EVALUATION OF AN EXPERIMENTAL PROTECTIVE COATING FOR BRIDGE STEEL

by

David C. Streb
Project Manager

Under the Supervision

of

C. Dwight Hixon, P.E.
Research Division Engineer
Research and Development Division

Oklahoma Department of Transportation
Oklahoma City, Oklahoma

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This report describes the application of an experimental metal sealer to bridge beams which are coated with lead-based paint.

Regulations developed by the Environmental Protection Agency (EPA), prohibit the introduction of material containing lead into the environment. Containment and disposal methods required for sandblasting lead-based paints have proven to be costly. The Oklahoma Department of Transportation is searching for an economic alternative to sandblasting steel.

Two bridges in western Oklahoma were treated with the experimental metal sealer in 1962. A visual survey was conducted on these bridges to evaluate the performance of the sealer. However, the formulation of the sealer applied to these bridges is unknown.

The experimental sealer required that only dirt, grease, and hard scale be removed prior to application. The sealer was thin and had a tendency to run, even when applied at the manufacturer's suggested rate. The cost of the sealer application was less than removal and containment methods previously used.

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EXECUTIVE SUMMARY

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INTRODUCTION

When old lead-based paints are removed from steel bridges prior to repainting, particles containing the lead are emitted to the air, water and land surrounding the bridge. New regulations, developed by the Environmental Protection Agency (EPA), prohibit the introduction of materials containing lead into the environment. These EPA regulations have hindered the bridge painting program in the state of Oklahoma. Previously, when bridge steel needed repainting, the steel was sandblasted to bare metal before the new paint was applied. This sandblasting allowed lead-based paints to enter into the environment. Containment and disposal systems are required for sandblasting in order to comply with the new EPA requirements. Containing and disposing of lead-based paint is a difficult and costly effort. The Oklahoma Department of Transportation (ODOT) is searching for an economic alternative to abrasively cleaning steel. A possible alternative is to use a coating which does not require abrasive cleaning prior to application.

BACKGROUND

Removal and Containment Methods

Various techniques are being used for the removal and containment of lead-based paints from bridge structures. The techniques are listed below with a brief description. (1)

1. Blast Enclosures - The abrasive blast operators are completely enclosed to confine the blast particles. The blast particles are funneled to capture the debris.
2. Centrifugal Blasters - The abrasive is shot onto the surface to be cleaned by high-speed rotating blades. The abrasive is retrieved and recycled.
3. Drapes - These are placed on both sides of a bridge to direct the blast particles downward to a net or some catching device.
4. Ground and Water Covers - The blast debris is caught and held by an appropriate material which is suspended from the bridge or laid on the ground.
5. Vacuum Blasters - Abrasive blasting is used to remove the old coating and the debris is recovered with a suction system around the blast nozzle.
6. Vacuum-Shrouded Hand Tools - Power hand tools with shrouds are used to minimize dust and debris.
7. Water Curtains - A water spray is directed downward from the edges of the bridge so that debris from the blasting is washed to the ground.

8. Water Screens - Floating dams are anchored to the banks of a waterway to screen out the floating debris from the blasting.
9. Wet Blasting - This technique uses a pump, high pressure hose and nozzle to apply a water blast to remove the old coatings. This is a dust free technique.

The techniques above offer a number of options for the safe removal of lead-based paints. The geometry and environmental concerns of each bridge painting project must be examined prior to choosing a lead-based paint removal and containment method.

Once the lead-based paint has been removed and contained, it must then be disposed. The disposal of the lead-based paint residue is a costly process. If sandblasting is used, all of the sand used must be disposed of properly in a toxic dumping area. The same is true of water blasting. The water used must also be disposed of properly since it has been contaminated.

Regardless of the method chosen for a particular bridge, the cost of the project will increase whenever the removal of lead based paint is involved. For this reason, ODOT is evaluating commercial coatings that are intended for application on highway bridge steel that is rusty and less than abrasively cleaned.

