Research Report
KTC-99-51

EXPERIMENTAL MAINTENANCE PAINTING BY OVERCOATING ON THE I-64, I-71 AND KY-22 BRIDGES

By

Theodore Hopwood II
Associate Engineer, Research

And

Bobby W. Meade
Research Investigator

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

in cooperation with

Kentucky Transportation Cabinet
Commonwealth of Kentucky

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or the policies of the University of Kentucky, nor the Kentucky Transportation Cabinet. This report does not constitute a standard, specification, or regulation.

July 1999

TABLE OF CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

In 1995, KYTC let three experimental maintenance-painting projects. Two of those projects involved the painting of multiple bridges along interstate routes. Those projects encompassed four mainline steel bridges on I-64 in Franklin County, 16 mainline and overpass steel bridges along I-71 in six counties, and 660 steel rockers on 36 concrete bridges on I-71. The steel projects included mainline deck girder structures on the I-64 project and a mix of mainline and overpass deck girder structures and steel bearings on concrete bridges in the I-71 project. The third project entailed the painting of a single steel truss bridge, KY-22 over the Licking River at Falmouth, KY. All of those bridges had existing lead based paint. The condition of the existing paint varied from extremely poor on the KY-22 bridge to fair-to-good on the I-64 and I-71 structures. Each of the projects was awarded to a different contractor.

These projects incorporated the then current KYTC practice of non-invasive painting. Surface preparation procedures were specified that were intended to avoid generation of hazardous wastes. The resulting specifications did not incorporate mechanical surface preparation procedures. However, to provide more efficient cleaning of the existing paint, the washing pressure on the three projects was increased (1,500 psi for the I-71 project, 2,500-psi for I-64 project and 3,500 psi for KY-22 project) over previous experimental projects.

Polyurethane paints were employed on all three projects. This was due to the good performance achieved by that type of coating in previous experimental projects. The paint systems used on the I-64 and I-71 projects were compositional specifications provided by KYTC. The paint system for the I-64 project employed both spot and full prime coats of aluminum-pigmented moisture cure polyurethane followed by a two-component aliphatic acrylic high-gloss polyurethane topcoat. The paint system for the I-71 project used a spot prime coat of an aluminum- and micaceous iron oxide (MIO)-pigmented moisture cure polyurethane and a two-component aliphatic acrylic high-gloss polyurethane topcoat. Different paint manufacturers supplied paint for the I-64 and I-71 projects. A proprietary polyurethane coating system from a third manufacturer was used for the KY-22 project. The spot and full prime coats consisted of aluminum-pigmented moisture cure polyurethane paint followed by a two-component aliphatic acrylic high-gloss polyurethane topcoat.

On all three projects, the primer was to be applied by brushing. The contractor on the I-64 bridges was allowed to apply the intermediate coat by rolling. The contractors could use brushing, rolling or spraying to apply the topcoats. The contractor on the I-64 project sprayed on the topcoat. The contractor on the I-71 project brushed and rolled topcoat on the overpass bridges and sprayed topcoat on the mainline ones. The contractor on the KY-22 Bridge elected to use paint mitts to apply all three coats of paint due to the close proximity of houses to the structure.

The projects began in the spring of 1995 and were completed that fall. There were no major problems encountered on any of the projects. Several minor disputes arose between the contractors and KYTC inspectors concerning workmanship issues that were quickly resolved. On the I-64 project, the contractor had work scheduling problems due to deck work on two bridges. As a consequence, he exceeded the re-coat window for applying the topcoat on several bridges. Painting condition restrictions were relaxed slightly to allow him to apply the moisture cure primer earlier in a workday. Several batches of the

aluminum/MIO primer used on the I-71 Bridge were rejected due to quality problems.

Typically, the painters accessed the bridge steel from portable scaffolds suspended from cables strung between bearings or hung from the upper chords on the KY-22 Bridge. Lane closures were required when working on both the mainline and the overpass bridges, except for painting of the bearings on the concrete bridges on I 71. Work would progress across a structure with pressure washing being performed in one location (e.g. a bay), priming in another and topcoating in yet another. This separation of activities simplified the inspection process and prevented missed steps in the cleaning, application and inspection processes.

KYTC and Kentucky Transportation Center (KTC) paint personnel monitored the three projects throughout the progress of the work, from the pre-construction meetings through the final inspections. Field inspections were assigned to KYTC inspectors who had worked on previous overcoating projects. For the most part, those inspectors worked outside their assigned KYTC Districts, as the Districts in which the projects were performed did not have knowledgeable paint inspectors.

When the projects were completed, KYTC final inspections revealed that the workmanship on the projects met the intent of the specifications and the expectations of KYTC and KTC paint personnel. The bridges' appearance also met or exceeded their expectations.

From 1996 through 1999, KTC researchers monitored the performance of those experimental coatings systems. On the Westbound I-64 Bridge, cold weather promoted disbonding at several sites on the exterior face of one girder. KYTC and KTC repaired those areas in 1996. Several events impacted the coatings on the I-64 bridges (follow-on concrete deck/parapet work by other contractors) and the KY-22 bridges (a major flood in 1997). The deck/parapet work on the I-64 Bridge damaged the paint and caused extensive staining of the exterior faces of the girders. On the KY-22 Bridge, the flood left tree limbs lodged in the truss and may have caused the topcoat to disbond from the intermediate coat in spots.

On most of the I-64 bridges the overcoating system is still performing well. Localized coatings failures and corrosion are occurring on steel under deck joints and at locations where the coatings were applied over thick stratified rust. Those locations represent a small portion of that project. Mainline bridges on the I-71 project have performed similarly though more corrosion damage has occurred at deck joints on the Kentucky River bridges. The I-71 overpass bridges have spot coatings failures and corrosion on the lower flanges of girders and transverse bracing where they cross roadways. The performance of coatings on bearings varies. Some bearings under deck joints have coatings failure and corrosion. Other bearings are still performing well. The paint on the KY-22 bridges is performing satisfactorily. Localized coatings failures and corrosion were observed on the lower chords and floor beams. The coating on the guardrail is in poor condition with extensive corrosion and some disbonding of the topcoat. Some topcoat disbonding was also observed on the lower chords. That may be due to flood damage.

The unit costs for the I-71, I-64 and KY-22 bridges were \$1.07/ft^2, \$1.48/ft^2 and \$1.71/ft^2 respectively (using estimates of steel surface areas – 125 ft^2/ton for girder bridges and 165 ft^2/ton for light built-up truss bridges – based upon steel tonnages from bridge plans). The unit cost for the I-71 project does not factor in the costs for painting 660 rockers on concrete bridges! The higher cost of the KY-22 project relates to mobilization costs, structure complexity and the extremely poor condition of the existing paint.

It had the worst existing paint of any KYTC overcoating project to date. Nationwide bridge maintenance painting cost data for the period of 1993-1996 had averages of $4.56 for overcoating and $10.76 for full removal

In general, these experimental projects were successful, as they have performed reasonably well and they met their primary goal of low initial project costs. KYTC Division of Operations officials may elect to eventually repair some of the coatings in the future rather than completely re-paint the bridges. The polyurethane coatings applied during these projects will weather much slower than the alkyd systems they covered. They will inhibit the alkyds from further weathering and retain them on the bridges allowing the lead-based primers to continue protecting the steel.

The following recommendations relate to our long-term findings.

1. Most overcoating coatings rely on barrier effects to protect the steel substrate from corrosion. Economical coatings systems with 1 or 2 coats of paint may be beneficial on certain remote bridges or on those possessing existing paint in very good condition. Results from these projects indicate that, for most major bridges, 3-coat systems will probably perform better from a life cycle cost standpoint.
2. It should be noted that in these projects, a large amount of bridge steel was painted for a low cost. The localized failures encountered on those projects can be eventually repaired under spot painting projects. Using spot painting, the lives of these overcoating projects can be extended to 20 or 30 years. It should be noted that the Pennsylvania DOT has successfully employed spot painting for many years.
3. In conducting bridge maintenance and rehabilitation projects, KYTC needs to better consider the scheduling and sequencing of other bridgework. Paint is somewhat fragile. It cannot be subject to impacts such as falling deck concrete. Spot repairs of obvious damage may not be the answer as impact damage that may initiate paint failure not evident for months. Besides mechanical damage to new paint, other maintenance or rehabilitation work may deposit concrete stains that significantly detract from the esthetic appearance of paint. Also, leaking or open deck joints promote rust staining and rust back and diminish coating performance. The bearings of many I-64 and I-71 bridges have corroded due to joint leakage and to their sheltered locations that extend the time of wetness. In contrast, the open bearings on the KY-22 Bridge have performed very well. Better planning would lead to painting only after deck or other concrete rehabilitation is complete and deck joints have been repaired/modified to inhibit leaking. In cases where maintenance painting must precede work that could damage the paint, the specifications should mandate that contractors take special care to avoid damage of the paint and that they repair damaged paint to the satisfaction of KYTC. Where overcoating operations are performed on bridges with leaking deck joints, follow-up joint repairs should be made as soon as possible to prevent coatings failures.

INTRODUCTION

Background

In 1991, the Kentucky Transportation Cabinet (KYTC) initiated an experimental program to investigate bridge maintenance painting by overcoating (1). Since then, KYTC has painted approximately 50 bridges by overcoating. Most of those projects have been experimental using a variety of surface preparation methods, coatings systems, and application procedures. Despite those variations, most of the projects have been successful and are still performing well. Many of those projects were completed at low initial costs. As a consequence, KYTC has saved millions of dollars on maintenance painting compared to similar work performed by other state highway agencies.

Inexpensive maintenance painting has been and remains a prime requisite of the KYTC overcoating program. As the program has been evolutionary, KYTC officials have been able to investigate a range of painting actions starting from the very minimal, gradually adding levels of complexity as the findings of experimental projects dictated. However, the focus has always remained on low first-cost bridge painting with life-cycle performance a strong secondary consideration. This evolutionary process has entailed an incremental increase in painting requirements. As this change has been gradual, it created a "comfort level" for painting contractors. Once they became familiar with KYTC procedures and specification enforcement (inspection), they were willing to provide exceptionally low bids for maintenance painting projects. The gradual addition of painting requirements has not been mirrored by corresponding increases in painting costs. A very competitive paint application market has also helped keep prices low.

The initial experimental overcoating work through 1994 constituted the first phase of overcoating research. That work focused on the use of propriety paint systems and very limited surface cleaning. One objective of those projects was to not generate hazardous wastes. To achieve that end, mechanical surface preparation was rarely specified and washing pressures were held below 1,000 psi. Several experimental projects conducted in 1994 employed moisture-cure polyurethane penetrating sealers to coat rusted substrates and fill exposed edges of existing paint. Brushing was specified to work penetrating sealers and primers into the existing substrates.

1995 Experimental Projects

In 1995, KYTC let three experimental bridge overcoating projects. Those involved multiple and single structures on interstate and state secondary routes. One experimental project included painting of 4 plate-girder bridges on I 64 in Franklin County with approximately 2,400 tons of steel. The second project involved painting of 14 plate-girder and I-beam bridges (totaling 3,450 tons of steel) and 660 steel rockers on 36 concrete bridges on or over I 71 in 6 counties between Louisville and the junction of I 71 & I 75 near Cincinnati, OH. The third project involved painting of a single 2-span truss bridge (199 tons of steel) on KY 22 over the Licking River at Falmouth. Research for two of those projects was funded under Kentucky Highway Investigative Tasks 28 (Experimental Maintenance Painting of I-64 Bridges in Franklin County) and 29 (Experimental Maintenance Painting of I-71 Bridges in Various Counties). Work on the KY-22 Bridge project was funded under an earlier SPR study. It is discussed in greater depth in this report due to its many parallel features with the interstate projects.

The projects were considered experimental as they incorporated untried surface preparation procedures (pressure washing) and new paint systems. The primary experimental objectives related to those projects were to 1) determine the effectiveness of the specifications, 2) to evaluate the application characteristics of different paint systems and 3) to assess the utility of those methods based upon the unit costs and the quality of the completed work. The two projects involving interstate bridges marked a turning point in the KYTC overcoating program. Those were the first large-scale overcoating projects involving multiple bridges. Prior to that time, most experimental overcoating projects had addressed single structures. The painting of multiple bridges also reflected the level of confidence KYTC personnel had in the coatings and procedures employed in those projects.

Sufficient time has passed since those projects were completed allowing a good determination of their long-term performance. Also, several unanticipated events have impacted two of those projects – the follow-on concrete maintenance work on the I-64 structures, and the 1997 flood of the Licking River on the KY-22 bridge. Many of the insights gleaned from these experimental projects were immediately incorporated in specifications for subsequent maintenance painting projects.

All of the bridges on those projects possessed aged alkyd paint systems applied over mill scale. The existing paint systems all contained Type 615D red-lead primer. The colored alkyd topcoat on the I-64 and KY-22 bridges and on several of the I-71 bridges also contained lead. Some I-71 bridges possessed aluminum-pigmented alkyd topcoats that did not contain any lead. The I-64 bridges over the Kentucky River had been overcoated previously and were disbonding especially on the exterior faces of the main girders.

Typically, the exterior paint had chalked significantly at exterior surfaces. The existing paint in the poorest condition throughout was encountered on the KY-22 Bridge (Figure 1). On that structure, most of the paint was thick and very brittle. On surfaces exposed to direct sunlight, the pigmented topcoat had completely weathered away revealing the red lead primer. The paint was peeling and disbonding at many sites and the underlying steel was corroding in many locations. Much of the paint on that bridge was covered with soil deposits from years of service.

Both the I-64 and I-71 projects contained large (770-ft span) twin bridges that spanned the Kentucky River. At many locations on those structures, the existing paint had disbonded exposing large areas of mill scale (Figures 2 and 3).

Extensive mildew contamination was present on interior existing paint on the I-64 bridges. The existing paint on the two smaller plate girder bridges in the I-64 project over KY 420 had disbonded at some locations, but was in better condition. The existing paint on the other 12 main line and overpass bridges comprising the I-71 project was in fair condition with some spot corrosion.

