

**MICHIGAN DEPARTMENT OF TRANSPORTATION
M•DOT**

**EVALUATION OF EXPERIMENTAL PAINTING
OF A588 STEEL BRIDGES**

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**Research and Technology Section
Materials and Technology Division
Research Projects 83 G-261
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Executive Summary

This final report on experimental painting of A588 steel bridges in Michigan describes the field performance of the coating system since the initial inspection. Surface preparation, paint application and initial inspections were previously covered in the February 1986 Interim Report (4).

Six bridges were coated with an experimental three coat system to protect the severely corroded A588 steel. After five years, an examination of the six bridges shows that they were effectively protected from the environmental conditions prevalent in the Detroit metro area. Based on this performance, we project a 30 to 40 year life span for the coating system on these bridges.

Since 1984 this system, consisting of an epoxy zinc-rich primer, an epoxy intermediate, and an urethane topcoat, has been used on 77 unpainted A588 steel structures, and will continue to be used in the future. The initial six structures will be inspected periodically until they are recoated or replaced.

Background

Michigan's highway environment is very corrosive due to the liberal use of deicing salt and prolonged wet seasons, and it takes a serious toll on all steel bridges, particularly those made of A588 steel. Michigan has more than 500 unpainted A588 steel bridges which are not resisting corrosion properly. In 1984, the Michigan Department of Transportation initiated a research project to document the cleaning and coating of six A588 steel structures. The coating system evaluated was a zinc-rich epoxy primer, a polyamide epoxy intermediate and an aliphatic polyurethane topcoat.

Several research reports (1, 2, 3) document the corrosion problems on A588 steel structures. Environmentally exposed A588 steel surfaces, or severely corroded previously painted structures exhibit some exfoliation or severe corrosion, and blast cleaning reveals significant pitting of the steel in these areas. The most desirable coating system would arrest corrosion and prevent additional section loss or pitting caused by chloride and moisture trapped in pits at the steel surface. With this in mind, MDOT selected a combination sacrificial and barrier coating system. The zinc in the primer will oxidize before the steel, thus 'sacrificing' itself and delaying corrosion of the steel. The barrier portion of the coating system is comprised of solvent-based organic binders which prevent moisture penetration.

Descriptions of Individual Structures

In 1984, MDOT began the total field painting study on six A588 steel structures using the three coat, organic zinc-rich systems supplied by Ameron, Koppers, Porter, Sherwin Williams, and Tnemec. Contractors coated 77 additional structures through 1993, and those inspected by MDOT are listed

in Appendix A. MDOT examined these structures annually to determine if any rusting, adhesion problems, blistering, appearance problems (fading, uneven color), or mechanical damage had occurred, and assessed the overall condition of the painted surfaces. The annual inspections of all the coated A588 steel structures revealed good to excellent coating system performance. Trace rusting on some of the structures resulted from minor application and surface preparation problems.

Brief background information on the application of the coating systems and detailed description of the current condition of each of the original six structures follows. A summary of the 1991 final inspection is in Appendix B.

Inspection Criteria

Rust Rating: ASTM D 610
Blister Rating: ASTM D 714

<u>Result/Rating</u>	<u>Area Without Damage</u>	<u>Area With Damage</u>
Excellent	0% Rust No Blistering No Chalking No Lifting	0% Rust No Lifting at Scribe
Very Good	0% Rust No Blistering Minimal Chalking No Lifting	0% Rust Some Lifting Slight Chalking
Good	0% Rust Minimal Blistering Minimal Chalking	≤0.1% Rust, ASTM Rating 8 or 9 Some Lifting Slight Blistering
Fair 7	0% Rust Slight Blistering Slight Cracking in Topcoat <1" Total Length	≤0.3% Rust, ASTM Rating Lifting-Starting to Curl Blistering
Poor	<0.1% Rust, ASTM Rating 8 or 9 Slight Blistering Slight Chalking Cracking in Topcoat 1-4"	≤1% Rust, ASTM Rating 6