Coatings Applied over Corroded Structural Steel Surfaces

ODOT is currently evaluating the alternative of applying coatings to a rusty or contaminated steel surface without prior sandblasting. The purpose of evaluating these coatings is to

considerably reduce the cost of repainting bridge structures. A number of manufacturers claim their product provides corrosion protection when applied over rusty surfaces. However, there is no field evidence available to support most of the manufacturers' claims. (2)

A research study is being conducted by the University of Oklahoma working in cooperation with ODOT. This research study is under the direction of Dr. Raymond Daniels. The objective of this study is to evaluate a number of commercial coatings that are intended for application on highway bridge steel that is rusty and is less than abrasively cleaned. The performance of these coatings will be compared with that of coating systems applied in the conventional manner over abrasively cleaned surfaces. At the time of this writing, the final report for this research study is near completion.

Coinciding with the above mentioned research study, ODOT Maintenance Division submitted a contract to repaint two bridges on SH 9 in Cleveland County. These bridges were painted with one of the experimental coatings being evaluated in the University of Oklahoma research study. The coating (Black Gold Metal Sealer by Tri-F Inc.) does not require abrasive cleaning prior to application. The Research Division monitored the application of the sealer during the project. Two bridges near Clinton, Oklahoma, which were painted with this product in 1962, were also surveyed by the Research Division. The findings of the paint monitoring and evaluation are presented in the remainder of this report.

EVALUATION OF TWO BRIDGES IN WESTERN OKLAHOMA

In 1962, two bridges near Clinton, Oklahoma were sealed with TRI-F Black Gold Metal Sealer. The bridge numbers of the sealed bridges are 2002-0038NXF and 2002-0415SXF. They are located on the I-40 frontage road just west of Clinton, Oklahoma.

Due to the remote rural location, the bridges have received minimal salt applications. Combine this with the low average daily traffic and the dryer climate of Western Oklahoma and the result is less than opportune conditions for corrosion of the steel bridge beams.

A visual survey was performed on all of the beams on these two bridges. The beams appeared to have a heavy coat of sealer applied to them. This could be because the sealer used to be sold as a concentrate and it had to be thinned prior to application. Thus, there is no way to determine how thick the applied coat of sealer is on these bridges. The only portions of the beams where corrosion could be detected was along the top flange where the concrete deck rested. The sealer on the webs showed signs of wearing but there were no sizeable spots of rust present. The sealer seemed to be wearing from the outside prior to rust coming through from the inside.

DESCRIPTION OF CONSTRUCTION

General

The construction procedures in the application of the Black Gold Metal Sealer and the Black Gold Armor Coat manufactured by TRI-F Incorporated are described. Included in the procedures are project information, the condition of the beams prior to construction, cleaning the beams before application, application of metal sealer, application of armor coat, and summary of the construction procedures.

Project Information

ODOT Maintenance Division submitted a contract (MC-14(294)) to repaint two bridges on SH 9 in Norman, Oklahoma. These bridges cross Bishop Creek 3.2 miles east of I-35. (Refer to Figure 1.) Bridge number 1409-0325SX was painted with TRI-F Black Gold Metal Sealer only. Bridge number 1409-0325NX was painted with the metal sealer plus a finish coat of TRI-F Black Gold Armor Coat. The contract was awarded to Darryl Bond Construction Company on August 7, 1989 for a lump sum bid price of $9,995. The painting job was completed by three painters in approximately two weeks.

Beam Condition Prior to Construction

Perhaps the most important feature in evaluating this product is to accurately record the condition of the steel bridge beams which are being repainted on the two bridges. Figure 2 is a plan