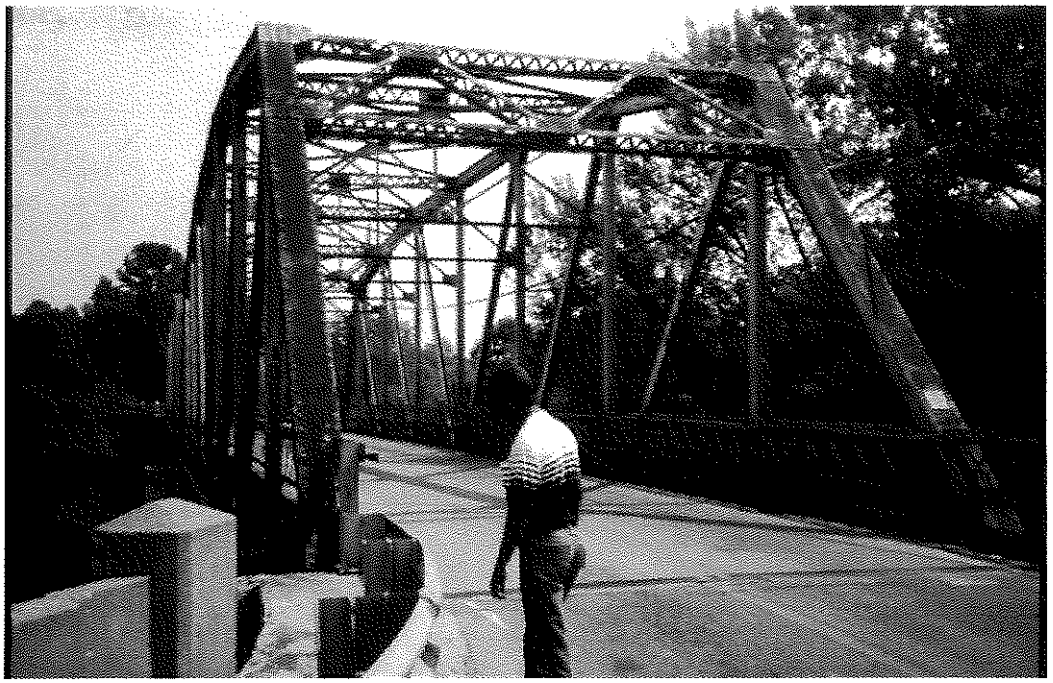

FIGURE 1. KY-22 BRIDGE AT FALMOUTH SHOWING POOR CONDITION OF EXISTING PAINT.

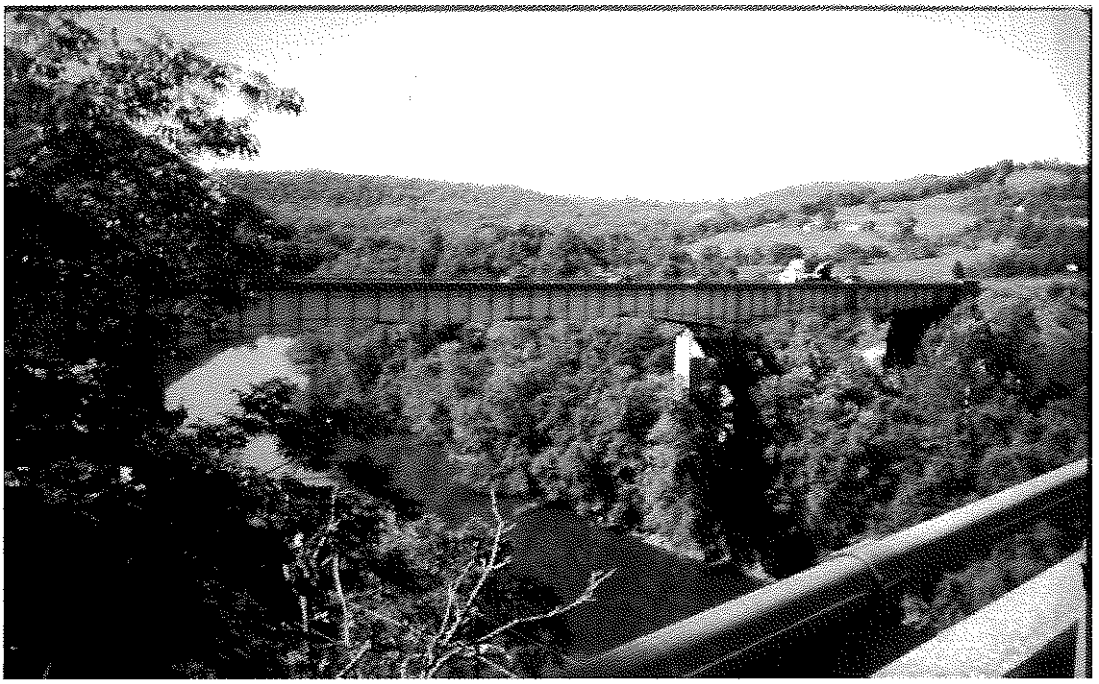

FIGURE 2. SOUTH MAIN GIRDER OF THE I-64 EASTBOUND BRIDGE OVER THE KENTUCKY RIVER SHOWING SEVERE DISBONDING OF THE EXISTING PAINT ON EXTERIOR FACE OF GIRDER.

FIGURE 3. I-64 WESTBOUND OVER THE KENTUCKY RIVER SHOWING THE CONDITION OF THE EXISTING PAINT.

Project Specifications

On the three projects, surface preparation was limited to high-pressure washing. On the I-64 bridges, 2,500-psi washing was employed due to the presence of tenacious grime on the existing paint. On the I-71 bridges, 1,500-psi pressure washing was used. Occasionally, this was supplemented by the use of bleach, detergents and hand wiping with wet rags to remove the mildew, chalk and grime. At the pre-construction meeting, the contractor on the KY-22 project elected to use 3,500-psi pressure washing to provide more rapid cleaning than the 1,500 psi washing pressure KYTC had specified. Fan tips were used on the I-64 and I-71 projects and fan tips. 0^0 spinner tips were used on the KY 22 project.

Different coating systems were specified for the three experimental projects. On all three projects, a spot prime coat was applied by brushing at locations where the existing coating had failed by corrosion or disbonding. On the KY-22 and I-64 projects, full intermediate coats were applied by rolling or brushing. No intermediate coat was used on the I-71 project. Gray topcoats were used on the I-64 and I-71 projects. The KY-22 Bridge was painted with a light blue topcoat to match the color of the existing paint.

On all three projects the topcoat could be applied by either spraying or rolling. Spraying was used on the I-64 and I-71 main line bridges and rolling was employed on the I-71 overpass bridges to minimize overspray damage to vehicles. Due to the proximity of the KY-22 bridge with houses and buildings in Falmouth, brushing was employed for the topcoat. On that project, the contractor was allowed to use painting mitts instead of brushing.

All three experimental projects employed polyurethane coatings as KYTC had obtained favorable performance with similar coatings on previous experimental overcoating projects. The polyurethane coatings systems employed on the I-64 and I-71 projects were based upon cookbook/performance specifications provided by a resins manufacturer. They were very similar to an experimental coatings

system used on the Bluegrass Parkway overpass over US 60 in Woodford County in 1992. The paint system for the I-64 project employed both spot and full prime coats of aluminum-pigmented moisture cure polyurethane followed by a two-component aliphatic acrylic high-gloss polyurethane topcoat. The paint system for the I-71 project used a spot prime coat of an aluminum- and micaceous iron oxide (MIO)-pigmented moisture cure polyurethane and a two-component aliphatic acrylic high-gloss polyurethane topcoat. Different paint manufacturers supplied paint for the I-64 and I-71 projects. A proprietary polyurethane coating system from a third manufacturer was used for the KY-22 project. The spot and full prime coats consisted of aluminum-pigmented moisture cure polyurethane paint followed by a two-component aliphatic acrylic high-gloss polyurethane topcoat. The percent solids by volume of the proprietary coatings used on that project were lower than those for the coatings required by the KYTC specifications.

PROGRESS OF FIELDWORK

Overview

The projects began in the spring of 1995 and were completed that fall. There were no major problems encountered on any of the projects. Typically, the painters accessed the bridge steel from portable scaffolds suspended from cables strung between bearings or hung from the upper chords on the KY-22 Bridge. Lane closures were required when working on both the mainline and the overpass bridges, except for painting of the bearings on the concrete bridges on I 71. Work would progress across a structure with pressure washing being performed in one location (e.g. a bay), priming in another and topcoating in yet another. This separation of activities simplified the inspection process and prevented missed steps in the cleaning, application and inspection processes.

The specifications for those projects required that the contractors have a designated quality control QC inspector. That person could have other duties. On those projects, the QC inspector was the foreman or the contractor himself. After each activity was completed to the satisfaction of the QC inspector, a KYTC inspector would inspect the area either requiring additional work or allowing the contractor to complete the next stage of his work. Several minor disputes arose on all three projects concerning workmanship issues. Periodically, contractors would complain about the extent of cleaning required or, when painting, the need to touch-up small missed areas. In part, the cleaning disputes were related to the specification wording. In all cases, the contractors relented and provided the desired quality. However, continual close inspection was needed to ensure satisfactory quality. In several cases, the KYTC inspectors would traverse the work areas on scaffolds with the painters pointing out misses so they could be corrected on the spot. In such instances, the KYTC inspectors were inadvertently acting as QC inspectors for the contractors (Figure 4).

On one project, a contractor verbally threatened a KYTC inspector. Work on that project was halted and the contractor was required to meet with the Director of Construction who admonished him about that behavior.

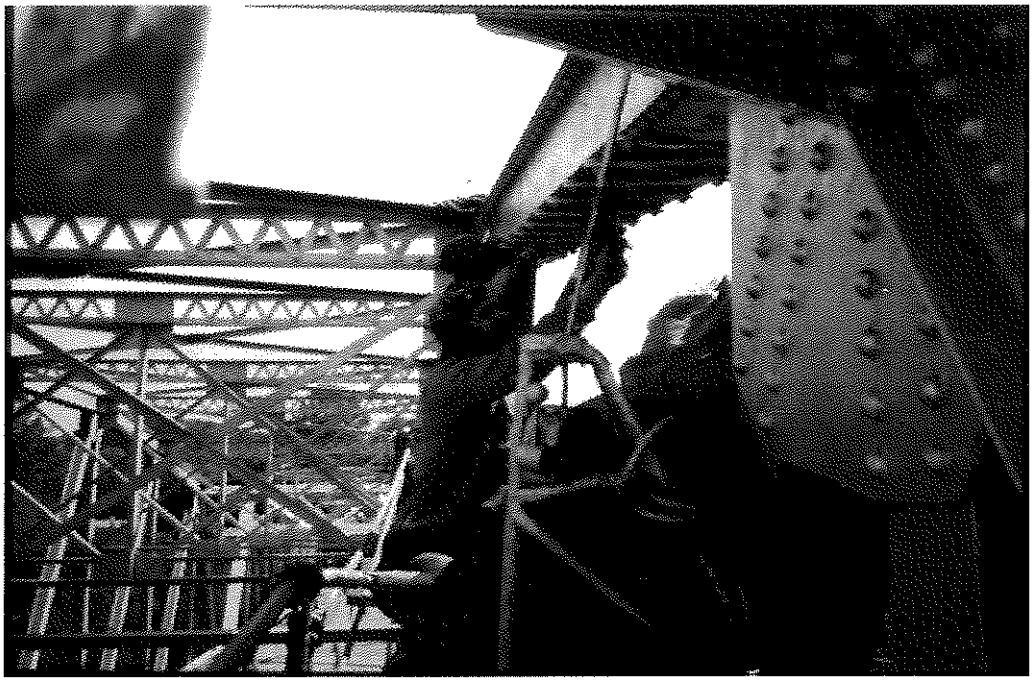

FIGURE 4. KYTC INSPECTOR PERFORMING QC INSPECTION ON THE KY-22 BRIDGE.

The contractor for the I-64 project was concerned about the possibility of a high lead content in the soil adjacent to the structures spanning the Kentucky River. That concern was related to the large amount of paint that had previously disbonded from those structures and the possibility of previous contamination from traffic that had used leaded gasoline. He employed an environmental consulting firm to take lead measurements in the soil adjacent to those bridges before beginning work on the project. Those results were not provided to KYTC

Surface Preparation

Small pressure washers equipped with long hoses connected to the sprayer wands were used on all of the projects. Typically, potable water was supplied from large water tanks mounted on the beds of pick-up trucks. The pressure washing resulted in the inadvertent removal of a small amount of existing paint on the larger structures of I-64 and I-71 projects (Figure 5). NREPC Division of Water personnel observed the I-64 project during washing operations and did not cite the contractor or KYTC for those releases. Due to the high washing pressure, much existing paint was removed from the KY-22 bridge (Figure 6). A belly tarp was placed under the bridge to collect the paint chips. They were disposed as a hazardous waste. Pressure washing on the I-64 bridges, though conducted at a higher pressure than that used on the I-71 bridges was probably less satisfactory, as no spacing had been established between the spray nozzle and the substrate being cleaned. The contractor's personnel were observed holding the nozzles as far away as three feet or more. This achieved sufficient cleaning and limited the amount of paint chips

removed. It also limited the amount of spot painting the contractor needed to perform and left weakly bonded existing paint that was subsequently overcoated.

FIGURE 5. PRESSURE WASHING OF THE I-71 NORTHBOUND BRIDGE OVER THE KENTUCKY RIVER AT CARROLTON. NOTE THE REMOVAL OF CHALK BY THE WASHING PROCESS.

