EVALUATION OF EPOXY COATED REINFORCING STEEL IN OREGON BRIDGES

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INTRODUCTION

Since the early 1960's when the use of deicing salts became prevalent, premature deterioration of bridge decks has been a major drain on highway maintenance budgets. Much of the deterioration has been in the form of concrete spalling due to the corrosion of reinforcing steel. Because the corroding steel expands, stresses are created which exceed the tensile strength of the concrete causing delamination and eventually spalling. Galvanic corrosion of the reinforcing steel is accelerated by the presence of chloride in the concrete deck.

One of the methods available for combating this problem is epoxy coating the reinforcing steel. By insulating the reinforcing steel from the galvanic circuit, the epoxy coating prevents corrosion.

In October 1975, under the National Experimental and Evaluation Program (NEEP) of the Federal Highway Administration, the Oregon Department of Transportation began this investigation. The purpose of the study was to determine the effectiveness of epoxy coated reinforcing steel in preventing bridge deck deterioration. Two bridges were selected; the Yachats River Bridge on the Oregon Coast Highway (US 101) in Lincoln County and the Shelton Ditch Bridge on 13th Street S.E., in Salem, Oregon.

PROCEDURE

The Shelton Ditch Bridge was constructed during the fall of 1975 and opened to traffic in December 1975. This bridge has a portland cement concrete surface and carries two lanes of traffic on a one way street which is a principal arterial servicing the eastern edge of downtown Salem, Oregon. Although the City of Salem did not anticipate that deicing salt would be applied directly on the bridge, a nearby intersection would be salted and salt would most likely be tracked onto the bridge.

Epoxy Powder 720-A-0009 manufactured by Cook Paint and Varnish Company, Kansas City, Missouri, was used to coat bars in the top mat of reinforcing steel in the bridge deck. Nine straight No. 5 bars were tested. Three bars were uncoated. Three bars were coated, but did not have defects retouched. Three bars were coated and the damage to the coating from

fabrication and installation was repaired. All nine bars were wired for testing with No. 8 stranded wire (THHN thermoplastic insulation, nylon coating). CG8 connections with silver solder were used to connect the wires to the bars. A Scotch putty and Scotch Wrap corrosion protection was used to cover the bare spots at the connections. The wires were terminated at a 4 in. by 6 in. by 4 in. junction box located under the deck.

The Yachats River Bridge was opened to traffic in March 1977. This bridge is located on a two lane section of the main north-south highway along the Oregon coast and has an asphalt concrete wearing surface on the deck. No applications of deicing salts were anticipated; however, the bridge is in a marine environment where ocean salt is carried by fog, wind and rain. All the reinforcing steel (except control bars) was epoxied. Flintflex 531-6080 manufactured by Dupont, Inc., Wilmington, Delaware, was the coating used. Six straight No. 5 bars were tested. Three bars were uncoated and three bars were coated but no repairs were made to fabrication or installation damage. Wiring and connections for testing were similar to the Shelton Ditch Bridge.

Two tests, half-cell potential measurement and chloride ion content, were conducted on each bridge deck. The half-cell measurements were made using a battery operated volt-ohmeter and a copper-copper sulfate reference electrode. The ground connections were made at the built-in junction boxes. The 1980 ASTM Standards (Part 14, C876) used to interpret the half-cell voltages were as follows:

(1) If potentials are numerically less than -0.20 V then there is a 90 percent probability that no corrosion is occurring.

(2) If potentials are in range of -0.20 to -0.34 V then corrosion activity is uncertain.

(3) If potentials are numerically greater than -0.34 V then there is a 90 percent probability that corrosion is occurring.

Samples for the chloride concentration tests were taken using an electric drill with a 5/8 in. bit. After the surface was thoroughly cleaned to prevent contamination, a one inch deep hole was drilled. The resulting pulverized concrete was spooned into plastic sample bags and the hole blown clean before the drilling was continued to the next one inch increment of depth.

RESULTS

The testing program for the Shelton Ditch Bridge was as follows:

Half-Cell Measurement	July 20, 1982
Chloride Samples	July 20, 1982

The half-cell readings showed no significant difference between the three groups of bars tested; bare steel, coated without damage repaired, and coated with damage repaired. Multiple readings were taken both near the curb and 3 ft from the curb. The highest reading was 0.16 V and the lowest was 0.09 V. All readings were below the threshold for active corrosion.

Four 0 to 1 in. chloride ion samples were taken along the curb line. Three of the samples had a chloride concentration of 0.2 lb/cu yd concrete and the fourth had a concentration of 0.1 lb/cu yd concrete. These measurements are far below the level of choride contamination required to neutralize the natural alkalinity of the concrete and permit galvanic corrosion to occur.

There is no visual evidence of corrosion caused defects on the Shelton Ditch Bridge. The bridge has now been in service seven years.

The testing program for the Yachats River Bridge was as follows:

Half-Cell Measurements	October 9, 1978 January 7, 1980 February 2, 1982
Chloride Samples	July 19, 1982

All the half-cell measurements were between 0.07 and 0.16 V indicating a low probability of corrosion, except for two readings obtained from uncoated bars at the last test date. These two readings, 0.30 V, fall into the uncertain range and it is not possible to state whether or not corrosion is occurring at these two sites.

Five samples were taken for determination of chloride ion content in the concrete. The four samples at the 0 to 1 in. level average 0.7 lb/cu yd concrete and the one sample at the 1 to 2 in. level contained 0.1 lb/cu yd concrete. These measurements show insufficient chloride ion concentration to cause accelerated corrosion.

There is no visual evidence of corrosion caused defects on the Yachats River Bridge.

CONCLUSIONS

Since the chloride contents of both bridge decks are well below the corrosion causing level and no indication of corrosion is apparent, it is not possible at this time to determine conclusively the effectiveness of the epoxy coatings. However, since the accumulation of salt is very slow in both bridges, it is not feasible to continue the formal evaluation to establish a firm conclusion. Studies by other agencies have confirmed the effectiveness of epoxy coated reinforcing steel in

eliminating chloride caused distress in concrete bridge decks. On this basis, epoxy coating has been adopted in Oregon as a standard for all steel on coastal bridges and for any steel within 4 in. of the deck surface on inland structures.

Although this experimental features project is being terminated with this final report, analysis of chloride samples and half-cell readings will be continued at two-year intervals, probably for six more years. If significant findings emerge, a supplementary letter report will be submitted.