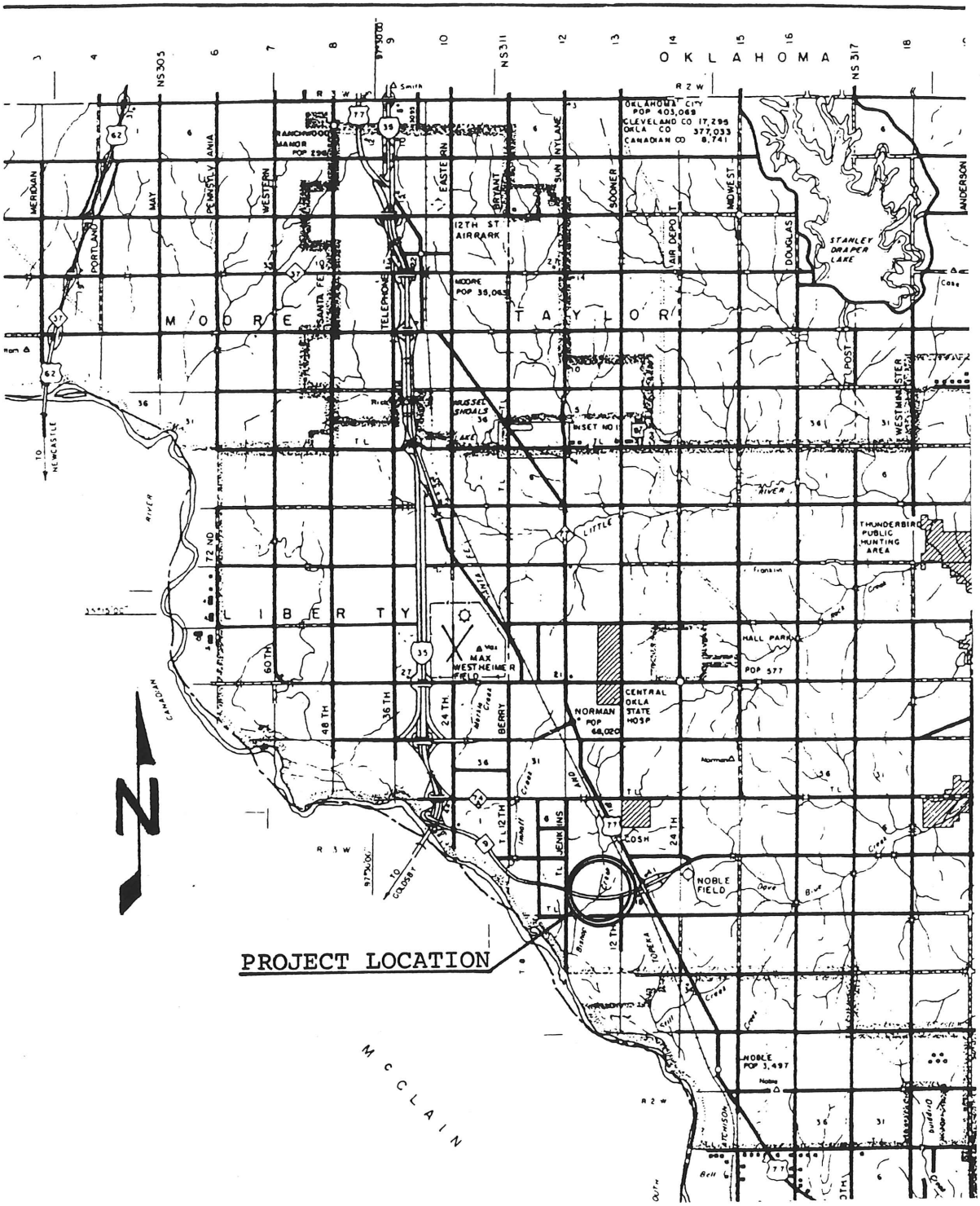

Figure 1. Project Location.

