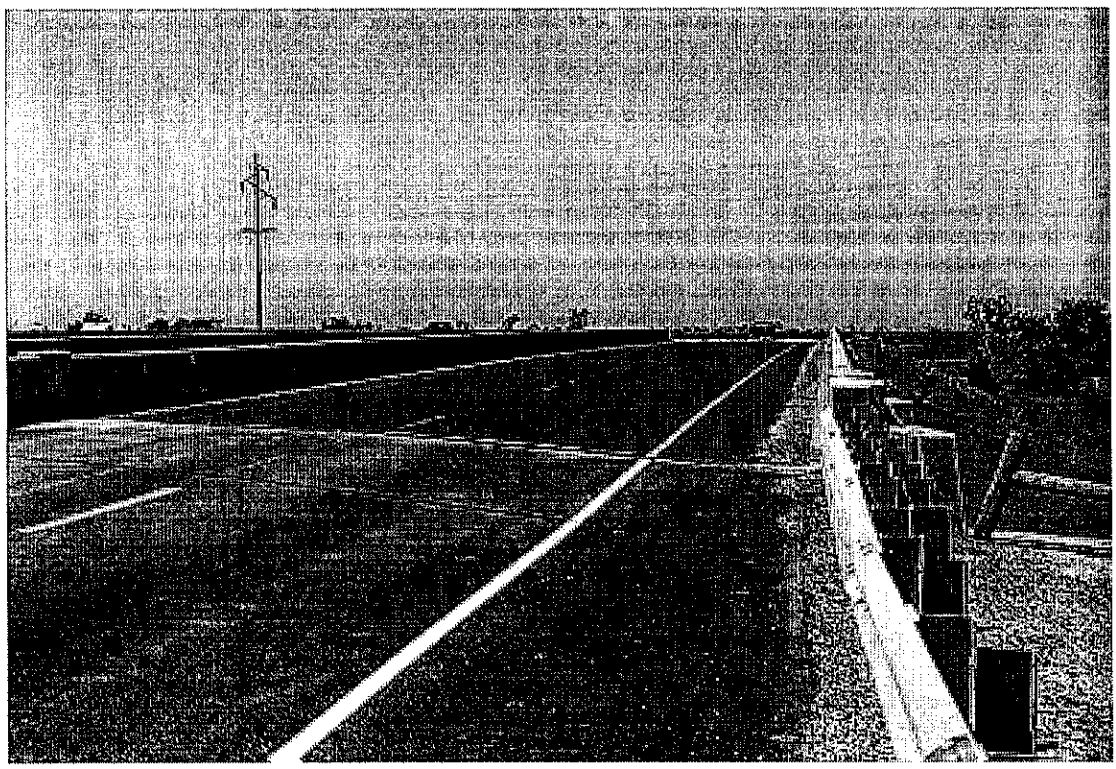
Evaluation of Thin Lift Polymer Bridge Deck Overlays on I-57 Bridges at Clifton, IL

Construction Report



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Brian A. Pfeifer, P.E. and Gary Kowlaski, P.E.

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Bureau of Materials and Physical Research
126 East Ash Street
Springfield, Illinois 62704-4766

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16. Abstract

This construction report summarizes the placement of two thin lift polymer bridge deck overlays on adjacent structures carrying Interstate 57 near Clifton. Various tests were performed before overlay placement to determine the condition of the structures. Half-cell potential tests indicated that corrosion was underway in at least one-third of the southbound passing lane. Just before full-scale overlay placement, a test area was constructed using the proposed surface preparation and overlay placement methods. Pull-off tests (ACI 503R-80) indicated that the methods were sound, so construction proceeded.

The overlay was placed during 4 days in September of 1995 using a broom-and-seed application method. A durable rhyolitic stone aggregate (trap rock) was used on both lifts. While the cost of thin polymer overlays is much greater compared to conventional overlays, the higher cost can be justified when a reduction in dead load is required. One potential benefit of thin polymer overlays, if proven successful, is in reducing lane closure times. This was not the case on this contract, since patches were cured for at least 28 days. However, recent contracts in Missouri have been completed with minimal curing periods. Future studies should include an evaluation of methods for expediting construction.

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Evaluation of

Thin Lift Polymer Bridge Deck Overlays on

I-57 Bridges at Clifton, IL

FAI 57
Section (38-2)RS-1
Iroquois County
Contract 86589

CONSTRUCTION REPORT

by

Brian A. Pfeifer, P.E.
Concrete Field Engineer
Bureau of Materials & Physical Research

Gary Kowalski, P.E.
Final Plan Control Unit Chief
Bureau of Bridges & Structures

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Notice

The Illinois Department of Transportation does not endorse products or manufacturers. Trade names, trademarks, or manufacturer names appear herein because they are considered essential to the object of this report.

Executive Summary

This construction report summarizes the placement of two thin lift polymer bridge deck overlays on adjacent structures carrying Interstate 57 near Clifton. Funding for the contract was provided by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), Section 6005(e)7.

Just before full-scale overlay placement, a test area was constructed using the proposed surface preparation and overlay placement methods. Pull-off tests (ACI 503R-80) indicated that the methods were sound, so construction proceeded. The overlay was placed during four days in September of 1995 using a broom-and-seed application method. A durable rhyolitic stone aggregate (trap rock) was used on both lifts. Skid testing was performed four weeks, 10 months, and 20 months after construction. Skid numbers were well above typical friction numbers for new bituminous and portland cement concrete pavements at four weeks, and were still comparable to new PCC pavement after 20 months.

