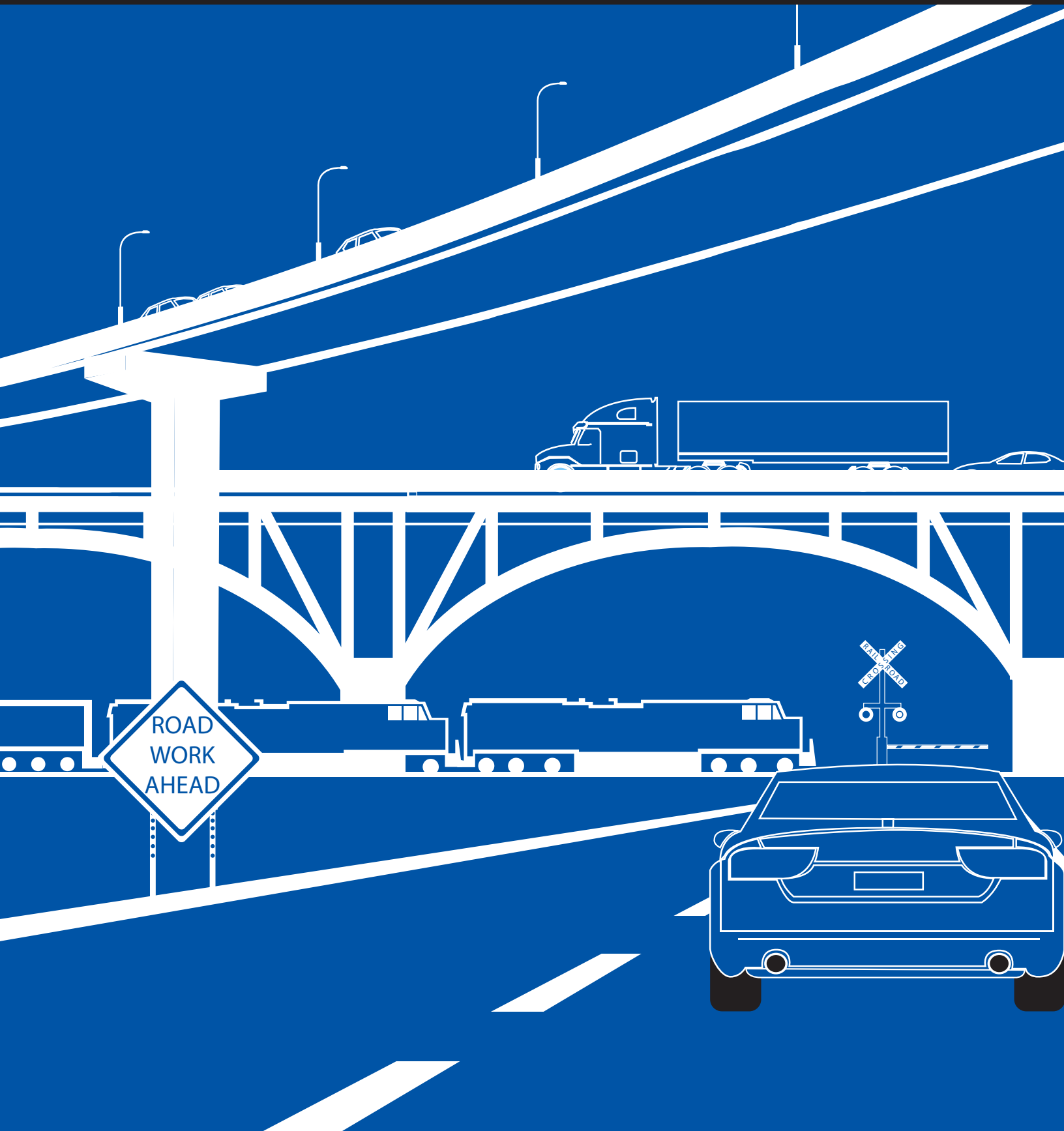




# Experimental Rapid Renewal Project (Bridge Construction)

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Kentucky Transportation Center  
College of Engineering, University of Kentucky, Lexington, Kentucky

in cooperation with  
Kentucky Transportation Cabinet  
Commonwealth of Kentucky

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**Research Report**  
KTC-16-28/FRT200-1F

**Experimental Rapid Renewal Project (Bridge Construction)**

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January 2016

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<b>16. Abstract</b> The objectives of this study were to develop specifications and contract language and to monitor the implementation them to effectively use rapid reconstruction and extended service life concepts in new bridge construction. Through the use of A + B bidding, a duplex protective coating system using Hot Dipped Galvanizing (HDG) and paint, and preservation techniques such as concrete sealers and stains the Kentucky Transportation Cabinet attained those goals.					
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## Table of Contents

Introduction.....	1
Hot Dip Galvanizing .....	1
Duplex Systems.....	2
Field Work .....	4
A + B Bidding .....	4
HDG and Duplex Coating.....	4
Progress of Work.....	9
Research.....	14
Observations.....	14
Appendix A — Special Notes for Bridges 11-1075 And 11-1076.....	16
Appendix B — Draft Notes for Change Order .....	26

## List of Figures

Figure 1 Galvanizing growth layers and content. ....	1
Figure 2 Corrosion rate of zinc versus pH. ....	2
Figure 3 USGS map of rain fall pH. ....	3
Figure 4 Inconsistent surface preparation. ....	5
Figure 5 Inconsistent surface preparation reflected in the galvanizing. ....	5
Figure 6 Thick – irregular galvanizing. ....	6
Figure 7 Cracks in galvanizing on the bottom flange. ....	6
Figure 8 DFT measurement locations on the beams. ....	6
Figure 9 Average DFT of 10.3 mils. ....	7
Figure 10 Different zinc DFT on areas of beams. ....	7
Figure 11 Blisters and pin-holes in epoxy coating. ....	8
Figure 12 Forming abutment caps for casting in laydown yard. ....	10
Figure 13 Preassembling painted beams on precast abutments. ....	10
Figure 14 Formwork to cast deck panels at laydown yard. ....	11
Figure 15 Casting deck panels at laydown yard. ....	11
Figure 16 Precast deck panel placed on precast abutment cap. ....	11
Figure 17 Class M concrete used to tie precast deck panels together. ....	11
Figure 18 Cleaning bridge deck with 5,000 psi wash. ....	12
Figure 19 Applying methyl-methacrylate crack sealer to cold joint at tie pour. ....	12
Figure 20 Spreading and smoothing crack sealer with a roller. ....	12
Figure 21 Cold joint at tie pour is partially exposed and partially covered with concrete slobber. ....	12
Figure 22 Application of penetrating deck sealer. ....	13
Figure 23 Concrete stain on bridge wing wall. ....	13
Figure 24 Concrete stain not applied on bearing area of abutment. ....	13

## List of Tables

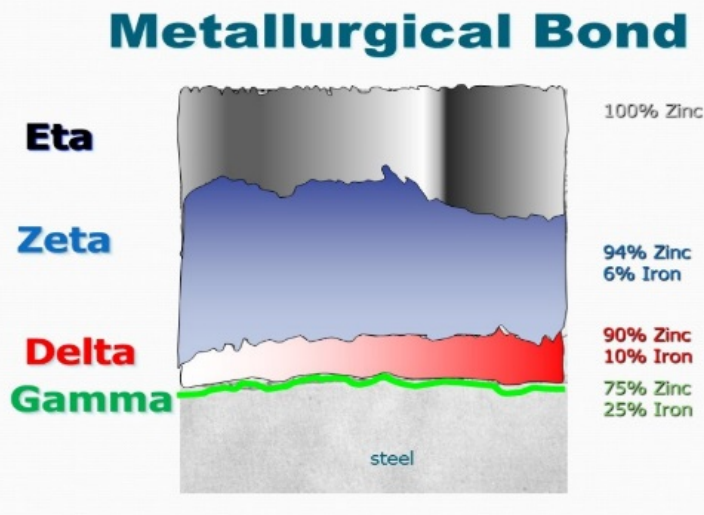
Table 1. Direct adhesion tensile testing on test beams. ....	14
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## Introduction

The 2014 US bridge inventory lists over 600,000 highway bridges. Industry experts believe that the cost of repairing corrosion damage on those bridges is at least \$30 billion annually. Bridge owners do not have the resources to maintain bridges in good condition. Approximately 3,000 new bridges are constructed each year around the United States. Those new bridges must not impose additional maintenance burdens on the already inadequate bridge maintenance budgets. The Federal Highway Administration (FHWA) has long sought a 100-year bridge design. Historically, bridges have been designed for a theoretical 50-year service life but in most cases remain in service for 75 years or longer. To seek design service lives of 100 years implies that the foreseeable service lives will actually exceed 100 years. One tool that bridge designers can employ in pursuit of this goal is the use of hot dip galvanized structural steel (HDG) with the application of a protective coat of paint to form a duplex protective coating system. The system, where appropriate, may greatly extend the service life of the structural steel components of bridges. The FHWA, Kentucky Transportation Cabinet (KYTC), and Kentucky Transportation Center (KTC) partnered on a bridge replacement project to assess the use of the HDG duplex system as part of a FHWA SHRP2 Rapid Renewal initiative. KTC provided the following: Draft Special Notes for HDG and Duplex coating, monitoring of HDG and duplexing coating, application of a crack sealer to the cold joints at the tie-pour boundaries of the bridge decks, application of a penetrating deck sealer, and monitoring of the field construction of two bridges in Knox County. The Special Notes included in the contract are included in Appendix A.