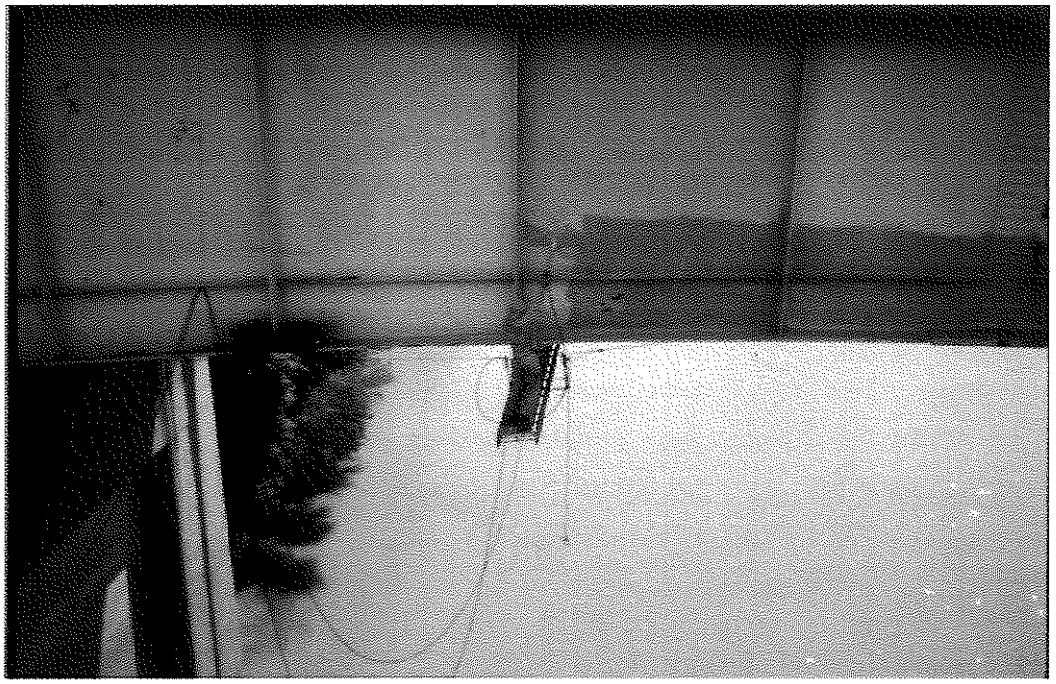

FIGURE 6. TRUSS ON THE KY-22 BRIDGE SHOWING EXTENSIVE REMOVAL OF THE EXISTING PAINT BY PRESSURE WASHING. PAINTER IS USING A MITT TO APPLY THE SPOT PRIMER.

The washing pressures used on the I-64 and I-71 projects were not effective in removing thick, stratified rust encountered on some steel (e.g. bearings, cross bracing and beam-ends) under deck joints and at bearing areas. Where the existing lead-based paint had already completely disbonded from those locations, the contractors on the I-64 and I-71 projects removed some of the scaly rust by manually hammering the steel.

Another problem was encountered in cleaning operations on the I-71 project. A tenacious chalk was found on the aluminum topcoats of several overpass bridges near Louisville that could not be removed by pressure washing. The contractor was given several options including the use of cleaning compounds or dry wiping with burlap. The contractor employed a biodegradable alkaline cleaner that was able to remove the chalk. That chalking problem was difficult to detect visually. However, wiping a surface with a rag and then inspecting it for a chalky deposit could locate it.

Coatings Application

Painting of the three projects was relatively uneventful. Representatives from the coatings suppliers for the KY-22 and I-64 projects visited the job sites prior to painting and showed the contractors how to apply the paint. A representative from the coatings supplier for the I-71 project visited the job site after work had been in progress for several months.

Extensive spot priming was required on the I-64 and I-71 projects (Figures 7 and 8). On the I-71 project, most of the spot priming was on the Kentucky River bridges and on the bearings under deck joints of other spans. Due to the large amount of paint removed in the pressure washing process, the spot prime constituted almost a full coat of paint on the KY-22 Bridge (Figure 9). An intermediate coat of primer was subsequently applied to the I-64 and KY-22 structures (Figures 10 and 11).

The spot priming was conducted by either brushing or by wiping with paint mitts (Figures 12 and 13). The intermediate coat was applied using rollers (on I-64) or paint mitts (on KY-22). The topcoat was applied by brushing/mitt wiping (I-71 overpasses and KY-22 respectively), rolling (I-71 overpasses), and spraying (I-64 and I-71 mainline-except I-75 overpasses) (Figure 14). On the I-64 bridges over the Kentucky River, the contractor used a two-level scaffold to paint the deep haunched main girders (Figure 15).

The contractor on the I-64 project encountered frequent delays in his painting operations due to ambient moisture. The I-64 Kentucky River bridges were down in a valley surrounding the river. On some mornings, a heavy fog shrouded those structures. By 10:00 a.m., sunlight had burned off the fog. Typically, he did not achieve the specified atmospheric conditions for painting, especially under the bridges until noon. As the moisture-cure primer was fairly tolerant of high humidity conditions, the contractor was allowed to apply that paint when the temperature of the steel in area being painted coincided with the dew point temperature. The normal KYTC requirement for coatings application is that the steel must be 5 ^{o}F above the dew point with the temperature rising. That requirement was imposed on the contractor when he applied the two-component polyurethane topcoat.

FIGURE 7. SPOT PRIMING ON THE WESTBOUND I-64 BRIDGE.

FIGURE 8. SPOT PRIMING ON THE NORTHBOUND I-71 BRIDGE.

FIGURE 9. KY-22 BRIDGE SHOWING COMPLETED SPOT PRIMING ON ONE-HALF OF THE TRUSS.

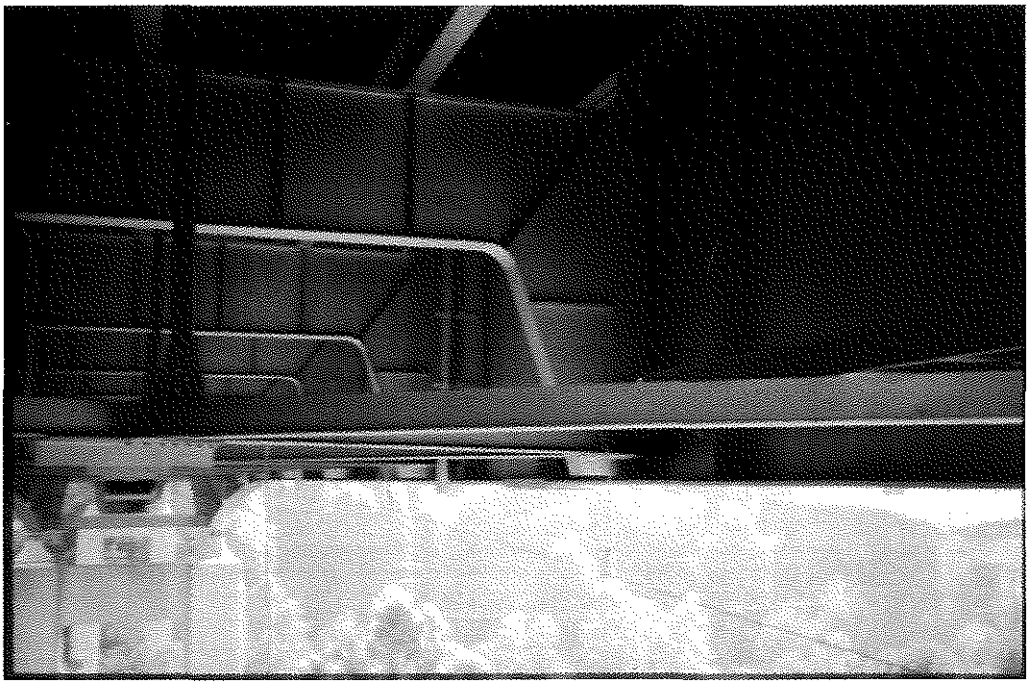

FIGURE 10. FULL PRIME ON THE I-64 WESTBOUND BRIDGE OVER THE KENTUCKY RIVER.

FIGURE 11. FULL PRIME ON END BENT OF THE KY-22 BRIDGE.

FIGURE 12. BRUSH APPLICATION OF SPOT PRIME ON THE I-71 NORTHBOUND BRIDGE OVER THE KENTUCKY RIVER.

FIGURE 13. USE OF A PAINT MITT TO APPLY SPOT PRIMER ON THE KY-22 BRIDGE.

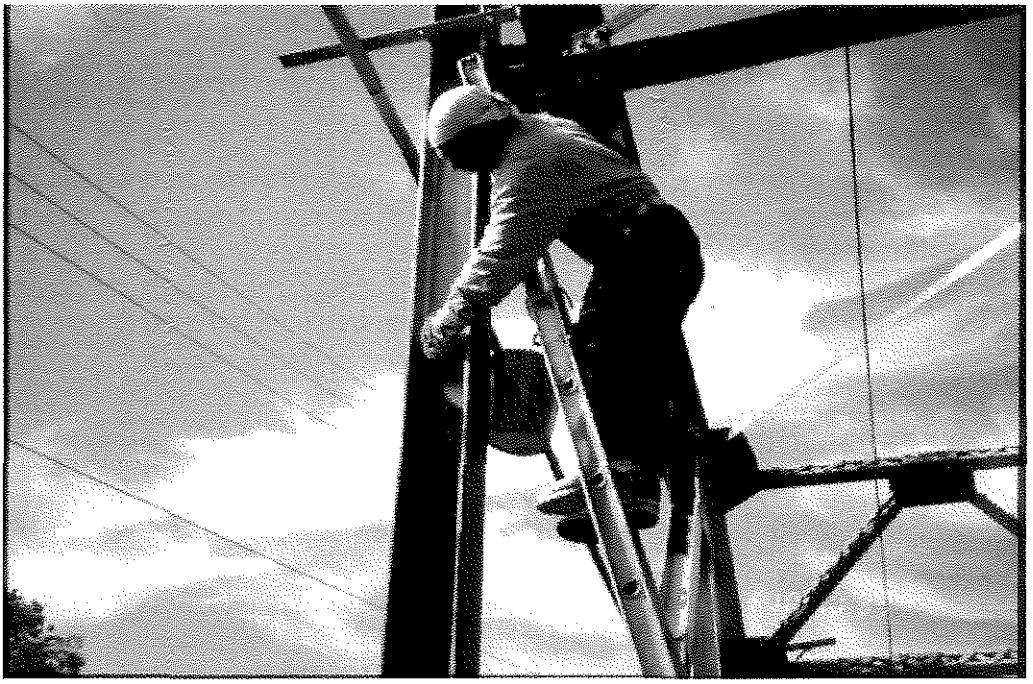

FIGURE 14. SPRAYING TOPCOAT ON I-64 WESTBOUND OVER THE KENTUCKY RIVER.

Coating systems used on the KY-22 and I-64 projects had limited re-coat windows (1 & 3 days respectively) that proved inconvenient to the contractors. The I-64 project contractor had to work around deck repairs being performed on the two smaller mainline bridges over KY 420. As he had to adapt to the schedule of the deck contractor, he was forced to abandon work on the westbound bridge over the Kentucky River after it had been completely primed and begin work on the smaller structures. As a consequence, he did not return to topcoat the primed bridge for several weeks posing a concern as he had exceeded the re-coat window. The aluminum-MIO primer used on the I-71 project had a 30-day re-coat window that did not pose a problem to that contractor.

A material quality problem was encountered with the aluminum-MIO primer. Division of Materials personnel encountered settling of solids in an acceptance-testing sample taken from a batch of paint shipped to the job site. A subsequent sample of primer that the paint supplier provided for testing had a different appearance and a unit weight that varied significantly from the original sample. The supplier provided a product data sheet showing that the paint could vary by several pounds per gallon. After several discussions between Division of Materials officials and the coatings supplier related to consistency of coatings, primer was provided that was acceptable to KYTC. However, that situation delayed painting operations for several weeks.

Several interesting observations were made during KYTC/KTC monitoring of the I-71 project. One set of mainline bridges had existing aluminum alkyd topcoats over the Type 615D red lead primer. The inter-coat adhesion between those two paints was known to be a weak-link in the overcoating process. After those structures were overcoated, KTC personnel found that they could slit the paint with a knife and readily peel the new paint along with the existing aluminum-pigmented topcoats from the Type 615D primer which remained adherent to the steel. A similar phenomenon had been observed on the Bluegrass Parkway overpass project in Woodford County. That did not raise any concerns as the Bluegrass Parkway project had performed satisfactorily for some time with the same weakly bonded overcoating paint. On the I-71 mainline bridges over the Kentucky River near Carrolton, the new coating system was not performing well at sites where extensive rusting and stratified corrosion was present (i.e., at locations under deck joints). Incipient rusting had occurred through the newly applied primer at several locations. The contractor knocked off some of the scaly rust and applied several coats of the primer at those locations (Figure 16). However, during the final inspection, rust bloom was observed through the new topcoat at locations under the deck joints.

FIGURE 15. TWO-LEVEL SCAFFOLD USED IN PAINTING MAIN GIRDERS ON THE I-64 BRIDGES OVER THE KENTUCKY RIVER.

FIGURE 16. BRUSHING ADDITIONAL PRIMER ON TRANSVERSE BRACING AT THE I-71 SOUTHBOUND BRIDGE OVER THE KENTUCKY RIVER.

KYTC/KTC Inspections and Monitoring

KYTC and Kentucky Transportation Center (KTC) paint personnel monitored the three projects throughout the progress of the work, from the pre-construction meetings through the final inspections. At the pre-construction meetings, they reviewed the specifications and answered questions from the contractors and District officials. They arbitrated disputes between KYTC inspectors and the contractors and worked to resolve other minor problems that the contractors encountered during the work. They also participated in final inspections of the completed projects. KYTC Division of Materials personnel conducted acceptance testing of every shipment of paint supplied to the three projects.

Field inspections were assigned to KYTC inspectors who had worked on previous overcoating projects. For the most part, those inspectors worked outside their assigned KYTC Districts, as the Districts in which the projects were performed did not have knowledgeable paint inspectors. The inspectors were present each day during the contractors' operations. At the time of those inspections, District paint inspectors had not been provided with equipment suitable for overcoating work. As a consequence, the Central Office Division of Construction provided inspectors with semi-destructive measuring devices, Tooke gages to enable them to measure coating thickness of the applied paint -- the prime quantitative indicator of project quality (Figure 17).

When the projects were completed, KYTC final inspections revealed that the workmanship on the projects met the intent of the specifications and the expectations of KYTC and KTC paint personnel. The bridges' appearance also met or exceeded their expectations.