While the surface of the overlay is performing well thus far, little is known about its ability to slow or stop the rate of corrosion. The overlay should, by virtue of its very low permeability, prevent further chloride intrusion. However, enough chlorides were present in the deck before the overlay was placed to support corrosion, and half-cell testing indicated corrosion in areas of one lane of one structure.

Thin polymer deck overlays have been used successfully in other states and have provided durable, skid-resistant surfaces for 15 years or more. While the cost of polymer overlays is currently much higher than for other bridge deck overlay options such as microsilica concrete, they do serve a useful purpose in reducing dead load. The greatest potential advantage of thin polymer overlays is in expediency of construction. The Clifton overlays were limited in regards to total lane closure time by the 28 day curing period for partial and full depth patches; however, recent projects in Missouri have been completed with minimal curing periods. Future studies should include an evaluation of methods that accelerate construction. The performance evaluation for this contract is ongoing, and will be completed in September of 2000.

TABLE OF CONTENTS

Acknowledgments iii
Executive Summary iv

Introduction 1
Field Evaluation 2
Construction 2
Data Collection 5
Cost 10
Discussion 13
Conclusions 14
Recommendations 14

References 16
Appendix: Special Provision for Bridge Deck Polymer Concrete Thin Overlay 17

Introduction

A number of aging bridge decks contain uncoated reinforcing steel that is susceptible to corrosion. Rehabilitative measures can be an effective alternative to costly and time-consuming deck replacement. These measures include repairing delaminated areas and overlaying the deck with a wearing surface. Microsilica concrete overlays have been used with some success, but require seven days to cure and are sensitive to weather conditions and construction methods. Bituminous membrane systems tend to delaminate, crack, and lose skid resistance under heavy traffic.

Polymer overlays have the potential to provide a durable and relatively impermeable, skid resistant surface for over 15 years [*1*]. The first modern polymer overlay was placed in 1976 on Route 44 in Grand Rapids, Michigan and was still in service in 1992 [*2*]. In the past, polymer overlay systems suffered from problems such as insufficient flexibility, sensitivity to moisture, poor freeze-thaw resistance, poor abrasion and skid resistance, and long curing periods [*3*]. Advancements in resins and the use of more durable aggregates give modern polymer overlays the potential to overcome these problems.

Modern polymer overlays are not problem free, however. For example, on a Washington State bridge, small aggregate was pulled out of a polymer overlay by traffic [2]. Improper mixing or measuring of resin components or a high moisture content in the deck can prevent bond strength from developing and can cause delamination problems. Other potential problems include age hardening, excessive flexibility in the deck, freeze-thaw degradation, ultraviolet degradation, reflective cracking due to an insufficient amount of resin, and porosity caused by air bubbles in the resin due to overmixing [*4*].

There are two application methods commonly used. In 1991, the multi-layer broadcast or "broom-and-seed" method was believed to provide the highest degree of elasticity and compressive values of all currently available polymer overlay systems [3]. In this method, the resin components are mixed and spread with notched squeegees. The aggregate is applied immediately thereafter either by a mechanical spreader or by hand.

Excess aggregate is removed and the process is repeated until the desired overlay thickness is met. Another method is the slurry method, in which the aggregate is mixed into the epoxy and then applied to the deck by hand-screeding. Non-skid textures are obtained by broadcasting aggregate over the surface before the polymer hardens [5].

Field Evaluation

A thin lift polymer bridge deck overlay system was chosen as a rehabilitative measure on two structures on Interstate 57 south of Clifton, Illinois. The primary reason for the selection of a polymer overlay system was the need for a reduction in dead load. The IDOT Bureau of Bridges and Structures submitted the I-57 structures to the FHWA as a candidate project for thin bonded overlays in April of 1993. Funding was provided by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), Section 6005(e)7.

The polymer overlay placed on the two I-57 structures consisted of two layers of aggregate imbedded in epoxy with a total thickness of 1/4 inch. The overlay was applied using the broom-and-seed method. The Clifton bridge decks were originally constructed in 1966 and have an ADT of 14,350 vehicles per day.

A durable rhyolitic stone aggregate (commonly called trap rock) was acquired from Iron Mountain, Missouri. The aggregate used in the bottom layer had an average particle size of 1/16 inch. The aggregate used in the top layer was slightly coarser, with an average particle size of 1/8 inch. Both aggregates were required to contain less than five percent passing the #20 sieve and less than one percent passing the #200 sieve. These requirements are in place in order to ensure that an adequate amount of the voids are filled by epoxy resin rather than aggregate fines.

Construction

The construction process outlined in the Special Provision in the Appendix was modified from a Missouri Department of Transportation specification. One notable construction variance from the Special Provision was the use of Sikadur 21 LoMod LV (Low Viscosity) in place of the specified Sikadur 22 LoMod epoxy system. The reason stated

for the change was a need for a lower viscosity material due to the cooler temperatures predicted.

Surface preparation started on September 18, 1995 on both the southbound driving lane and the northbound passing lane. Surface preparation started on the remaining lanes on September 27. Application of the overlay took place on September 25, 26, 29, and 30, 1995. Photographs of the surface preparation and application processes are found in Figures 1 and 2. On September 25, prime coats were placed on the southbound driving lane and the northbound passing lane, and the first aggregate layer was placed. The second aggregate layer was placed the next day, and both lanes were opened to traffic the following day after the excess aggregate was removed. A similar schedule was used for the remaining two lanes.

On September 29, shotblasting and brooming operations in the southbound passing lane were observed, as was the application of the first coat of aggregate on the northbound driving lane. The deck surface preparation sequence was as follows:

1. Mill to a depth of 1/4 to 1/2-in.
2. Scarify to a level surface.
3. Shotblast to clean and create a smooth surface.
4. Broom and clean with compressed air to remove debris before application.

