

# A Unique Solution for Repairs during a 5-Day Outage

Northern Florida

Submitted by Premier Corrosion Protection Services, Inc.



Considerable deterioration of concrete walls and slab due to aggressive chemicals that are discharged into Mix Box at any given time

Constructed of cast-in-place concrete, the “Mix Box” at this pulp and paper mill facility is 106 ft (32.3 m) long and 13 ft (4.0 m) wide. It varies in height from 5 to 9 ft (5 to 2.7 m).

Over the years, there has been considerable deterioration of the concrete walls and slab due to the aggressive chemicals that are discharged into the Mix Box at any given time. In addition to the damaged walls and slab, a severely damaged underwater dike, made from cement bags used to aerate the chemicals and air, had to be redesigned and replaced.

## INSPECTION AND EVALUATION

Inspection and testing were done on the Mix Box to help determine the best repair method. Inspection methods included visual as well as sounding of concrete to determine void areas using a sounding instrument specifically designed for spall detection. Because of the corrosive nature of the product processed in the facility, it was also determined that core samples were necessary to ascertain the structural integrity of the walls.

Once the physical inspection was performed and the results of the core samples received, the engineer

was contacted to review the data and recommend the repair method best suited for this project.

The Mix Box is subject to any number of corrosive fumes at any given time; over the life of the plant, these fumes had caused severe spalling, delamination, and corrosion of the reinforcing steel. Initial testing showed that the concrete had in fact severely deteriorated and that the existing exposed reinforcing steel had to be enhanced.

## REPAIR SYSTEM SELECTION

Prior to the repair, the walls and floor were prepared per ICRI Technical Guideline No. 310.1R-2008, “Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion,” and Guideline No. 310.2-1997, “Selection and Specifying Concrete Surface Preparation for Sealers, Coatings and Polymer Overlays.”

Additionally, materials and application methods were determined by adhering to the recommendations of ICRI Technical Guideline No. 320.1R-1996, “Guide for Selecting Application Methods for the Repair of Concrete Surfaces”; Guideline No. 320.2R-2009, “Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces”;



*Condition of dike once Mix Box was drained*



*Surface preparation underway*



*Temporary plywood roof erected over Mix Box to allow for work to continue day and night*



*FRP panels prepared to be welded to each other*

and ACI 440.2R-08, “Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures.” In addition, a new fiber-reinforced polymer (FRP) dike had to be designed, fabricated, and installed to replace the old dike.

Repair methods and materials had to be carefully selected not only for the chemical resistance but also for the extremely limited schedule of 5 days!

## **SITE PREPARATION**

A work platform was built over the active Mix Box to allow plant production to continue. Because the Mix Box was still active and it was impossible to determine the actual composition of the chemicals

flowing in the box, as a safety precaution, all workers had to wear self-contained breathing apparatus (SCBA) gear while working in or around the Mix Box.

Additionally, because of the limited schedule, a temporary plywood roof was erected over the Mix Box to allow for work to continue day and night, even in inclement weather.

All spalls were prepared per ICRI Technical Guideline No. 310.1R-2008. All concrete cutting was completed creating right angles per ICRI standards. Contaminated concrete was removed from behind the reinforcing steel and an epoxy bonding agent/corrosion inhibitor was applied. Additional reinforcing steel and wire mesh were installed and formwork was erected. With this in place, a



high-strength, fast-curing, silica-fume-enhanced polymer concrete was then used to fill the prepared area to flush with the existing surface.

After the concrete had cured, prefabricated FRP panels were installed on top of the repaired concrete



Columns are installed first to receive formwork for wall



New FRP dike installed



Project complete

using stainless steel fasteners. Each panel was welded to the other using hand-applied FRP straps welded to the FRP plates and continued over the top of the repaired wall to lock in the FRP panels and to prevent chemicals from damaging the concrete wall when it spilled. A smooth, tinted wax coat finish completed the repair.

## UNFORESEEN CONDITIONS

Because the Mix Box was in constant use and would not be available for inspection until the planned plant shutdown, there were several conditions that became apparent once the repair began. The severe deterioration of the original dike and the expanse of the delamination were surprising.

## SPECIAL FEATURES

The ability to weld the FRP sheets installed over the repaired walls, floor, and dike made this a seamless liner from top to bottom for its entire length, effectively protecting the concrete from further chemical attacks and providing a long-lasting solution to the client.

The repair and rehabilitation of this Mix Box was a team effort from the start. The client had a very tight schedule during their planned shutdown. When it was suggested that the work on the Mix Box begin prior to the plant shutdown, the client denied the request because of the toxic nature of the chemicals. Once it became apparent that this portion of the work was on the critical path, the client looked for a solution. A work platform was designed that was suspended above the flowing mix for the repair team to work. In addition, it was recommended that the crew use SCBA gear for safety reasons. The plant safety manager reviewed and approved the solution and the crew began to work. This solution allowed the crew to complete the repairs ahead of schedule, which resulted in a very happy client.

## A Unique Solution

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