Cathodic Protection for Reinforced Concrete Bridge Decks

Yakima River Bridge 24/5
Demonstration Project 34

Final Narrative Report

WA-RD 87.2.2

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Washington State Department of Transportation
Planning, Research and Public Transportation Division

in cooperation with the
United States Department of Transportation
Federal Highway Administration

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

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15. SUPPLEMENTARY NOTES

The study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

Under FHWA Demonstration Project No. 34, "Cathodic Protection for Reinforced Concrete Bridge Decks," a non-slotted cathodic protection system was installed on the deck of the Yakima River Bridge 24/5, near Yakima, Washington, in the summer of 1985. The project involved repairing the deck, then fastening Raychem premanufactured anodes to the deck to impress current to the top mat rebar. Impressing current through the concrete to the top mat steel prevents further corrosion of the steel. A latex modified concrete overlay was placed over the deck anode.

Some of the embedded monitoring devices have failed, but this is not considered a problem, since the sytem is voltage controlled and not potential controlled. The monitoring devices only provide information and do not control the system. Polarization decay tests indicate the bridge deck is being cathodically protected.

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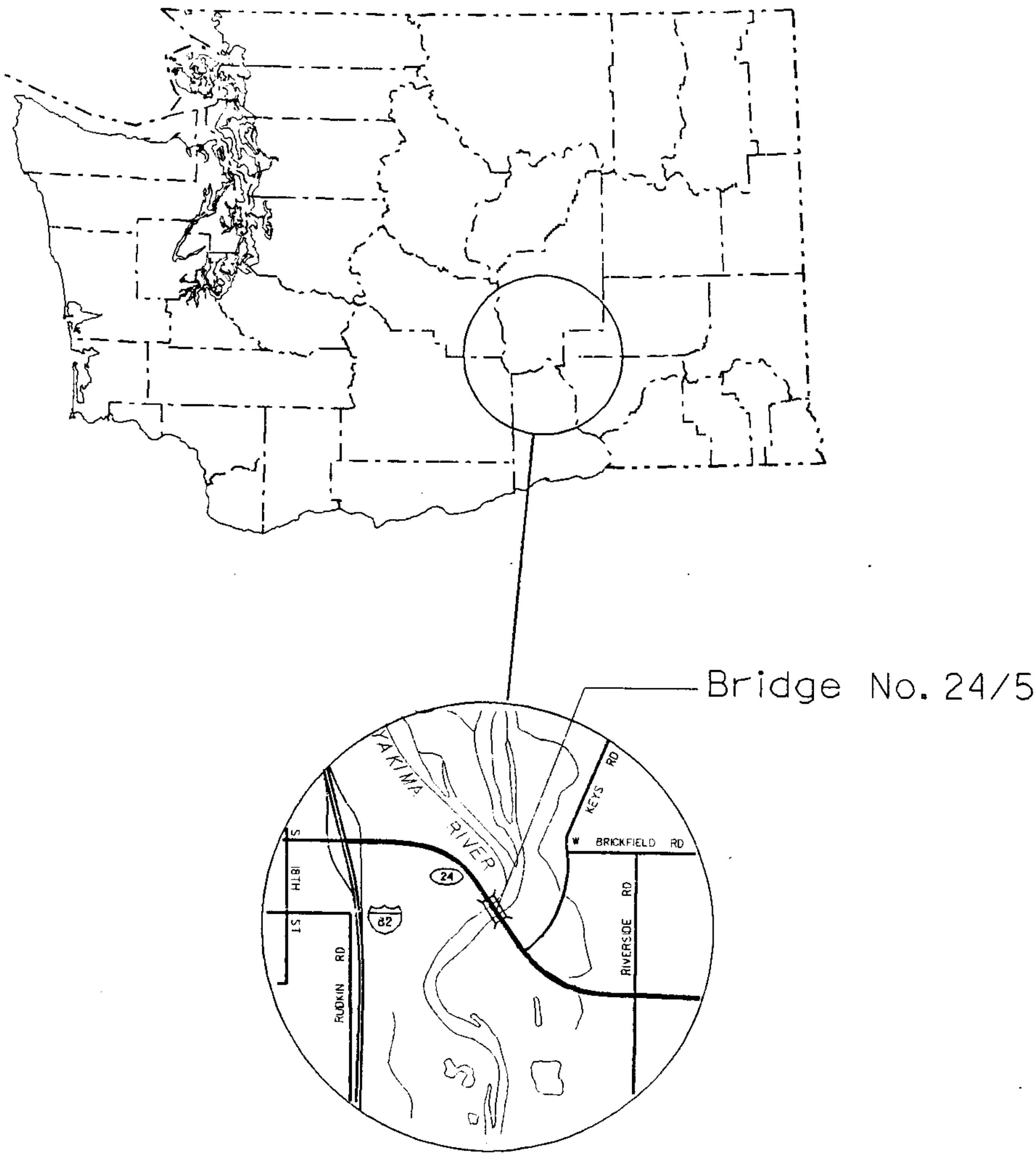