### Hot Dip Galvanizing

HDG is a process in which a protective coating of zinc is grown on a steel surface. A steel article (a bridge beam in this case) is prepared and dipped into a molten zinc bath. Preparation typically consists of: dipping a steel article in an alkaline cleaning bath, rinsing, pickling it in an acid cleaning bath, re-rinsing, and dipping it in a flux followed by immersion in a bath of molten zinc.



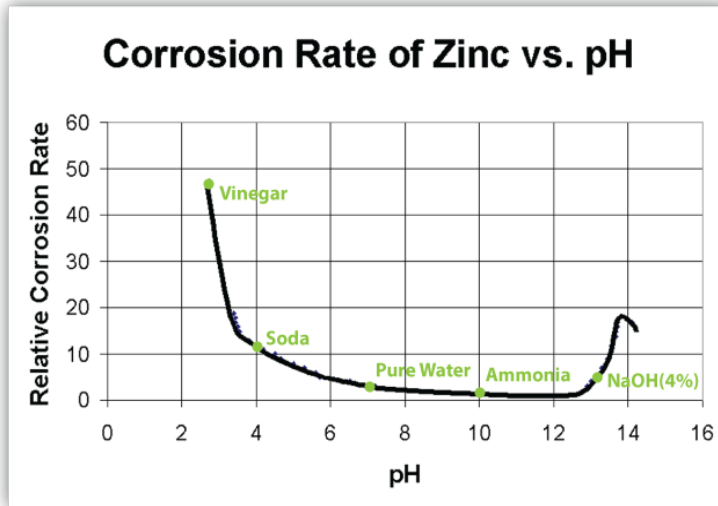
**Figure 1** Galvanizing growth layers and content.

As the steel article is brought up to the zinc bath temperature of 830 to 840°F, a protective coating is grown on the steel surface. The protective coating consists of four layers (see Figure 1) beginning with a thin layer at the steel surface, referred to as the Gamma layer, which is 75% zinc by content. The second layer, referred to as the Delta layer, is 90% zinc. Atop this is a Zeta layer, which is 94% zinc and then finally the Eta layer, which is 100% zinc. This protective coating is metallurgically bonded to the steel surface and

provides excellent galvanic and barrier protection to steel. HDG has great potential as a protective coating for steel since zinc corrodes at a much slower rate — 1/20<sup>th</sup> to 1/30<sup>th</sup> the rate of steel<sup>1</sup>.

### **Duplex Systems**

A duplex coating is an organic liquid applied coating (paint) or powder coating over HDG steel. In bridge construction, this would typically be a liquid applied coating. Duplex coating systems have been used since the 1940s in Europe. In the 1960s and 1970s, a significant number of infrastructure and utilities were duplex coated in Europe and appear to be performing well today.



**Figure 2** Corrosion rate of zinc versus pH

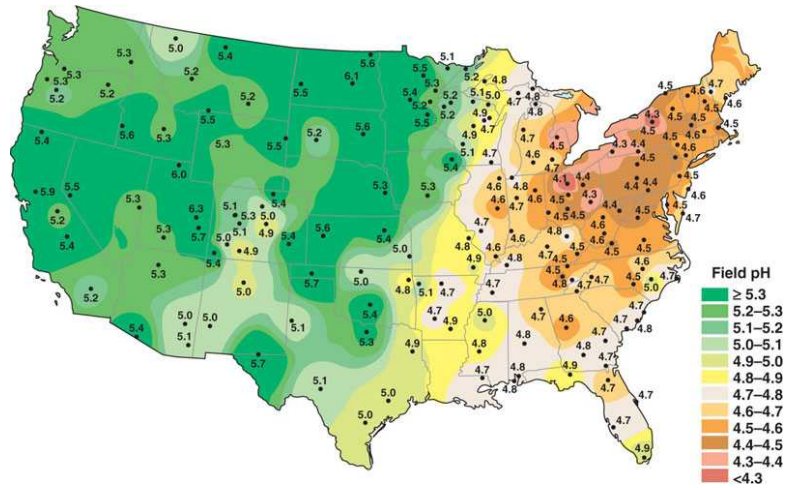
The application of paint over the HDG provides two primary benefits — it enhances the performance and aesthetics. First, in many parts of the country, where tourism is a major industry, as well as at sports venues, the appearance of structures is very important. A duplex system is available in any color whereas zinc typically has a metallic-to-grayish color.

Secondly, paint can significantly extend the time that the HDG protects the structural steel. Zinc provides excellent corrosion protection in environments with pH values between 7 and 13. As Figure 2 shows, when the pH rises above 13 ½ or falls under 4, the corrosion rate of zinc increases rapidly. Between pH values of 7 and 4 the corrosion rate of zinc increases but not as much as at either pH extreme. Figure 3 is a USGS chart of the pH value of rainfall data in the US<sup>2</sup>. As the chart illustrates, rainfall increases in acidity from the West Coast to the East Coast. The pH value of rainfall on the West Coast is typically between 5 and 6 whereas the pH value of rainfall east of the Mississippi River is as low as 4.1 and consistently between 4 and 5. These pH values are in the range that would suggest the presence of elevated zinc corrosion rates. Duplex coatings applied over the zinc would then provide protection in low or mild pH environments.

<sup>1</sup> <http://www.galvanizeit.org/hot-dip-galvanizing/how-long-does-hdg-last>

<sup>2</sup> <http://water.usgs.gov/edu/ph.html>





**Figure 3** USGS map of rain fall pH

## Field Work

### A + B Bidding

The Knox County project was part of the FHWA and American Association of State Highway Transportation Officials' (AASHTO) second Strategic Highway Research Program (SHRP2) rapid reconstruction project. Rapid reconstruction was achieved by A + B bidding where the B component of the total bid was the number of days from bridge closure until the bridge would be reopened to new traffic. The low bid was determined by using the formula,  $(A) + [(B) \times (\$10,000.00)]$ , included in the contract. The low bid had a B value of 35 days. The B component was for bid evaluation only and was not a pay item.

### HDG and Duplex Coating

The 100-year bridge design concept was included in the project. To achieve the long service life and low maintenance desired for the 100-year bridge design, the design team included galvanizing of all structural steel, duplex coating of all exposed galvanizing, the use of galvanized reinforcing steel in one bridge deck, the replacement of masonry coatings with a concrete stain to retard chloride intrusion, and sealing the bridge decks with a penetrating sealer shortly after construction.

The project consisted of two bridges in Knox County, which is located in rural southeastern Kentucky. One bridge carries KY 6 over Stewards Creek, while the second bridge carries KY 6 over Lynn Camp Creek. Both bridges have a low average daily traffic volumes of approximately 1,300 vehicles. Both bridges have low stream clearances. During low-water conditions, the clearances are approximately 4 feet. Periodic flooding submerges the bridges several times each year. Because of this, weathering steel would be inappropriate. Designers concluded that galvanizing and duplex coatings offered a better alternative. The bridge at Stewards Creek has 4 beam lines 48 ½ feet long, whereas the bridge at Lynn Camp Creek has 6 beam lines 59 feet long and with galvanized reinforcing steel incorporated into the bridge deck. The general contractor fabricated all bridge steel in a shop at Corbin, KY, which is approximately 5 miles from the bridge locations.