The temperature varied between 65°F and 85°F throughout the day. Application of the prime coat started at 11 a.m. A prime coat of Sikadur 21 LoMod LV was applied in order to fill cracks and maximize the bond between the overlay and the existing deck. Epoxy components were mixed in five gallon buckets for one minute, then distributed onto the deck by a squeegee. The Special Provision and manufacturer literature both specify a three minute mixing time. The epoxy mixing and placing process took about 1 1/2 hours for the 374-ft. long deck. At 1:30 p.m., the first coat of aggregate was disbursed to excess over the epoxy.

When epoxy was applied to the deck surface, it spread to the vertical surfaces of the circular deck drains. Aggregate was then embedded in the epoxy, further obstructing

Figure 1.
Epoxy Applied to Prepared Surface

Figure 2.
Aggregate Broadcast over First Layer of Epoxy

the drains. This occurrence could be avoided in the future by covering drain openings during the overlay process.

The resident engineer noted that the milling machine used in this contract left an uneven surface that was difficult to level with shotblasting. Furthermore, the resident engineer recommended that scarifying equipment with a greater number of teeth be specified in order to provide a smoother surface for the shotblasting operations. Also, a transition area was required immediately adjacent to the expansion joints since milling was not possible.

Data Collection

In June of 1995, cores from the I-57 bridge decks were tested by the Bureau of Materials and Physical Research. Samples were taken from each core at four depths and tested for chloride ion content in accordance with AASHTO T 260. The total chloride ion contents at all depths ranged between 1.1 and 9.4 lbs. Cl^-/yd^3 concrete, and the average at the top reinforcement depth was 2.6 lbs. Cl^-/yd^3 concrete. Reinforcing bars can begin to corrode when chloride ion levels near them reach 1.0 to 2.0 lbs. Cl^-/yd^3 concrete [*1*]. Results from these tests are summarized in Table 1 and Figure 3. Figure 3 shows a trend of decreasing chloride content with increasing depth, with the exception of Core 1.

In August of 1995, half-cell potential tests (ASTM C 876) were performed on the passing lane of the southbound structure by IDOT District 2 personnel. About a third of the 435 tests indicated a greater than 90 percent probability of corrosion at those locations. Only 10 percent of the tests indicated a greater than 90 percent probability of no corrosion. The remaining 58 percent of the tests were inconclusive.

Three additional cores were taken before the overlay was placed. The cores were sent to the manufacturer of the overlay system for rapid chloride permeability testing (AASHTO T 277). The manufacturer reported that two of the cores indicated "very low" chloride ion penetrability and one of the cores indicated "negligible" penetrability, according to the ratings in the AASHTO T 277 test method. These ratings are

Table 1.
Chloride Ion Content of Bridge Deck Cores

Sample No.	ppm of Cl^- ions	lbs Cl^- / yd^3 concrete[a]
1A	694	2.7
1B	636	2.5
1C	695	2.7
1D	896	3.5
2A	2072	8.1
2B	899	3.5
2C	565	2.2
2D	549	2.2
3A	1694	6.6
3B	282	1.1
3C	594	2.3
3D	656	2.6
4A	2389	9.4
4B	958	3.8
4C	689	2.7
4D	733	2.9
5A	1178	4.6
5B	500	2.0
5C	535	2.1
5D	566	2.2
Average	889	3.5
"B" Level Avg.[b]	655	2.6

[a]unit weight assumed to be 145 lbs/ft^3
[b]approximate level of top reinforcing steel
NOTE: Samples drilled at: A=1-in., B=2.5-in., C=4.25-in., D=6-in.

