SITKA SOUND SCIENCE CENTER: RESTORING AN IMPORTANT PART OF SITKA'S HERITAGE

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INTRODUCTION

Constructed in 1929, the Sage Memorial Building is located on the waterfront of Crescent Bay within the National Historic Landmark district of the former Sheldon Jackson College campus in Sitka, Alaska (Fig. 1). Sitka was the principal Russian settlement in North American before Alaska was purchased by the United States in 1867. The building was once part of the Presbyterian Missionary School for Alaska Natives which provided training in vocational skills such as carpentry and boat building (Fig. 2). Through the 1990s, the building also played an integral role in the supply of energy for the campus through its 140 horsepower hydroelectric plant.

Fig. 1: Archival photograph of Sage Memorial Building with ornamental parapet (1935, Sitka Historical Society)

Fig. 2: Archival photograph of student boat builders, likely 1950s (Sitka Historical Society)

Beginning in the early 1970s, the building was used to provide training in aquaculture, fisheries science and management, and received the first state-issued salmon hatchery permit in Alaska. The Sage Memorial Building houses scientific classrooms and laboratories where many students went on to become leaders in natural resource management in Alaska. In 2001, Sheldon Jackson Training School was designated a National Historic Landmark. The historic district consists of 20 contributing structures including the Sage Memorial Building.

Today, the nonprofit Sitka Sound Science Center owns and occupies the Sage Memorial Building. The Center is dedicated to increasing understanding and awareness of terrestrial and aquatic ecosystems of Alaska through education and research. The building houses a working fish hatchery and aquarium.

The Sage Memorial Building is rectilinear in plan, measuring approximately 80 ft (24.4 m) by 52 ft (15.8 m), with two full stories above grade, and one basement level below grade. The modified Gothic-style building has a cast-in-place reinforced concrete facade with punched window openings. The exterior concrete surfaces were coated and have remnants of several previous coating layers. Decorative clay tiles are inset into the concrete surface at select locations, such as above the first floor

Fig. 3: Archival photograph of Sage Memorial Building with ornamental parapet removed, likely 1960s (Sitka Historical Society)

windows and below the roof coping. During a previous project, the decorative parapet of the building was removed and replaced with a sheet metal cap (Fig. 3). The original windows were also removed in a subsequent project, leaving the steel perimeter window frames embedded in the concrete within the perimeter of the window openings. The replacement windows did not extend the full height of the window openings at the head, which was infilled with painted plywood (Fig. 4).

FIELD INVESTIGATION

A facade assessment was performed that included a visual condition survey, sounding, non-destructive testing, removal of concrete core and coating samples for laboratory studies, and creation of inspection openings to examine concealed conditions.

The concrete facade on the building incorporated cast-in-place construction typical of this vintage, finished with a facing mortar approximately 1/4 inch (6 mm) thick on the exterior surfaces. The typical as-built construction observed at the majority of the exterior consisted of concrete walls and parapet walls up to 12 inches (305 mm) thick.

Deterioration of concrete was observed throughout the facades but was most severe around window openings and architectural features, primarily on the windward (east and south) elevations of the building. At inspection openings, portions of the original window frames were observed to have not been removed during a previous window replacement in the 1980s. At several locations around windows, expansive forces due to the corrosion of remaining embedded steel components resulted in large areas of loose and dislodged concrete. Some cracking and delamination of previous concrete repairs were also noticed. Areas of the exposed concrete foundation wall surfaces exhibited severe localized freeze-thaw damage. Several layers of existing coatings on the exterior surfaces of the building were experiencing severe blistering.

The north entrance to the building has an architectural surround with a projected sawtooth concrete molding. The tops of the sawtooth elements have a mortar finishing layer that was observed to have debonded in some locations, with portions of the corners exhibiting freeze-thaw damage.

LABORATORY STUDIES

Laboratory studies of concrete samples included petrographic examination (ASTM C856),[1] chloride content analysis (ASTM C1218),[2] carbonation assessment and compressive strength (ASTM C42).[3] The concrete mix included crushed limestone coarse and fine aggregate, and the compressive strength was approximately 4,500 psi (31 MPa). No evidence of aggregate removed from the ocean (i.e., with a high chloride content) was found in the tested samples. The base concrete and face mortar layer were not air entrained, as expected for concrete of this age. As revealed in the samples examined, the sand and cement facing mortar layer was generally 1/16 to 1/4 inch (1.6 to 6 mm) thick and bonded to the base concrete. Chloride content levels were variable, with some above the threshold known to cause corrosion in wet conditions.

