Reinforced Concrete Corrosion Mitigation with Embedded Distributed Galvanic Anodes

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Summary

This paper first introduces galvanic corrosion protection and embedded distributed galvanic anodes (DAS) for reinforced concrete structures. Then the 10 years of DAS anode monitoring data is presented, and finally applications are briefly discussed.

Keywords: Galvanic anodes, corrosion prevention, corrosion control, cathodic protection, reinforced concrete, Distributed Anode System (DAS).

Introduction

Cathodic Protection with Impressed Current system (ICCP) has been proven to prevent corrosion initiation and arrest on-going corrosion for reinforced concrete since 1970s, however extensive continuous monitoring and maintenance to make the system effective has prevented many Departments of Transportation and other structure owner from adopting ICCP system. 'Build and forget' is the norm for many owners who want to simply walk away after the completion of the new construction or major rehabilitation, which Distributed galvanic Distributed Anode System (DAS) fits well. DAS anode system is a Gavlanic cathodic protection system free of maintenance and monitoring. The system has been monitored by Ministry of Transportation, Ontario, Canada and Vector Corrosion Technologies since 2003, which has proved that the DAS anodes are able to provide adequate corrosion protection to the reinforced concrete. Long-term performance data of North Otter Creek Bridge, Ontario, Canada and a few other bridges in North America will be presented and discussed. Applications in Japan will be also presented.

Galvanic corrosion protection

Galvanic corrosion protection is a technique to reduce rebar corrosion by making the rebar surface the cathode of an electrochemical cell. The cathode in an electrochemical cell is the electrode where reduction (no corrosion) occurs. In a galvanic anode system, the current is generated by the potential difference between the zinc anode (-1100mV) and the steel reinforcement (typically at 350 to 500mV for corroding steel). There is no monitoring required to keep the sacrificial anodes working. Historically, impressed current cathodic protection (ICCP) has been used to arrest concrete corrosion. In an impressed current system, the source of current is generated from a rectifier to the reinforcing steel through the anode in the concrete or the conductive coating on the concrete surface, in which continuous monitoring is required.

Corrosion mitigation systems generally fall into three performance categories: corrosion prevention,

corrosion control, and cathodic protection. In all categories, the anodes provide a level of protective current to the reinforcing steel to mitigate corrosion activity. However, they differ in terms of the intended application and the intensity of the protective current required for achieving the mitigation objective. Corrosion prevention aims to prevent corrosion from initiating in repairs or new structure, corrosion control will significantly reducing on-going corrosion, and the cathodic protection will stop on-going corrosion activity.

Monitoring

DAS anodes are designed for long-term corrosion control and cathodic protection. the Ministry of Transportation, Ontario, Canada, and Vector Corrosion Technologies conducted a trial using DAS galvanic anodes in bridge deck overlay to address the global corrosion issues in the structure in September, 2003. The bridge was built in 1960 and was first rehabilitated in 1984. A condition survey conducted in 2000 found that the concrete deck (assessed by means of cores and sawn samples) was in good condition, however the chloride contents at steel level and the corrosion potentials were high. 10 years of monitoring data have revealed that adequate current was supplied by DAS anodes to 100mV criteria.

Applications

In 2006 DAS anodes installed in concrete jackets for 764 reinforced concrete piers supporting Robert Moses Causes, Long Island, New York, USA. Polarization is well above 100mV and the projected service life is more than the design service life of 35 years.

DAS anodes were installed in the precast slabs to prevent corrosion from initiating in aggressive environment, White Beach Piers, US Naval Base, Okinawa, Japan.

Conclusions:

10 years of monitoring data shows DAS galvanic anodes can provide adequate current and polarization to effectively arrest the on-going corrosion. Applications and monitoring in other projects also provide very positive results. The advantage of free of maintenance and monitoring has made this DAS galvanic anode system widely accepted and used in the world.