S03 of 82292 - Ecorse Rd Over I 75

This bridge was painted in 1986 with Koppers' coatings on the west half of the bridge and Ameron's coatings on the east half. The 1987 inspection revealed that the topcoat was missing from one edge of two diaphragms and that the paint had chipped down to bare metal for about six inches on another diaphragm at the center of the east abutment. The 1988 inspection documented very minor blush rusting on the inside of both fascia beams, probably caused by inadequate film thickness of the primer coat. The department changed the specifications from a minimum dry film thickness of 3 mils of primer to 4 mils after these six bridges were painted. The 1988 report also showed the 7th beam from the south was beginning to rust at the gusset plates where a gap up to 1/4 in. prevented complete coverage. The 1991 inspection showed the only additional minor rusting occurred on the southbound bridge at the edge of the bottom flange over the right and center lanes. There appeared to be no difference between the Ameron and Koppers systems, and the overall condition of this bridge was good.

S13 of 82291 - Northbound I 275 over Northline Rd

The northbound bridge was painted in 1986 using Ameron's coating system. The 1987 inspection revealed rust stains from a leaking joint at the south hangers, while the 1988 inspection showed some topcoat peeling, under one square foot total, on the south end of the north tailspan. On the 3rd beam from the east, the topcoat had peeled off causing a small amount of pinhole rusting.

Leakage at the expansion joint at the north pier and the construction joint at the south pier caused some staining and splattering. The detailed inspection showed staining coming from the interface of the steel beam and concrete deck. Concrete pieces had broken off the interface leaving exposed steel which caused staining on the beams. Inspectors observed no change in conditions in 1991. The overall condition of the bridge is good.

S08 of 82291 - Southbound I 275 over Northline Rd

This bridge is the same as the northbound bridge, except it has Tnemec's coating system instead of Ameron's. A very slight amount of rusting occurred at some of the rockers, but there was no peeling on the bridge. There were no apparent changes in 1991, and the southbound bridge is in good overall condition.

S06 of 82194 - I 75 over Fort St

The Fort St bridge was painted in 1986 with Porter coatings on the north half and Sherwin Williams coatings on the south half. The initial inspection in 1987 showed no observable defects in either paint system. The 1988 inspection revealed only minimal amounts of staining at the rockers; adhesion and appearance were good with no blistering or mechanical damage. The overall condition after one year was very good. In 1991, there was a severe problem in a small area (with minimal clearance) over a chain link fence. Peeling and continued rusting of the surface resulted from applying the intermediate and topcoat over an unblasted surface. The overall condition of the bridge was good.

S28 of 82123 - Grand River Ave over I 96

The Grand River Ave bridge was painted in 1985 with Ameron's system on the east half and Tnemec's system on the west half. Interim Report R-1272 (4) includes a detailed description of the cleaning and coatings. In 1987, inspectors noted several small areas of blush rust on the bottom flange edges at the pin and hanger connection. Also, workers painted over a small area on the southeast corner of the abutment which had rust build-up. Inspectors noted rust-through at a few scaffolding support points and at a few slivers, noted again in the 1988 inspection. In addition, inspectors discovered a few very small areas where urethane was flaking off the north side of the fascia. The 1991 inspection revealed some edge rusting on the eighth beam from the north side, but detected no difference in the performance based on the abrasive used. The overall bridge paint condition was good.

S34 of 82112 - 8 Mile Service Rd Structures over US 10

The 8 Mile Rd structures were painted in 1984. Interim Report R-1272 (4) includes a detailed description of the cleaning and coating. Inspectors found no apparent changes in 1988 or 1991, except slight staining at the joints and the overall condition of the structures was good.

Costs

The cost of cleaning and coating A588 steel structures ranged from \$2.00 per sq ft in 1985 to \$3.00 per sq ft in 1988. The total cost per sq ft for cleaning and coating A588 steel structures was and still is approximately the same as repainting previously coated structures.

Conclusions

Since the first use of organic zinc-rich coating in 1984, over 77 unpainted A588 steel structures have been coated. To date, this coating system has performed well, based on observations made throughout the project. The field evidence from the past several years leads us to expect the coating system to continue performing satisfactorily, with minor maintenance repairs, for 30 to 40 years. Therefore, this coating system remains the one of choice for field maintenance painting of A588 steel structures in Michigan.

