

MATES

MICHIGAN DEPARTMENT OF TRANSPORTATION

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LABORATORY EVALUATION PROCEDURES FOR BRIDGE PAINTING SYSTEMS

Bridge painting with organic zinc-rich epoxy primer, white epoxy intermediate coat, and a urethane topcoat has been recognized as Michigan's 'new' bridge painting system for several years. This system evolved from a number of other experimental paint systems designed to replace the 'old' red lead coatings. After years of laboratory and field work, our current coating system fulfills the requirements of best life-cycle cost performance, protecting the environment, allowing paint to be applied in the climatic conditions that exist during Michigan's summer months, and keeping within an economically feasible budget.

In previous years sprayed-on materials of many types have been evaluated. The materials have included inorganic zinc-rich primer with vinyl, epoxy, or urethane topcoat, and a brushable system compatible with the old red lead systems, as well as our present system. During the developmental process, some of these systems have been used on selected bridges, and performance results caused further changes in the systems. The vinyl topcoat faded unevenly and some moisture-cured urethane peeled. Yet, it was through such experimental applications that our current system evolved.

This new system is one of the best available paint systems today; however, experimental formulations of coatings are always being developed. To stay up to date with these products, the Materials and Technology Division conducts yearly evaluations of the current bridge paint system, as well as experimental systems for possible future use.

The evaluation procedure includes the following steps:

- 1) Submission of the materials by the manufacturer,
- 2) Application of the materials to test panels in the laboratory,
- 3) Testing and evaluation of paint test panels,
- 4) Quality assurance for field application of the accepted materials.

Submission of Material

Each year a package of literature is sent to paint manufacturers across the U.S. and Canada. This package invites the manufacturers to submit paint for our structural paint evaluation program. It includes Michigan's performance specifications, including the current Qualified Products List (QPL), procedures for sample submission, a copy of the manufacturers' results (where applicable) with an explanation of the computer printout and finally, a copy of the report, "The Development of Michigan's Performance Specification."

The requirements for our current coatings include the following:

- 1) All products must be from the standard product line of the submitting company, i.e., special products just for Michigan are not allowed.
- 2) A history of good field performance and/or accelerated test results must be supplied for any product not previously tested in the Michigan program.

3) In order to remain on our QPL, a system must be tested every year, by MDOT as described below.

4) All products must be free of lead and chromate except for trace amounts in driers. (Zinc and the other coating constituents are environmentally safe.)

5) All intermediate coats shall be white.*

6) Topcoats shall be light blue or light grey.

7) The primer must meet the Structural Steel Painting Council definitions for an organic zinc-rich primer.*

8) The system must contain an epoxy intermediate coat and a urethane topcoat.*

This year, paint manufacturers submitted material in three different categories:

1) Our current system: first coat, organic zinc-rich epoxy primer; second coat, epoxy intermediate; and, third coat, urethane topcoat.

2) Low volatile-organic-content (VOC) systems including water-based coatings.

3) Cold-temperature systems which can be applied at 35 F.

The latter two types are included to develop acceptable coating systems meeting proposed low VOC environmental restrictions, and to experiment with coatings that may be applicable during a wider range of weather conditions. To date, no cold weather systems have been approved for general use.

Application of Material to Test Panels

Once the materials have been submitted, the Research Laboratory subjects them to a series of tests. First the coatings have to be properly applied to standard 3 by 6 by 1/4-in. steel panels. Each panel must have the edges rounded, a solvent wash to remove any grease film, an identification number stamped on the back of the panel and, finally, they must be abrasive-blasted to obtain a 1.0 to 2.5-mil surface 'profile,' or anchor pattern, prior to painting. ('Profile' is the surface texture that helps the paint stick to the surface. A mil is one one-thousandth of an inch.) Seven panels are prepared for each coating system submitted.

When each panel is ready to paint, the coatings are prepared. The coating may be a one, two, or three-component paint. Each component must be thoroughly mixed before combining in the proper ratio. These coatings are mixed with a high-shear mixer until a smooth, lump-free consistency is obtained. When preparing for the cold-temperature systems, the individual components are cooled to the 35 F limit before mixing is begun. These products tend to have a higher viscosity (thicker consistency) than the other groups of coatings. If it is necessary to thin the coating, the thinning is done in accordance with the manufacturer's recommendations.

*These requirements apply to material submitted for our current system; developmental paints may be otherwise.

After the panels have been cleaned and the coating prepared, the material is sprayed on the panels using an airless spray system. The thickness of each coat applied varies, depending on the particular paint category. The specified minimum dry film thicknesses for our current system are 4.0 mils for the primer coat, 3.5 mils for the intermediate coat, and 1.0 mil for the topcoat. For the other two categories, the thickness recommended by the manufacturer is applied.

Once the prescribed coating has been applied and cured, some panels are scribed or scratched with an 'X' through the paint to the bare metal, and the others are left intact. (Scribing simulates possible damage to coatings on a structure, and shows whether a coating will continue to adhere to the metal adjacent to corroded areas.) Then, all of the backs and edges of the panels are coated and the panels are ready for testing.

