

Intake Structure Rehabilitation and Strengthening

Crystal River, FL

Submitted by MAPEI Corporation



External view of intake structure

Water intake structures divert water from a river or channel for a variety of purposes, including water supply, hydroelectric power generation, and irrigation. Engineers consider many factors when designing water intake structures and, historically, water diversion has focused on large-scale structures. The withdrawal of water from rivers, lakes, or oceans for the cooling of nuclear electric power plants or manufacturing facilities may result in adverse environmental impacts on aquatic life. These impacts include impingement, whereby aquatic life becomes pinned against filtering screens or other components of cooling water intake structures (CWIS), and entrainment, whereby aquatic life is drawn through CWIS and injured or killed.

Work on this project involved the inspection, repair, and strengthening of four intake structures for this facility located directly on a river in Florida. Each of the intake chambers has seven concrete support beams and was built in 1965. In over 40 years, there had been no remedial work

done to them to repair, restore, or protect the concrete from the harsh deleterious elements of a saltwater environment.

PROBLEMS THAT PROMPTED REPAIR/ CAUSES OF DETERIORATION

The scope of work for the contractor included designing the repair and strengthening system for all four of the intake chambers, which suffered the most severe loss of the reinforcing steel cross section. This area is constantly exposed to the saltwater in what could be considered a “splash” zone similar to that of a bridge piling. The incoming tides raise the water level and submerge the concrete, and then the tides go out, exposing the concrete but allowing the chlorides to penetrate into the concrete pore structure.

Each chamber is approximately 15 x 50 ft (4.6 x 15.2 m) long and comprised of two sections. One section is the intake portion, which is separated from the pump section by a permanent, rolling, stainless steel screen. The pump section has a 50,000 lb (22,679 kg) intake pump overhead that was supported by badly deteriorated concrete beams. Due to the advanced corrosion and extremely poor condition of the concrete, the facility became dangerously close to ceasing operations because site conditions were becoming unsafe for the employees at the plant.

THE SITE AND SURFACE PREPARATION

All seven overhead beams in all four chambers had severe structural deficiencies, making it easier than normal to locate all hollow sounding areas that were marked for concrete removal. On all concrete repairs, saw cutting around the spalled areas was completed, creating right angles wherever possible. As per ICRI and American Concrete Institute (ACI) standards, the highly contaminated concrete was removed from behind the reinforcing steel to allow for placement of the repair material,



Workers chipping deteriorated concrete. Note complete loss of reinforcing steel



View of overhead deck repair with forms in place for pouring repair mortar



View of overhead deck area showing replaced reinforcing steel



Fiber-reinforced polymers encasing existing beam

allowing it to completely encapsulate the primed steel reinforcement bars and re-establishing the protective passivating environment.

Most of the steel reinforcement that was exposed and any reinforcement with minimal concrete cover was corroded to the point of nonexistence. The majority of the steel reinforcement had to be replaced with new reinforcing bars that were doweled and bonded with epoxy into the existing slabs and support beams to accept the new concrete restoration materials.

THE REPAIR AND PROTECTION SYSTEM SELECTION

It was decided early in the planning stages that a carbon-fiber system would be added to the rehabilitation to provide additional support capability. Because of the severe loss of steel reinforcement and the cross section on the remaining steel, it was thought that a carbon-fiber system would not only add to the strength of the concrete where the reinforcement had been compromised but

would also provide a noncorrosive barrier to prevent additional chloride contamination to the repaired overhead concrete slab and beams.

It was determined that several concrete repair and restoration materials would be required to perform the work that was needed. Materials selected for use on this project included, but were not limited to: a two-component, 100% solids epoxy bonding agent; a fast-setting, one-component repair mortar with a corrosion inhibitor; a one-component, form-and-pour repair mortar with a corrosion inhibitor; a non-sag epoxy gel and a low-viscosity epoxy resin for crack injection; an epoxy gel to dowel new steel reinforcement into existing concrete; and a triaxial carbon-fiber fabric system.

THE REPAIR PROCESS EXECUTION AND APPLICATION METHOD

The majority of the concrete repairs for the project were overhead repairs, which are possibly the most labor-intensive type of repair. The con-



Floating platform fabricated to work inside intake chambers

tractor used state-of-the-art methods and materials to expedite the process because the volume of overhead repair would have proven to be too costly for a hand-applied or trowel application of a repair mortar.

Because most of the repairs were overhead, a one-component, polymer-modified, corrosion-inhibiting, enhanced form-and-pour repair material was used. This material was pumped from the top side of the walkway through openings saw cut in the slab. Wooden forms were erected in an already-difficult work area where headroom was scarce.

ADDITIONAL CHALLENGES TO OVERCOME

Due to the grating system, saltwater was able to enter into the chambers at all times during the reconstruction of the concrete slabs and overhead beams. This meant that all work had to be completed while the water continued to rise and fall according to the tides. At certain times of the day, based on the time of the high tide, there was only 4 ft (1.2 m) of clearance between the base of the platform and the overhead concrete slab.

The clearance problem was overcome by building floating platforms that were lowered piece by piece into the chambers, where they were assembled and covered over with marine plywood. These floating platforms were built “wall to wall” with a gap of approximately 3 in. (76 mm) all around the perimeter and with handrails constructed at both ends. When one cell was completed, the platform was simply dismantled and brought to the next chamber, where it was reassembled. At the end

of the project, the floats were dismantled, placed on a trailer, and shipped back to their shop.

Where the plywood deck came in touch with the concrete, 40 lb (18.1 kg) roofing felt was run 6 in. (152 mm) up the wall to keep all debris on the platform, as no debris was allowed to fall into the water. The debris was swept up daily and had to be manually lifted out of the chambers to be disposed. Five gal. (19 L) buckets and ropes were used for the small stuff and chokers with several workers were used to hoist the larger pieces of concrete out.

THE FINAL STEP TO COMPLETE THE RESTORATION PROCESS

The final step in completing this restoration project used a sealer/healer epoxy resin on the top side of the intake structure. The intake structure itself is partially submerged and presented numerous problems with reinforcement corrosion and concrete spalling; however, another factor that contributed to the deterioration of the concrete top of the intake structure was simply the exposed and unprotected surface.

Over the years, exposure to the elements created numerous cracks in the top deck of the structure. A very low-viscosity epoxy sealer designed to deeply penetrate into the worn but sound concrete was chosen for application to the surface. This system sealed hairline cracks and penetrated the concrete pore structure to form a subsurface barrier that effectively arrests carbonation and stops the penetration of chloride ions into the concrete deck.

FINAL RESULTS

All work was completed while parts of the intake structure were operational, incurring minimal downtime for the client. Completion was reached safely in only 3 weeks and—to the client’s delight—on budget!

Intake Structure

OWNER
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Crystal River, FL

REPAIR CONTRACTOR
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