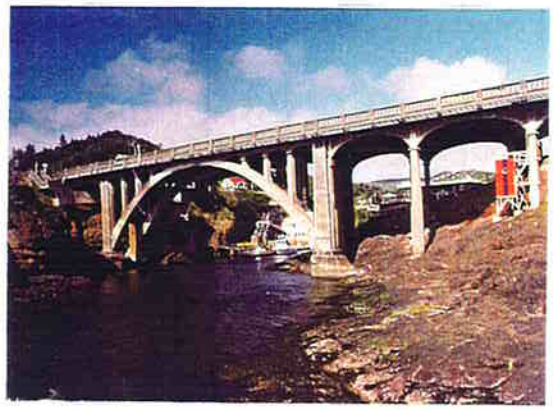
Research Note 97-01

LONG-TERM REHABILITATION AND PRESERVATION OF OREGON'S HISTORIC COASTAL BRIDGES using CATHODIC PROTECTION



Oregon's Pacific coast has an extensive collection of historical treasures including the bridges designed and constructed by Conde B. McCullough in the 1930's. These Highway 101 bridges, which have been subjected to six decades of salt ladened ocean spray, have suffered extensive reinforcing steel corrosion resulting in severe deterioration of the steel-reinforced portland cement concrete bridge elements. The Oregon Department of Transportation is actively trying to preserve these bridges through rehabilitation and cathodic protection. Impressed current cathodic protection is central to the ODOT's strategy to insure long-lasting repairs.

Oregon has demonstrated the potential for preserving historical monuments with cathodic protection which is beginning to be recognized throughout the nation. In response, the Oregon Department of Transportation has created a video in conjunction with the FHWA Local Technical Assistant Program and the Office of Technology Applications. This video, available through ODOT and FHWA, is designed to aid other DOTs in understanding the rehabilitation process when impressed current cathodic protection is used as the strategy for a long term protection project.

What many do not realize is that cathodic protection requires a strong commitment from the DOT. Not only must the anode be reapplied periodically (about 25 years for zinc); it should constantly be monitored. ODOT has successfully implemented a remote monitoring system on each bridge which supplies data on voltages, currents and climate to a central office via a modem. This information ensures that the systems are working correctly and indicates if any modifications or adjustments need to be made. The data collected from these remote monitoring systems will also be used to evaluate the effectiveness of cathodic protection on a long term basis.

FOR MORE INFORMATION

The Oregon Department of Transportation is proud to be in the forefront with developing and implementing cathodic protection technology. The ODOT is making this video available to aid other DOTs in implementing cathodic protection systems.

For more information on Oregon's involvement with cathodic protection research projects, please contact H. Martin Laylor at the Oregon DOT Research Unit (telephone: 503-986-2850; fax: 503-986-2844; email: harold.m.laylor@state.or.us).

Additional information regarding Oregon's latest plans and specifications for bridge rehabilitation may be obtained through Galen McGill at the ODOT Bridge Preservation Unit (telephone: 503-986-3330; fax: 503-986-3407; email: galen.e.mcgill@state.or.us).

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HOW DOES CATHODIC PROTECTION WORK ?

Reinforcing steel in concrete is normally protected from corrosion by a passive film formed due to the alkalinity of the concrete. The corrosion is caused by salts entering the concrete, reducing the alkalinity, and destroying the passive film. These salts are normally from de-icing salt application, anti-icing procedures or air-borne salts from sea water. The salt permeates the concrete until a critical concentration is reached at the level of the reinforcing steel. Once this happens it is only a matter of time until the expansive rust from the steel creates sufficient internal pressures in the concrete to cause cracking and spalling.

Cathodic protection is used to control the corrosion rate of reinforcing steel. When steel corrodes, iron atoms lose electrons and react with oxygen and the moisture in the concrete. Cathodic protection provides electrons from an installed anode to prevent the corrosion of the reinforcing steel .

In impressed current systems, an electrical current from an external power supply provides the electrons. Current passes from the power supply to the anode and through the concrete to the reinforcing steel. The circuit is completed by a wire from the reinforcing steel to the power supply. The moisture in the concrete behaves as an electrolyte which supports the current flow through the concrete.

ODOT decided to implement cathodic protection systems as part of the rehabilitation process to preserve the remaining McCullough-designed historical bridges after being forced to replace the deteriorating historic McCullough-designed Alsea Bay bridge at a cost of $43 million. ODOT estimated that rehabilitation with cathodic protection could be done on three of the McCullough bridges at a cost of about $20 million compared to the estimated cost of replacement of at least $70 million. The decision to implement cathodic protection has not only saved taxpayers millions of dollars but also is preserving the treasured historical bridges . To date, the McCullough bridges which have been rehabilitated and cathodically protected include the Cape Creek, Yaquina Bay, and Depoe Bay bridges.

HOW OREGON APPLIES CATHODIC PROTECTION

Prior to applying cathodic protection, there are several preliminary steps. First, each bridge structure is examined to locate all concrete damaged by corrosion induced cracking and spalling. Then the electrical continuity of the reinforcing steel is checked to determine its ability to carry an electrical current. All cracks, spalls, delaminations, and other defects in the concrete are then repaired prior to installing the cathodic protection system.

In order to apply the arc-sprayed zinc coating, ODOT had to first construct an enclosure around the bridge to trap the zinc dust, concrete dust and fumes. This proactive environmental stance taken by ODOT provided several benefits for the environment as well as the workers and provided the additional benefit of both warm and dry conditions which is necessary for year around work on the Oregon coast.

The zinc anode has many advantages over other anode systems. Zinc coatings are very conductive and are relatively easy to replace. There is no significant increase in the load on the bridge and they do not destroy or obstruct the architectural details in the concrete. In addition, by using the zinc coatings, the original historical value of these McCullough bridges will be preserved.

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