The project design team consisted of the KYTC Divisions of Structural Design, Materials and Construction, and the Kentucky Transportation Center (KTC) Bridge Preservation Program. The design team was not experienced in the use of HDG and duplex coatings. The team's first lesson learned came early in the project, when the bridge steel was prepared for galvanizing. Contractual language directed the team to perform abrasive blasting of the bare steel to an industry standard. After consulting with the galvanizing industry and bridge owners, the consensus was that abrasive blasting was unnecessary. As such, it was deleted from the contract.



**Figure 4** Inconsistent surface preparation



**Figure 5** Inconsistent surface preparation reflected in the galvanizing

The contractor elected to pass all the bridge steel through a centrifugal blast cabinet, but since there was not an inspection standard a consistent surface preparation was not achieved (Figure 4). Dark vertical bands on the steel beams were mill scale and rust that remained after an inconsistent abrasive blast. After going through the HDG process at the galvanizing plant, including acid pickling, those areas reflected through the galvanizing. This produced an inconsistent HDG surface appearance, Figure 5. Those areas may not have posed a performance problem, but they had slightly more zinc and were visually differentiated from the surrounding HDG.

There were other issues with the quality of the HDG bridge steel. Dry film thickness (DFT) measurements indicated that the zinc thickness ranged from 5 mils to 85 mils with very irregular surfaces (Figure 6). KYTC officials expressed concern over whether the zinc would adhere at the higher thicknesses and communicated apprehension over the possibility of obtaining a continuous film of paint over the rough surface of the zinc. Researchers from KTC performed direct tension



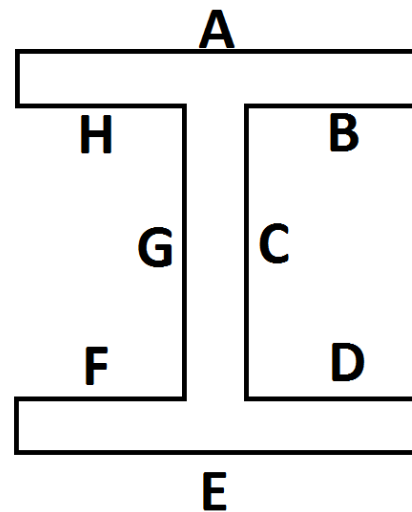
**Figure 6** Thick – irregular galvanizing



**Figure 7** Cracks in galvanizing on the bottom flange

adhesion tests<sup>3</sup> on the zinc product. Those were conducted in relatively thick areas of 30 to 40 mils of zinc as well as in thinner areas of 12 to 16 mils of zinc. Since this was a rapid reconstruction project and time was critical, a quickset epoxy was chosen to affix the test dollies to the zinc surfaces. Regardless of the thicknesses of the zinc, the tensile adhesion pulls indicated 1,500 to 2,000 psi strength with all failures in the epoxy. When the surface was readied for paint application, cracks were observed on the bottom flanges of all beams, Figure 7. Because of the irregularity of the zinc build on the steel and of the cracks, KYTC officials rejected this product.

The general contractor attempted to remove the galvanizing from the steel beams by running them through the blast cabinet. After several passes through the cabinet the contractor returned the bridge steel to the galvanizing facility with some zinc remaining on it. The residual zinc was removed by pickling the steel in an acid bath for an extended period. The bridge steel was then re-galvanized with better results than the first attempt. The only documented processing difference between the first and second galvanizing attempts was that the beams were removed from the zinc bath at as steep an angle as possible. DFT measurements of the galvanizing were taken at various locations on each beam (Figure 8). Figure 9 illustrates that the zinc's thickness ranged from approximately 6 to 13 mils and averaged 10.3 mils. A comparison of the DFT of zinc on different areas on the beams revealed that the top portion of top flanges averaged 8 mils of zinc (Figure 10), with the thickness of the zinc steadily increasing through the bottom of the bottom flange of each beam where the average was 12.3 mils. This appears to be a result of the steel's dwell time in the zinc bath. Inspection of the galvanized bridge steel revealed that there were still a few cracks on the edges of bottom flanges of beams but far fewer than on the first galvanizing



**Figure 8** DFT measurement locations on the beams

<sup>3</sup> ASTM D4541-02 Standard Test Method for Pull-off Strength of Coating Using Portable Adhesion Testers – A4

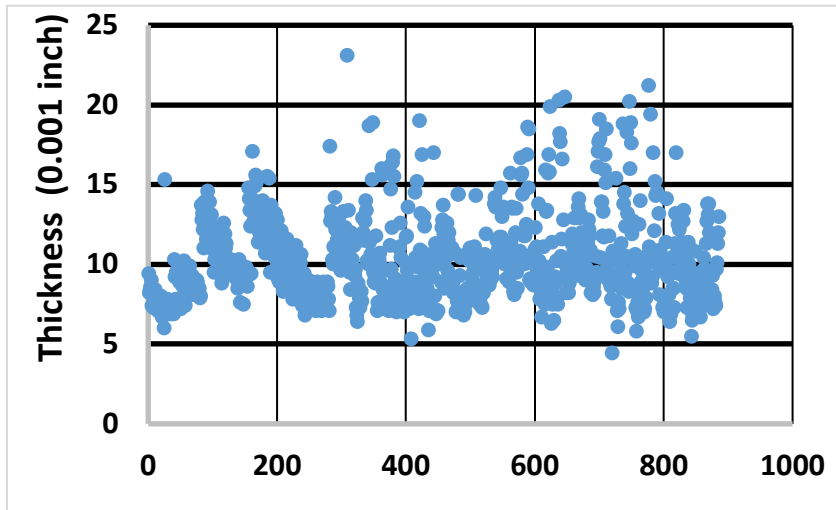


Figure 9 Average DFT of 10.3 mils

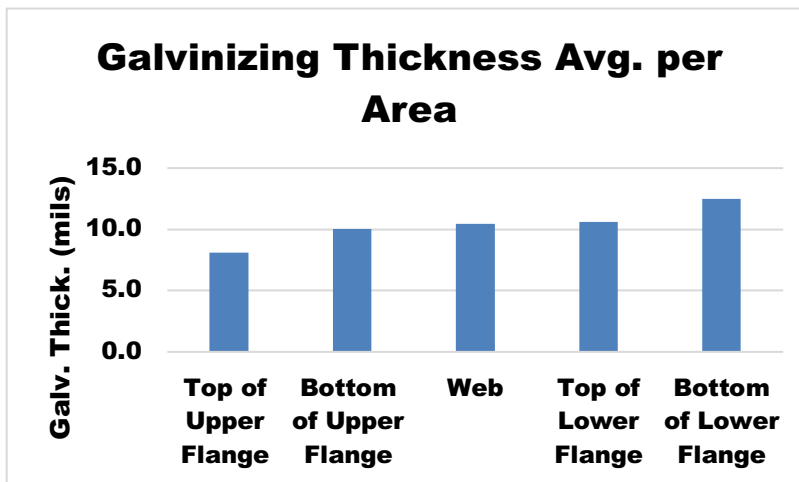


Figure 10 Different zinc DFT on areas of beams

attempt. Some beams did not have any cracks in the zinc. The cracked areas were repaired by removing the loose zinc and touching it up with an organic zinc-rich primer that was applied by brushing.

After the bridge steel had been inspected, repaired, and accepted, the zinc surfaces were prepped to accept the paint, which would complete the duplex system.

Current guidance mandates that paint must be applied over HDG within certain time frames and under specified conditions to be successful. If a coating is applied within eight hours of galvanizing (before deleterious corrosion products are formed), it's performance will probably be acceptable. HDG steel beams do not cool sufficiently in the eight-hour window to permit paint application. If the HDG weathers for at least a year to fully develop the corrosion

products, with the final product being a zinc carbonate, a simple pressure wash and coating application will probably be successful. Between that eight-hour window and one-year time frame, some type of surface preparation is required for the practical painting of galvanized steel. A shorter timeframe is necessary for most new construction projects.