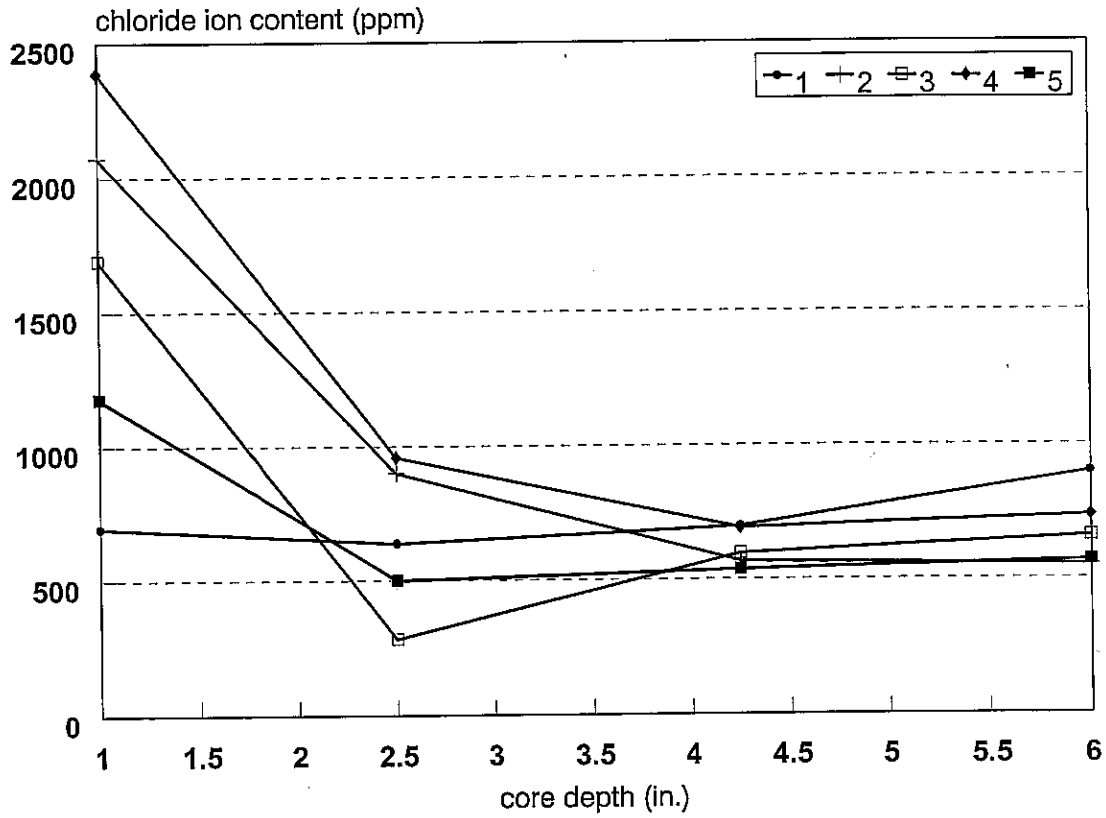

Figure 3.
Chloride Content Variance with Depth of Core

Table 2.
Friction Test Results

	November 1995	July 1996	May 1997
FN (Treaded Tire)	70	53	60
FN (Smooth Tire)	69	54	51
Overlay Age	4 wks.	10 mos.	20 mos.

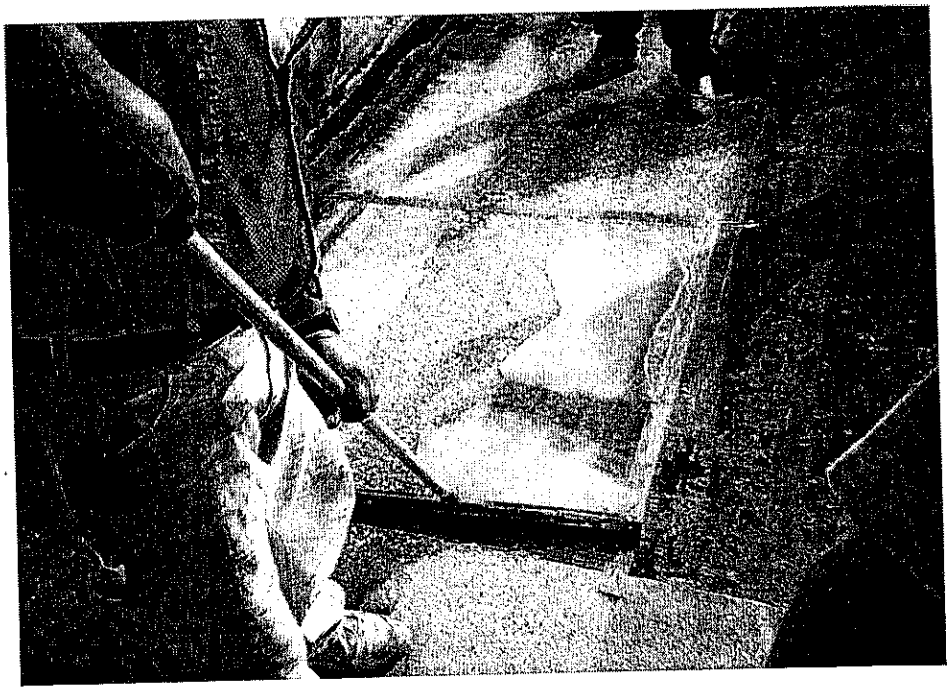

Figure 4.
Primer Applied to Test Area

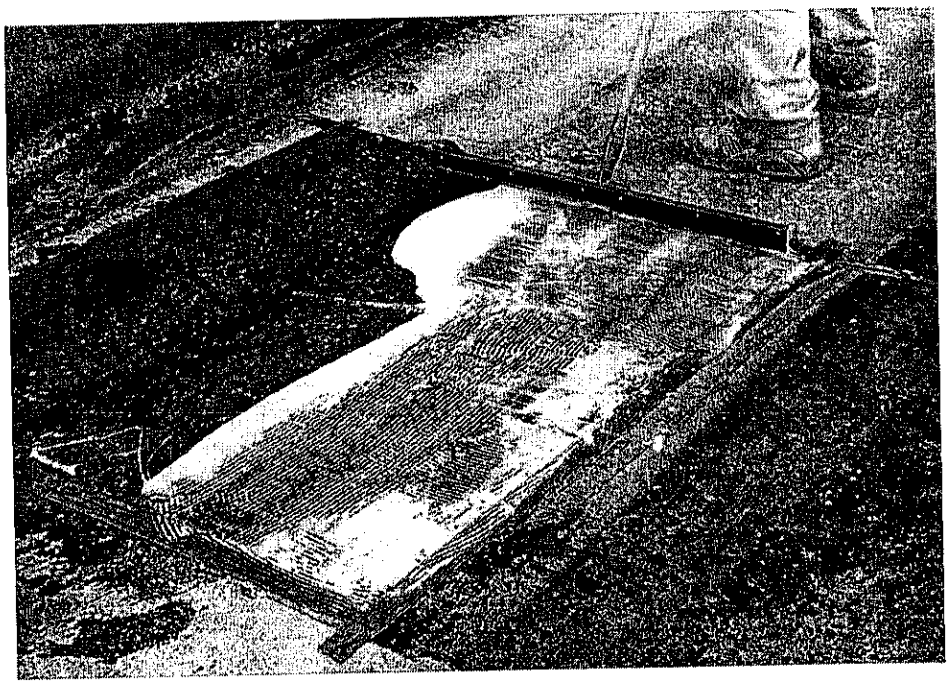

Figure 5.
First Layer of Epoxy Applied over Primer

Figure 6.
Aggregate Broadcast over First Layer of Epoxy

Figure 7.
Aggregate Broadcast to Excess

unreasonably low considering that the existing deck was 29 years old when the cores were taken. The cause of the unrealistic test results was not determined.