Fig. 4: South elevation facing Crescent Bay prior to repairs, during mock-up phase (2014)

INVESTIGATION FINDINGS

The deterioration of the concrete facades included distress caused by corrosion of embedded reinforcement, freeze-thaw damage, and debonding of concrete layers. The majority of the facade deterioration was due to corrosion of embedded ferrous metal angles at the perimeter of window openings (Fig. 5), where components of the steel frames were left in place after replacement of the original windows.

Freeze-thaw damage was primarily observed along the basement level foundation walls at the lower portions of the building and at projecting window sill elements. The freeze-thaw damage was observed to be most severe along the south and east elevations of the building, which are the windward sides of the building.

The corrosion of the embedded steel was the result of carbonation of the concrete which protects the embedded reinforcing steel and penetration of airborne chloride-laden moisture from the adjacent saltwater into the concrete facades. Carbonation occurs when carbon dioxide from the air penetrates the concrete and, through chemical reaction, reduces the pH to as low as 8.5, at which level the passive film on the steel is not stable and corrosion can occur in the presence of moisture. The corro-

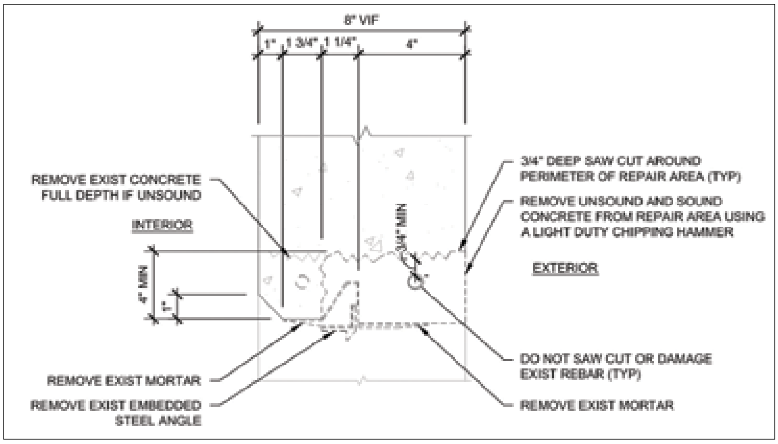

Fig. 5: Repair sketch indicating location of steel angle embedded in concrete at window rough opening

Fig. 6: Deteriorated concrete window jamb at facade of building. Note vertical crack at location of embedded steel angle from previous window frame (2014)

Fig. 7: Removal of steel frame embedded in concrete at window opening (2014)

sion of the ferrous metal components of the original window frame was exacerbated by exposure to moisture as a result of failed and missing sealant at the perimeter window joints.

Architectural concrete features of the original facades, including projecting bands, decorative parapet, embedded tiles, and other elements had been repaired in the past due to corrosion of embedded steel and freeze-thaw damage of the concrete. During the most recent repair project in 2012, limited concrete repair to deteriorated window sills and coating of the concrete was performed on the north facade. That project generally consisted of localized surface preparation, installation of a polymer-modified repair mortar, and the application of a concrete coating to refresh the street side building appearance.

In addition to the observed concrete distress, the built-up roofing membrane systems at both the main roof and turbine roof areas were found to be at the end of their useful service life. Insulating glass units in the aluminum-framed retrofit windows were cracking, possibly in part as a result of expansive forces created by the corrosion of the original steel angle embedded in the concrete opening at the window perimeter.

REPAIR AND REHABILITATION

A comprehensive repair program was designed and implemented in 2014 that included concrete facade repair, window replacement, and roofing membrane system replacement. As the Sitka Sound Science Center is a historic building and is listed in the National Register of Historic Places, work was performed in accordance with the Secretary of Interior's Standards for the Treatment of Historic Properties. A primary goal of the rehabilitation was to match the appearance of the original concrete and windows.

The construction phase provided unique challenges for the contractor. The Science Center's oceanfront location in Sitka exposes it to extreme weather exposures, wind driven rain, and chloride-laden air, while limiting the summer timeframe for repairs. The building's working fish hatchery and aquarium remained operational throughout the construction. These limitations required the contractor to tent the building to protect the occupants and fish hatchery during lead paint removal, as well as provide shelter to extend the construction season. The contractor coordinated with the building users to phase the work to limit disruption. Careful planning and coordination of the work by the contractor was also required due to the location of the Science Center and because most of the construction materials arrived by barge.