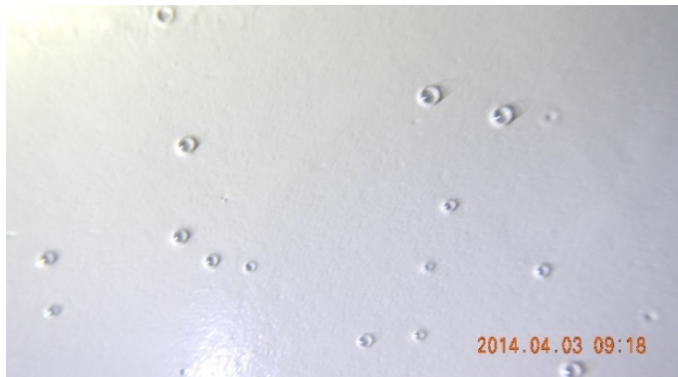
A major concern of KYTC officials was painting process's ability to establish a durable coat of paint over the galvanized steel. ASTM D 6386<sup>4</sup> is amenable to various surface preparation methods, but the project design team voiced two primary concerns. One concern was that the alkaline cleaning solution permitted in ASTM D 6386 might be difficult to remove completely and therefore prevent the paint from achieving its maximum performance. Because of this concern, its

<sup>4</sup> ASTM D 6386 "Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting"

use was not permitted. A more pressing concern related to the need for an angular anchor profile to provide a suitable mechanical bond for the paint. A newly galvanized surface will yield a profile measurement typically in the range of 1 mil. However, this is due to irregularities resulting from the hot-dipping process, which does not provide an angular surface profile with high peak density.

One project requirement specified the development of a means and methods approach for surface preparation before applying paint. Tests indicated that the desired surface preparation was best achieved by using a fine 120-grit garnet at a blast pressure of approximately 80 psi to produce sweep blast. A concern was the excess removal of the HDG's soft zinc surface in order to achieve the angular surface profile. Measurements indicated that this process left an angular surface profile of 1.0 mil while removing approximately 0.5 mil of the existing zinc. After sweep blasting, the intermediate and finish coats of the paint system were applied (these were selected from the Cabinet's List of Approved Materials).

The approved paint system consists of an organic zinc-rich primer (used as the touchup primer), with an epoxy mid coat and a two-component urethane topcoat. Application of the epoxy paint over the galvanizing resulted in a number of pinholes or bubbles (Figure 11). Two methods were effective in addressing these flaws. The first method was to back roll after spray application of the



**Figure 11** Blisters and pin holes in epoxy coating

epoxy. The second — and preferred — method for this project was to spray apply a mist coat of epoxy followed by a thicker coat to achieve the desired film build.

After the paint was applied, inspected, and approved, the bridge steel was moved to the contractors' facility for temporary assembly and casting of the concrete elements of the bridge. A site visit to the bridges, approximately 15 months after the coating application, indicated that the epoxy-urethane paint system averaged

approximately 9 mils DFT, and the zinc galvanizing averaged approximately 13 mils. There were no defects observed.

## **Progress of Work**

The following is a general timeline of project activities.

<b>Dec. 2013</b>	Steel fabrication and abrasive blasting completed in contractors' shop. HDG in Nashville
<b>Feb. 2014</b>	Surface preparation (abrasive blast) and paint application on HDG beams in contractors' shop.  Direct tension adhesion tests on prepared HDG surface indicates 1,550 to 2,125 psi. Numerous cracks in HDG found on most beams. KYTC rejects HDG articles and processes change order for re-dipping. KTC prepared draft note for re-dipping (see Appendix B)
<b>Apr. 1, 2014</b>	Re-dipping beams in Nashville
<b>Apr. 4-9, 2014</b>	Surface preparation and shop painting of structural steel completed. Touch-up and connections areas to be completed after bridge erected in the field.
<b>May–Aug., 2014</b>	Abutment caps for both bridges cast in lay-down yard. Beams moved to lay-down yard and assembled to final configuration. Deck panels cast. Ready to be moved to field. Figures 12, 13, 14, and 15.
<b>Sept. 30, 2014</b>	Old structure removed at Lynn Camp Creek
<b>Oct. 9, 2014</b>	Excavation, pile driving, and mud seal completed and precast abutment caps set at Lynn Camp
<b>Oct. 10, 2014</b>	First precast deck section placed Lynn Creek. Figures 16 and 17
<b>Oct 11, 2014</b>	Second and third precast deck section placed at Lynn Creek
<b>Oct. 17, 2014</b>	Remove old structure at Stewards Creek
<b>Oct. 23, 2014</b>	Excavated abutments, drove piling, poured mud seals, and placed precast abutments for Stewards Creek
<b>Oct. 24, 2014</b>	Closure pours for abutments at Stewards Creek completed.
<b>Oct. 25, 2014</b>	Both precast deck segments placed at Stewards Creek
<b>Oct. 27, 2014</b>	Class M deck closure pour at Stewards Creek
<b>Oct. 29, 2014</b>	Remove debris and pressure wash the Lynn Camp bridge deck at 5,000 psi. with a 0 degree spinner tip.
<b>Oct. 30, 2014</b>	Applied a high-density methyl-methacrylate crack sealer (BASF DegaDeck CSP (Crack Sealer Plus)) to the tie pour cold joints. The field tie pour left the joint exposed in some areas and covered with concrete

slobber in other areas. Areas with concrete slobber precluded sealing the cold joint. Applied penetrating deck sealer Hydrozo Silane 40 included in the List of Approved Products in the **SPECIAL NOTE FOR CONCRETE STAIN AND SEALER** in Appendix A to Lynn Camp bridge deck. Sealer was applied with hand sprayers and spread with brooms to distribute sealer. Applied sealer at rate of 175 ft<sup>2</sup>/gal.

- Nov. 4 6, 2014** Completed grade to both bridges, began asphalt placement at Lynn Camp, cleaning and painting of connections and damaged areas.
- Nov. 7, 2014** Asphalt base in place and traffic returned to both bridges
- Nov. 10, 2014** Pressure washed and applied deck sealer to Stewards Creek bridge using the same material and methods used at Lynn Camp Creek bridge.
- Nov. 12, 2014** Asphalt surface courses completed at both bridge approaches. Contractor had previously applied a masonry coating not specified in the contract to concrete at both bridges. The masonry coating was removed by abrasive blasting and a concrete stain, SWD D.O.T. Bridge and Highway Concrete Sealer B97-Series, included in the **SPECIAL NOTE FOR CONCRETE STAIN AND SEALER** was applied on the Lynn Camp bridge abutments.
- Nov. 13, 2014** Abrasive blast removal of masonry coating and application of concrete stain on Stewarts Creek bridge abutments.



**Figure 12** Forming abutment caps for casting in laydown yard



**Figure 13** Preassembling painted beams on precast abutments





**Figure 14** Formwork to cast deck panels at laydown yard



**Figure 15** Casting deck panels at laydown yard



**Figure 16** Precast deck panel placed on precast abutment cap



**Figure 17** Class M concrete used to tie precast deck panels together



**Figure 18** Cleaning bridge deck with 5,000 psi wash



**Figure 19** Applying methyl-methacrylate crack sealer to cold joint at tie pour



**Figure 20** Spreading and smoothing crack sealer with a roller



**Figure 21** Cold joint at tie pour is partially exposed and partially covered with concrete slobber



**Figure 22** Application of penetrating deck sealer



**Figure 23** Concrete stain on bridge wing wall



**Figure 24** Concrete stain not applied on bearing area of abutment

## Research

One of the primary concerns of bridge owners pertaining to duplexing is the short amount of time between surface preparation and application of a paint system. ASTM D6386 requires that paint be applied within one hour of surface preparation of the galvanizing. SSPC-SP 16<sup>5</sup> has language that requires painting within one work shift. A one-hour coating window does not appear to be feasible for bridge steel surface preparation and coating. The contract, as part of the research portion of the Knox bridge project, required the contractor to provide test beams for evaluation of the recoat window. Four short test beams were provided, prepared by abrasive blasting, and coated at different time intervals after blasting. Surface preparation and paint application were conducted in the contractors' paint shop, where the ambient conditions were fairly consistent at 75° F and a relative humidity of 55%. Table 1 includes data from direct adhesion tensile testing conducted on these test beams. Again, a quick set epoxy was used to attach the dollies. All breaks were epoxy

Test Beam #	Side	Date Tested	Coated After Blasting (hr)	Pull 1 (psi)	Pull 2 (psi)	Pull 3 (psi)	Average (psi)
2	A	5/9/2014	0.25	1442	1617	1681	1580
2	B	5/9/2014	7	2127	2270*	1837	1982
3	A	5/9/2014	22	2012	1982	1956	1983
4	A	5/9/2014	31	1591	2255*	2246*	1591
2	A	9/23/2015	0.25	1904	2211	2288	2134
2	B	9/14/2015	7	1723	1699	1909	1777
3	A	9/14/2015	22	1414	1286	1702	1467
4	A	9/14/2015	31	1520	1449	1205	1391

**Table 1** Direct adhesion tensile testing on test beams

failures, which simply indicates that the coatings were stronger than the epoxy. Coatings were applied at 15-minute, 7-hour, 22-hour, and 31-hour intervals after surface preparation. Testing indicated 1,400 to 2,000 psi adhesion strengths. Additional tests were conducted in September 2015 with similar results.