A 4-ft² test area was constructed on the south end of the southbound driving lane on August 29, 1995. Photographs of test area construction are found in Figures 4-7. The same preparation and application methods were used on the test area as were used on the full scale application.

Adhesion or "pull-off" tests (ACI 503R) were conducted on September 18, 1995 in four locations within the test area. Photographs of pull-off tests are found in Figures 8-11. In each test, the core broke within the existing concrete, proving that the tensile strength of the bond between the overlay and concrete was greater than the tensile strength of the concrete. However, the objective of this test was to determine bond strength at a time that the overlay was expected to be opened to traffic. Since the test was performed 20 days after application instead of after one to two days, this objective was not met.

Cores were taken to verify the thickness of the overlay. The cores indicated that the overlay was at least 1/4 inch thick. Friction testing was first performed on November 1, 1995. Smooth and treaded tire friction numbers ranged from 66 to 71 in eight tests. These numbers are well above typical friction numbers for new bituminous and portland cement concrete pavements. Friction testing was also performed in July of 1996 and May of 1997. Table 2 summarizes the results for all friction tests. After twenty months, friction numbers are comparable to typical values for new portland cement concrete pavements and are still well above typical values for new asphalt concrete surfaces.

Cost

The square yard cost for both the overlay and surface preparation was $72.50. The surface preparation and overlay were bid separately, at $19.50 and $53.00 per square yard, respectively. The use of a mechanical spreader would most likely lower costs since fewer laborers would be required.