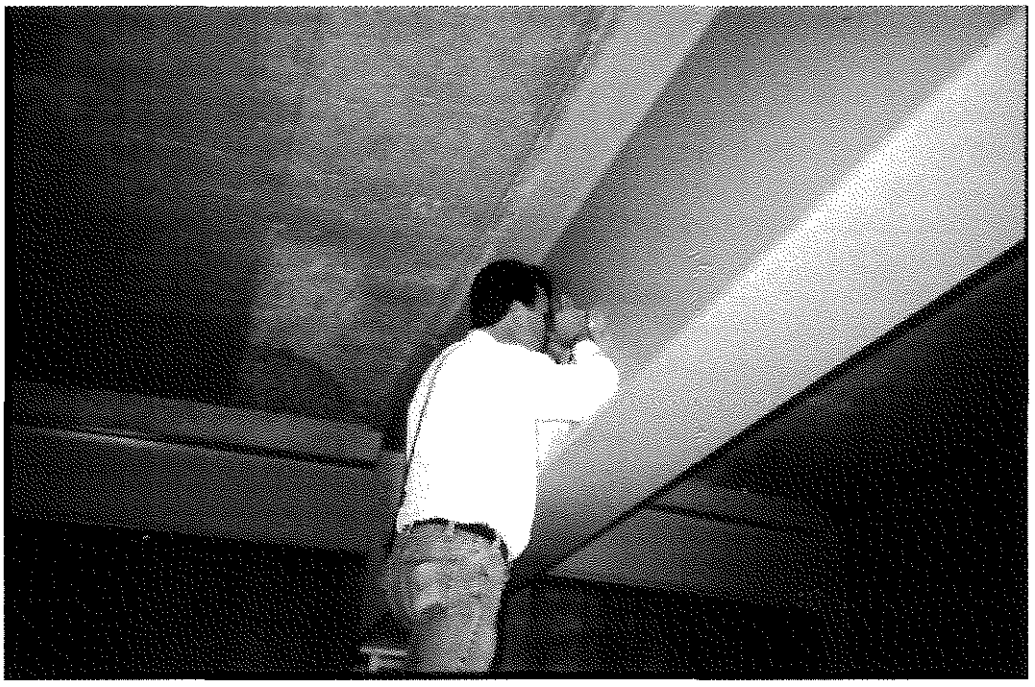

FIGURE 17. KYTC DIVISION OF CONSTRUCTION PERSONNEL MEASURING COATING THICKNESS WITH A TOOKE GAGE.

FOLLOW-ON MONITORING

I-64 Bridges

Through the winter of 1996, all of the projects appeared to be satisfactory. There were several extreme cold spells in Kentucky during the winter of 1995-96. In March 1996, a patch of paint on the exterior face of the south main girder of the westbound I-64 bridge over the Kentucky River was observed to have disbonded from the mill scale on the exterior portion of a fascia girder (Figure 18). The failure area was relatively small (less than 50 ft^2), but it was disconcerting. Follow-on inspections of all other bridges painted under the three projects did not find any similar disbonding failures. As previously noted, the contractor's personnel had not placed their pressure washing nozzles close to the paint in an effort to prevent generation of hazardous wastes. It is believed that the failure might have been due to a weak bond between the existing alkyd paint and the mill scale. In July 1996, KYTC and Kentucky Transportation Center personnel used a snooper to access the disbondment site and apply new paint. By then, several additional failure sites had appeared. The new sites were smaller (each less than 5 ft^2). All the failures entailed complete detaching of all paint from the mill scale. At the disbonded sites, a scraper was used to remove the detached and poorly bonded paint back to where it was adherent to the substrate. Exposed mill scale was observed to have significant map cracking. After that operation, new paint was applied by rolling (Figure 19). As the snooper availability was limited, most of the sites were painted only with the two-component topcoat. On completion of that work, the repaired sites were not discernable from the adjacent bridge (Figure 20).

While the snooper was available, KTC personnel were able to closely examine the overcoating paint on the exterior face of the main girder. Some rust-through was observed on the top face of the lower flange at locations where heavily built-up rust was present (Figure 21). Apparently, the contractor's personnel had not used chipping hammers at those locations. At most other sites, the paint appeared to be in excellent condition. A follow-up inspection of the I-64 structures in 1997 revealed similar rust-back on the lower flanges of all 4 I-64 bridges where the contractor had painted over heavy rust. Rusting was also observed on some bearings of those structures.

In 1997, deck work was initiated on the two I-64 bridges over the Kentucky River. The contractor doing that work employed hydro blasting to remove weak deck concrete. That operation knocked chunks of loose concrete onto the underlying steel and partially dislodged some of the stay-in-place deck forms (Figures 22-24). The repair concrete dripped onto the steel and caused some white staining of the paint (Figure 25). KYTC required the contractor to perform spot repairs where falling concrete had damaged the paint. However, some concrete stains on the exterior faces of the girders were not removed and the exterior faces were not repainted.

Additional damage to the paint on all 4 I-64 bridges occurred in 1998-99 when the old-style parapets were replaced with New Jersey-style barrier walls. That work left massive concrete stains on paint on the exterior faces of those bridges (Figures 26,27). Some disbonding sites were also evident.

Much of the paint applied during this project is still performing well. Where not applied over thick stratified rust, or under open or leaking deck joints, the paint is intact and currently functioning well (Figures 28, 29). The high-gloss gray topcoat is still retaining gloss and has not chalked. If the bridges

had not been so badly stained by the concrete runoff, they would still have an acceptable appearance (Figures 30-33).

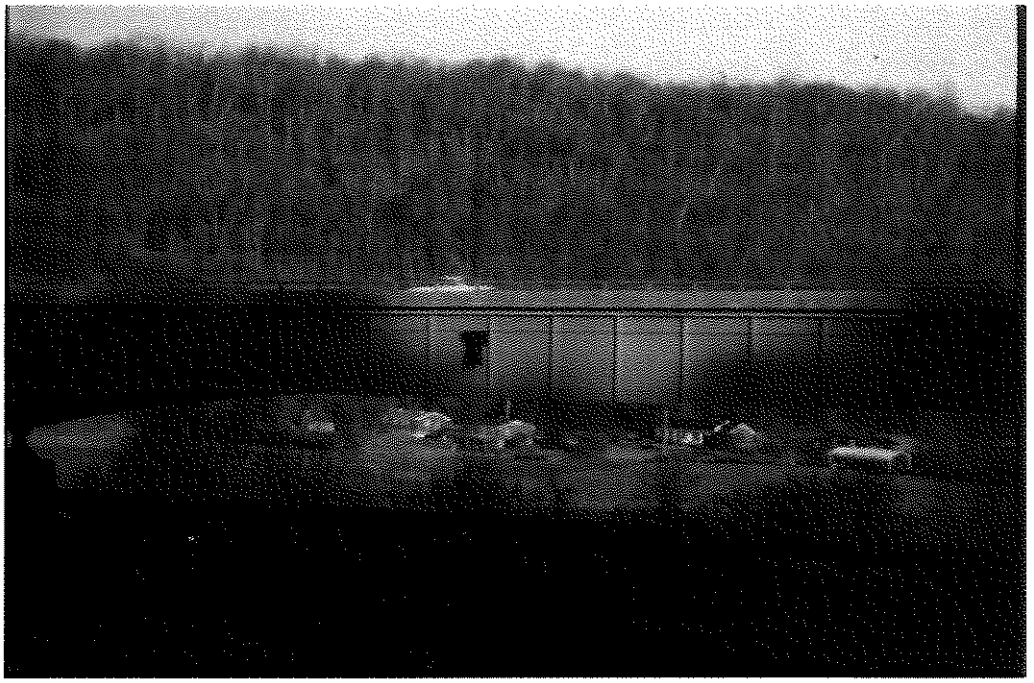

FIGURE 18. DISBONDING ON THE EXTERIOR FACE OF THE SOUTH MAIN GIRDER OF THE WESTBOUND I-64 BRIDGE OVER THE KENTUCKY RIVER.

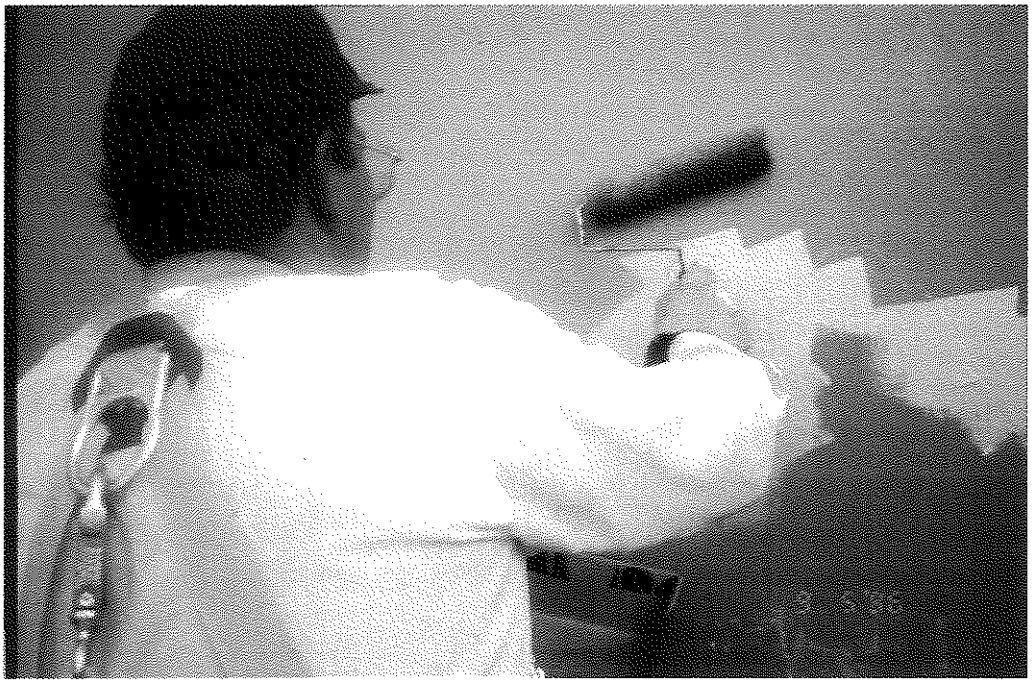

FIGURE 19. KTC PERSONNEL REPAIRING PAINT DISBONDING SITE ON THE I-64 WESTBOUND BRIDGE OVER THE KENTUCKY RIVER.

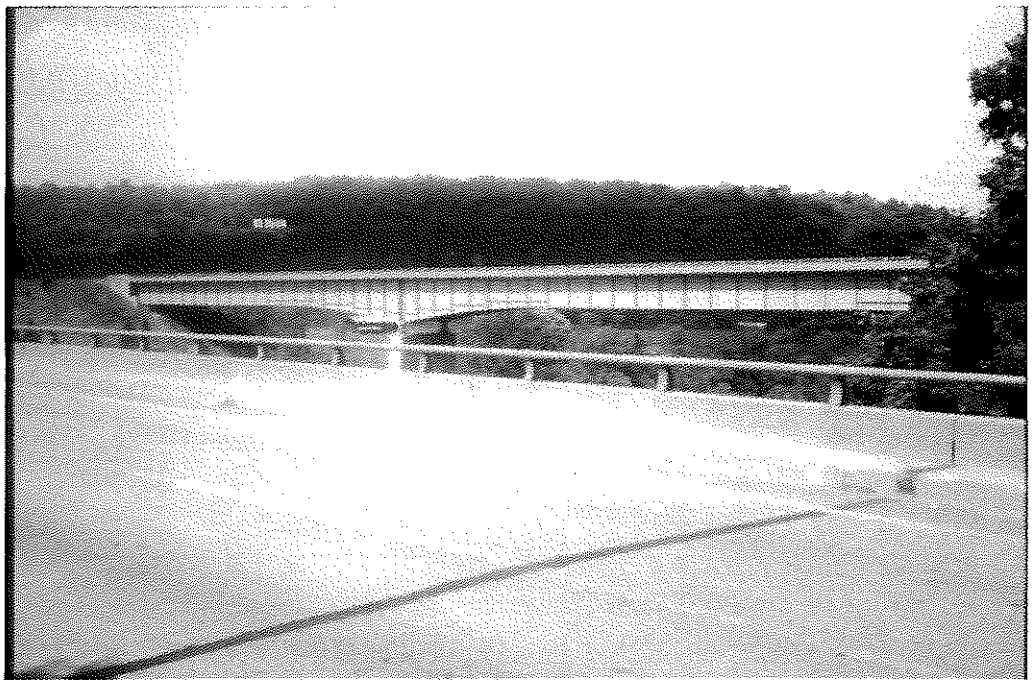

FIGURE 20. THE EXTERIOR FACE OF THE SOUTH MAIN GIRDER OF THE WESTBOUND I-64 BRIDGE OVER THE KENTUCKY RIVER AFTER SPOT PAINT REPAIR.

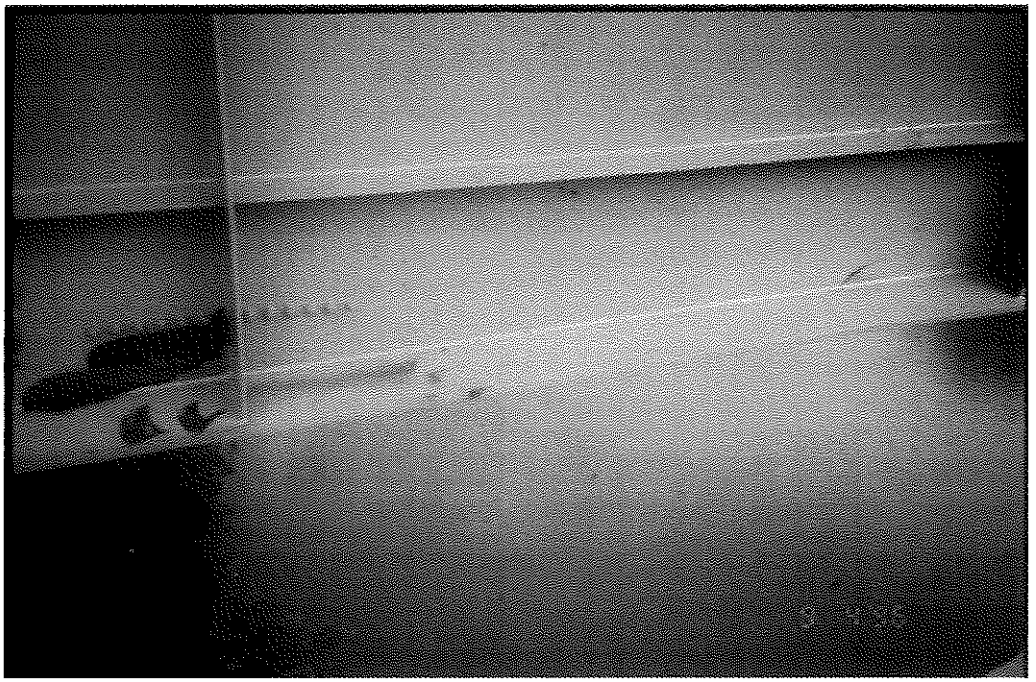

FIGURE 21. RUSTING ON UPPER FACE OF THE LOWER FLANGE ON THE LEFT SIDE OF THE VERTICAL STIFFENER. NOTE THE SMALL DISBONDING SITE ON RIGHT OF VERTICAL STIFFENER (1996).

