From Abandoned Buildings to Aquatic Resource Center

By David White and Dave Clarke

The Fort Wetherill Aquatic Resource Center was created from three buildings that were built from 1908 to 1912. They are part of both a historic waterfront and the original army base that comprises 5.5 acres on the east side of Conanicut Island, Jamestown, Rhode Island.

During the two world wars, mines were deployed into Narragansett Bay to protect the U.S. shores from enemy battleships and other foreign naval aggression. The mines were transported in and out of the buildings via rail to the water, barged into placement, and eventually brought back to the buildings for maintenance and storage.

Need for Rehabilitation

Before the current rehabilitation, the buildings were abandoned, left deteriorating, and possibly on track for future demolition. The roofs of each building contained numerous holes and were leaking for years. In addition, the concrete exterior façades were cracking and spalling.

Completed project

The largest structure, 32 ft (10 m) wide x 105 ft (32 m) long, was a two-story mine storage building, constructed in 1908. The structure immediately to the west, 30 ft (9 m) wide x 63 ft (19 m) long, was the cable tank room that was used to keep the mine cable submerged in large tanks to prevent deterioration. The third and smallest building, at 26 ft (8 m) wide x 46 ft (14 m) long, was a wood-frame building with an exterior cement stucco finish. It contained steel and concrete silos below the floor, used to store explosives.

All of the buildings were served by a narrow-gage rail system used to transport mines and related equipment from building to building and to the end of the dock. Those buildings were part of a more extensive network of forts that employed long-range cannons to guard the entrance to Narragansett Bay. Because of their significance, the complex is eligible for listing on the National Register of Historic Places as part of a Fort Wetherill Historic District.

A New Design

An architecture firm was retained by the State of Rhode Island's Department of Environmental Management to evaluate these historic buildings for possible restoration and reuse as a Marine Fisheries Facility. It was eventually determined that it would serve as the site for the consolidation of the Marine Fisheries Section of the Rhode Island Department of Environmental Management's (RIDEM) Division of Fish and Wildlife. The Aquatic Resource Center's three buildings would house a "wetlab" capable of circulating 200 gal. (760 L) of seawater per min. It would also contain office space, research laboratories, and small boat maintenance for approximately 15 RIDEM Fish and Wildlife Marine personnel. Additionally, the new design provided improved fishing access to Narragansett Bay and new public restroom facilities. The architect also designed general site improvements that would connect, by means of a foot trail, this 7-acre parcel to the existing Fort Wetherill State Park. This plan maximizes the existing building space without destroying the historical, cultural, or military significance of the site or the exterior and interior features of the buildings.

Evaluation

Numerous trips were made by various experts to help in the inspection of the buildings and evaluation of their structural integrity. The first two buildings were found to be structurally sound, although in need of major concrete repairs. The third building had a good roof structure, but the wood and stucco walls were deteriorated beyond repair. Because the buildings are located in a velocity flood zone, a concrete masonry and stucco wall system was used to replicate the original construction of the smaller third building.

Testing

For the two larger buildings, tests were run to determine the causes of the scaling, cracking, and spalling of the concrete. Due to the proximity to the ocean, the concrete was tested for chloride content. In addition, based on the age of the buildings and weather exposure, the depth of carbonation and strength of the concrete was also tested.

In steel-reinforced concrete construction, the concrete protects the steel by its naturally high pH (alkalinity). This high pH forms a passivating oxide layer around the embedded reinforcing steel, protecting it from corrosion. Two principle factors, either together or independent of the other, can break down this natural passivation; the first is carbonation and the second is the presence of free chloride ions (salt) in the concrete.

The most common cause of loss of passivating alkalinity is carbonation. This is a process where atmospheric carbon dioxide reacts with the soluble alkaline calcium hydroxide and other cement hydrates in the concrete. These are then converted into insoluble calcium carbonate. This process is completely natural, but the pH of the concrete matrix is reduced and its passivating ability is lost progressively from the surface inward. Once the concrete comes in contact with the reinforcing steel and carbonates, the steel is no longer protected. In the presence of moisture and oxygen, corrosion is inevitable. The speed of penetration or the rate of carbonation depends mostly on the permeability of the concrete and its moisture content or humidity.