### Observations

Current literature indicates that steel chemistry is very important to the HDG process. The amounts of silica, phosphorus, and manganese have an effect on the quality of the HDG product<sup>6</sup>. Mill certifications indicate that the 10 beams included on the Knox County Kentucky project involved two separate heats of steel. Each heat can have variations in the amount of the silica, phosphorus, and manganese in the steel, therefore producing a different HDG product. Specifications should place limits on the steel composition.

Preparation of the steel's surface impacts the quality of the HDG product. While the pickling process may be sufficient, KYTC's position is that in the future, all steel to be HDG for Kentucky bridge projects will have a consistent surface preparation, which will be an abrasive blast to either SSPC SP 6 or SSPC SP 10 condition.

<sup>5</sup> SSPC-SP 16-Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels and Non-Ferrous Metals

<sup>6</sup> <http://www.galvanizeit.org/knowledgebase/article/why-is-steel-chemistry-important-in-the-hot-dip-galvanizing-process>

The angle of removal from the HDG bath is a very critical influence on the quality of the HDG product on larger articles such as bridge beams. After each article has galvanized sufficiently, it should be removed as quickly and at as steep an angle as is practical to facilitate drainage of the molten zinc alloy.

Both the Knox County project in 2014 and the I-24 project in 1977 appeared to have some issues with HDG cracking in the lifting-handling areas. These cracks establish locations for early failure of the protective coating system. While no ferrous corrosion was visible for the first 40 years on the I-24 project, it is now visible in at least one location (approx. 4' long), whereas the remainder of the steel surface appears to have many decades of corrosion protection still available.

In Kentucky's experience, the time between abrasive blasting of the HDG surface and application of the paint did not appear to be critical at the ambient conditions ( approximately 50% relative humidity and 70 °F) which were present at the time of surface preparation and paint application.

Thicker HDG with irregular surfaces may prove challenging with respect to obtaining a continuous film of paint for duplexing but is adherent to the underlying steel. Good hot-dipping practices can minimize HDG irregularities.

Frequently, there are areas of HDG that need to be repaired before construction in the field. Any touchup of these areas should be completed with a primer compatible with the subsequent coatings that will be applied as part of the duplex system.

Industry literature indicates that small changes in zinc bath temperature can significantly affect the zinc growth. Observation of the HDG process for the Knox County project revealed that bath temperature varied by as much as 6° F over a short time period.

The standards and guides currently available appear to have been written primarily for thinner cross-section steel. Most of the tables and charts currently available treat steel cross-section in small increments up to 0.25 inch. Bridge steel is typically much thicker, sometimes in excess of 1.0 inch. Standards and guides should be reviewed and revised to reflect the heavier steels used in bridge construction.

Tie pours in the field provide a cold joint that is a possible leak through the bridge deck. Although a crack sealer was applied to the cold joints at the Lynn Camp Creek Bridge, the cracks leaked during precipitation afterwards. The sealer was unable to penetrate the joints due to concrete slobber bridging the joint. Finishing the cold joint with an edging tool could provide a better opportunity to seal the cold joint.

Assembling the structures to final geometry in the laydown yard and precasting bridge elements proved very successful. The elements fit together well in the field and aided the contractor in meeting the rapid reconstruction goals.

## **Appendix A — Special Notes for Bridges 11-1075 And 11-1076**

SPECIAL NOTE FOR VALUE ENGINEERING SPECIAL NOTE FOR PROJECT TEAM SPECIAL NOTE FOR SUBMITTALS

SPECIAL NOTE FOR STRUCTURAL STEEL FABRICATION

SPECIAL NOTE FOR HOT DIP GALVANIZING OF STRUCTURAL STEEL SPECIAL NOTE FOR SURFACE CLEANING, PREPARATION, AND PAINTING SPECIAL NOTE FOR PRE-CASTING DECK SLABS

SPECIAL NOTE FOR CONCRETE STAIN AND SEALER

SPECIAL NOTE FOR PAINT STORAGE, HANDLING, SAMPLING, MIXING AND THINNING

SPECIAL NOTE FOR QUALITY CONTROL SPECIAL NOTE FOR PAINT

SPECIAL NOTE FOR ENVIRONMENTAL AND WORKER SAFETY REGULATIONS SPECIAL NOTE FOR MARKING

SPECIAL NOTE FOR PRE-BID CONFERENCE DISTRICT 11 SPECIAL NOTE FOR PAYMENT

SPECIAL NOTE FOR CONTRACT COMPLETION DATE, LIQUIDATED DAMAGES AND INCENTIVE PAY ON “A+ B” BIDDING CONTRACT

### **SPECIAL NOTE FOR VALUE ENGINEERING**

No Value Engineering Change Proposals (VECP) will be accepted for this project.

### **SPECIAL NOTE FOR PROJECT TEAM**

This is an experimental project developed, administered and monitored by a Project Team. The Team consists of Kentucky Transportation Cabinet (KYTC) officials and representatives and University of Kentucky - Kentucky Transportation Center (KTC) personnel. The function of KYTC officials and representatives on the TEAM will be primary design, QC/QA, materials verification, and project administration. The KTC function will be to assist in project design, monitoring, and reporting. The Contractor will provide and allow sampling of all materials in accordance with KYTC Standard Specifications 812 and 821 (2012).

The Contractor's/Subcontractor's work will be monitored and documented by the KTC Bridge Preservation Program. The Contractor is required to accommodate requests of KTC to: 1) access of fabrication shops and work sites, 2) photograph the Contractor's/Subcontractor's operations, 3) question the Contractor's/Subcontractor's personnel concerning their work 4) take nondestructive measurements of coatings and 5) obtain project-related information.

The Contractor/Subcontractors will be required to provide the KTC Bridge Preservation Program personnel with 5 working days advanced notice prior to performance of each Phase of work. They shall also furnish KTC with a list of personal safety equipment required at their work sites/plants. The Contractor/Subcontractors will allow KTC personnel to inspect all steel and concrete items at the work sites/plants prior to shipment and also observe handling and securing of those items for shipment to the next phase of work.

KTC personnel will not be making any accept/reject decisions nor provide any guidance on how a task is to be performed or the suitability of any materials or completed work.

KTC representatives will be in attendance at the Cabinets' Pre-Bid and Pre-Construction Conferences for this project, to answer questions. KTC contact information is:

Ted Hopwood	859-257-2501	<a href="mailto:ted.hopwood@uky.edu">ted.hopwood@uky.edu</a>
Sudhir Palle	859-257-2670	<a href="mailto:sudhir.palle@uky.edu">sudhir.palle@uky.edu</a>
Bobby Meade	502-517-1257	<a href="mailto:bobby.meade@uky.edu">bobby.meade@uky.edu</a>

All correspondence will be through and final decisions made by the Cabinets' Section Engineer.

### **SPECIAL NOTE FOR SUBMITTALS**

A Pre-construction Conference is required for this project. Submit a Written Narrative and Activity Bar Chart per KYTC Standard Specification 108 (2012). The "Activities" on the Bar Chart will include the Phases of work listed in the "SPECIAL NOTE FOR QUALITY CONTROL". Submit a "Quality Control" Plan meeting all requirements for quality control inspections specified in the Contract. Submit a "Groundwater and Surface Water Protection Plan" as required in the "SPECIAL NOTE FOR ENVIRONMENTAL AND WORKER PROTECTION PLAN". All submittals must be received by the Engineer at least two days prior to the Pre-Construction Conference.