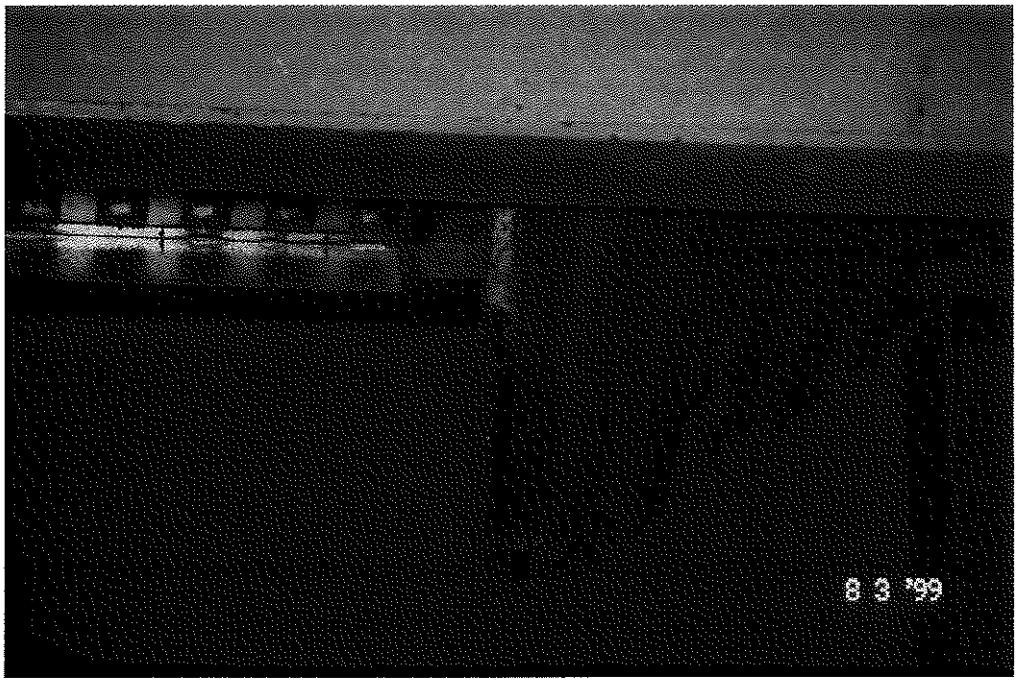

FIGURE 22. PARTIALLY DETACHED STAY-IN-PLACE FORM UNDER WESTBOUND I-64 BRIDGE OVER THE KENTUCKY RIVER.

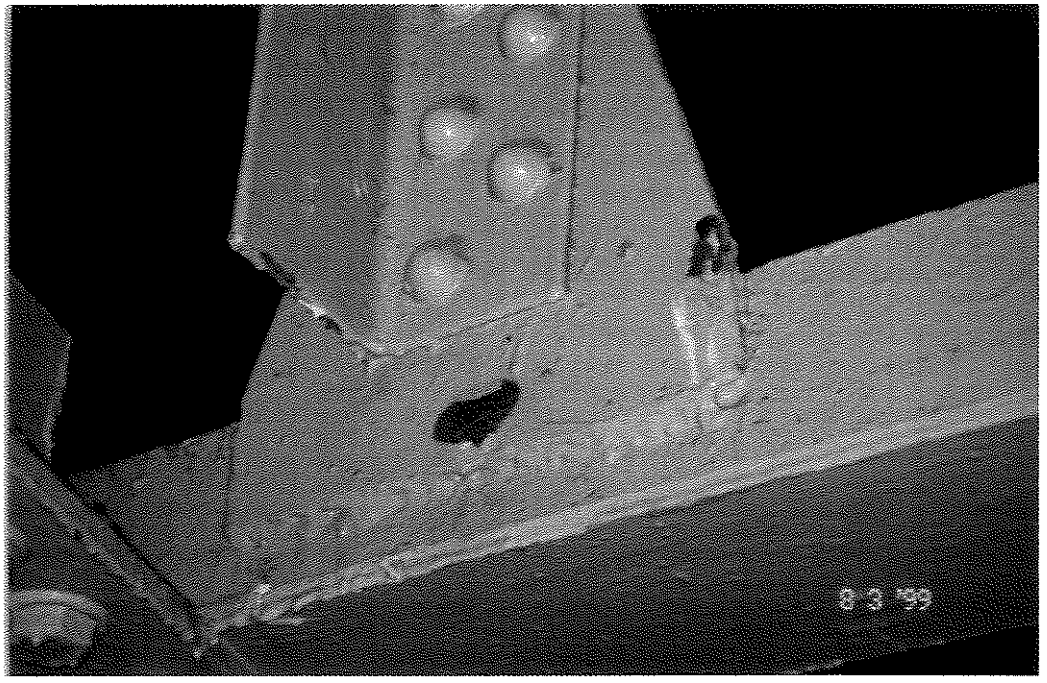

FIGURE 23. PAINT DAMAGED BY FALLING CONCRETE.

FIGURE 24. DECK JOINT FILLED WITH CONCRETE AFTER DECK WORK.

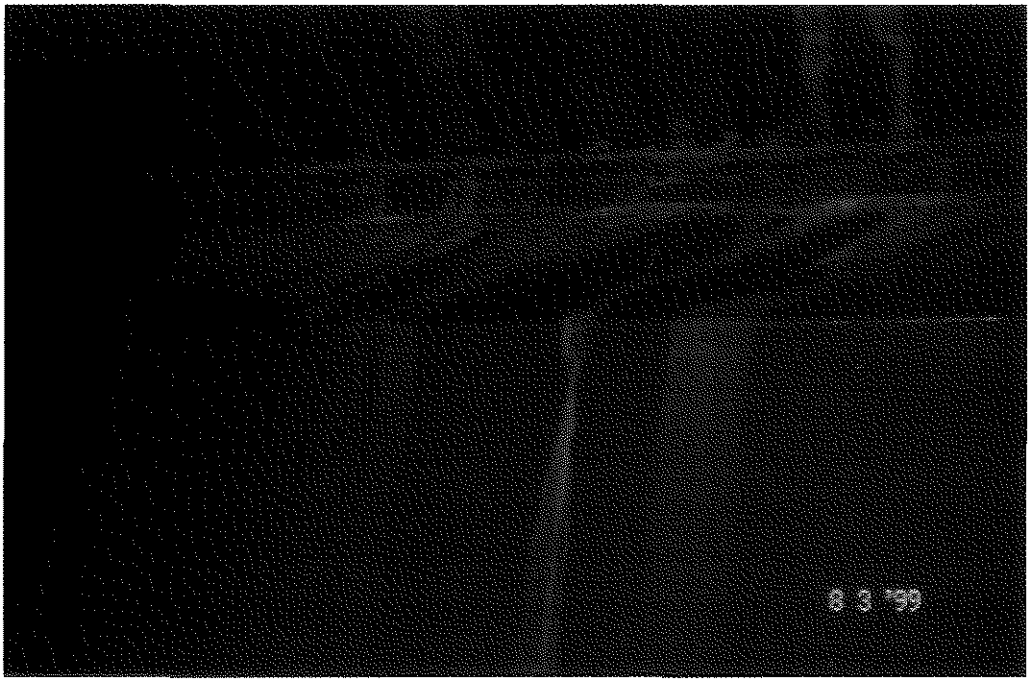

FIGURE 25. CONCRETE STAINING CAUSED BY DECK WORK.

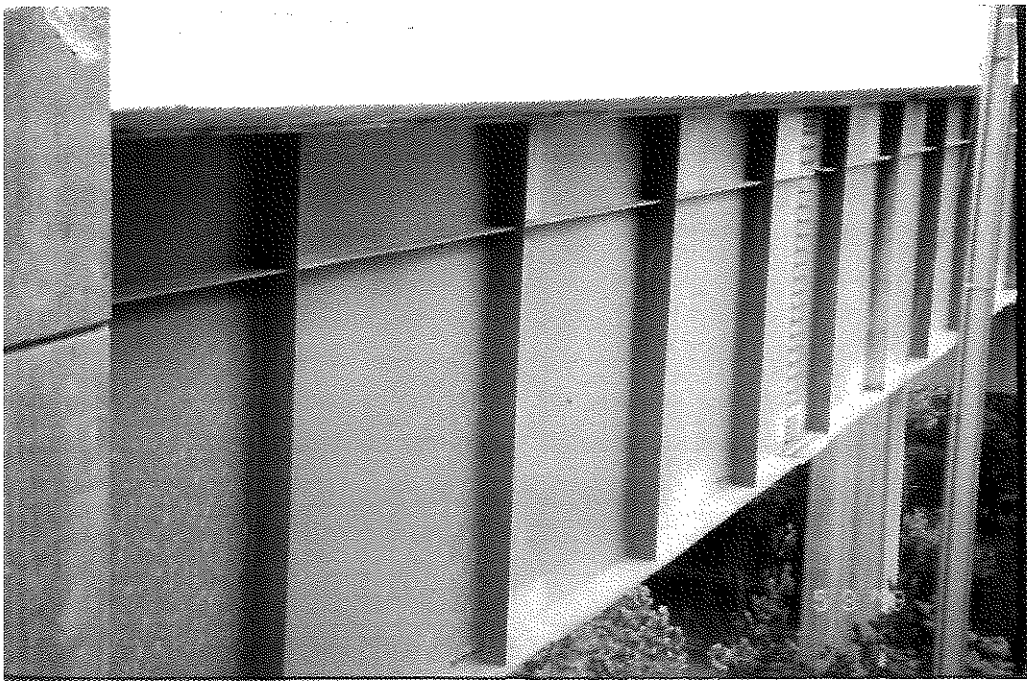

FIGURE 26. CONCRETE STAINING ON I-64 BRIDGE OVER KY 420.

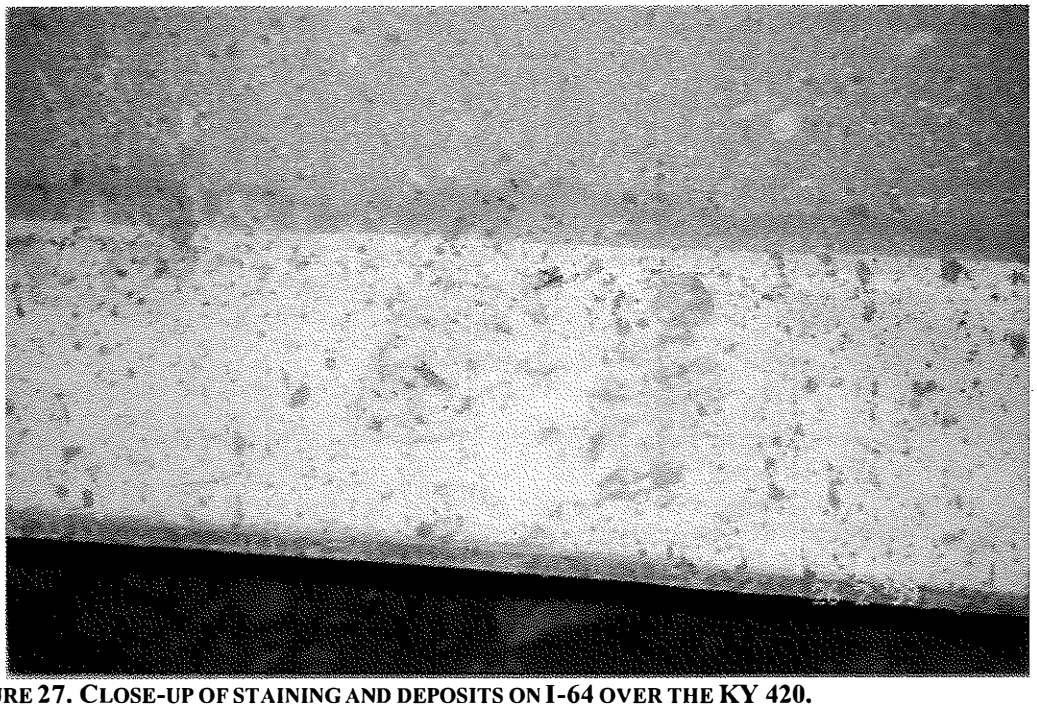

FIGURE 27. CLOSE-UP OF STAINING AND DEPOSITS ON I-64 OVER THE KY 420.

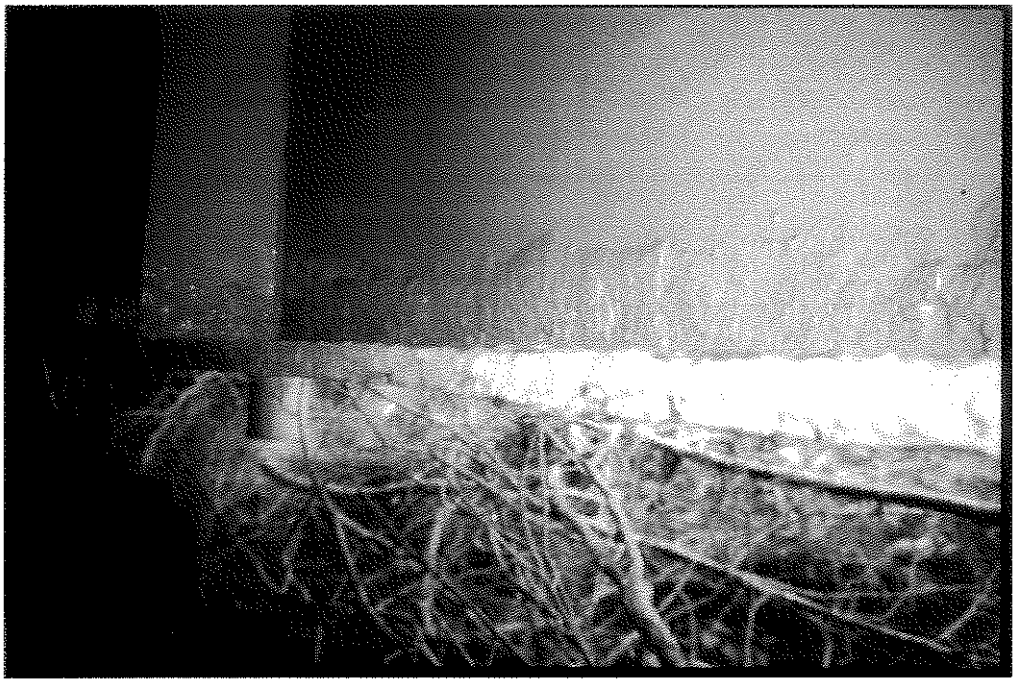

FIGURE 28. I-64 EASTBOUND OVER KY 420 SHOWING CORROSION WHERE COATING WAS APPLIED STRATIFIED RUST (1997).