Figure 8.
Test Area with Four Core Locations

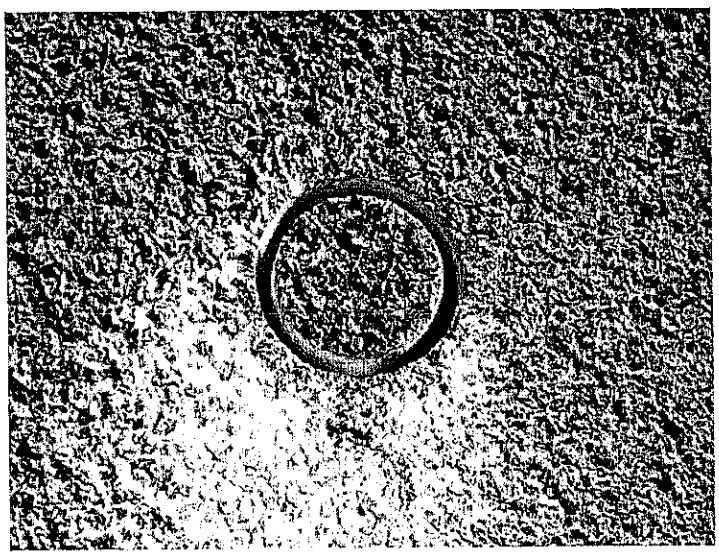

Figure 9.
Core in Test Area

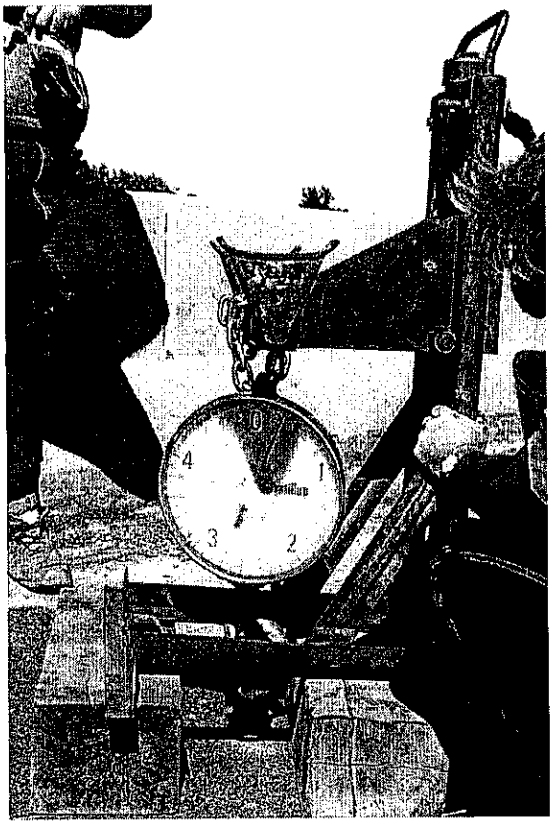

Figure 10.
Pull-off Testing

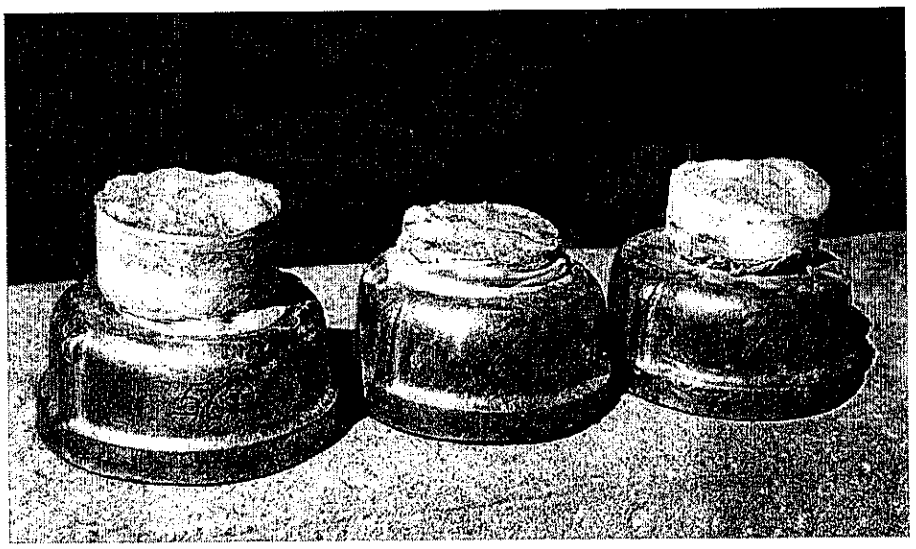

Figure 11.
Cores Failed in Existing Concrete Deck

Also, as the number of contracts increase, cost should decrease. Two contracts were let with thin lift polymer overlays soon after the Clifton contract. The overlay and surface preparation for the first contract was bid at $62.80 per yd^2 despite having a total square yardage less than one-half of the Clifton bridges. The second contract had less than one-fourth of the total square yardage of the Clifton bridges, and was bid at only $68.80 per yd^2.

Discussion

A critical question that needs to be addressed when considering the utilization of a polymer overlay or any other rehabilitative measure on an aging bridge deck is whether or not the reinforcement will continue to corrode. Even if the deck is overlaid with a relatively impermeable layer, the reinforcement may continue to corrode.

Data listed in a 1993 SHRP study indicates that the application of a polymer overlay reduced the average annual increase in chloride ion content. Some of the data showed an average annual decrease in chloride ion content, but this was probably caused by movement of existing ions to greater depths within the concrete [*1*]. Cores from the Clifton bridge decks had an average total chloride ion level of 2.6 lbs. Cl^-/yd^3 of concrete at the top reinforcement depth, which exceeds the level at which corrosion can occur. Also, the half-cell potentials indicated that the reinforcement was corroding in at least one-third of the passing lane on the southbound structure.

The presence of existing chloride ions lowers the pH of the concrete and destroys the passivity of the steel. In turn, the loss of passivity causes the steel to be more susceptible to corrosion. The presence of moisture and dissolved oxygen also affects the development of corrosion [*7*]. The 1993 SHRP study states that "the presence of a polymer overlay...had little effect on the rate of corrosion" [*1*]. It is likely that some moisture was present in the deck when the overlay was placed, and dissolved oxygen is normally not the limiting factor [*6*].

Conclusions

Based on a review of literature and observations made on this contract, the following conclusions are made:

1. If applied correctly, polymer overlay systems have the potential to provide an impermeable and durable surface with high skid resistance for 15 years or more.
2. Polymer overlays are much lighter than conventional overlays and can be opened to traffic as soon as ten hours after application.
3. The application of polymer overlays on the structures on I-57 near Clifton was successful in decreasing the dead loads of the structures.
4. In order to ensure that acceptable overlay performance is attained, contractors must be trained in application procedures.

The performance of the overlay depends greatly on the quality of workmanship. The aggregate layers were applied by hand at the Clifton structures, and the aggregate was cast from heights of about three feet or more. ACI Committee 548 recommends that the aggregate be broadcast "as close to the surface as possible to avoid displacement of the resin" [*4*]. A mechanical spreader would ensure even distribution of aggregate, minimize the amount workers step on the aggregate before the resin sets up, and expedite the application process.

Recommendations

The following three recommendations are discussed below:

1. Specify pull-off testing within 48 hours after test area application.
2. Require that milling machines leave level surfaces.
3. Investigate new moisture barrier systems and construction methods that will help to minimize lane closure times for projects in high traffic locations.

It is recommended that the Special Provision specify that pull-off testing on the test area be performed within 48 hours after application in order to ensure adequate early bond strength. While there were apparently no problems with early bond strength on this particular project, different types of epoxy combined with cool temperatures would result in stripping of the aggregate in future contracts if they are opened to traffic too soon.

Based on the comments made by the resident engineer regarding the uneven surface left by the milling machine, it is recommended that special attention be directed to this issue in future specifications.

The high cost of thin polymer overlays may limit their use to cases in which structures would benefit by a reduction in dead load. One potential case where the high cost of polymer overlays may be justified is in locations where disruption of traffic flow is paramount to cost. The most recent revision (February 25, 1999) of the Special Provision found in the Appendix requires a 28 day curing period for partial and full depth patches.

Missouri DOT, however, has allowed as little as 72 hours of curing when patches are sealed with approved moisture barriers that are in turn allowed to cure for a specified period of time, usually one day. With the use of a moisture barrier, the polymer deck overlay process could be completed from start to finish in eight to ten days. A microsilica concrete deck overlay application takes 15 or more days to complete from start to finish. It is recommended that research be conducted to establish limits of available products in order to minimize lane closure times for appropriate projects.

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Appendix

Special Provision for Bridge Deck Polymer Concrete Thin Overlay

Bridge Deck Polymer Concrete Thin Overlay
Effective: March 1, 1995
Revised: April 3, 1995

This item shall consist of furnishing all labor, material and equipment necessary to place a 6 mm (1/4 inch) thick Epoxy Polymer Concrete overlay for the bridges carrying FAI Route 57 over SBI route 25 and the I.C.G. Railroad, Section 38-2HVB-1, Iroquois County, SN 038-0013 and 038-0014.

This work shall include the surface preparation of the existing concrete deck as shown on the plans, as directed by the Engineer and as herein specified.

