

Accelerated Innovation Deployment (AID) Demonstration Project
Field Metalizing of a Steel Beam Bridge
Vermont Agency of Transportation
Structures Design Section
Final Report
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Project Scope and Selection

The purpose of this project was to demonstrate the use of field metalizing of a state-owned steel beam bridge in Hardwick, VT. This bridge (Br. 1) is an 82 ft. long multi-beam bridge carrying VT 16 over Haynesville Brook near the VT 16/VT15 intersection. This structure was constructed in 1950 and the steel beams are protected with a three-coat paint system last applied in 1995. The paint system is currently rated a “6” and the system has failed at several locations namely at the beam ends, scupper and downspout locations and blistering is occurring along the edges of the bottom flanges of the steel beams. This bridge is functionally adequate as it is 33 ft. wide providing provide 4 ft shoulders and 11 ft travel lanes. The superstructure is composed of 6 steel rolled beams with steel diaphragms. There are concrete curtain walls at each end so there are no open expansion joints.



Hardwick VT 16 Br. 1 (Looking south toward VT 15)



Hardwick VT Br. 1 (Fascia beam paint deterioration)

What is Metalizing?

Metalizing is the process of thermal spraying molten zinc on a prepared abrasively blasted surface. A sealer coat is then applied to the metalized surface. Metalizing offers several advantages over painting that make it an attractive alternative for protective coatings on steel bridge structures. VTrans current painting specifications consists of a three-coat system (primer, mid and top coat). Metalizing is applied in one pass. Metalizing provides a much longer service life estimated at several times that of a paint system. Metalizing creates an impermeable, non-porous, abrasion resistant and well-bonded, corrosion resistant coating for steel beams. There is no drying or cure time. It is healthier for the environment as there are no volatile organic compound (VOC) emissions in metalizing. Metalizing can be completed in the field in a much wider range of temperatures as compared to painting which is a big advantage in Vermont given our short construction season due to weather limitations.

The performance goals for metalizing of steel bridges is to extend the coating and protection of the structural steel to at least a 50-year life span. The Agency is currently planning periodic cyclical and condition-based maintenance on bridge elements with major rehabilitations generally planned within 50-65 years of the original construction. The application of a metalized bridge coating will ensure the structural steel is protected through to the life span of the bridge of over 100 years. The performance of the system will be monitored every two years as part of the NBIS bridge inspection program that will include a condition rating of the coating along with photos so that the performance of the system can be tracked.

Project Advertisement and Award

The project was advertised for construction bids on 3/25/20 and bids were opened on 5/08/20. Two bids were received for this project as follows:

Tri-State Painting	\$464,840
J. P. Sicard	\$627,645
Engineer's Estimate	\$748,372

VTrans did not have any bid data on field metalizing. Information was obtained from MassDOT and Connecticut DOT on their experience with bidding field metalizing projects. The Engineer's Estimate was developed as a factored increase in the estimate cost the clean and paint this bridge.

The main item for the difference between the Engineer's Estimate and Low Bidder was the Special Provision Item (Field Metalizing of Existing Structural Steel). This item was \$279,795 below the estimated unit price. The bid analysis revealed no advantage to the contractor or disadvantage to the State. Conversations with the contractor during construction revealed that they bid this project mainly to get the experience and reference for a field metalizing project as there is indications that more states in the northeast may be leaning toward more field metalizing projects. Therefore, the low bid price was not as high as it may have been.

Contractor Certification for Metalizing

At the time of advertisement there were only six contractors nationwide that held the SSPC-QP6 certification for metalizing. There were no contractors located in the northeast part of the country. Tri-State Painting from Tilton, NH was in the process of a company and employee certification for metalizing at the time of bidding and were certified at the time of award. This company has performed field metalizing on portions of the Longfellow Pedestrian Bridge in Boston and was highly regarded by MassDOT whose performance met the project specifications.

Pre-Construction Period

A major amount of time was spent reviewing the contractor submittals (and re-submittals) to ensure compliance with the contract specifications. Traffic control for this project was minimal as there was ample right-of-way adjacent to the structures with simple access to VT 16. The following is a list of contractor submittals needing review and acceptance prior to the start of construction:

- Personnel Qualifications
- Quality Control Plan
- Inspection Access Plan
- Surface Preparation Plan
- Abrasives Identification
- Metalizing Plan
- Sealing Plan
- Progress Schedule
- Metalizing Repair Procedure

Construction Staff

Resident Engineer: Scott Wheatley

VTrans Structural Steel Inspector: Ryan Foster

KTA-Tator Consultant Inspector: Steve Holdner

VTrans was fortunate to have a very experienced structural coating team to serve on this project during construction. Scott Wheatley was the resident engineer on several I-89 bridge painting projects. Ryan Foster is well versed in the Agency specification for removal of paint systems and application of various coatings including metalizing. VTrans did have experience with metalizing steel girders in the shop but not in the field. Ryan Foster brought in Steve Holdner with KTA-Tator as an additional inspector. Steve has many years of experience with metalizing.