FIGURE 29. I-64 EASTBOUND OVER KY 420 SHOWING BEARING CORROSION (1997).

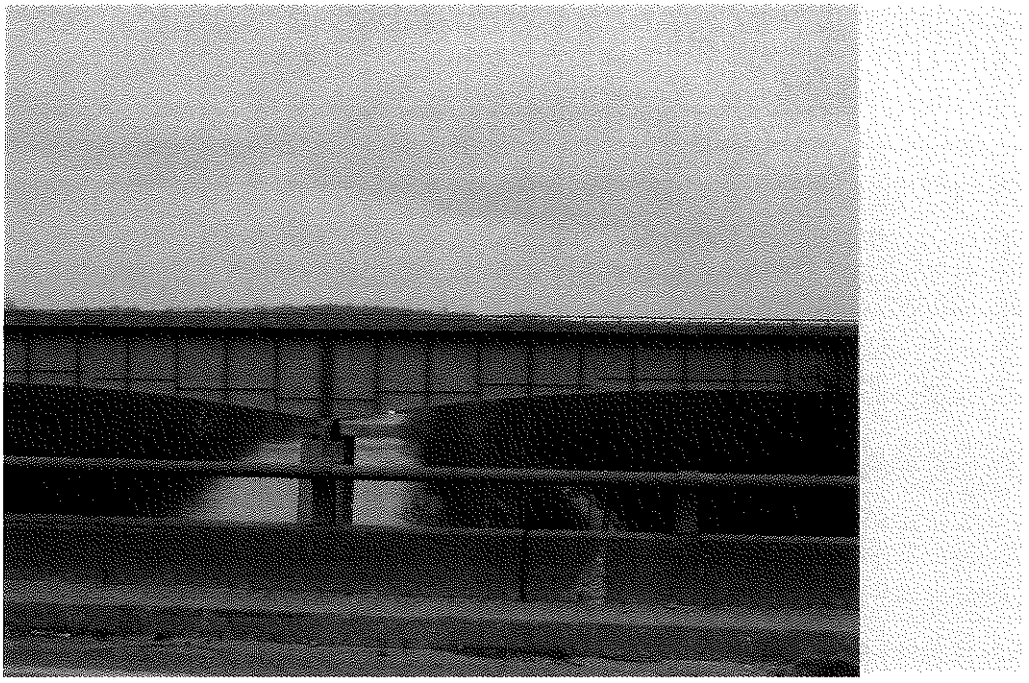

FIGURE 20. I-64 WESTBOUND OVER THE KENTUCKY RIVER IN 1997.

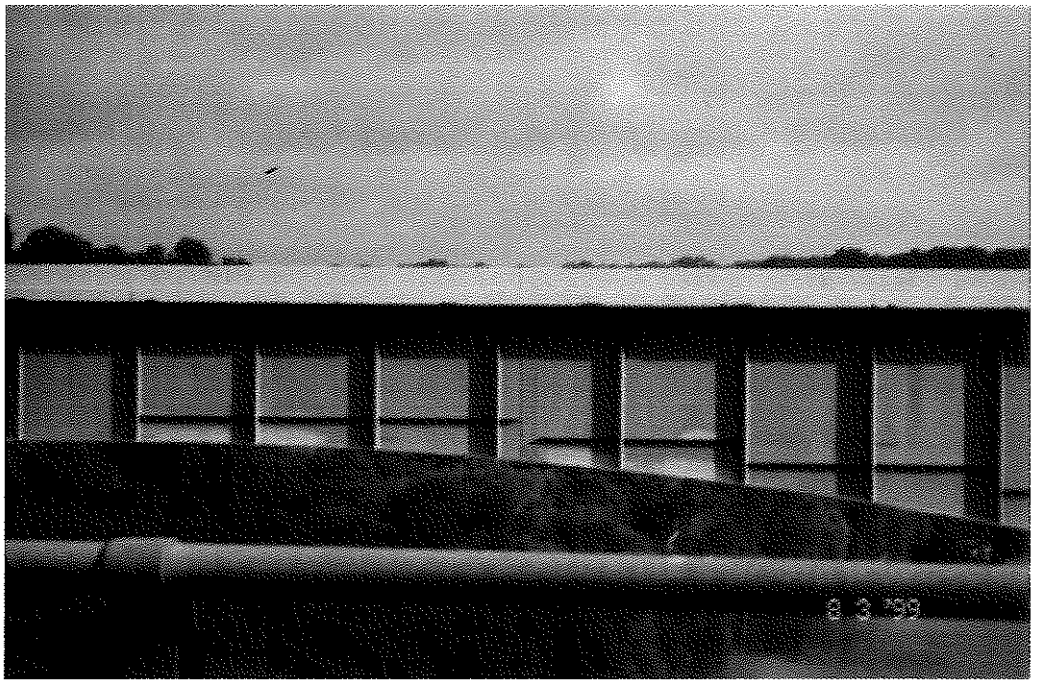

FIGURE 31. I-64 WESTBOUND OVER THE KENTUCKY RIVER IN 1999.

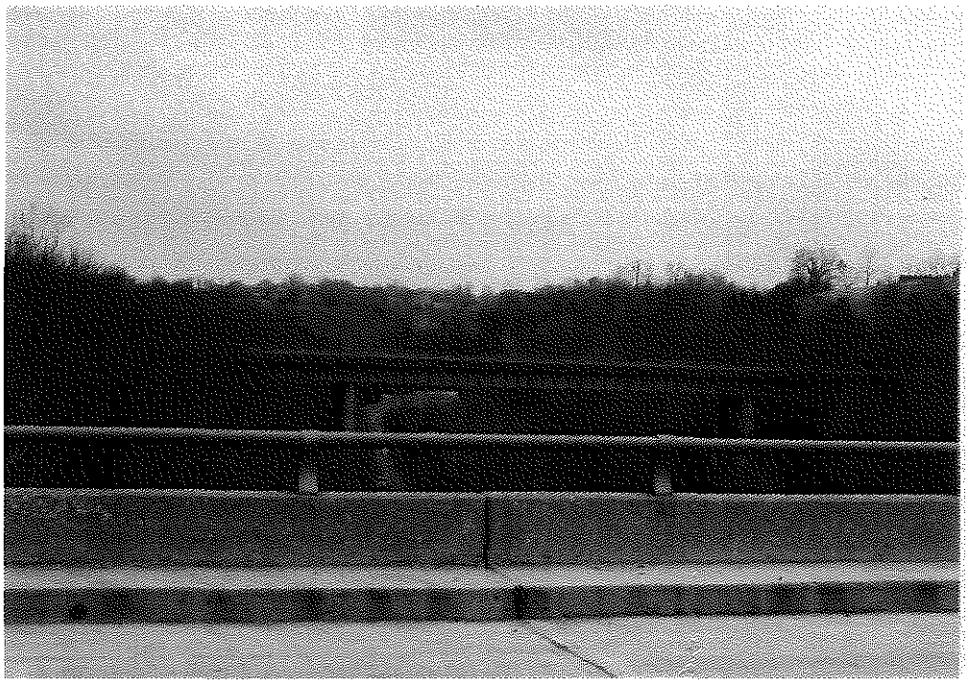

FIGURE 32. I-64 EASTBOUND OVER KY 420 IN 1997.

FIGURE 33. I-64 EASTBOUND OVER KY 420 IN 1999.

I-71 Bridges

From September1996 through and January 1999, several follow-on inspections were conducted on the I-71 bridges. In 1997, most of the bridge paint appeared to be in good condition. Some corrosion was observed on a few of the bearings on both concrete and steel bridges (Figures 34 and 35). On the I-71 bridges over the Kentucky River, rust-back and rust staining was occurring in joint areas and along the lower flanges of the main girders (Figure 36). The paint on the I-71 mainline bridges over Sulphur Creek and the CSX Railroad was performing well except at the abutment and pier bearings (Figure 37). A slight amount of corrosion was present on the bottom faces and along the edges of lower flanges of several overpass bridges and on some of the transverse bracing (Figures 38 and 39). That corrosion was either at locations directly over roadways where vehicular traffic kicked-up aerosols from the wet roadways onto the bridge steel or at beam ends under deck joints.

The 1999 inspection revealed more extensive corrosion on the lower flanges, especially the bottom faces and edges of the steel overpass bridges (Figures 40-42). Corrosion was beginning on the exterior webs of the fascia girders Springdale Road Bridge over I-71 (Figure 43). Most paint on the mainline bridges was in good condition except at locations under deck joints (Figures 44-46). The performance of paint on bearings under deck joints varied. As noted in the 1997 inspection, the paint on some bearings had failed and the bearings were corroding (Figure 47.). In other cases, the coatings on the bridge bearings remained intact. Most of the corrosion was on bearings where the paint had begun to fail in 1997. Open or leaking joints were probably the cause of those failures. The paint on bearings not directly under deck joints was performing well (Figure 48).

Despite the failures noted, most of the paint applied during this project is still performing well. The coatings are performing better on the mainline bridge steel than on that of the overpass bridges. Even on overpass girders and beams that have some corrosion, the bulk of the paint is in good condition. In areas where rusting and rust staining is not occurring, the paint has an excellent esthetic appearance.

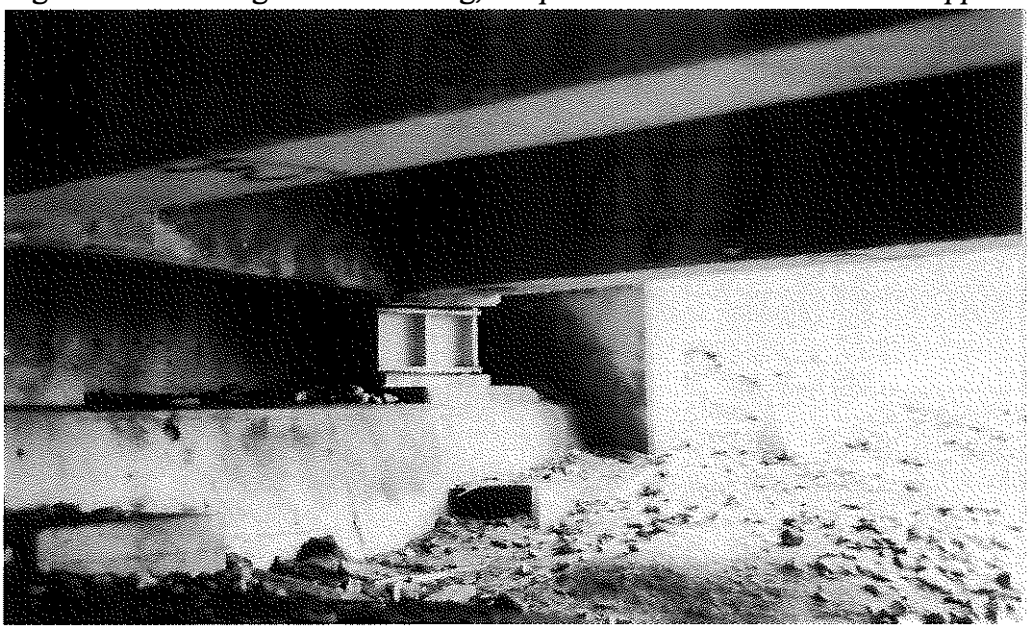

FIGURE 34. I-71 CONCRETE OVERPASS BRIDGE SHOWING STEEL BEARING CORROSION (1997).

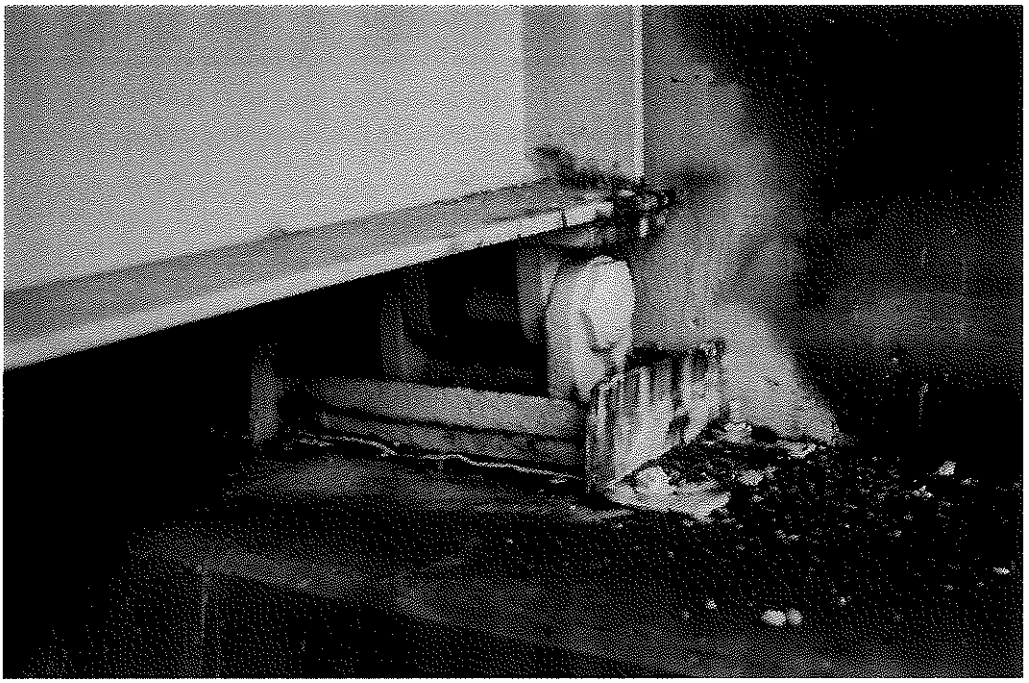

FIGURE 35. I-71 STEEL MAINLINE BRIDGE OVER SULPHUR CREEK AND THE CSX RAILROAD SHOWING BEARING CORROSION (1997).