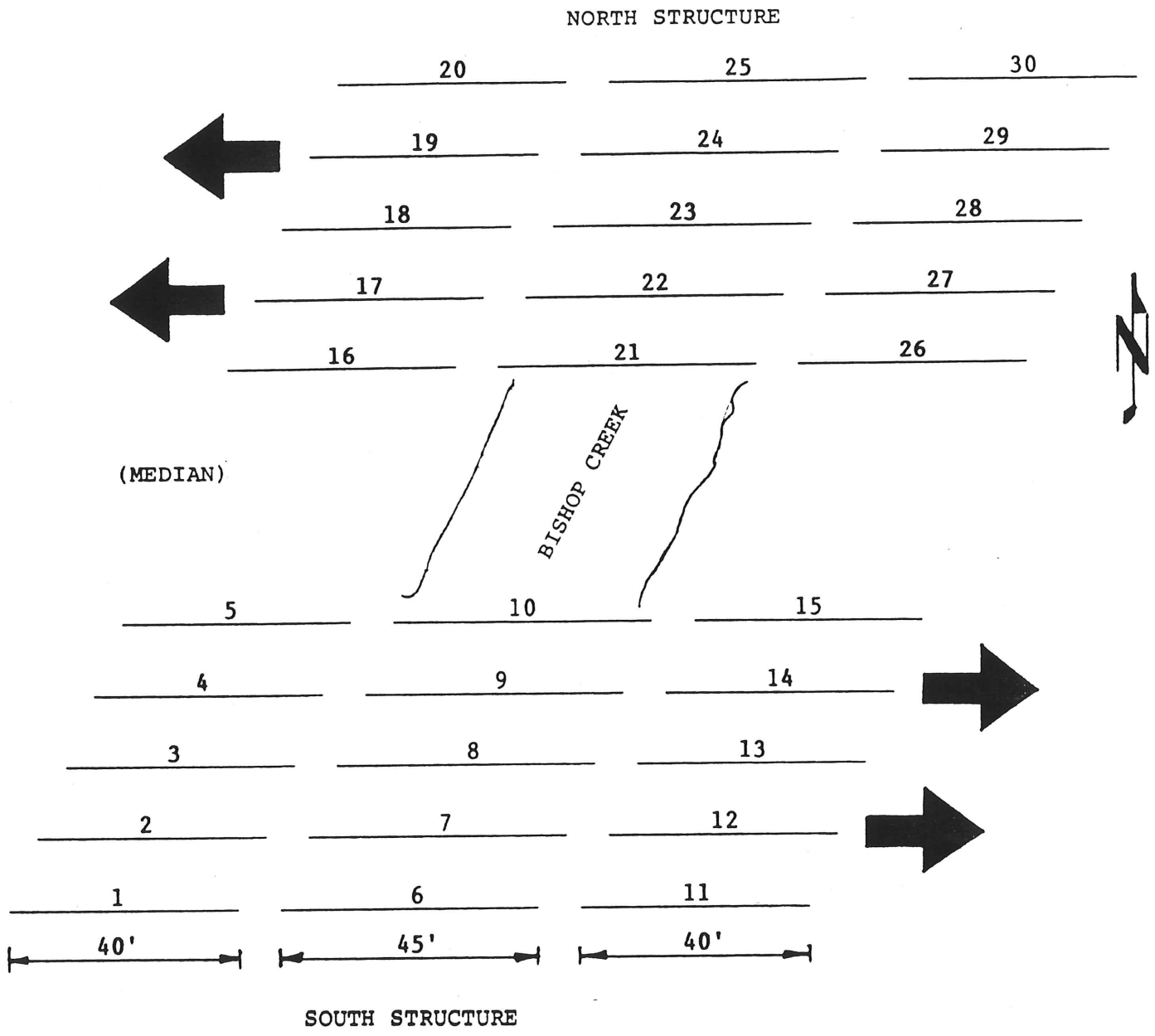

Figure 2. Identification of Bridge Beams.

view of the two bridges with a number assigned to each bridge beam. Table 1 is a table which identifies the condition of each beam prior to repainting and identifies whether the beam had one or two coats applied. The south structure received only a coat of the metal sealer so that the sealer's performance could be monitored. In summary, the beams were in excellent condition with minor scaling and corrosion present on a few beams. The corrosion found on these beams was in the form of light rust with no pitting. One observation of significant interest was that the beams on the east span of the south structure appeared to have been scraped by a bulldozer performing dirt work along the east slope. The scrapes were approximately 1/2 inch wide by 1/8 inch deep extending the width of the bottom face of the bottom flange on beams #11, 12, 13, 14, and 15. These scrapes had light rust developing and should be monitored for signs of corrosion coming through the Black Gold sealer in the future.