APPENDIX A

A588 STEEL BRIDGES INSPECTED SINCE 1985

<u>Location</u>	<u>Control</u>	<u>Bridge No.</u>
I 275 Under Sibley Rd	82291	S05
I 275 Under Pennsylvania Ave	82291	S06
I 275 Under Eureka Rd	82291	S07
I 275 Under Grand Rd	82291	S10
I 96 Under US 24	82122	S19
Portage Over Power Canal	17011	
Meridian Over Power Canal	17011	
I 96 Under Levan Rd	82122	S03
I 96 Under Yale Ave	82122	S04
I 96 Lt Trn W/Levan	82122	S36
I 96 Lt Trn E/Levan	82122	S37
I 96 EB Over 8 Mile Rd	82125	S01
I 96 EB Under 7 Mile Rd	82125	S03
I 275 Under Hannon Rd	82292	
I 275 Under Tyler Rd	82292	
I 94 Under 8 Mile Rd	82025	S22
I 75 Over Fort St	82194	S06
M 39 NB Service Rd U-Turn	82123	S04
I 96 EB Outer Roadway	82123	S05
I 96 EB Inner Roadway	82123	S06
I 96 WB Inner Roadway	82123	S09
I 96 EB Turn Roadway	82123	S10
I 75 Under 8 Mile	82252	S10
I 96 WB Turn Roadway	82123	S11
I 75 Under Nevada	82252	S23
I 75 Under Oakland	82252	S24
I 275		
SB Over US 24	58171	S05
I 275 NB Over US 24	58171	S11
I 75 Under I 75 Ramp Near State Line	58151	S13
M 53 Over I 69	44044	S15

APPENDIX B

CHART 1

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Summary of 1991 Inspections

Bridge*	Painted	Supplier	Rusting	Adhesion	Blistering	Appearance (fading)	Mechanical Damage	Overall Condition
1	1986	Koppers (west half) Ameron (east half)	Very minor rusting on inside of facias where it probably has thin primer. Also on the 7th beam from the south at gusset plate (welding would help). Edge rust bottom flange over SB right and center traffic lanes.	Good	None	None	None	Good
2	1986	Ameron	On the 3rd beam from the east, pinhole rusting occurs where paint is peeling at expansion joints (north end) and const. joint (south end) there are some staining splatters.	Peeling on S. end of tail span, <1 ft.	None	None	None	Good
3	1986	Tnemec	At some joint and rockers, heavy staining occurs	Good	None	None	None	Good
4	1987	Porter (north half) Sherwin Williams (south half)	Very slight staining on rusting on rockers. Pinhole rusting on several interior beams and one beam has large blisters covering 6' in length on bottom of bottom flange at south expansion joint.	Good	Very few in a small area due to poor application over moisture.	None	None	Good
5	1985	Ameron (east half) Tnemec (west half)	Slight rusting on splice plate crevice. Lower flanges on N. and S. facia beams have a small area rusting (from scaffolding). Also 8th beam from N. side has some edge rusting.	Urethane flaking off in spots - N. side.	None	None	None	Good
6	1984	Ameron	Slight staining at joints.	Good	None	None	None	Good

- #1 - S03 of 82292 (Ecorse Road over I 275)
- #2 - S13 of 82291 (NBL I 275 over Northline Road)
- #3 - S08 of 82291 (SBL I 275 over Northline Road)
- #4 - S06 of 82194 (I 75 over Fort Street)
- #5 - S28 of 82123 (Grand River over I 96)
- #6 - S34 of 82112 (8 Mile Road Service Structures over US 10)

REFERENCES

1. Allemeier, K. A., "Unpainted Weathering Steel Bridges in Michigan," Paper presented at the Northwest Bridge Engineers Seminar, Boise, ID, October 6, 1981.
2. Hare, C. H., NCHRP Report 136, Protective Coatings for Bridge Steel, Transportation Research Board, National Research Council, Washington, D. C., pp. 5, 19, December 1987.
3. McCrum, R. L., Arnold, C. J., and Dexter, R. P., "Current Status Report Effects of Corrosion on Unpainted Weathering Steel Bridges," Michigan Department of Transportation, May, 1985.
4. Tinklenberg, G. L., "Investigation of the Field Coating of Environmentally Exposed Weathering Steel - Interim Report," Michigan Department of Transportation, February 1986.
5. Hare, C. H., NCHRP Report 136, Protective Coatings for Bridge Steel, Transportation Research Board, National Research Council, Washington, D. C., pp. 34, December 1987.