### **SPECIAL NOTE FOR STRUCTURAL STEEL FABRICATION**

Fabrication Requirements - After fabrication (cutting, welding shear connectors, drilling, etc.) is complete, all holes shall be de-burred and all fins, scabs or other surface/edge anomalies shall be ground or repaired per ASTM A6 (Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling). Provide a minimum of 4 test panels (18 inches x 18 inches with the same thickness of the structural steel beams). The test panels will be prepared as structural steel is prepared, galvanized, and retained for the purpose of testing surface preparation and coating application as determined by the Project Team. Test panels costs are incidental to "structural steel".

### **SPECIAL NOTE FOR HOT DIP GALVANIZING OF STRUCTURAL STEEL**

Description - This work shall consist of surface preparation and hot dip galvanizing all structural steel specified on the plans and test panels.

Surface Preparation - The Contractor shall consult with the galvanizer to insure proper removal of grease, paint and other deleterious materials prior to galvanizing.

Application of Hot Dip Galvanized Coating - Steel members, fabrications and assemblies shall be galvanized by the hot dip process in the shop according to AASHTO M111 (Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products). All fins, burrs, scabs or other surface/edge anomalies evident after preparatory baths will be ground or repaired per ASTM A6 prior to immersion in the zinc bath.

Bolts, nuts, washers and steel components shall be galvanized in the shop according to AASHTO M232 (Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware).

All steel shall be safeguarded against embrittlement according to ASTM A143 (Standard Specification for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement).

Water quenching or chromate conversion coatings shall not be used on any steel work that is to be painted. All galvanized steel work shall be handled in a manner to avoid mechanical damage and minimize distortion.

Beams shall be handled, stored and transported with their webs vertical and with proper cushioning to prevent damage to the member and coating. Members shall be supported during galvanizing to prevent permanent distortion.

Hot Dip Galvanized Coating Requirements - Coating weight, surface finish, appearance and adhesion shall conform to requirements of ASTM A385 (Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip) and AASHTO M111 or AASHTO M232, as appropriate.

Any high spots of zinc coating, such as metal drip lines and rough edges, left by the galvanizing operation in areas that are to be field connected or in areas that are to be painted shall be removed by cleaning per SSPC-SP2 (Hand Tool Cleaning) or SSPC-SP3 (Power Tool Cleaning). The zinc shall be removed until it is level with the surrounding area, leaving at least the minimum required zinc thickness.

Testing of Hot Dipped Galvanized Coating - Inspection and testing of hot dip galvanized coatings shall follow the guidelines provided in the American Galvanizers Association publication "*Inspection of Products Hot Dip Galvanized After Fabrication*". Sampling, inspection, rejection and retesting for conformance with requirements shall be according to AASHTO M111 or AASHTO M232 as applicable, with the target coating thickness of 152 microns (6 mils). Coating thickness shall be measured according to AASHTO M111, for magnetic thickness gage measurement and AASHTO M232 as appropriate. The Cabinet may elect to conduct testing in addition to the Standards required testing.

All galvanized steel will be visually inspected for finish and appearance.

Bolts, nuts, washers, and steel components shall be packaged according to AASHTO M232. Identity of bolts, nuts and washers shall be maintained for lot-testing after galvanizing according to Article 505.04(f)(2) for high strength steel bolts.

Repair of Hot Dip Galvanized Coating - Surfaces with inadequate zinc thickness will be repaired using zinc based solder in accordance to ASTM A780 (Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings) Section 4.2.1 and AASHTO M111. Any fins or slivers present after galvanizing will be removed and repaired ASTM A780 (Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings) Section 4.2.1 and AASHTO M111.

Surfaces of galvanized steel that are damaged after the galvanizing operation shall be repaired according to ASTM A780. Damage that occurs in the shop shall be repaired in the shop. Damage that occurs during transport or in the field shall be repaired in the field. Any drips or runs in the galvanizing will be removed by grinding to match the surrounding surface.

All bolt holes shall be reamed or drilled to their specified diameters after galvanizing. The Cabinet's Project Team must inspect and approve the galvanized steel prior to the subsequent Phase of Work.

## **SPECIAL NOTE FOR SURFACE CLEANING, PREPARATION, AND PAINTING**

General - Paint all galvanized structural steel except as specified in the "Shop Application of the Paint System" Section of this Special Note. The surfaces to be painted shall be prepared per ASTM D6386 (Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting) and as described herein.

Surface Cleaning - Galvanized surfaces to be painted will be cleaned per ASTM D6386 with the exception that Aqueous Alkaline Cleaning (5.3.1) will not be permitted.

Surface Preparation - Galvanized surfaces to be painted will be prepared per ASTM D6386 Section 5.4 and 5.4.1. Sections 5.4.2, 5.4.3, 5.4.4, 5.4.5, and 5.4.6 will not be permitted. The blast cleaned surface will have a surface profile of 0.5 to 1.0 mil, not to exceed 1.0 mil, as measured by ASTM D4417 (Standard Test Method for Surface Profile of Blast Cleaned Steel) Method B.



Surface Preparation Process Approval - The Contractor will select an abrasive media and perform a Test Blast on the test panels. Project Team representatives must be onsite to observe the Test Blast and ascertain that the process (means and methods) yields the desired conditions prior to performing surface preparation of the remaining structural steel surface. Project Team representatives will be on site to observe surface preparations and insure adherence to the approved process.

Shop Application of the Paint System - Following the galvanizing and the surface preparation for painting, apply the intermediate and finish coats of a paint system on the KYTC List of Approved Materials Class I, Type I or Type V; or Class II, Type I to the structural steel. Shear studs on the top flanges of beams, surfaces of the beams 12 inches from each beam end, and faying surfaces at bolted connections will be masked off prior to painting. Guard rails will not be painted. Apply paint in accordance with KYTC Standard Specifications (2012) for Road and Bridge Construction Section 607. The finish coat color will be Federal Standard Color Number 595B X6186. After application of the paint system, painted structural steel will remain undisturbed a minimum of 14 days to allow curing of the paint system. The Cabinet's Project Team must inspect and approve application of the intermediate coat prior to application of the finish coat. The Cabinet's Project Team must inspect and approve application of the finish coat prior to the subsequent Phase of Work.

Transportation and Handling of Painted Structural Steel - Handle steel members with care to minimize damages to or contamination of the coating. Handle large members with synthetic slings, padded chains and lifting clamps or other non-injurious methods.

Coated members will be stored and transported on padded or otherwise protected blocking.

Construction Requirements - If white rust is visible on the contact surfaces for any field connections, the galvanized surface shall be cleaned by hand wire brushing in accordance with SSPC SP2 or according to SSPC- SP7 (Brush-Off Blast Cleaning). Power wire brushing is not allowed. Ensure the galvanized coating thickness complies with the requirements for Testing of Hot Dip Galvanized Coating. Repair all non-compliant areas in accordance with Repair of Hot Dip Galvanized Coating.

After field erection of the structural steel, the following areas shall be prepared by cleaning according to SSPC-SP1 (Solvent Cleaning) then painted or touched up per manufacturers' recommendations with the same paint used for shop application (both the intermediate coat and the finish coat):

- unpainted areas at bolted connections
- areas where the shop paint has been damaged
- any other areas as directed by the Engineer.

All paint materials for the shop and the field shall be supplied by the same paint manufacturer.

### **SPECIAL NOTE FOR PRE-CASTING DECK SLABS**

Ensure that all structural steel is protected during transportation and handling to preclude damage to galvanized or coated surfaces. All concrete slobber or other deleterious materials deposited on the exposed galvanized or coated surface are to be removed by low pressure washing before curing or "setting". Washing pressure will be the minimal pressure required to remove the deleterious material and will not damage the coating. The Cabinet's Project Team must inspect and approve the pre-cast deck slab work prior to the subsequent Phase of Work.

### **SPECIAL NOTE FOR CONCRETE STAIN AND SEALER**

Concrete Stain - Contrary to Section 601.03.18, masonry coating is not required on this project, however all surfaces of the end bents normally required in Section 601.03.18 to be coated with masonry coating must be coated with concrete stain. Apply a concrete stain from the Project List of Approved Materials (see below) . Comply with the stain manufacturers recommendations for surface preparation and application. The stain color will be grey Federal Standard Color Number 595B X6622. The stain will be treated as paint and will meet all requirements in the "SPECIAL NOTE FOR PAINT" and the "SPECIAL NOTE FOR PAINT STORAGE, HANDLING, SAMPLING, MIXING AND THINNING". Include all costs (labor, materials, equipment, etc) in the unit bid price for "Concrete Sealant".