SOUTH STRUCTURE		
BEAM NO.	**CONDITION PRIOR TO APPLICATION OF SEALER**	**PROTECTIVE COATING APPLIED**
1	Excellent	Sealer
2	Excellent	Sealer
3	Excellent	Sealer
4	Corrosion on Top Face of Bottom Flange	Sealer
5	Excellent	Sealer
6	Excellent	Sealer
7	Excellent	Sealer
8	Excellent	Sealer
9	Excellent	Sealer
10	Excellent	Sealer
11	Scrape on Bottom Face of Bottom Flange	Sealer
12	Scrape on Bottom Face of Bottom Flange	Sealer
13	Scrape on Bottom Face of Bottom Flange	Sealer
14	Scrape on Bottom Face of Bottom Flange	Sealer
15	Scrape on Bottom Face of Bottom Flange	Sealer
NORTH STRUCTURE		
BEAM NO.	**CONDITION PRIOR TO APPLICATION OF SEALER**	**PROTECTIVE COATING APPLIED**
16	Corrosion on Top Face of Bottom Flange	Sealer & Armor Coat
17	Excellent	Sealer & Armor Coat
18	Excellent	Sealer & Armor Coat
19	Excellent	Sealer & Armor Coat
20	Excellent	Sealer & Armor Coat
21	Corrosion on Top Face of Bottom Flange	Sealer & Armor Coat
22	Excellent	Sealer & Armor Coat
23	Excellent	Sealer & Armor Coat
24	Excellent	Sealer & Armor Coat
25	Excellent	Sealer & Armor Coat
26	Corrosion on Top Face of Bottom Flange	Sealer & Armor Coat
27	Excellent	Sealer & Armor Coat
28	Excellent	Sealer & Armor Coat
29	Excellent	Sealer & Armor Coat
30	Excellent	Sealer & Armor Coat

Table 1. Beam Condition Prior to Sealer Application.

Cleaning the Steel Beams for Application

An important task in any painting job is to ensure that the surface to be painted is properly prepared before application. By using this experimental coating, the need for abrasive cleaning to bare metal is eliminated. The manufacturer recommended that only hard scale areas need be removed by rough sanding and the beams need to be free of dirt and grease prior to the sealer application.

The painting contractor erected a steel scaffold which attached rollers to the second and fourth beams of a five beam wide bridge. The scaffold could be raised and lowered by two battery powered winches each attached to a beam above. The scaffold could then be moved laterally within each bay simply by rolling on the beams bottom flanges. Figure 3 depicts the scaffold erected and ready for use by painters. This scaffold setup was used for cleaning as well as paint application.

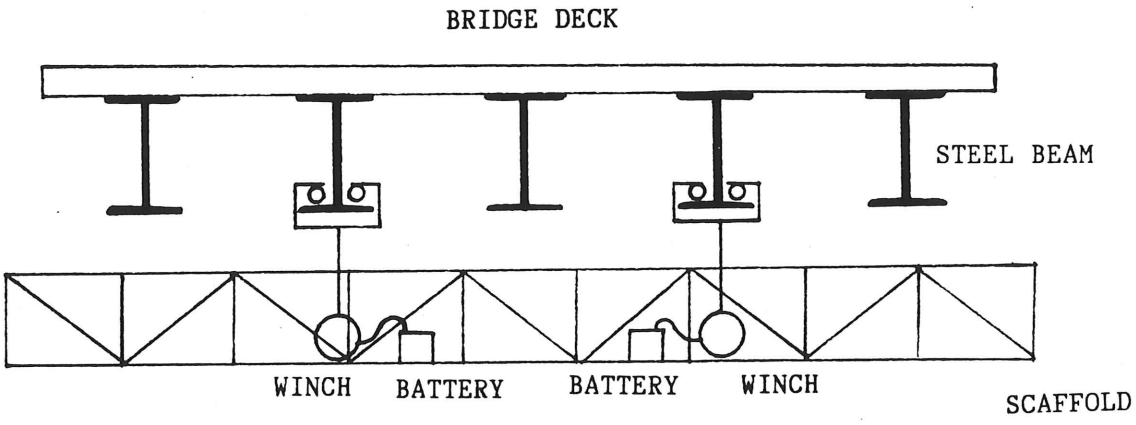

Figure 3. Scaffold Setup.