Testing and Evaluating the Panels

Each coating system is subjected to a set of six tests. Five of the six tests involve laboratory accelerated testing. The American Society for Testing and Materials (ASTM) standards cited below precisely specify how each test is to be performed. The accelerated laboratory testing is performed in the following manner.

1) Salt Fog (ASTM B 117) - A set of scribed test panels is placed in 5 percent salt fog for a period of 5,000 hours and evaluated every 1,000 hours.

2) Ultraviolet Condensation Chamber (ASTM G 53) - A set of scribed test panels is subjected to an eight-hour exposure to ultraviolet light (simulating sunlight) at 140 F followed by a four-hour exposure period at 104 F. The second period introduces moisture which condenses on the panels. The panels are evaluated every 1,000 hours for a total of 5,000 hours.

3) Humidity - A set of scribed panels is placed in a 100 percent humidity room at 77 F and evaluated every 1,200 hours for five cycles, or a total of 6,000 hours.

4) Weather Cycle - One cycle consists of: a) five wet freeze-thaw cycles, b) 200 hours in the ultraviolet condensation chamber, and, c) 50 hours in the salt fog chamber. A set of unscribed panels is evaluated after each two complete cycles, and the test continues for a total of 10 cycles.

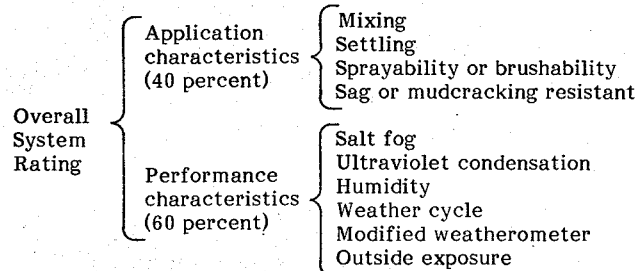
5) Envirotest Chamber - The chamber has a paddle-wheel arrangement that makes one revolution every four hours. The top of the chamber is heated to 120 F and contains an ultraviolet light source. The bottom contains

a 3 percent salt solution into which the panels are submerged for 80 minutes during each rotation. A set of panels is scribed before testing, and is evaluated every 1,000 hours for a total of 5,000 hours.

6) Outdoor Weathering - A set of scribed panels are placed out-of-doors for a one-year pass/fail field test.

All of the tests use a combination of ASTM D 610 rust rating, ASTM D 714 degree of blistering, and a consideration for chalking or whitening of the panel, to give it a numerical value. The values range from a perfect 10.0 down to a completely rusted value of 1.0. The combinations also may include a special rating for above and below the scribe mark, or a topcoat delamination rating. Our current requirements give a final overall system rating using the weighted rating system shown below:

WEIGHTED RATING SYSTEM



Quality Assurance for Field Application of the Accepted Material

Once the coating system is on the QPL, a quality assurance program must be maintained. The field inspectors should visually inspect the paint for proper labeling, consistent color and viscosity between individual containers, and check the applicator's preparation, mixing procedure, application technique, and film thickness to ensure that the best possible coating is applied to the bridge. If any of the items during the visual inspection seem unusual, a sample of each component should be taken and sent to the Materials and Technology laboratory for a check to see whether it meets the intended conditions. The complete coating systems are retested in the laboratory every year to ensure that the manufacturers maintain their quality.

The bottom line is: the paint system can only be as good as the team effort between our laboratory, field personnel, and contractors' crews.

-Eileen Phifer

TECHADVISORIES

The brief information items that follow here are intended to aid MDOT technologists by advising or clarifying, for them, current technical developments, changes or other activities that may affect their technical duties or responsibilities.

PERSONNEL NOTES

Jens E. Simonsen retired on January 12 after 31 years with the Department. Jens came to MDOT after graduating from Michigan Tech, and after a short stay in the Design Division, joined M&T's Research Laboratory. As a member of the Physical Research Unit, Jens worked in many areas before transferring to the Materials Research Unit from which he retired. He is known throughout the country for his work in the development of methods for rapid patching of concrete pavements, thus allowing them to be opened to traffic after a short duration. A hard worker both in the lab and in the field, Jens will be remembered, and appreciated, for his many contributions to the Department...Jon Reincke is the new head of the Research Laboratory

Section, having been promoted from the Structural Services Unit of the Testing Laboratory. Jon formerly worked in the Research Laboratory, and we look forward to the contributions he will make to the Division...In another transfer, Steve Cook has been promoted from the Bituminous Technical Services Unit to a job in the Structural Services Unit of the Testing Laboratory...Four new members have joined us, Tom Work has taken over the Geoenvironmental Services Unit of the newly formed Geotechnical and Environmental Section. Accompanying him into the new Unit is Resource Specialist Tom Killingsworth. New Engineering Techs Jim Belanger with the Structures Research Unit of the Research Laboratory, and Alan Ferrier working for the Structural Services Unit of the Testing Lab are now aboard. We welcome them to our staff.

This document is disseminated as an element of MDOT's technical transfer program. It is intended primarily as a means for timely transfer of technical information to those MDOT technologists engaged in transportation design, construction, maintenance, operation, and program development. Suggestions or questions from district or central office technologists concerning MATES subjects are invited and should be directed to M&T's Technology Transfer Unit.

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