FIGURE 36. I-71 SOUTHBOUND MAINLINE BRIDGE OVER THE KENTUCKY RIVER SHOWING CORROSION ON LOWER WEB AND FLANGE. NOTE THE CORROSION UNDER DECK JOINTS (1997).

FIGURE 37. I-71 STEEL MAINLINE BRIDGE OVER SULPHUR CREEK AND THE CSX RAILROAD SHOWING PAINT IN GOOD CONDITION (1997).

FIGURE 38. I-71 OVERPASS BRIDGE GIRDER SHOWING SPOT CORROSION AT BRACING AND ALONG EDGES OF LOWER FLANGE (1997).

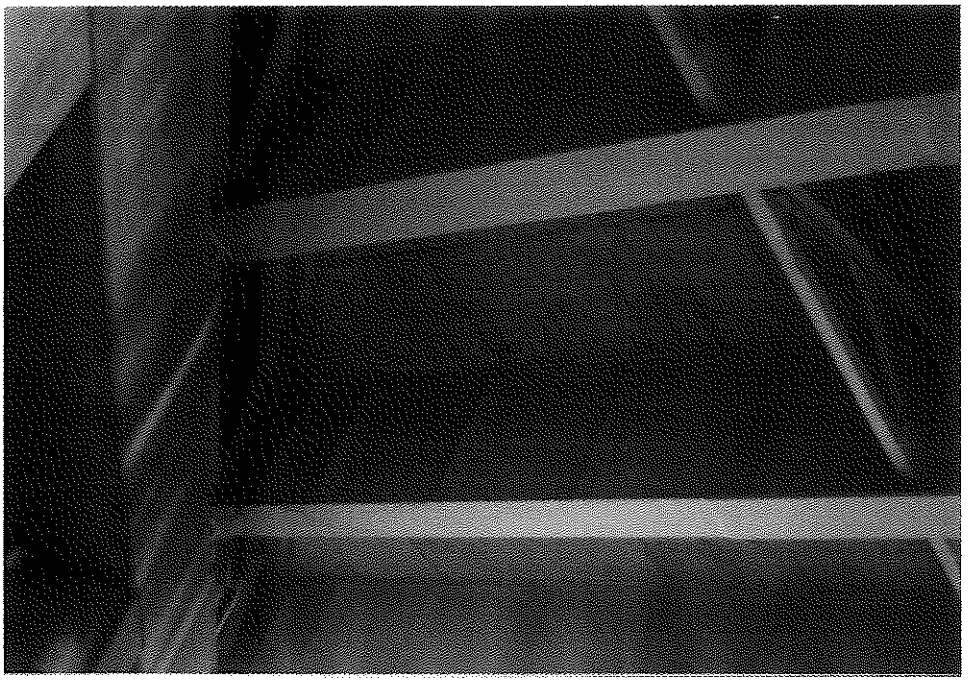

FIGURE 39. I-71 OVERPASS BRIDGE GIRDER SHOWING SPOT CORROSION ON LOWER FLANGE AT END OF GIRDER BRACING AND ALONG EDGES OF LOWER FLANGE (1997).

FIGURE 40. I-71 NORTHBOUND BRIDGE OVER I-75 SHOWING CORROSION ON LOWER FLANGE OF FASCIA GIRDER (1999).

FIGURE 41. KY 146 OVERPASS BRIDGE OVER I-71 SHOWING CORROSION ON LOWER FLANGE UNDER DECK JOINT (1999).

FIGURE 42. LIME KILN LANE BRIDGE OVER I-71 SHOWING CORROSION ON TRANSVERSE BRACING AND LOWER FLANGES (1999).

FIGURE 43. SPRINGDALE ROAD BRIDGE OVER I-71 SHOWING CORROSION ON EXTERIOR FACE OF FASCIA GIRDER (1999).

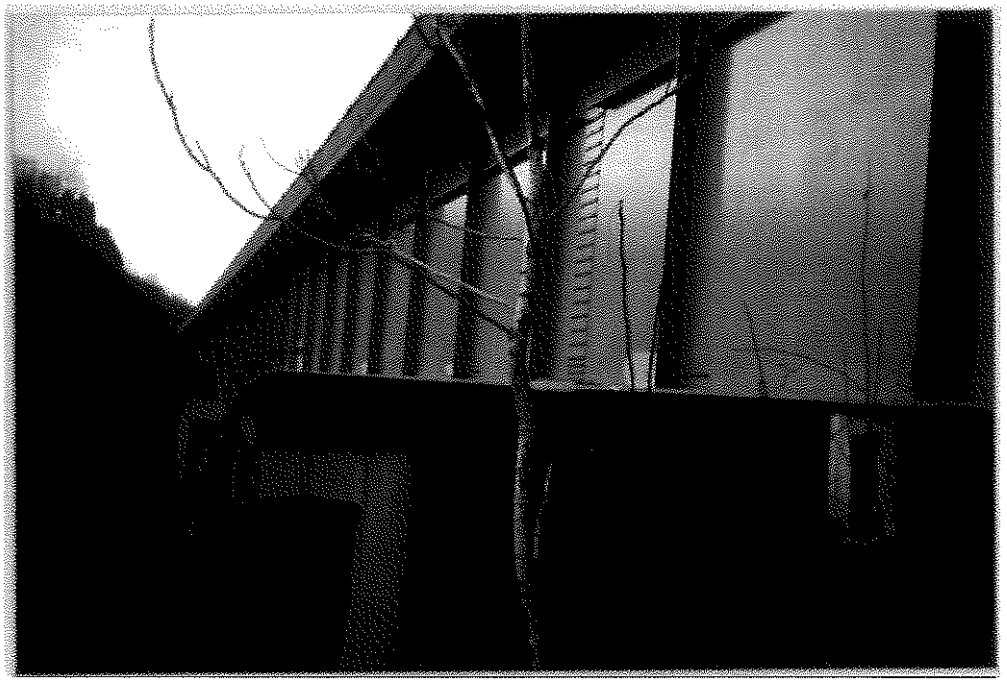

FIGURE 44. I-71 NORTHBOUND MAINLINE BRIDGE OVER SULPHUR CREEK AND THE CSX RAILROAD SHOWING PAINT IN GOOD CONDITION (1999).

FIGURE 45. I-71 SOUTHBOUND MAINLINE BRIDGE OVER THE KENTUCKY RIVER SHOWING A SLIGHT INCREASE IN CORROSION OVER 1997 - REF. FIGURE 36 (1999).

FIGURE 46. CORROSION ON I-71 NORTHBOUND BRIDGE FLOOR BEAMS UNDER DECK JOINT (1999).

FIGURE 47. I-71 NORTHBOUND MAINLINE BRIDGE OVER SULPHUR CREEK AND THE CSX RAILROAD SHOWING PAINT FAILURE AND BEARING CORROSION (1999).

FIGURE 48. I-71 CONCRETE BRIDGE SHOWING PIER BEARING IN GOOD CONDITION (1999).

KY-22 Bridge

In June 1999, the KY-22 Bridge was inspected. From the vantage of motorists, most of the paint still had good cosmetic appearance (Figure 49). Closer inspection revealed spot failures and rust back along the lower chords, but, generally, they were in good condition (Figures 50, 51). Typically, paint failures and corrosion on chord members occurred at the edges of batten plates where they were in contact with channels and on horizontal surfaces (Figure 52). The most significant failures (corrosion and disbonding) had occurred along the guardrails detracting from the appearance of the paint (Figure 53). The guardrails were laced riveted members that contained many edges. Most of the rust-back was occurring that the edges (Figure 54). Some disbonding failures were observed between the primer and topcoat on horizontal surfaces of the lower chords and guardrails (Figure 55). At those locations, the topcoat appeared to have been excessively thick (greater than 10 mils). The other steel above deck level was in good condition except for a few localized spot failures (Figures 56).

An extensive amount of running was observed in topcoat on vertical and diagonal members (Figure 57). The runs dried in place indicating that the topcoat was applied too thickly. The runs did trap some dirt. Fortunately, they were not visible at a distance or from vehicles using the bridge. They probably could have been prevented if the inspectors had been concerned with them.

While no inspections were conducted during the 1997 flood, it was learned that a substantial amount of driftwood had washed onto the bridge. Apparently, the floodwaters had reached at least the deck level. Inspection under the bridge revealed a few branches still lodged in the bracing (Figure 58). Impacts from floating driftwood had not damaged the paint. However, the aforementioned disbonding may have resulted from portions of the bridge being submerged for an extended period during the flood.

Much of the paint applied during this project is still performing well. Riveted truss bridges are difficult to paint properly by any method due to the many edges, faying surfaces, and hard to access areas. On such structures, spot failures are inevitable and some occurred. Most of the paint on steel above deck level is in good condition. Those locations were probably not under water when the flooding occurred. The light blue topcoat has lost its gloss, but it has not chalked and has a pleasing esthetic appearance.

FIGURE 49. NORTH END OF THE KY 22 BRIDGE.

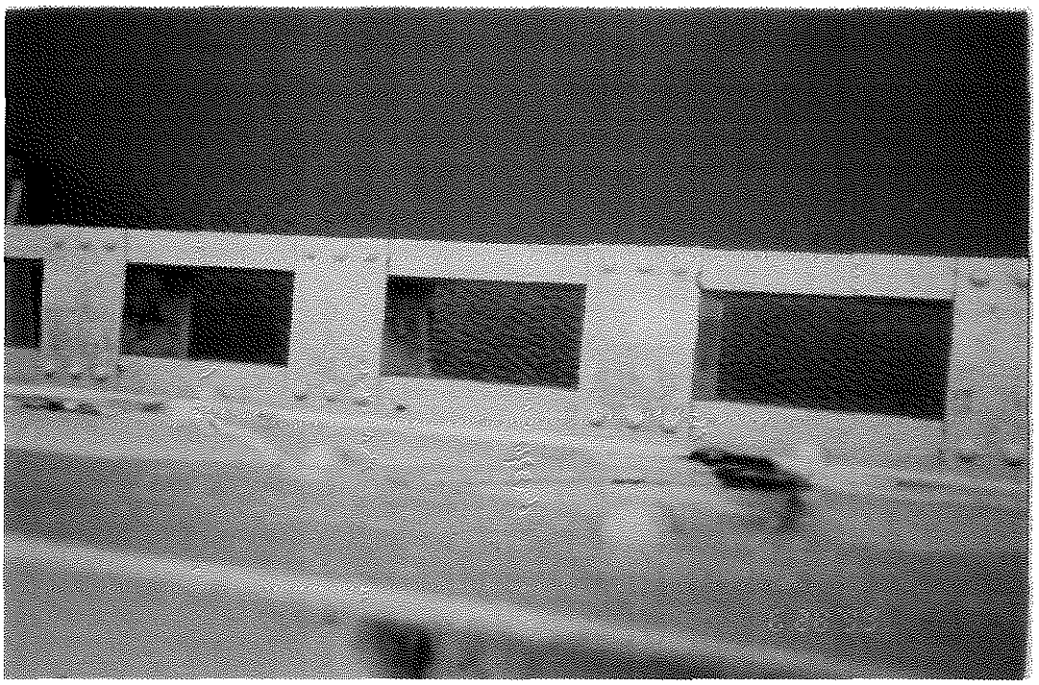

FIGURE 50. BATTEN PLATES ON DOWNSTREAM LOWER CHORD OF KY 22 BRIDGE SHOWING PAINT IN GOOD CONDITION.

FIGURE 51. BATTEN PLATES ON DOWNSTREAM LOWER CHORD OF KY 22 BRIDGE SHOWING SLIGHT CORROSION AND RUST STAIN ON WEB.

FIGURE 52. BATTEN PLATES ON UPSTREAM LOWER CHORD OF KY 22 BRIDGE SHOWING COATING FAILURE.

FIGURE 53. KY 22 BRIDGE GUARDRAIL SHOWING EXTENSIVE COATING FAILURE.

FIGURE 54. KY 22 BRIDGE GUARDRAIL SHOWING EXTENSIVE COATING FAILURE AT EDGES OF LACING BARS.

FIGURE 55. KY 22 BRIDGE GUARDRAIL SHOWING DISBONDING ON HORIZONTAL SURFACE OF TOP RAIL.

FIGURE 56. SOUTH SPAN END BENT, PORTAL AND UPPER CHORD OF KY 22 BRIDGE SHOWING PAINT IN GOOD CONDITION.