The supplier of the material shall furnish a technical representative at the job site at all times during overlay placement.

Materials:

Materials shall comply with the applicable portions of the Standard Specifications except as follows:

Sikadur 22, Lo-Mod Epoxy Broadcast Overlay System as manufactured by Sika Corporation, 201 Polito Avenue, Lyndhurst, New Jersey 07071. Telephone 201/933-8800. The manufacturer shall also be certified as meeting the ISO 9000 Quality Standard at all facilities producing the specified product.

(a) Resin Formulation.

The resin shall be a two-part resin system free of any fillers, nonreactive diluent, volatile solvents. The system shall be formulated and designed to provide simple volumetric mixing ratio of two components such as one to one or two to one mixing ratio by volume.

The resin system shall be formulated to provide flexibility in the system without sacrificing any of the hardness, chemical resistance or strength of the resin system. Use of external or conventional flexibilizers are not acceptable. The system must remain flexible at all operation temperatures.

Properties of Cured Resin System:

(1) Adhesion to Concrete. When components are mixed as per manufacturer's recommendation and tested in accordance with ACI Method 503R-1980, it shall adhere to specified concrete surface so 100% failure occurs in concrete in the performance of this test. The prepared specimens, minimum of 3, shall be conditioned for 3 days at 24° ± 1° C (75° ± 2° F) prior to testing.

(2) Hardness. The resin material when tested in accordance with ASTM D2240-86 shall have a Shore D Hardness between 58 to 75. Samples shall be prepared on a structurally sound surface with a minimum thickness of 3 mm

(0.12 inch) and allowed to cure for 3 days at 24° ± 1° C (75° ± 2° F) prior to testing.

(3) Abrasion Resistance. Abrasion resistance shall be evaluated on Taber abrader with a 1000 gram load and CS-17 wheel. Duration of the test shall be 1000 cycles. The wear index shall be calculated in accordance with ASTM D4060 (modified) and the wear index of the catalyzed materials shall be not more than: 2 max. at 49° C (120° F) and 1.4 max. at 23° C (73° F). The test shall be run on cured samples of material which shall be applied at a film thickness of 381 to 508 microns (15 to 20 mils) to Code S-16 stainless steel plate. The film shall be allowed to cure for 3 days at 24° ± 1° C (75° ± 2° F) prior to testing.

(4) Tensile Strength. When tested in accordance with ASTM D638 the resin material shall have a minimum tensile strength of 17240 kPa (2500 psi). The Type IV semi-rigid specimens shall be cast in a suitable mold and pulled at a rate of 5 mm (0.20 inch) per minute by a suitable dynamic testing machine. The samples (minimum of 3) shall be allowed to cure at room temperature for at least 3 days at 24° ± 1° C (75° ± 2° F) prior to testing.

(5) Tensile Elongation. The elongation produced at the break in the tensile strength test must be a minimum of 20 percent at 23° C (73° F).

(6) Compressive Strength. When tested in accordance with ASTM C109-87 properly cured resin material (including aggregate) shall have a minimum compressive strength of 34475 kPa (5000 psi). Three samples shall be conditioned for 3 days at 24° ± 1° C (75° ± 2° F) prior to testing. The rate of load application of these samples shall be no more than 13 mm (0.5 inch) per minute.

(7) Water Absorption. When tested in accordance with ASTM D570 the water absorption of the cured resin system shall not exceed 0.3 percent.

(8) Rapid Chloride Permeability. When tested in accordance with AASHTO T277 the chloride ion permeability of the cured resin system 6 mm (1/4 inch) min. shall not exceed 0.0 coulombs.

(b) Aggregate

Aggregate for all layers shall be bauxite, crushed porphyry, aluminum oxide or other similarly hard durable aggregates as recommended by the manufacturer and approved by the Engineer and shall conform to the following gradation:

Sieve Size		% Passing by Weight
4.75 mm	(No. 4)	100
850 microns	(No. 20)	0 - 5.0
75 microns	(No. 200)	0 - 1.0

The material to be used shall have a proven record of a minimum of two years on similar bridge decks within the contiguous United States and which can be inspected by the Engineer if so desired. Such performance, however, does not waive the independent testing and verifications of other mentioned criteria in this specification.

The material manufacturer shall furnish a notarized certification that the material complies with the requirements of this specification. It shall not be inferred that the provision of a certification of compliance waives state inspection, sampling or testing. The manufacturer shall provide specific test results certified by an independent, nationally recognized testing laboratory verifying properties of the cured resin system. Such certified test data shall be provided as soon as possible after award of the contract.

The location of similar bridge decks mentioned above shall be included as a part of the certification.

Promptly after execution of the contract, the Contractor shall notify the Engineer of the source of material he expects to use. The manufacturer shall furnish samples of resin material as required by the Engineer.

Construction:

(a) Deck Preparation and Repairs:

(1) Bituminous concrete removal, partial and full depth patches and scarification shall be done in accordance with the special provision for "Bridge Deck Overlay" except that scarification shall be done after full and partial depth patches are completed.

(2) After scarification, shotblast the concrete surface including new concrete patches. Remove all grease, oil and other bond inhibiting materials which have penetrated into the concrete. Use compressed air and water to remove all remaining loose particles such as sand, laitance and dust. When using compressed air, the air stream must be free of oil. The shotblasting equipment shall be capable of cleaning all detrimental foreign matter, as determined by the Engineer, from the concrete deck surface. The cleaning residues shall be contained and removed by the shotblasting equipment.

(3) Construction traffic shall not be allowed on any portion of the deck which has been shotblasted or on the overlay without specific approval of the Engineer. The deck surface shall be overlaid within 24 hours of the deck surface preparation and repair operation.