PROJECT SITE

PROJECT PLANNING

The deck of the Yakima River Bridge No. 24/5 needed extensive repairs, including a suitable overlay. In accordance with WSDOT policy concerning overlays, latex modified concrete was selected. Since this is a box girder bridge, the top slab is a part of the longitudinal girder system. Deterioration of the top slab could result in a reduced load carrying capacity and, in an extreme case, a structure failure. It was therefore desirable to give the bridge deck maximum protection against corrosion.

Through Demonstration Project No. 34, the FHWA has encouraged the use of cathodic protection. WSDOT elected to install a non-slotted cathodic protection system. A premolded anodic system manufactured by Raychem was used.

PROJECT CONSTRUCTION

This bridge is a two-lane, box girder structure, 31½ feet wide and 600 feet long. During the project, it was necessary to keep one lane open to traffic, which somewhat complicated the construction process.

The first phase of the project was to scarify the deck ¼ inch to remove surface contaminants such as oil and grease. The deck was then chain dragged to locate delaminations, and delaminated areas were marked in red paint. Many of the previously patched areas were again delaminated.

Next, pneumatic equipment was used to remove the delaminated areas per contract special provisions. Premixed fondu was used to repair the delaminated areas by hand. This patch material was somewhat unsatisfactory since under traffic it came loose around the periphery of the patch in some areas and extra patching was necessary.

Some expansion dams were loose, and these were repaired by injection with epoxy. This work was not foreseen in the contract and had to be performed under change order.

Cutouts were made in the deck to install the reference cells and rebar probes. In this project, deck instruments were incorporated to monitor the system, not to control the system. The deck was further prepared by sandblasting and was then ready for installation of the cathodic protection anode.

The first step in the process was to fasten the panel mounting rod to the deck near the curb line. This rod served to hold down and align the ferex anode strand. Next, the ferex anode panels, which came in large rolls wrapped in plastic, were rolled out on the deck. These premanufactured anodes are basically copper wires coated with a conductive polymer. The anode wire looks like regular electrical wire. The ferex anode was manufactured by the Raychem Company, which to our knowledge is the only company that makes this type of anode.

The anode panel was stretched to size and fastened to the deck with plastic fastener inserts. The deck was further cleaned by water blast just prior to pouring the latex modified concrete (LMC) overlay. The Bidwell paving machine screed vertical alignment was tested prior to the LMC pour by moving the machine over the entire length of the bridge.

It was desirable to pour the latex modified concrete at night because deck temperatures were cooler and traffic volumes were lower. Placing the overlay when the deck was cooler helped to minimize cracking of the LMC. An LMC slurry bond coat was brushed on the deck prior to placement of the LMC. Plywood was used on the deck to distribute the weight of the LMC truck on the anode. Some damage to the anode did occur but was easily repaired.

Latex modified concrete from the truck chute was deposited directly on the deck in front of the paver. Further spreading of the LMC by hand in front of the paver was generally necessary to ensure no voids would be left around the anode material. The last operation was to cover the LMC behind the paver with the wet burlap necessary for curing the LMC. Specifications called for 96 hours curing time before restoring traffic.

Only two bids were submitted. Bid price for the cathodic protection system, exclusive of the LMC overlay and deck preparation, was $130,000, which amounts to $6.88 per square foot. This figure is comparable to other commercially available bridge deck cathodic protection systems.

PROBLEMS AND SOLUTIONS

1. Some ties were exposed during the scarifying operation. There was concern that the anode might develop electrical shorts on exposed steel. A careful visual inspection was made to locate exposed steel in the scarified deck. The contractor painted all exposed steel with a nonconductive epoxy to prevent possible contact with the anode. In addition, electrical checks were made to detect any grounding.

