

Kawaihae Harbor Mooring Structure Cathodic Protection

Kawaihae Harbor, Hawaii
Submitted by Electro Tech CP



Mooring dolphins, built in 2001, are supported by prestressed, octagonal piles. The piles are driven directly into the bottom of the harbor sea floor

Located on the Big Island in Hawaii, the Kawaihae Harbor serves an important purpose for the United States Armed Forces. The U.S. military facility at Kawaihae Harbor serves as the main port for supporting military equipment and vehicles used for training purposes at the Pohakuloa Training Area.

Ships arrive at the facilities' mooring dolphins, built in 2001. They consist of two dolphin structures and a concrete ramp. An abandoned mooring dolphin closest to the shore was not included in this project. Dolphin No. 2 is a concrete platform supported by 21 prestressed, octagonal concrete piles; and Dolphin No. 3 is supported by 19 prestressed, octagonal concrete piles. The piles are driven directly into the bottom of the harbor sea floor.

The owner conducted several inspections of the dock and piers, including underwater inspections. During these condition inspections, the owner discovered that the piles had cracks in the concrete, allowing ingress of seawater, causing the prestressed steel to corrode. It was determined that the cracking was most likely the result of driving forces during construction and the impact of vessels during

mooring operations. Because this structure is so vital to the training center, it was critically important to repair the damage caused by the corrosion and create a long-term corrosion mitigation and impact-resistant solution for the piers.

SOLUTION DEVELOPMENT

The owner wanted a repair system that would provide corrosion protection to the concrete piers. The system, however, would have to be extremely durable so it would not be easily damaged by impact from large ships that frequented the harbor or large floating debris. The owner opted to use a sacrificial cathodic protection system.

In addition to cathodic protection, a compression panel made of a wood/plastic composite material was used for each face of the piles to secure the expanded zinc mesh anode sheet to the concrete surface. The contact face of each panel was cut with 1/4 in. (6 mm) longitudinal grooves to allow for wicking action of seawater between the panel and pile surface. A composite wrapping material covers the zinc mesh and compression panel cathodic protection system.



Zinc mesh panels were cut to fit each face of the octagonal pile and connected by soldering a zinc strap at the top of the panels prior to placement on the piles



Zinc and compression panels installed and held in place with bands

A solar-powered remote monitoring system was also used for each dolphin to monitor the system following installation.

SITE PREPARATION AND ACCESS

The remote location of the dolphins in an active military harbor required a well-planned access and repair plan. Work equipment was situated on top of the dolphins and the contractor used floating access that would enable work crews to clear the area for any ship activity in a short period of time, while also providing access where vertical clearance was limited.

One of the major challenges was working within the tides. During high tide, crews could not work on the concrete piles. When the tide was low, there was a large crew on the water to get as much accomplished before the tide rose again. In addition to the tides, strong winds and quick changes in weather gave crews little time to adapt. Further, the location required clearance since it was a secure area and the dock remained active during the entire project and crews had to work around incoming shipments.

SURFACE PREPARATION

The initial work on the dolphins involved a thorough cleaning of the concrete piles designated for installation. The surfaces were cleaned of marine growth, oil, grease, and dirt to ensure a tight zinc mesh concrete interface. Divers cleaned the piles using

mechanical equipment and brushes. The repair team marked the concrete surfaces to designate the proper locations for the electrical continuity access holes, cathodes, anode elevation, and reference electrodes.

CONCRETE REINFORCEMENT PREPARATION

Prior to the installation of the impact and corrosion protection wrap (ICPW) system, electrical continuity testing was performed on all prestressed strands and spiral ties on the piles that were to be protected. Strands were located using a pachometer, or cover meter. The two test methods used to determine if the metallic elements were electrically continuous were the DC mV and the DC resistance methods. After initial electrical continuity testing on each piling was completed, the repair contractor installed continuity corrections on any reinforcing steel that was found to be electrically discontinuous.

Continuity corrections and then negative connections to the reinforcing steel were accomplished by welding or brazing a steel rod or wire between the discontinuous and continuous steel tendons. All connections received a coat of 100% solids, nonconductive epoxy so that no brazing material was in contact with the concrete when access holes were patched. After connections were epoxy coated, the holes were filled with premixed mortar to the original profile. Two negative connections were installed per pile and continuity was checked across each of the cable end connections to ensure that a good electrical connection was made. The entire connection was then encapsulated with a nonconductive epoxy resin. After the epoxy cured, crews reinstated the mortar around the breakout area of the connection.

MONITORING SYSTEM SETUP

Silver/silver chloride reference electrodes used to provide data to the monitoring system were installed prior to the ICPW system installation. Three reference electrodes per pile were installed on the monitored piles.

For underwater installations, the reference electrode was attached to the concrete surface of the pile at the specified elevations. Attachment was made using nonferrous banding or straps, with care taken to avoid damage to the electrode. The attached cable was secured to the pile using the same procedure. For each pile designated for monitoring, a separate negative connection was established specifically for use with the reference electrodes. The negative connection was installed using the same procedure as the negative connection for the entire system.

JACKET INSTALLATION

The team inspected and assembled materials for the ICPW system to ensure that the system was installed in accordance with the specification. The

anode connector cable was attached to the assembly and secured to the pile continuing to the monitoring box. This cable was permanently routed inside the ICPW system at one of the corners of the pile surface.

Installation of the zinc mesh and compression panels required the use of temporary work platforms to position and secure the panels at the required elevation. The zinc mesh sheets were fabricated in a group of eight to permit alignment with one sheet for each pile face. The sheets were attached by soldering a strip of anode grade zinc around the top of all sheets, with a "tag" end remaining for attachment to an anode cable. The zinc mesh assembly was positioned on the temporary work platform so the pile was surrounded completely. The assembly is held in place using plastic ties to connect the open ends. The compression panels were then positioned on each pile face, using elastic cords or rope to temporarily hold the panels in place. The compression panels were permanently secured by stainless steel banding affixed at 1 ft (0.3048 m) increments from top to bottom. Upon completion of the zinc mesh/compression panel installation, the temporary work platforms were removed.

To install the composite wrapping material, a primer was applied to the exterior surface of the system. For portions of the installation above the waterline, water was sprayed thoroughly on every layer of material as it was installed. Three layers of wrap were used.

ACTIVATING THE REMOTE MONITORING SYSTEM

All conduits were routed to the remote monitoring control box located on the west face of each dolphin. Conduits were routed to minimize openings and wire pulls.

The remote monitoring unit provides the ability to collect test data from the monitored piles, store it, and download it to the designated main control unit. The remote monitoring units and the main control unit communicate by a wireless connection that is completely powered by solar energy.

The data acquired will be shared by the project team to verify system performance and give the owner ongoing monitoring for these structures.

SPECIAL FEATURES

Although the remote location of this project required tremendous foresight and planning by the repair team, the repair strategy was a success. Despite many challenges, the installation of a remote monitoring system solution will provide the project team and owner with valuable data on system performance and continual monitoring. Further, the use of solar power to provide energy for the remote monitoring system and wireless communications devices creates a sustainable solution for years to come.



Wiring has been connected to the anodes, testing instruments, and reinforcing and awaits placement in conduits and termination at control boxes



Completed jackets and conduit for wiring



Installation of remote monitoring system on dolphin platform face. Note the solar panel used to provide energy needed to run wireless communications

Kawaihae Harbor Mooring Structure

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PROJECT ENGINEER/DESIGNER

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REPAIR CONTRACTOR

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