CONTROLLING CORROSION ON THE LA UNIDAD BRIDGE IN CAMPECHE, MEXICO

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Located in a remote area of Mexico, the La Unidad Bridge is critical to two villages. The bridge connects the village of Isla Aguada with the city of Ciudad del Carmen and is vital to the well-being and economy of these two towns, as well as the entire Yucatán peninsula. Nearly 2 miles (3.2 km) long, the 30-year-old bridge is subjected to an aggressive marine environment and is part of a major highway that runs along the coastline from Texas to the tip of the Yucatán peninsula. A visual inspection of the structure revealed that cracks had penetrated the concrete matrix and corrosion of the reinforcement was present and active. Because the bridge is essential for the community, and any detour would be lengthy, the Mexican federal and local transportation authorities elected to repair it.

The first repair attempt, completed in the 1990s, included standard point and patch repairs, which did not last as long as the owner would have liked. The second repair, completed in 2002, involved adding fiberglass jackets around the concrete piles with an epoxy filler material. While this repair approach provided a few more years between repairs, it still did not provide the long-term repair solution that the owner desired because the strategy did not address the ongoing corrosion of the reinforcement. When the jackets were removed, the corrosion had worsened and it was evident that a corrosion mitigation solution was needed.

LONG-TERM SOLUTION

To find a better solution, officials representing the bridge owner visited bridges in Florida that were subject to similar conditions. These officials saw a number of structures repaired by the Florida Department of Transportation using various methods, including a system consisting of a fiberglass jacket with an integral cathodic protection system (Lifejacket® system). During this visit, the team met with the system supplier to learn about cathodic protection and determined that this technology would be a good solution for the La Unidad Bridge. Cathodic protection systems operate by causing a direct current to flow from an external source (the anode) to surfaces of the reinforcing steel within the structure (the cathode). When the current is adequate and properly distributed, corrosion is mitigated and the structure is cathodically protected. After this visit

La Unidad Bridge

and inspection, the owner decided a fiberglass jacket system in combination with a sacrificial, metalized zinc cathodic protection system would be the most appropriate, as well as be a long-lasting solution for the La Unidad Bridge.

Because this was the owner's first experience with these systems, they decided to conduct a test to see how the cathodic protection system would perform. In October 2004, the owner, system supplier, and system installer teamed to evaluate the structure to ensure that they understood the corrosion mechanism. This included a visual investigation and electrochemical testing. This information was used to design the cathodic protection system and establish the baseline for measuring the cathodic protection system's performance.

The prototypical cathodic protection system was then installed on one of the bents in November 2004 and was monitored for 2.5 years. Fourteen fiberglass jackets with a cathodic protection system were installed in bent number 20. The test system was designed and installed in 2 months. The team worked with a contractor who was already mobilized on the bridge to install the systems.

The owner was pleased with the results and they opted to install the system on the bridge. The selected system consists of a combination of Lifejackets® for the marine piles and a metalized zinc cathodic protection system operating in galvanic mode for the pile caps. To begin installing the system, the old fiberglass and epoxy jackets were removed. At this point, crews noticed that several piles would need to be recast because of the level of damage. For the piles that did not need to be recast, crews sandblasted the surface to prepare the concrete. The team then began to establish

Lifejacket filled with concrete

electrical continuity in the steel reinforcement. When they did not find electrical continuity, they had to establish it by welding. An electric arc thermal spray unit was used to melt the zinc alloy and apply it to the surface. Zinc was applied to the piles in the amount of 1 lb/ft^2 (0.042 kg/m^2).

ABOUT METALIZED CATHODIC PROTECTION SYSTEMS

Metalized cathodic protection systems have enjoyed increased acceptance for corrosion protection of steel reinforcement in concrete since their introduction in the early 1980s. More than 2 million ft^2 (185,806 m^2) of metalized anodes for cathodic protection systems are in operation in North America. The bulk of these installations use zinc as the anode material. Other anode materials include an aluminum-zinc-indium alloy with high output capacity, zinc-aluminum alloys of various compositions, and catalyzed titanium. Although metalized cathodic protection systems have developed a good

Completed installation of Lifejacket® and metalized zinc cathodic protection systems reputation as sacrificial systems using zinc, certain anodes installed by thermal spray can also be used for impressed current systems.

In a sacrificial cathodic protection system, the anode is thermal-sprayed onto the surface of the concrete. Contact is made to the reinforcing steel with specially designed hardware attachments. These systems do not require outside sources of power and are self-regulating. This means the current output from the anode is primarily controlled by the resistance of the concrete. If the resistance is low, a condition generally conducive to higher corrosivity, the anode will deliver higher current outputs. If the resistance is higher, the opposite will be true.

Sacrificial zinc and aluminum-zinc-indium alloy cathodic protection systems have been used successfully for the protection of concrete structures in a wide variety of environments. Metalized cathodic protection systems operating in sacrificial mode are appropriate for warm, humid environments, such as marine structures and along coastal areas. Systems using aluminum-zinc-indium alloy anodes are effective for structures requiring higher current outputs or where the concrete is drier or less conductive. These systems are currently being used for bridge substructures, piles and columns, high-rise balconies, parking garages, concrete cooling towers, concrete intake and outfall structures in power plants, dock facilities, and more. Several State Departments of Transportation (DOTs) in the U.S. have standardized the use of these systems for repair and rehabilitation of bridges and other structures.

SYSTEM USED

The Lifejacket® system was codeveloped by the Florida Department of Transportation and Jarden Zinc Products to meet a growing need to repair and protect numerous concrete piles suffering from corrosion-induced deterioration throughout the state. The system has evolved from the initial prototypes installed in the early 1980s to the current system. For the bridge in Campeche, the jackets were placed around the piles after electric continuity was confirmed or established among all the reinforcing steel within the pile. The contractor assembled the jackets around the pile and poured a mortar mixture into the annular space. The anode grade zinc mesh, preinstalled at the factory, is on the inside face of the pile. The anode is connected to the steel reinforcement at a small junction box above the jacket. The jacket comes with a preinstalled copper wire and a similar wire is connected to the steel in the field. The connection is competed at the junction box. Reference electrodes were placed at strategic locations on several piles to provide information about the system's performance. In addition, the amount of electrical current that is leaving the jacket is monitored using shunts installed at the junction box. This allows the team to determine the efficiency of the system and decipher how long it can remain in place before its serviceable life is expended.

Based on the readings, the system is working well and will be in place for a minimum of 25 years, providing the long-term solution that the owner desired. More than 1400 piles are scheduled to be repaired and protected using this technology. To date, 240 jackets have been installed during the first two phases of this project.

Cathodic protection is a technology introduced to the bridge owner only recently, and the La Unidad Bridge is the first structure in their transportation system using cathodic protection to extend the useful life of a very important structure. In spite of the remote location and the limited resources available in the area for a project as complex as this, the local work force, contractor, and local authorities demonstrated resourceful skills, clear understanding of the concepts, and a commitment to use advanced technologies to preserve an important component of the infrastructure in southern Mexico.

La Unidad Bridge

OWNER
Secretaría de Obras Públicas del Estado de Campeche

SYSTEM SUPPLIER
ElectroTech CP

SYSTEM INSTALLER
PenMar

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