**Project List of Approved Materials- Concrete Stain**

The Sherwin Williams Company	SWD D.O.T. Bridge and Highway Concrete
Sealer	B97-Series
PPG Pittsburgh Paints	Perma-Crete Vertical Concrete Stain

Concrete Deck Sealer - Acquire a sufficient quantity, according to the manufacturers minimum indicated coverage, of Concrete Sealer from the Project List of Approved Materials (see below) to seal the entire deck of both bridges. Deliver the Concrete Sealer to the storage location identified by the Cabinet. Acquire the Concrete Sealer in individual containers not larger than 5 gallons. Include all costs (materials and delivery) for the Concrete Deck Sealer in the unit bid price for “Concrete Class AA”.

**Project List of Approved Materials- Concrete Deck Sealer**

<b>Product name</b>	<b>Supplier</b>
Hydrozo Silane 40	BASF
PowerSeal 40	Vexcon Chemicals Inc.

## **SPECIAL NOTE FOR PAINT STORAGE, HANDLING, SAMPLING, MIXING AND THINNING**

A paint storage site shall be established for receiving and storing paint delivered for use on the project, shop and field. All new paint shall be received at the storage site for inventory and acceptance testing. At that time, have the Contractor's QC inspector (**SEE SPECIAL NOTE FOR QUALITY CONTROL**) and the Department's inspectors independently inventory the supplied paint by batch number and quantities delivered. The Department's inspector examines all paint containers delivered and rejects those with 1) broken seals, 2) rust, 3) and altered, missing or illegible batch numbers or labels. A representative of the Department samples each lot of material (**SEE SPECIAL NOTE FOR PAINT**). Rejected paint containers shall be labeled "REJECTED" and dispose of them promptly. The unapproved and/or rejected containers of paint shall be stored separately from those that have been approved.

The addition of solvents to paint shall be permitted **only** by written approval from the Engineer.

Use only new solvents supplied by the paint manufacturer. Solvents shall only be used in the presence of the Department inspector. Solvents from new, unopened containers with the solvent manufacturer's labeling intact shall be used. The QC inspector shall record locations where solvent-thinned paint was used.

Solvents used for cleaning at the job site shall be kept in sealed containers away from mixing operations. Solvents used to clean brushes, rollers, or spray equipment shall be collected in sealed containers and stored as a hazardous waste.

The paint manufacturer shall be required to provide a technical representative at the job site, shop or field, when requested by the contractor or the Department at no additional cost to the Department.

**WORKMANSHIP** - All structural steel surfaces shall be properly cleaned and painted to the satisfaction of the Engineer. There shall be no provision for missed areas or substandard work regardless of size of the area in question. **All improperly prepared or painted surfaces shall be repaired to meet the provisions of this specification.**

Allowable field variation of the color of all cured finish coats on structural steel shall be 2.0  $\Delta E^*$ .

These values shall be obtained from a spectrophotometer utilizing a D65 illuminant at 45 degrees illumination and 0 degrees viewing with a 2 degrees observer. The reference for this test shall be readings obtained on the initial test patch (**SEE SPECIAL NOTE FOR QUALITY CONTROL**). Surfaces with finish coats with color variations exceeding the 2.0  $\Delta E^*$  value shall be repainted at the option of the Engineer.

## **SPECIAL NOTE FOR QUALITY CONTROL**

The contractor shall provide QC inspectors to monitor all work, insure that all work is completed in accordance with the Special Notes and KYTC Standard Specifications (2012), and record inspection results.

QC inspectors for shop or field painting shall possess at a minimum one of the following certifications: **SSPC-BCI level 1 or NACE CIP level 1 & CIP One Day Bridge Course**. The QC inspector(s) shall not perform production work that requires QC inspection. The Department, through the Project Team or other representative, will conduct in-progress reviews of the Contractor's operations and perform follow-up quality assurance (QA) inspections after the QC inspector has certified that a portion of work is complete.

**Progress of Work** - Work shall proceed by Phases, with each Phase of work requiring acceptance of the Cabinets' Project Team prior to beginning work on the subsequent Phase. Phases of work will be:

1. Structural Steel Fabrication,
2. Hot-Dip Galvanizing,

3. Application of Intermediate coat,
4. Application of Finish coat,
5. Pre-casting Deck slabs,
6. Field Assembly.

Quality Control Point inspection and approval shall precede the start of succeeding phases of work. Quality Control Points are progress milestones that occur when one phase of work is complete and ready for inspection prior to continuing with the next operational step. At those points, the Contractor shall provide the Departments QA inspectors with OSHA compliant access to inspect all pertinent surfaces. If QA inspection indicates a deficiency, that phase of the work shall be corrected and re-inspected prior to beginning the next phase of work.

The QC Inspector shall inspect prepared surfaces to determine whether those conform to the Specification. Inspect each individual coat of paint using **KM 64-258-08 Procedure C**. Inspect for areas of incomplete coating coverage and coating defects. The Engineer may request tests, including destructive DFT tests, at additional sites or she/he may elect to perform additional tests.

The QC inspector shall maintain a handwritten record of all-painting activities, operations and inspections in a log book(s). At a minimum, the following information must be recorded:

1. all paint inventory and approval information,
2. daily records of ambient conditions (including all measurements taken),
3. daily progress of work information including start-up/shut-down times,
4. QC inspection information including evaluations at control points, rework comments, or approvals.

Make entries on consecutive pages of the logbook (in indelible ink) and make corrections by marking through mistakes with a single line. Do not remove pages or erase or obliterate entries in the logbook.

All logbooks shall be maintained at the job site at all times during the project, made available, upon request, to the Department's representatives and submitted to the Engineer at the end of the project for his review and records.

### **SPECIAL NOTE FOR PAINT**

Use a coatings system from an approved supplier. A list of approved suppliers shall be found in the Department's List of Approved Materials maintained by the Division of Materials. All paint supplied shall conform to the applicable Special Notes contained in this proposal. The Department requires acceptance testing of samples obtained on a per-lot basis per-shipment. The Division of Materials shall perform acceptance testing. At his option, the Engineer may elect to conduct more frequent sampling and testing. Test samples shall be taken at the Contractor's paint storage site. Department personnel shall perform sampling. Allow (10) working days for testing and approval of the sampled paint.

**Note: It is the Contractor's responsibility to maintain an adequate inventory of approved paint. The Department shall assume no responsibility for lost work due to rejection of paint or approved paint subsequently found to be defective during the application process.**

### **SPECIAL NOTE FOR ENVIRONMENTAL AND WORKER SAFETY REGULATIONS**

#### **(A) Governing regulations**

Be knowledgeable of and comply with, all environmental and health regulations governing the Contractor's operations. Comply with regulations current at the time the work is performed and all requirements herein. Collect, transport to waste

storage sites, and store hazardous wastes in accordance with applicable environmental and health regulations. The contractor is solely responsible for collection, transport, storage and disposal of all industrial wastes.

**(B) Liabilities and Obligations**

The contractor shall be solely responsible for compliance with all applicable environmental and health and safety regulations to the satisfaction of the applicable government regulatory agencies and the Department. The Department assumes no obligations or liabilities for work stoppages or fines due to enforcement actions by government regulatory agencies or to related delays that the Department deems necessary.

**(C) State and Local Regulatory Agencies**

State and local regulatory agencies charged with enforcing **most** regulations affecting the generation of hazardous wastes and worker safety issues are:

Kentucky Occupational Safety and Health Program, Labor Cabinet, Commonwealth of Kentucky, Frankfort, Kentucky

Environmental and Public Protection Cabinet, Commonwealth of Kentucky, Frankfort, Kentucky

**(D) Groundwater and Surface water Protection**

The contractor shall prepare and implement a groundwater and surface water protection plan in accordance with **401 KAR 5:037 (Ground Water), KRS 224.70-110 and 401 KAR 10:031 (Surface water)** with the exception that hazardous waste or hazardous materials container volume is not limited to greater than 55 gallons or weight to 100 pounds.

**SPECIAL NOTE FOR MARKING**

In addition to the stencil required in Standard Drawing BGX-006, c.e., stencil the month and year of the project completion date and the bridge number on the structure at locations identified by the Engineer. Make the legend in letters and numerals 2 inches high, and use a paint color that contrasts with the background.

