RESTORATION AND RECONSTRUCTION OF THE ST. CHARLES MUNICIPAL CENTER RIVER WALL AND PLAZA

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ABSTRACT
The Municipal Center located along the eastern shore of the Fox River in St. Charles, Illinois, consists of the Municipal Building, plaza, river wall, fishing platform, and north viewing platform. Listed on the National Register of Historic Places, the Municipal Center was designed by noted architect R. Harold Zook and was completed in 1940. The plaza, which abuts the north, south, and west sides of the building, was originally designed to complement the design features and style of the building. The west edge of the plaza is defined by a 4 m (12 ft.) tall concrete river wall clad with Lannon limestone.

For more than sixty years, the river wall was exposed to an extreme environment. This exposure to this extreme environment resulted in an advanced state of deterioration of the concrete and stone elements. In addition, significant alterations to the original plaza were performed in the 1970s and 1990s. An investigation was performed between 2006 and 2007 to determine the extent and causes of deterioration to the plaza and river wall as well as develop a plan for restoration.

Reconstruction of the original design of the plaza and river wall was performed. The intent of the project was to re-establish the design features of the plaza and river wall based on original available drawings, as well as our interpretation of the original designer's intent. The primary objective of the repairs was to use materials and techniques that would be sympathetic to the original design intent and perform well under the extreme environmental conditions at the site.

KEYWORDS: limestone, concrete restoration, reconstruction, river wall

INTRODUCTION
Located in the western suburbs of Chicago, the St. Charles Municipal Center is a rare example of Art Moderne architecture in the United States. Built at a time when little construction was occurring, this structure combines modern building systems as well as historical techniques. Alterations to the exterior terrace surrounding the building dramatically changed the intent of the original designer, Harold Zook, to create interaction between the exterior and interior of the building. While the building itself is in good condition, much of the original plaza was replaced and portions that remained intact were significantly deteriorated.

HAROLD ZOOK
Roscoe Harold Zook was a noted architect who practiced between 1920 and 1950. Zook's designs can be found throughout the western suburbs of Chicago, as well as Iowa, Wisconsin, and Tennessee.

Zook was born in Valparaiso, Indiana in 1889. He was one of five children. After completing high school, he enrolled at Chicago's Armour Institute of Technology (the predecessor of I.I.T.) where he received a degree in architecture in 1914. Zook's career began in the office of Howard Van Doren Shaw and eventually he opened his own office.

MUNICIPAL BUILDING
The St. Charles Municipal building was completed in 1940, at a cost of $250,000, on the site of the old Fixture Factory which had burned in 1929. Designed in the Art Moderne style, which combines smooth lines, flat surfaces, and minimal ornament, the building incorporates administrative offices, city council chambers, and a museum, see Figure 1. A multi-colored terrazzo terrace was incorporated into the original design which provided access to the building as well as a view of the Fox River. The west edge of the plaza was defined by a 4 m (12 ft.) tall limestone river wall. A major renovation was undertaken in the 1990s which included ADA upgrades, as well as the addition of a two-story structure connecting the Municipal Building with the Old City Building. The 1990s renovation also included major modifications to the original terrace.

Figure 1: Historic Rendering of Municipal Center

MUNICIPAL BUILDING TERRACE
The original terrace wrapped around the north, south and west facades and consisted of a terrazzo topping on a reinforced concrete slab which was integrated into the river wall. The terrace included planters and walkways which allowed pedestrians to pass directly by the windows in the public portions of the building, see Figure 2. The original terrace was

substantially altered in the 1990s by including planters adjacent to the building walls on the north, south and west facades as well as changing the paving system to brick and concrete. A cast-in-place concrete observation terrace was also added at the north end of the original terrace. The limestone clad sea wall incorporates two decorative fountains as well as a stair which extends from the terrace to water level. The sea wall also incorporates a limestone clad fish ladder at the north end.

