



Aesthetic Coatings for Wisconsin Bridge Components

PUTTING RESEARCH TO WORK

BRIEF

Over the past several years, the Wisconsin Department of Transportation (WisDOT) has experienced performance-related issues with aesthetic and protective coatings used on Wisconsin bridges. Public agencies make significant investments in coating materials to enhance the aesthetics and durability of steel bridges and their components. It is expected that these coatings should have reasonably good quality and performance over the relatively long service life of such structures (between 50 and 100 years). Proper material selection and application of aesthetic/protective coatings for bridges should help achieve the expected service life and reduce associated maintenance cost. The intent of this research project was to evaluate the effectiveness of available aesthetic and protective coating materials for Wisconsin highway steel bridge applications and to develop recommended specifications and guidelines for future selection and application of coating materials.

What is the problem?

The primary causes of coating failures in steel bridge applications are ineffective surface preparation prior to application, improper application and poor choices in material selection. Through selecting appropriate coating materials and using proper application processes, the service life of the coating can be increased. This will reduce the overall required cost for bridge maintenance and enhance the longevity of the bridge structure. The primary problem that can result from poor choice and application of coating materials in steel bridges is corrosion of steel substrate. Even partial or local failure of a coating system can cause exposure of steel to harmful environments including exposure to chlorides that result in corrosion. Not only does corrosion affect the aesthetics of a bridge, but it can impact the structural integrity and reduce the overall life span of the structure.

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Baraboo bridge railing damage due to freezing



Jefferson bridge loss of adhesion in rail coating

Research Objective

The objectives of the research were as follows:

- Identify appropriate coating materials that can enhance the aesthetics and durability of steel bridge components over a long period of service
- Conduct laboratory tests to verify long-term performance and quality of the selected materials
- Develop guidelines and specifications language for appropriate selection, surface preparation, and application of such coating materials, and to make implementation recommendations.

Methodology

From field visits throughout Wisconsin on various bridges, surveys of U.S. bridge owners and coating manufacturers and a literature review, information was gathered on individual coating types, coating systems, surface preparation, application, performance and accelerated weathering tests. Three types of coating systems were selected for this study: 2-coat zinc-rich systems, 3-coat zinc-rich systems and duplex systems (coating over galvanized steel).

Twelve steel coating systems were evaluated. These coating systems included 3-coat and 2-coat zinc-rich coating systems, duplex liquid coating systems and duplex powder coated systems. The selected coating systems were applied to the appropriate steel and galvanized substrates, and their performances were compared using two different accelerated weathering tests. These accelerated tests included a Freeze/UV/Prohesion test and Xenon Arc test. The Freeze/UV/Prohesion test subjected test panels to cycles of Freeze, UV light and Prohesion (Salt Fog). The Xenon Arc test subjected panels to cycles of Xenon light (full sunlight spectrum). During and after testing, evaluations were made based on different criteria including changes in gloss and color, rust creepage, holidays, adhesion and flexibility.

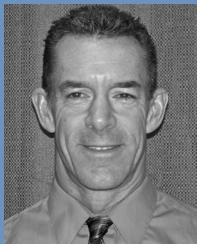
Results

- In most cases, the duplex coating systems gained greater adhesion properties than zinc-rich 2- and 3-coat systems. The enhancement was observed both after the initial coating application and after the completion of the accelerated weathering tests.
- Since only two 2-coat systems were included in the test program, no conclusive results could be obtained. However, for 2-coat systems to be effective, correct application by skilled operators is essential to ensure proper coverage in all areas. Unlike 3-coat systems, 2-coat systems have smaller tolerance to deficient application. In a 3-coat system, there is one additional coat, or layer of protection, that overcomes any unintended deficient coating application that may have been placed in some areas. The effectiveness of the 3-coat systems can be seen, especially in aesthetic railings where usually there are complex geometries and areas that are hard to reach during coating application that may result in thinner coating.
- The 3-coat fluoropolymer coating system has better color and gloss retention than the 3-coat polyurethane system; however, this may not justify its significantly higher cost over the 3-coat polyurethane coating system.
- While having the same initial cost and lower maintenance cost, the use of galvanized railing in duplex coating systems will yield far better aesthetic and protection results than the conventional 3-coat polyurethane or fluoropolymer systems. In aesthetic railings, galvanization can offer additional protection along sharp edges and corners where lower dried film thickness generally results and make them susceptible to corrosion failure.
- The most significant problem with the duplex powder coating systems (with the top coat including a mid-grade polyester and a top-grade fluoropolymer) was the coating application. During the application of both powder coat systems, extensive out-gassing problems existed that created multiple small craters or bubbles in the finished powder coat surfaces. Although good performance was observed for color and gloss retention, these coating systems were determined not to be a viable option for use on aesthetic steel bridge railings at this time due to potential high cost and until the out-gassing problem is resolved by the manufacturer.

Recommendations

The researchers recommend that only the galvanized liquid duplex coating system be used for highway and bridge railings. The most desirable performance may be achieved by using a fluoropolymer coating material on galvanized substrate, but this system was not included in the test program. It will be advantageous to include duplex systems with fluorocoatings in a future study. For galvanized railing members, special attention must be paid to surface preparation and fabrication of the number of vent holes in required locations to minimize water entrapment (additional language should be added to the WisDOT Special Provisions for galvanized railings). If non-galvanized steel is used for bridge railings, adequate drainage of water must be provided through fabricating the number of drilled holes and offering proper slopes to prevent water from becoming trapped inside the railings. Since galvanization of large steel girders (i.e. plate girders) is generally not practical, use of three-coat polyurethane coating systems is recommended for acceptable performance. A follow-up project will investigate the aesthetic properties of additional colors.

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