**SPECIAL NOTE FOR PRE-BID CONFERENCE DISTRICT 11**

The Department will conduct a Pre-Bid Conference of the subject project on Thursday

**August 1, 2013 at 10:00AM Eastern Standard Time at;**

Corbin City Hall 805 South Main St, Corbin, KY

The meeting room is on second floor and the Corbin City Hall phone number is 606 528- 0669.

Any company that is interested in bidding on the subject project or being part of a joint venture shall be represented at the conference by at least **one person of sufficient authority to bind the company**. No individual can represent more than one company.

At the conference, a roster will be taken of the representatives present. **Only companies represented at the conference will be eligible to have their bids opened at the date of letting.**

The purpose of the conference is to familiarize all prospective bidders with the contract requirements.

Department of Highways officials and the Project Team present at the conference will answer questions concerning the projects.

## **SPECIAL NOTE FOR PAYMENT**

Payment for “structural steel” will be according to Standard Specifications for Road and Bridge Construction (2012) Section 614.05 with the following modification to Section 614.05.

Partial payments will be based on acceptance of the following:

Fabrication and hot-dip galvanizing	30%
Intermediate Coat	10%
Finish Coat	10%
Precast Deck	10%
Field Assembly	30%
De-rigging, touch-up of de-rigging marks and damage	10%

## **SPECIAL NOTE FOR CONTRACT COMPLETION DATE, LIQUIDATED DAMAGES AND INCENTIVE PAY ON “A+ B” BIDDING CONTRACT**

The procedure for evaluation of bids on this project involves an “A+B” concept. The “A” component of the bid involves the dollar amount for all work to be performed under the contract.

The “B” component of the bid involves the total number of calendar days required for bridge closure\*.

## **PREPARATION OF BID PROPOSAL**

In addition to the requirements of Section 102 of the 2012 KYTC Standard Specifications, the bidder shall establish the number of calendar days necessary to complete the work in accordance with the plans and specifications and show this number in the bid proposal. The product of this number of calendar days multiplied by the bridge closure fee of \$10,000 per day shall be added to the total bid determined for bid items. The product of calendar days times the bridge closure fee shall not be considered in determining mobilization and demobilization costs. The maximum number of calendar days permitted for each bridge closure will be 28 calendar days. Any bid with a total closure time for both bridges greater than 56 days will be rejected.

## **PROPOSAL GUARANTY**

As a supplement to Section 102 of the 2012 Standard Specifications, it will not be necessary for the Proposal Guaranty to include an amount necessary to cover the product of calendar days times daily road user benefit.

## **CONSIDERATION OF BIDS**

Each bid submitted shall consist of two parts:

- A. The dollar amount for all work to be performed under the contract.
- B. The total number of calendar days required for each bridge closure added together regardless of whether the bridges are constructed concurrently or consecutively.

The lowest bid will be determined by the Department as the lowest combination of (A) and (B) according to the following formula:  $(A) + [(B) \times (\$10,000.00)]$

Please refer to bidcode 10200NC COST PLUS TIME in the proposal.

The value \$10,000.00 per calendar day is the stipulated bridge closure fee. The above formula shall be used only for determination of the lowest bidder and shall not be used to determine the final payment to the contractor when the project is completed.

#### **START AND COMPLETION DATE**

The Contractor has the option of selecting the starting date for this contract but “BRIDGE CLOSURE\*” must occur within 30 days of the contract starting date.

#### **EARLY COMPLETION OF WORK**

The contractor will be paid an incentive payment of \$2,000.00 for each calendar day the “COMPLETION OF BRIDGE WORK” on both bridges is achieved before the days based on the “B” value of the bid. The incentive shall not exceed \$14,000.00 in total.

#### **LATE COMPLETION OF WORK**

A disincentive fee of \$10,000 per calendar day will be charged for each calendar day exceeding the number of calendar days “B” established for the selection of lowest bidder. Contrary to Section 108.09 of the Standard Specifications, Contract Liquidated damages based on Part A of the original contract amount will not be charged per calendar day.

#### **DEFINITION OF A CALENDAR DAY**

A Calendar day is defined as a 24-hour period beginning at the nearest hour for the beginning of “BRIDGE CLOSURE” and ending at the nearest hour to the Engineers’ acceptance of “COMPLETION OF BRIDGE WORK”. The assessment of the per-day penalty or per-day incentive will be prorated to the nearest hour. The Engineer will begin charging calendar days on the date and time “BRIDGE CLOSURE” begins. The bridges may be closed concurrently or consecutively, however each bridge will be closed no more than 28 days. Contract time on each bridge will be counted continually beginning on “BRIDGE CLOSURE” with no regard to weekends, holidays or non working days, with exception of delays caused by catastrophic events.

”BRIDGE CLOSURE” is defined as the closure of the existing bridge until “COMPLETION OF BRIDGE Work” for the new bridge. No deviation of the proposal, plans, and Standard Specification will be accepted without written approval of the project engineer. Construction of the “Temporary Diversion” per Project requirement and preliminary activities that do not restrict traffic may be completed prior to “BRIDGE CLOSURE” with the Engineers’ approval.

\*COMPLETION OF BRIDGE WORK means all work required by this contract is completed and accepted to the satisfaction of Engineer, with the new structure in place, striping completed, all safety features in place, and road is open to traffic. Removal of the “Temporary Diversion” may be completed after the “COMPLETION OF BRIDGE WORK”.

## Appendix B — Draft Notes for Change Order

The Hot Dip Galvanizing (HDG) facility will provide a Quality Control Plan (QCP) for dipping structural steel for the specific plant or facility that will provide HDG structural steel for KYTC projects. The QCP must be reviewed and accepted by the KYTC prior to processing (HDG) structural steel for KYTC. The Contractor will provide a Quality Control Inspector (QC) to inspect and document; the structural steel surface preparation (prior to HDG), galvanizing (at the HDG facility and according to the Galvanizing Quality notes below), surface preparation prior to painting, painting, and field repair of coating systems. The QC inspector must meet the requirements of the Special Note for Quality Control in Contract ID 131203.

The previously HDG beams for CID 131203 will be abrasive blasted to a SSPC SP 10/NACE No.2 Near White Blast Cleaning prior to HDG. The abrasive must meet SSPC AB 1, AB 2, or AB 3, requirements as appropriate. The final abrasive blast surface cleaning will be by pressurized fluid (air) as opposed to a centrifugal wheel. The cleaned steel surface will have an angular anchor profile of 2.5 to 4.5 mils. Anchor profile will be inspected using D4417 – 11 (Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel – Method C). The minimum number of test locations (see Section 6.3.5) will be 8 per beam. The test locations for each beam will be:

1. Under side of top flange, approximately 4 feet from either end,
2. Web, approximately 4 feet from either end,
3. Top of bottom flange approximately 4 feet from either end,
4. Bottom of bottom flange approximately 4 feet from either end,
5. Under side of top flange near mid-point,
6. Web near mid-point,
7. Top of bottom flange near mid-point, and
8. Bottom of bottom flange near mid-point.

### Galvanizing Quality

After HDG, inspect beams according to ASTM A 123 with the exception that each beam will be a “Test Article” and seven thickness “Test Measurements” will be taken per “Specimen”. “Test Measurements” will be taken on each unique surface except the top of the top flange (ie. Bottom of top flange (both sides), web (both sides), top of bottom flange (both sides, and bottom of bottom flange. Each thickness “Test Measurement” will be the average of three individual gage readings in a 0.5 inch diameter circle.

The coating will be continuous, reasonably smooth and uniform in thickness, see ASTM A 123 Section 6.2. HDG surfaces with “caked”, “corrugated”, or similar rough surfaces (see Figures 1 and 2) will be rejected. Perform adhesion testing, per ASTM A 123 Section 8.3 with the same frequency as thickness testing.

In addition to QC inspections, KYTC representatives will monitor structural steel temperature, zinc bath temperature, and zinc bath contents. The HDG facility will provide at least one bath sample, by collecting dripping from structural steel beams or other mutually agreed on methods, for each beam. KYTC will perform any quality testing deemed necessary in addition to QC inspections.

### Surface Preparation for Painting

Contrary to ASTM D6386 (Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting) Section 5.4.1, surface preparation will be by means and methods



developed by the Contractor and approved by KYTC, namely sweep blasting with No. 100 grit garnet at 70 to 75 psi air pressure.



**Figure 1** Top of Top Flange



**Figure 2** Top of Bottom Flange