale can be protective to steel in the short term, but once breached, the millscale will tend to electrochemically accelerate the corrosion of adjacent bare steel. The presence of millscale can add to the risk associated with overcoating by limiting the adhesion of the overcoating paint and accelerating deterioration of the existing coating and the new overcoat at the site of any holidays or breaches in the paint film.
- **Surface contamination and corrosion** - paint performance can almost always be directly related to the quality of surface preparation. This is particularly true for paints applied over previously rusted or contaminated surfaces. In overcoating, the washing and mechanical surface preparation steps remove some, but not all of the rust and non-visible contamination from the surface. While some coatings are formulated to adhere to and perform better than others over contaminated or rusted surfaces, no coating will perform better over a contaminated surface than the same coating over a clean surface. Maintenance paints applied over previously pitted surfaces or over adherent or "packed" rust will likely fail first in those areas.[5,6]

## Cost Impact

Cost is the most common driver for the selection of overcoating versus full removal and replacement of existing paint systems. Due to the dramatic increase in costs for full maintenance painting operations spurred by environmental and worker safety regulations, overcoating has become increasingly popular. Present costs for overcoating lie in the range of $1 to $3 per square foot while full removal and replacement of paint systems is $5 to $20 per square foot. This large difference in initial cost of maintenance has made the choice of overcoating quite attractive to bridge owners. **While overcoating may be a viable maintenance and economic option in some cases, the feasibility of overcoating a particular bridge should also be based on the relative potential performance of each maintenance option** and the risk associated with potential early failure of overcoating systems. While an analysis of initial costs of various options will almost always point to overcoating, a life cycle analysis will often show full paint removal and application of a high durability coating system to be the most cost effective option, particularly for bridges or areas of bridges in marine environments or exposed to significant deicing salt application.

## Minimizing Risk

As detailed above, the performance of a newly applied overcoating is expected to be highly dependent upon the condition of the existing coating over which it is applied. Overcoating over existing aged paints that are often brittle and loosely adherent can pose a significant risk of early failure and large scale disbondment. The applied overcoat applies added stress to the existing coating in various ways; **an additional coating adds physical weight to the existing coating**; as the new coating drys or cures it shrinks which adds stress to the existing coating; as the ambient temperature cycles, the two paint systems expand and contract at different rates, adding stress to the existing system; and, the solvent contained in the overcoat can soften the existing coating and reduce its mechanical properties.

The risk of early failure cannot be avoided, but the following steps can minimize this risk:

1. Prior to deciding to overcoat a particular structure, assess the condition of the existing steel and paint system. Condition can include extent and distribution of rusting, and adhesion. The extent of metal loss due to corrosion and the extent and distribution of paint breakdown are important in determining the scope of the work required to clean and overcoat the structure. Paint failure confined to specific definable areas is easier to clean and overcoat than general paint failure over the entire structure. Adhesion should be assessed using either standard test methods (ASTM D4541 or D3359) or by attempting to cut and lift the coating with a knife blade. If the coating lifts easily or crumbles at the tip of the knife blade, then application of overcoating paints should be considered high risk.
2. Conduct a representative patch test of the new material over the existing material using representative maintenance painting practices. Allow this patch to weather several seasons and assess the compatibility of the systems. Research has shown that reasonably good performance is achievable with various different overcoating materials. A patch test will help eliminate coatings grossly incompatible with the existing paint on the structure.
3. Where possible consider using coatings similar to those currently on the bridge. Some investigators have seen good results from the application of newer, but generically similar alkyd coatings over older existing alkyd coatings. Some of the older technology coatings may present a compromise in overall durability when compared to newer coating materials, but in a maintenance mode, the compatibility of these materials is a definite advantage.

## Performance Experience

Several investigators have assessed the viability of overcoating and the relative performance of various overcoating materials in the recent past. Some evaluations have been performed in laboratory accelerated tests, but for the most part, patch or area tests on in-service structures have been used. Evaluations have brought mixed results. Several materials have proven to provide good service for several years in overcoating applications, but no paint material marketed as an "overcoating" or "surface tolerant" paint has proven to be a direct substitute for good surface preparation. Although the specific coating material chosen for a particular maintenance painting operation is certainly of importance, it is quite often other critical variables which determine the success of failure of an overcoating job. These factors include: the condition of the existing paint, the extent of corrosion on the substrate, the level of surface cleanliness achieved, and the environment of exposure. **A recently completed FHWA-sponsored study of various overcoating materials applied to bridge structures in various parts of the country resulted in the following general results: (a) Multicoat systems, overall, performed better than single coat systems, with three coat systems showing generally better performance than two coat systems. This result is thought to be directly related to the occurrence of holidays and pinholes during brush application of maintenance coating materials; however, it shows a measurable benefit of the application of multiple coats in a realistic scenario. Other studies have shown similar results.**

**(b) Coating materials performing well in the study were 3-coat moisture-cured urethane systems, and three-coat epoxy based systems using a penetrating low-viscosity sealer as a primer. In addition, two separate 3-coat low-VOC alkyd systems also performed well. Of the single coat systems, the coatings based on calcium-sulfonate alkyd resins did best. Similar generic results have been found by other investigators.**

**(c) In general, coatings that did well at any one test site did well at all four, diverse test sites (indicating some measure of surface tolerance, or "overcoating acceptability" for specific paint materials). Also, those materials that failed badly and early at any one site generally failed at more than one site. This would lend support to the use of patch tests as screening for acceptability of a particular overcoating material on a particular structure.**

In the subject testing, failures were of two varieties, (1) early coating disbondment due to incompatibility of the overcoating material with the existing paint, and (2) rust through of the newly applied overcoating material at areas where the coating is over bare steel or existing rust.

*Case (2) is well documented and not surprising. Virtually all coatings tested over "less-than-ideal" surface preparations will have a service life shorter than the same coating material applied over a clean surface., With respect to case (2) type failure, a considerable database of material performance results exists. Testing of paints on steel panels prepared to and SSPC SP-3 or SSPC SP-11 surface preparation (i.e., power tool-cleaning) has yielded enough results to use these data to judge the expected service life of maintenance coatings (overcoatings) when no gross incompatibility failures occur.*

*Case (1) failures are more difficult to quantify and almost impossible to prepare for as a bridge owner. For this reason, patch testing of a material and weathering for at least one or two (recommended) seasonal cycles on the structure of interest is recommended as a conservative approach to avoiding early failure of the overcoating application. Having done this and used existing data to predict a reasonable service life for the applied maintenance paint in the actual environment of the bridge over bare SP-3 steel, a reasonable prediction of the service life of the overcoating system as a whole can be made. This life prediction can be used to determine the life cycle cost of the overcoating application versus various other candidate maintenance painting options for the structure.*

## Regulatory Compliance

*Worker Protection* - Although overcoating operations are intended to minimize the removal of existing paint from a structure, if the existing paint contains lead, contractors must abide by the provisions of the OSHA Lead-in-Construction Standard (29 CFR 1926.62) for worker protection.

*Environmental Compliance* - Overcoating jobs do not generate the volume of lead-containing waste that abrasive blasting operations do; however, the paint chips removed and often the wash water used on the bridge must be collected and disposed of properly. Local environmental protection requirements will vary for jobs of this type and size.

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