(4) All surfaces to be overlaid shall be dry at the time of application. Immediately before applying the resin material, all prepared surfaces shall be cleaned with compressed air (or vacuumed) to remove dust and debris. The compressor shall be equipped with a filter to prevent oil in the air supply. The application of

the resin system shall not be made when rain is forecast within 24 hours of application, or at the direction of the manufacturer.

(5) If, in the opinion of the Engineer, the surface has become soiled or contaminated prior to the application of the overlay, it shall be re-cleaned to the satisfaction of the Engineer at no additional cost to the State.

(b) Placement:

The overlay shall be constructed during favorable weather conditions. The overlay shall not be placed unless the deck temperature is above 10° C (50° F) and the air temperature is predicted to be above 10° C (50° F) for at least 12 hours after placement. The overlay shall not be placed when rain is expected during the working period or as recommended by the manufacturer. If night placement is required, illumination and placement procedures will be subject to approval of the Engineer. No additional compensation will be allowed if night work is required because of limiting weather conditions.

(1) Field Testing.

Prior to commencing the overlay operation, a test area of overlay shall be placed on the bridge deck by the Contractor. The test overlay area shall be prepared as described above. The area should be large enough so that the cleaning equipment and methods of cleaning to be employed in the full-scale operation may be used. The degree of cleaning used on the test area shall be the minimum used on the remainder of the structure.

The application of the resin system to the test area shall establish the proper techniques for applying the overlay to the full bridge.

After the test area has cured for 72 hours, the Contractor shall test for adhesion in accordance with ACI 503R-1980. A minimum of 3 sample areas shall be tested. No test shall have an adhesive strength less than 1725 kPa (250 psi) and the minimum average value for the 3 tests shall be 2070 kPa (300 psi).

If the test of a sample area fails to meet the above requirements due to a cohesive failure of the concrete, the adhesive strength of the sample area will be considered acceptable.

Successful completion of the adhesion strength tests shall be required before the full-scale overlay operation is to begin.

(2) Mixing.

Proportion equal parts by volume of components "A" and "B" into a clean mixing container. Mix with a low speed (400-600 rpm) drill and approved paddle for 3 minutes, until uniform. Mix only that quantity that can be used within its pot life.

(3) Application:

Application of the resin system shall be done by the supplier or by a factory trained or licensed applicator with written approval from the manufacturer of the resin system.

The number of layers and the application rates of the resin in the various layers shall be as recommended by the manufacturer in order to achieve a minimum overlay thickness of 6 mm (1/4 inch) measured to the top of resin (not to the peaks of the imbedded aggregate).

A. Application of Resin. After mixing of the components, the resin shall be evenly distributed on the clean, dry deck surface at the rate as recommended by the manufacturer.

B. Application of Aggregate. After application of the resin, a minimum lapse period shall be allowed as required by manufacturer's instructions before broadcasting aggregates. The method and rate of aggregate application shall be in accordance with the manufacturer recommendations.

C. Removal of Excess Aggregate. After initial cure, removal of excess aggregate with a power vacuum or approved method shall be made prior to the application of subsequent coats.

D. Application of Additional Coats. Additional coats may be made immediately after the initial set of the preceding coat (as determined by the manufacturer) and removal of all excess aggregate. Maximum time allowed between each coat shall be at the discretion of the Engineer and the manufacturer of the overlay system and may vary depending on the temperature and circumstances of the project.

E. Thickness Verification. The Contractor shall verify to the Engineer that the overlay is at least 6 mm (1/4 inch) thick (measured from the deck surface to the top of the resin) at three random locations for every 836 square meters (1000 square yards) of deck surface. Thin areas shall be re-coated as described above and re-verified at no additional cost to the State. This verification may consist of cores, holes, etc., but in all cases any areas tested to destruction shall be repaired before final acceptance.

   In thin areas that have been re-coated to obtain the required minimum thickness, the Engineer may require additional adhesion strength tests in accordance with ACI 503R-1980 to verify the Contractor's procedure for re-coating existing overlay.

F. Overlay Surface. The finished surface shall consist of a uniform coat of imbedded exposed aggregate.

(4) Opening to Traffic. Traffic may be allowed on the final coat after the resin has cured 8-10 hours at 23° C (73° F) (as determined by the manufacturer) and after removal of all excess, loose aggregate.

(5) Storage and Handling:

A. Resin Material.

Resin material shall be stored inside a heated warehouse in a dry area. Storage temperatures shall be maintained within 10° to 32° C (50° to 90° F).

The resin material shall be stored on the job site in a weather protected trailer so that it is kept away from moisture and maintained within the temperature range of 10° to 32° C (50° to 90° F).

Protective gloves and goggles shall be provided by the Contractors to workers directly exposed to the resin material. Product Safety Data Sheets shall be provided by the Contractor to all workers as obtained from the manufacturer.

B. Aggregate.

All aggregate shall be dry and stored in a dry, moisture free atmosphere. The aggregate shall be fully protected from any contaminants on the job site and shall be stored so as not to be exposed to rain or other moisture sources.

Method of Measurements. The bridge deck polymer concrete thin overlay will be measured in square meters (square yards) of horizontal surface area of the deck finished and in place.

Basis of Payment. The bridge deck polymer concrete thin overlay, measured as specified, will be paid for at the contract unit price per square meter (square yard) for BRIDGE DECK POLYMER CONCRETE THIN OVERLAY. Which price shall be payment in full for completing the work in accordance with the plans and these specifications. The price bid for this item includes all the labor, material, equipment and manufacturer's technical assistance required to complete this work.