A high pressure water spray was used to remove dirt and grease from the steel beams. The nozzle pressure of this water spray was approximately 2500 psi. The water spray operators had to be cautious not to place the nozzle too close to avoid removing the red-lead paint undercoat. During the cleaning operation, some of the aluminum finish coat flaked off. However, 95 percent of the beam's surface area retained both the aluminum finish coat and the red-lead undercoat after the cleaning was complete. The beams were allowed to dry completely before applying the Black Gold Metal Sealer.

Application of the Metal Sealer

The Black Gold Metal Sealer was applied using an airless spray system. The sealer was supplied by the manufacturer ready to apply. No thinning of the sealer was necessary prior to application. The sealer was thinner than any paint the painting contractor had ever used.

During the first applications of the sealer, the contractor had to use extreme caution because the sealer ran easily. The manufacturer was present on the jobsite during application and he assured the contractor that the sealer need only be applied thick enough so it doesn't quite run. When the sealer is applied at this rate, the visual appearance lends to thinking the coverage is not complete. However, the manufacturer assured the contractor the coverage was adequate (4). The color of the sealer is black, but imperfections and color separations can still be seen through the sealer. The manufacturer recommended a

drying time of four hours. After four hours, the sealer was still tacky to the touch.

The coverage rate of the sealer was recommended at 300 sq. ft./gal. by the manufacturer. The paint contractor used 45 gallons of Black Gold Metal Sealer to seal both bridges. The coverage rate was 263 sq. ft/gal. or 2.09 tons/gal. The cost of the sealer was $900 at a rate of $19.95 per gal. This came to a sealing cost of $.08 per sq. ft. (Refer to Table 2.) A possible reason for the contractor having a 15% lower coverage rate than recommended is that the manufacturer based his rate on application to metal buildings. Naturally, there will be more waste when painting the corners of the bridge beams than the walls of metal buildings.

Application of the Armor Coat

This section of the report describes the application of TRI-F Black Gold Armor Coat. The finish coat was applied to bridge number 1409-0325NX. The south structure (1409-0325SX) did not receive the armor coat finish.

The Black Gold Armor Coat was applied using an airless spray system. No thinning of the armor coat was necessary prior to application. Before application special care had to be taken to insure the armor coat was completely mixed. The silver pigment in the armor coat was gelled into a ball at the bottom of each five gallon container. Once mixing was complete, the armor coat was prepared for application by the airless spray system.

The contractor had to use caution during application of the armor coat because it ran easily. The armor coat covered the surface completely with a light coat but it had a tendency to want to shift downward on the vertical faces of the beams. The color of the armor coat was high gloss silver which was appealing to the eye. The armor coat had no problem covering the metal sealer completely. The only problem encountered during the armor coat application was the tendency of the product to run.

The coverage rate of the armor coat was recommended at 150 sq ft/gal or 1.2 tons/gal. The cost of the armor coat was $800 at a rate of $19.95 per gal. This came to a finish cost of $.14 per sq ft. (Refer to Table 2.) The actual coverage was almost exactly that recommended by the manufacturer.

PAINT TYPE	MANUFACTURER'S RECOMMENDED COVERAGE (ft^2/gal)	ACTUAL COVERAGE (ft^2/gal)	COST/GAL
Black Gold Metal Sealer	300	263	$19.95
Black Gold Armor Coat	150	148	$19.95

Table 2. Paint Coverage Rate and Cost.

Summary of the Construction Procedures

The steel bridge beams were in excellent condition prior to the application of the Tri-F products. The bulldozer scrapes on the bottom of five beams should be monitored closely in the future for signs of rust coming through the sealer.

The Black Gold Metal Sealer was applied at 12 percent above the rate recommended by the manufacturer. This rate gave a visual appearance of less than complete coverage. The manufacturer was present during application to insure this was the proper application rate.

The Black Gold Armor Coat was applied at the rate recommended by the manufacturer. This coat completely covered the sealer with a high gloss silver. The only problem with the armor coat was the tendency to run.

The in place cost for the two coat system was $1.14 per sq. ft. or $144.00 per ton. This was based on the application to the north structure which received the sealer plus the armor coat.

RECOMMENDATIONS

1. Monitor the performance of the metal sealer and armor coat paying special attention to the locations where corrosion existed prior to application.

2. Continue to monitor the performance of the bridges painted in 1962 in Western Oklahoma.

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