Chlorides can enter the concrete through direct or indirect exposure to a structure in a marine location, such as is encountered here. The concentration of chlorides required to promote corrosion of embedded reinforcement is affected by the pH of the concrete. The concrete cover, density, and permeability of the concrete; depth of carbonation; and concentration of chlorides in the concrete affect the initiation and rate of corrosion.

Before and after complete repair and protection system application

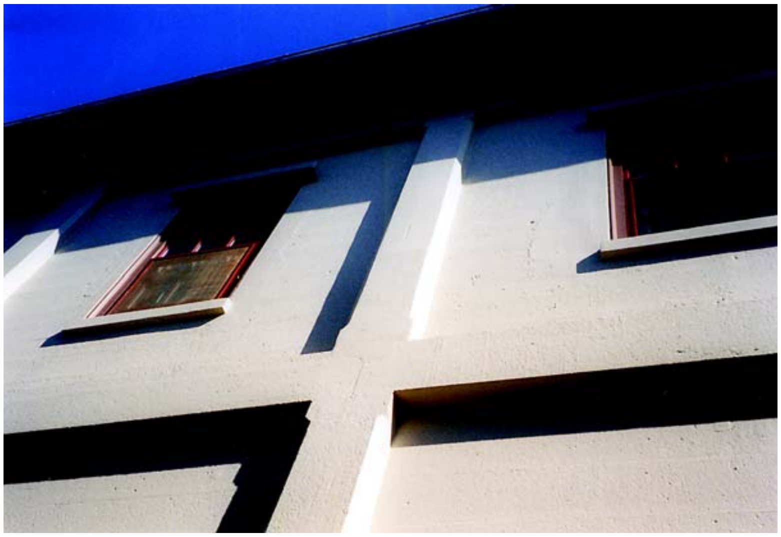
For these structures, four cores were taken. Both the depth of carbonation and compressive strength tests were performed on each core. The depth of carbonation varied from 1/4 to 3/4 in. (0.63 to 1.9 cm) from the face of the concrete, and the average compressive strength was 4400 psi (30 MPa). For the chloride ion analysis, seven tests at 3/4 in. (1.9 cm) deep and seven tests at 1.5 in. (3.8 cm) deep were completed. The shallow 3/4 in. (1.9 cm) tests had a chloride range from 1.79 to 2.55 lb/yd^3 (1.06 to 1.51 kg/m^3). The deeper 1.5 in. (3.8 cm) tests had a range from 0.96 to 2.71 lb/yd^3 (0.57 to 1.61 kg/m^3).

The testing showed classic causes of corrosion and concrete deterioration. The environment and concrete cover of the reinforcing steel in combination with carbonation and chlorides were contributors to corrosion and a subsequent increased rate of corrosion. The amount of corrosion and deterioration of the concrete varied with the elevation and its exposure. Once the cracking and spalling had begun, wetting-drying and freezing-and-thawing cycling accentuated the damage on the buildings. Wall cracks related to original settlement were stable and could be repaired.

Repair and Protection System

The sound quality of the parent concrete, combined with the available state-of-the-art materials and ICRI concrete repair and protection guidelines, made it possible for the buildings to be repaired. A concrete repair and protection system was designed for the exterior envelope repairs. New roofs and interior retrofitting were designed and completed in accordance with state authorities to be used as needed. Site protection was established to protect the ecology of the surrounding water. The buildings were scaffolded and the work began.

The concrete repair and protection system consisted of removing all deteriorated concrete spalled areas and saw-cutting around the patch perimeters to prevent feather edging. While removing the deteriorated concrete, if more than half of the twisted bar was exposed, the concrete behind the reinforcement was removed. All exposed reinforcement received two coats of an anti-corrosion coating, and a bonding agent was used to bond the old parent concrete to the new patching material. For large spalled areas, the voids were formed and a polymer-modified silica-fume patching concrete was poured in. The polymer modification adds to the bond and the flexural strengths, and the silica fume adds to the density and reduces permeability. This bag concrete was mostly used at windowsills, window eyebrows, corners, spandrel beams and columns, and foundation areas. Smaller spall voids were hand-patched with a similar mortar.