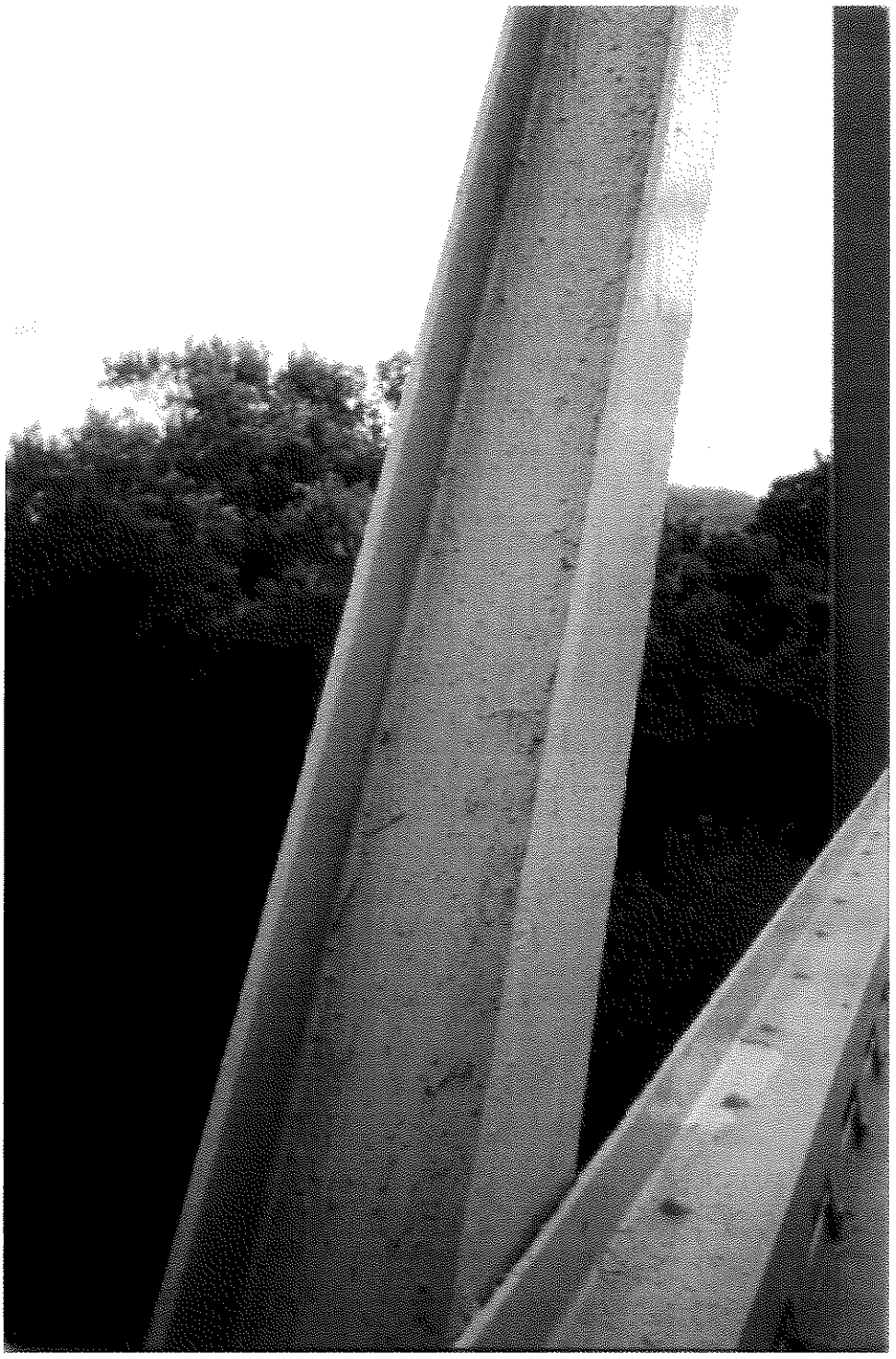

FIGURE 57. KY 22 BRIDGE DIAGONAL SHOWING PAINT RUNS AND DIRT BUILD-UP.

SUMMARY

In general, these experimental projects were successful, as they have performed reasonably well and they met their primary goal of low initial project costs. Going into these projects, KYTC did not seek to obtain paint jobs that would perform well for 15 to 20 years. Rather, the intent was to paint cheaply and over time, observe how well those minimal effort/cost projects would endure. KYTC Division of Operations personnel plan to eventually repair some of the coatings in the future. The polyurethane coatings applied during these projects will weather much slower than the alkyd systems they covered. Indeed, they will inhibit the alkyds from further weathering and retain them on the bridges allowing the lead-based primers to continue protecting the steel. It should be remembered that lead primers are good at resisting atmospheric corrosion. Overtime, those projects can be given additional low-cost spot repairs and overcoats maintaining economic protection of the steel over the lives of those bridges.

The appearance of the overcoating projects was very good with the exception of the localized coatings failures and the subsequent damage and some rust staining. Lessons gained on those projects enabled KYTC personnel to revise KYTC experimental overcoating specifications to achieve better performance on subsequent overcoating projects.

The project costs were acceptable to KYTC. The unit costs for the I-71, I-64 and KY-22 bridges were $\$1.07/ft^2$, $\$1.48/ft^2$ and $\$1.71/ft^2$ respectively (using estimates of steel surface areas – 125 ft^2/ton for girder bridges and 165 ft^2/ton for light built-up truss bridges – based upon steel tonnages from bridge plans). The unit cost for the I-71 project does not factor in the costs for painting 660 rockers on concrete bridges! The higher cost of the KY-22 project relates to mobilization costs, structure complexity and the extremely poor condition of the existing paint. It had the worst existing paint of any KYTC overcoating project to date. Nationwide bridge maintenance painting cost data for the period of 1993-1996 had averages of $4.56 for overcoating and $10.76 for full removal (2). The unit costs on the KYTC experimental projects is a good yardstick for measuring the success of those projects and the financial latitude that KYTC had in seeking additional improvements in the overcoating process.

KYTC personnel were impressed with the degree of cleaning achieved by the 4,000 psi washing on the KY-22 project. Not only did it remove a large amount of weakly bonded paint, but also it quickly cleaned adherent paint. The higher washing pressure used on the I-64 project (3,000-psi) was more effective in cleaning the paint than the lower washing pressure used on the I-71 project (2,500-psi). On I-71, the contractor had to resort to extensive hand scrubbing to remove chalk on some bridges. Those findings prompted KYTC personnel to investigate the use of higher washing pressures on future experimental projects.

Some of the localized paint failures on the I-64 and I-71 were related to the heavy, stratified rust that was not removed by pressure washing. That corrosion was encountered most frequently on rockers, bearing pads, beam ends and lower flanges of beams. Areas under deck joints were especially susceptible as they accumulated water and had longer times of wetness. Paint, even with good wicking characteristics could not penetrate the heavy rust. As a consequence, it caused the paint to fail very quickly. KYTC personnel determined that pack rust would need to be removed prior to painting. Consideration would be given on future projects to investigate the use of mechanical surface preparation to remove all loose rust and thereby provide better substrates for paint application.

The aluminum-pigmented moisture cure primers used on the I-64 and KY-22 projects were considered superior to the aluminum/MIO-pigment primer used on the I-71 project in terms of penetration and sealing. Also, it probably was a more effective barrier coating. Therefore, KYTC personnel decided to proceed with the use of the KYTC-specification primer in future projects. High-gloss polyurethane topcoats used on the projects were largely responsible for the bridges' good esthetics. From the roadways, it was difficult to tell that any of the bridges had been overcoated. KYTC personnel decided to use the KYTC-specification topcoat on future experimental overcoating projects. The long-term gloss retention of the KYTC topcoat on the I-64 and I-71 projects has been very good and exceeds that of the proprietary topcoat used on the KY-22 bridge.

The aluminum/MIO primer had one advantage over the aluminum primer in that it provided a longer re-coat window. The 1-day re-coat window that was required for the proprietary paint system on the KY-22 project was impractical. KYTC personnel believed that the 3-day re-coat window imposed by the supplier of the KYTC-specification coatings system on the I-64 project was too constraining. Besides the re-coat issue, KYTC Division of Materials personnel were concerned about consistent paint, especially after the problem with the aluminum/MIO primer that occurred on the I-71 project. Those problems indicated that the material specifications needed to be revised to establish constituent limits for main paint components. KYTC personnel developed a second-generation cookbook/performance specification for the aluminum-pigmented moisture cure primer/acrylic polyurethane topcoat system. It mandated a 5-day re-coat window for those coatings and placed requirements for pigment and resin composition

Incorporation of an intermediate coat on the KY-22 and I-64 projects was considered to be desirable for several reasons: 1) it furnished additional barrier protection, 2) it provided insurance against incomplete spot priming and 3) on curing, it leveled out and provided a uniform substrate for the topcoat (Figures 58,59). That provided a more uniform appearing topcoat on the I-64 bridges compared to those on I 71. The corrosion resistance of the 3-coat systems used on the I-64 and the Bluegrass Parkway overpass projects have proven to be superior to the 2-coat system used on I-71 project. The cost difference between the I-64 and I-71 projects indicated that better long-term performance and cosmetic appearance offset the added expense of an intermediate coat.

KYTC personnel were also concerned about the disputes with contractors. In part, those conflicts arose because the QC inspectors were foremen or owners/foremen and they were trying to establish looser workmanship standards than KYTC personnel/inspectors would accept. On future experimental projects, KYTC personnel would change the wording on the cleaning portion of the specification seeking to minimize the possibility of disputes.

The experimental projects that have been described in this report constitute the end of the first phase of KYTC overcoating work. Future experimental overcoating projects would employ better cleaning methods and revised KYTC-specification coatings to achieve more durable, better appearing projects while maintaining low project costs. Many lessons were learned on these projects through the construction process and in the period immediately thereafter. Periodic long-term review of them has and will continue to provide additional lessons that can be applied to benefit future overcoating projects.

FIGURE 58. I-71 OVERPASS BRIDGE SHOWING ROUGH SURFACE FINISH OBTAINED USING TWO-COAT PAINT SYSTEM.

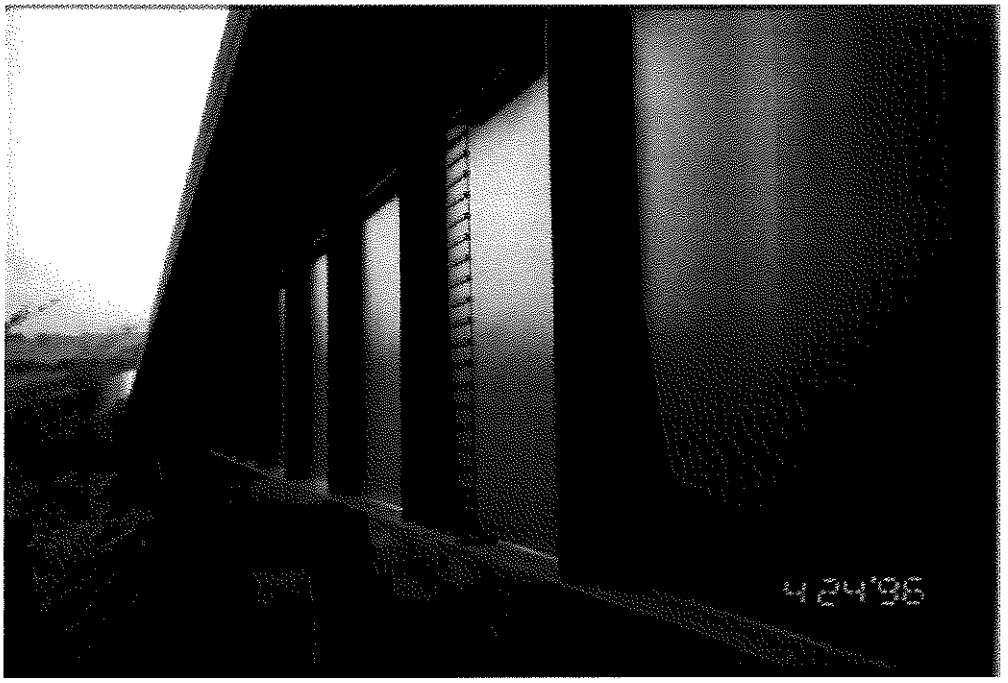

FIGURE 59. WESTBOUND I-64 BRIDGE OVER THE KENTUCKY RIVER SHOWING SMOOTH FINISH OBTAINED USING THREE-COAT PAINT SYSTEM.

RECOMMENDATIONS

Many of the lessons learned during the fieldwork and shortly after the completion of these projects were immediately incorporated into KYTC specifications for follow-on experimental overcoating projects. Other findings awaited a sufficient amount of time to adequately assess their service performance. Several unanticipated events, subsequent coating damage by other contractors and flooding, impacted the performance of the coatings on the I-64 and KY-22 projects. The following recommendations relate to our long-term findings.

1. Most overcoating coatings rely on barrier effects to protect the steel substrate from corrosion. Austere coatings systems with 1 or 2 coats of paint may be used to benefit on certain remote bridges or on those possessing existing paint in very good condition. Results from these projects indicate that, for most major bridges, 3-coat systems will probably perform better from a life cycle cost standpoint.

3. It should be noted that in these projects, a large amount of bridge steel was painted for a low cost. The localized failures encountered on those projects can be eventually repaired under spot painting projects. Under such contracts, a painting contractor would repair rusted areas designated by KYTC plans. As many of those areas are where the environmental stresses on coatings is high (e.g. bearings, webs of fascia girders, girder flanges over roadways, etc.), special spot painting procedures could be employed that would provide superior corrosion resistance. Areas visible to motorists such as exterior faces of fascia girders could be completely topcoated to restore their appearance. It is likely that large-scale spot painting contracts would be relatively inexpensive. Using spot painting, the lives of these overcoating projects can be extended to 20 or 30 years. It should be noted that the Pennsylvania DOT has successfully employed spot painting for many years.

3. A final issue that needs to be discussed is the scheduling and sequencing of other bridgework. Overcoated paint is somewhat fragile. It cannot be subject to impacts such as falling deck concrete. Not many paint systems, whether applied by overcoating or by full removal, can withstand such abuse. Spot repairs of obvious damage may not be the answer as impact damage that may initiate paint failure not evident for months. Besides mechanical damage to new paint, other maintenance or rehabilitation work may deposit concrete stains that significantly detract from the esthetic appearance of paint. Also, leaking or open deck joints promote rust staining and rust back and diminish coating performance. The bearings of many I-64 and I-71 bridges have corroded due to joint leakage and to their sheltered locations that extend the time of wetness. In contrast, the open bearings on the KY-22 Bridge have performed very well. Better planning would lead to painting only after deck or other concrete rehabilitation is complete and deck joints have been repaired/modified to inhibit leaking. Realistically, operational constraints make it difficult to properly sequence bridge maintenance operations. The Michigan DOT is currently maintenance painting some 30 bridges in the Detroit area. For various reasons, funding for that work was secured prior to MDOT acquiring deck rehabilitation funds. As a consequence, deck-overlaying work will be conducted following the painting operations. In such cases, the specifications for concrete work should mandate that contractors take special care to avoid damage of the paint and that they repair damaged paint to the satisfaction of KYTC. Where overcoating operations are performed on bridges with leaking deck joints, follow-up joint repairs should be made as soon as possible to prevent coatings failures.

ACKNOWLEDGEMENTS

The authors would like to thank the KYTC Paint Team members for their assistance on this study. Paint Team members include: Robert Banta (Operations), Scott Kring (Construction), Greta Smith and Derrick Castle (Materials) and Pam Beckley (Environmental Analysis).

REFERENCES

Hopwood, T. and Oberst, C.M., "Environmentally Safe Protective Coatings for Steel Structures – New Construction and Maintenance Painting", Kentucky Transportation Center, Lexington, KY, Report No. KTC-96-7, March 1996.

Appleman, B.R., "Survey of Nationwide Bridge Painting Costs", Paper Presented at the 15th International Bridge Conference and Exhibition, June 16, 1998.