Construction Schedule

Given that this contract was awarded at the onset of the COVID-19 pandemic, all awarded construction contract completion dates were extended by 12 months due to the strain of the pandemic on contractor staffing and securing materials. As a result the construction of this project did not occur until summer of 2021.

5/3/21	Begin de-greasing and blasting operation.
5/11/21	Pre-metalizing meeting.
5/17/21	Begin metalizing.
6/4/21	Metalizing complete.
7/09/21	Final Inspection.
8/19/21	Project Acceptance – Start Date of 2 yr. Warranty.
7/07/23	Field Review for Warranty.

Listed below are portions of the specifications for the metalizing application.

Environmental Conditions

- Steel surface shall be at least 5 degrees F above dew point for entire application.
- Temperature, dew point and relative humidity monitored every 2 hours.
- Once blast cleaned there is a 4-hour window to apply at least one coat of metalizing.
- An additional 4 hours was available if humidity levels kept below 50%.

Surface Preparation

- Steel surfaces to be metalized shall be white metal blast cleaned to meet SSPC-SP 5 using dry abrasive blast cleaning methods.
- Surface profile depth of 3.5 to 5.5 mils.

Metalizing (99.9% zinc wire)

- Prepared surface shall be metalized within 4 hours of blast cleaning.
- Daily coupons prepared and metalizing (8-12 mils) for bend tests (2" x 8" x 0.05" coupons).
- Adhesion tests performed daily for every 500 sq. ft. metalized and must meet 700 psi.
- Metalizing shall be performed with electric arc thermal spray metalizing equipment per material supplier and SSPC specifications.

- Application shall be done with overlapping passes with a second set of overlapping passes at right angles to the first set.
- 1/8" diameter zinc wire used on the project.

Listed below are comments on the surface preparation and metalizing application from the resident engineer and inspector:

- Removal of the existing grease coating was troublesome requiring hand scraping, application of solvent and hot water pressure wash with final solvent wipe to be sure grease was completely removed.
- The total thickness of metalizing shall be 8-12 mils. Contractor was allowed to apply a 2-mil initial coat and return to apply metalizing to obtain the full thickness.
- The sealer coat shall be applied within 8 hours of metalizing.
- A stripe coat shall be applied to all corners, edges and irregular surfaces by brush.
- Sealer shall be applied by spray and supplemented with rolling or brushing.
- Metalizing inside the enclosure is relatively difficult as compared to metalizing in the shop due to tight dark conditions.
- Ten Sq. ft. test panels were metalized at the start of work every day. All panels passed adhesion and bend tests.
- All adhesion tests, bend tests and coating thickness measurements consistently met the project specifications.
- The contractor used 1/8" zinc wire. Using 3/16" wire would increase the rate of production but may be more costly.
- A considerable amount of the zinc wire simply rebounds off the substrate creating a dusty environment within the enclosure which may have contributed to the final streaks in the coating.
- There was relatively poor visibility inside the enclosure during the metalizing even with dust collectors and air scrubbers running.
- Perhaps the uneven final appearance was a result of this poor visibility or uneven application of the sealer.
- Different color sealers are available or the final surface can be painted in areas where aesthetics is a concern.
- Overall weather conditions were good during the metalizing with no rain or damp humid weather to contend with.

- Construction engineering cost was higher than expected given the amount of review and resubmittals required to arrive at acceptable documents to perform the work.

Actual versus Estimated Project Costs

	<u>Estimated</u>	<u>Actual</u>
Preliminary Engineering (20%)	\$125,000	\$47,624
Right of Way	\$0	\$0
Construction	\$615,000	\$464,840
Constr. Engr. (15%)	\$92,250	\$132,073
Contingency Items	<u>\$80,000</u>	<u>\$0</u>
Total	\$912,250	\$644,537

Summary

This project to field metalize a steel beam bridge was the first of its kind in Vermont. VTrans benefitted from the very reasonable bid for this project given the contractor's desire to gain some experience with field metalizing an entire bridge.

The construction proceeded as well as could be expected. There were a few days when it was a struggle to maintain the humidity in the enclosure to meet the project specifications.

Aesthetic concerns were not an issue for this bridge. The streaks in the final coating can be corrected with a colored seal coat or subsequent coats of paint.

The life of this coating is 50-60 years relieving VTrans of applying paint system repairs or full removal and re-coating every 25-30 years to ensure protection of the steel beams.

A field review of the metalized coating at the 2 yr. warranty period yielded no defects of note in the coating.

VTrans will consider field metalizing as coating projects are programmed in future to develop a better understand of the true cost of these coatings.

Project Photos



Work Platform Suspended from Beams



Structure Containment in Place



Bottom of Sealed Work Platform



Air Filtration Equipment



Metalizing Inside the Enclosure



Streaks in the Final Coating



Repair Areas for Hanger Attachment



Finished Metalizing (Interior Beams)



Finished Metalizing (Fascia Beam)