2. The steel mesh set up to reinforce the expansion joints on the bridge was a potential area to short the anode, since it would have been on top of the anode. The mesh was shortened by change order to clear the anode.

3. This bridge is a two-lane structure and it was necessary to keep one lane open to traffic at all times. Therefore, the work progressed one lane at a time, and concrete trucks had to back over the anode to reach the screed machine. Plywood was used to distribute the load from the trucks over the anode. This system worked fairly well, but it would have been better not to drive on the anode.

4. Some breaks in the anode did occur due to the trucks driving over the plywood that was used to distribute their weight. Scarifying the deck made sharp angular point loading areas for the anode when it was placed on the deck. Visual as well as electrical means were used to locate the break.

5. Specifications required the deck to be sandblasted within 24 hours of pouring the latex overlay. It was thought that the sandblasting would scour the anode and reduce its effective life. A change order was written to allow water blasting as a final blast, and it seemed to work acceptably. The major sandblast was done prior to the anode placement. This procedure is recommended for future projects.

6. It is difficult to broom the latex slurry bond coat into the deck with the anode on the deck. This problem was eliminated by working the broom into

the fresh concrete first, then brooming the deck. In this manner, only the grout is picked up on the broom.

7. During the first annual inspection of the cathodic protection system, it was discovered that three reference electrodes, three rebar probes, and one thermistor were not functioning properly. It was decided not to replace these instruments, since none of them participates in the control of the rectifier. Also, a handheld copper/copper sulfate half-cell can be used instead of the embedded reference electrode.

It was not felt necessary to have the system monitored by a corrosion engineer since the polarization tests by the state inspector indicate the deck is being cathodically protected. All other consultant recommendations are being implemented.

CONCLUSIONS

For a first-of-its-kind project in the state, this installation went relatively smoothly. This type of deck protection system appears to have promise for future projects. Personnel involved in the project gained considerable experience with this type of work.

The system appears to be cathodically protecting the deck steel. The polarization decay test indicates that all three deck zones are receiving cathodic protection current.

8:BR-4

APPENDIX

Results of Inspection
by Corrosion Consultant
After One Year

PREPARED FOR:

WASHINGTON DEPARTMENT OF TRANSPORTATION
OLYMPIA, WA
C/O
ETCO ENGINEERING SERVICES, INC.
REDONDO, WA

CATHODIC PROTECTION CHECK-OUT SR 24 YAKIMA RIVER BRIDGE

NOVEMBER 1986

CONCLUSIONS

1. Reference electrodes R1, R3, and R4 are not functioning properly.

2. Rebar probes P-1, P-4 and P-5 are not functioning properly.

3. Thermistor R1, is not functioning properly.

4. All deck zones, 1, 2, and 3 are receiving cathodic protection current.

5. Using the 100-mV polarization decay or the 300-mV shift from native potential values as the criterion for acceptable levels of cathodic protection, all zones appear to be cathodically protected. The instant off potential value of a mortar coated steel structure is extremely difficult to measure with common field test instruments. Past experience has shown that accurate instant off potential values can only be measured with a laboratory oscilloscope that will time instant off as the alternating current reversal between the 60 cps frequency. Testing for instant off on a mortar coated structure with an oscilloscope has shown decreases in potential values from the "on" position to the rectifier "off" to be less than 15-mV, and in some cases no detectable change. Portable test equipment is being developed that will accurately measure the instant off potential values to facilitate field testing.

Conclusions Continued.

6. The thermistor data being collected will provide a historical record on the operation of the system. The system will be susceptible to seasonal changes which will be related to changes in temperature. There values should be recorded at each periodic monitoring.

7. Rebar probe corrosion has not been initiated at this time but will most likely occur in the future.

RECOMMENDATIONS

1. For accurate testing and monitoring, ineffective reference electrodes should be replaced.

2. Continue monitoring by WSDOT forces with present established procedures. Measurement of temperature values have been interrupted and should be resumed.

3. At the locations with ineffective reference electrodes, portable reference electrodes should be used for monitoring.

4. Maintain present rectifier settings until such time it is determined by an experienced Corrosion Engineer that changes are necessary.

5. This system should be monitored by an experienced Corrosion Engineer at three month intervals for one year to properly analyze the effects of seasonal changes on the operation of the system.