Before and after repair of spalls and window replacement

Large cracks were treated the same as the spalls and repaired with patching mortar. The smaller, nonmoving cracks were injected with epoxy to structurally bond the concrete together and to stop water from entering. Other cracks determined to be possible moving cracks were saw-cut, filled with sealant, and tooled flush to be coated.

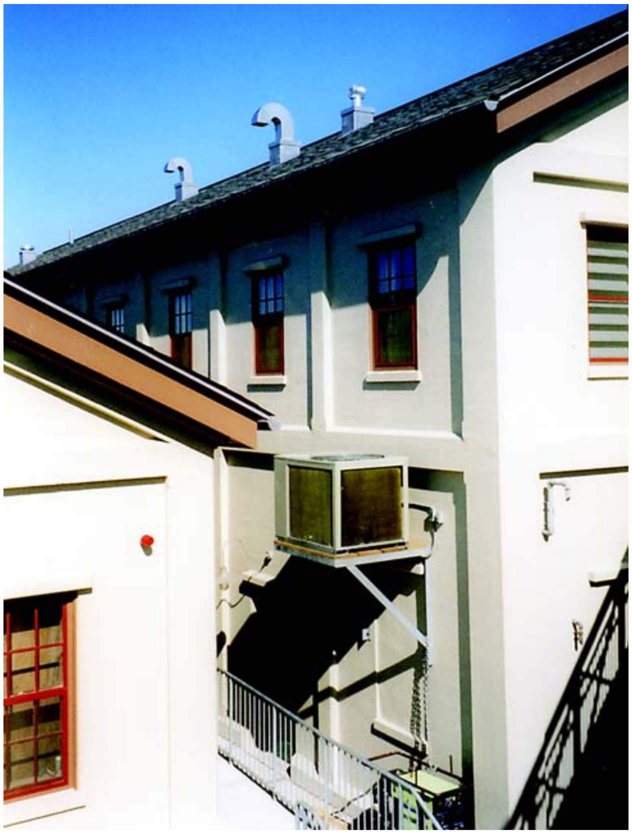
To help combat the chlorides in the concrete, a migrating corrosion inhibitor was applied in two coats to the entire exterior concrete envelope. This inhibitor helped displace the chloride ions from the reinforcement and reduce the corrosion currents on the reinforcement steel. To combat carbonation, a leveling mortar and anti-carbonation protective coating was applied to the concrete. The leveling mortar was used to fill bugholes and smooth out imperfections to help in applying the protective coating in a uniform layer. The applied coating was breathable, flexible, and waterproof, blocking carbon dioxide from entering the concrete and lowering the pH.

Special Requirements

Special considerations were needed because of the historic nature of the buildings. The new roofs had to resemble the original slate roof look. The windows were replaced, flashed, and sealant applied with a wood window identical in appearance to the original window, and doors were restored to match the original construction; hardware was reused where possible. The protective coating colors were chosen to match the colors that would have been selected in 1910.

This successful project began by determining the cause of the structures' problems prior to selecting a solution. It employed a wide variety of repair materials needed to implement an effective repair solution, including special solutions to maintain the look of the historic structure.

And, finally, the excellent communication and teamwork from the owner, architect, engineer, contractor, testing lab, material supplier, and material manufacturer turned these historic but deteriorated structures into a useful resource.



Before and after photo of repair of spalls and corner detail

Fort Wetherill Aquatic Resource Center

Owner

State of Rhode Island
Providence, Rhode Island

Project Engineer

The Robinson Green Beretta Corp.
Providence, Rhode Island

Repair Contractor

Berkshire Construction Services, Inc.
East Greenwich, Rhode Island

Material Suppliers

Sika Corporation
Lyndhurst, New Jersey

Contractors Supply, Inc.
Riverside, Rhode Island

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