To ensure coordination between existing conditions, repairs, and the new windows, as well as to review the mock-up work prior to full-scale implementation, the contractor installed trial repairs at select locations. Because the primary source of distress was related to the corrosion of embedded steel at the windows, the repairs included demolition of unsound concrete at the window openings (Fig. 6 and 7). The contractor shored the window openings and portions of the openings were saw cut from the exterior, as well as from the interior. The embedded angles from the original windows were removed. New concrete openings were formed and the repair concrete mechanically attached to the existing structure with supplemental epoxy-coated reinforcing steel.

Window sills required a variety of repair options because of varied levels of deterioration. The sills were redesigned to better accommodate the new windows and manage water, while still matching the historic profile and appearance. A recessed horizontal ledge was created in the existing window sills by saw cutting and chipping out existing concrete (Fig. 8 and 9). Where required, full-depth sill repair included demolition of the sill while leaving the existing reinforcing steel intact. The existing reinforcing steel was cleaned, sandblasted, and painted with a corrosion inhibiting coating. The repair concrete was keyed into the sill using epoxy-coated L-shaped rebar set in epoxy. Shallow distress was repaired by first saw cutting the exterior portion of the sill, leaving the existing reinforcing steel intact. Similar to the full-depth repairs, the existing reinforcing steel was then cleaned, sandblasted, and painted with a corrosion inhibiting coating, and the repair concrete was keyed into the sill using epoxy-coated L-shaped rebar set in epoxy.

At the architectural details, building corners, and other unique concrete elements of the building, unsound concrete was removed by carefully saw cutting and chipping. Existing reinforcing steel was left intact and supplemented with additional reinforcing steel. The existing reinforcing steel was cleaned and coated, and supplemental L-shaped epoxy-coated rebar was installed. The adjacent concrete repair surfaces were cleaned and sandblasted prior to the new concrete being formed. The contractor created custom formwork so that the architectural facade, details, corners, and other significant elements could be restored to match the original adjacent concrete profile and finish.

Two new windows were installed in a mock-up area and field water testing performed in order to verify window performance prior to window installation throughout the project. The new aluminum-framed windows incorporated insulating glass units that aesthetically replicated the historic character of the original window systems, while providing the enhanced thermal performance required for the adapted building use and local weather conditions. The new windows were installed, as well as new doors and transoms.

Fig. 8: Saw cutting and chipping of concrete sill to create recessed flashing ledge for new window sill (2014)

Fig. 9: Modified concrete window sill with recessed flashing ledge (2014)

Over the entire facade, the existing coatings were carefully removed by the contractor using special removal techniques. Cracks and joints in the facade were repaired by routing and filling with sealant. Care was taken in the sealant installation to minimize the visual impact. After sealant curing, a breathable architectural coating was applied to the concrete facade to match the original coating color.

In addition to the concrete repairs and window replacement, paint was removed from the decorative embedded tiles using the gentlest means possible, without damaging the original tile finish. A small number of the tiles that were too severely deteriorated to repair were removed and replaced with new tile matching the original. The concrete facade repair and rehabilitation project (Fig. 10) was completed in the fall of 2014.

CONCLUSION

Repair of historic and architectural concrete is more challenging than conventional concrete repair and requires a higher level of craftsmanship, collaboration, and experience of the project team. Proper planning and enough time in the schedule are important for samples, trial repairs, and the review and approval process.

Fig. 10: Completed repair and rehabilitation of exterior concrete facade (2015)

REFERENCES

1. ASTM C856, "Standard Practice for Petrographic Examination of Hardened Concrete," ASTM International, West Conshohocken, PA, 2014, 17 pp.

2. ASTM C1218/C1218M, "Standard Test Method for Water-Soluble Chloride in Mortar and Concrete," ASTM International, West Conshohocken, PA, 2015, 3 pp.

3. ASTM C42/C42M, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete," ASTM International, West Conshohocken, PA, 2013, 7 pp.

Restoring Historical Sitka Sound Science Center
Sitka, Alaska

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Sitka Sound Science Center
Sitka, Alaska

ENGINEER
Wiss, Janney, Elstner Associates, Inc.
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CONTRACTOR
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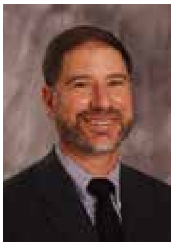
Central Point, Oregon



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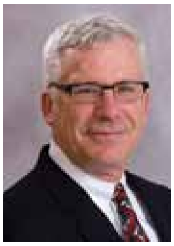

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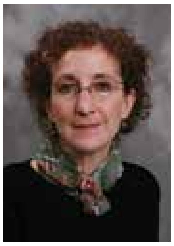

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