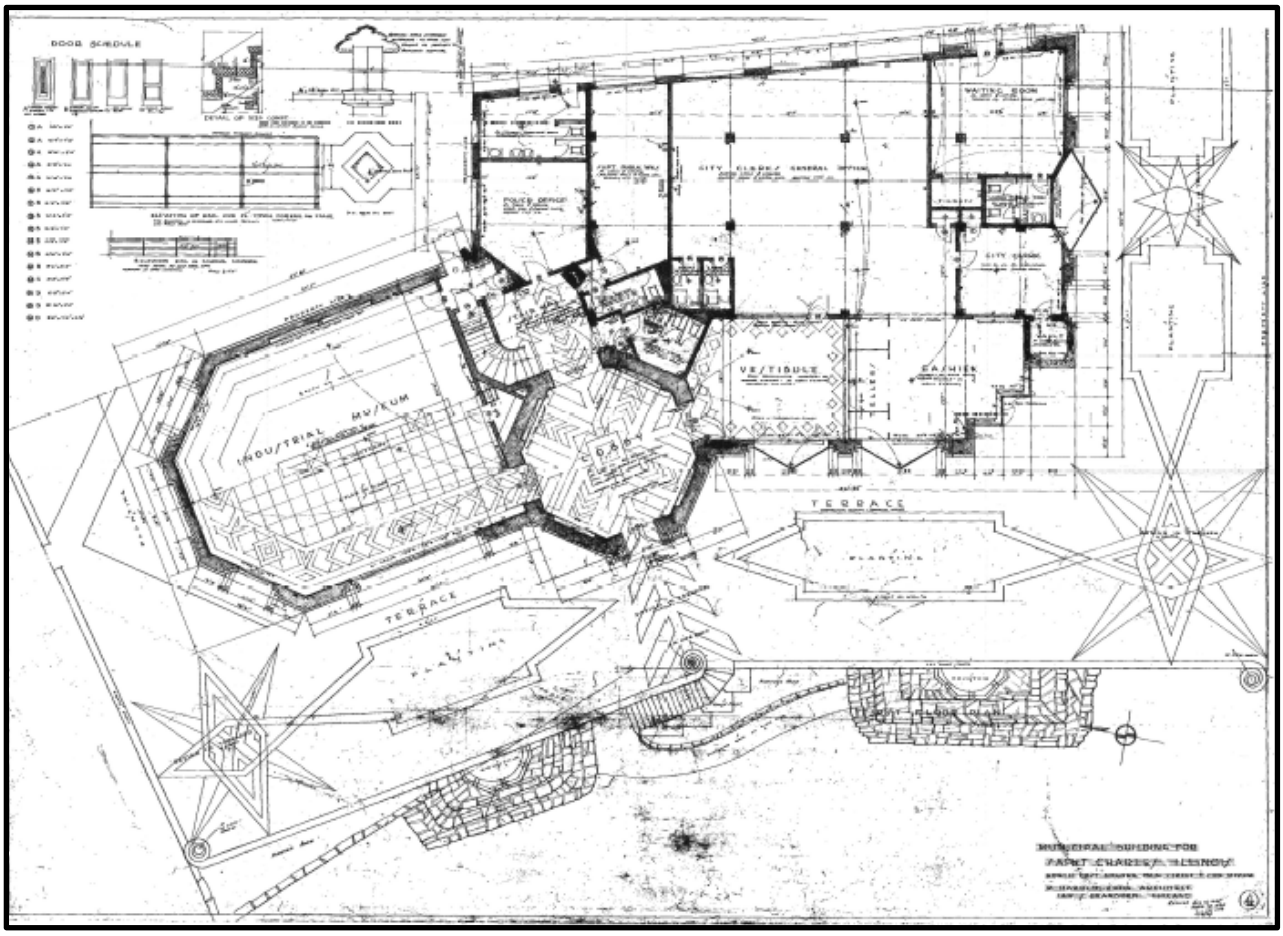

Figure 2: Original Ground Floor Plan of Building and Plaza

EVALUATION AND INVESTIGATION

A limited inspection and investigation of the river wall was performed by WJE. Significant findings of the various inspections are summarized below:

LIMESTONE CLADDING

Extensive distress was observed throughout the various components of the river wall. Typical distress observed in the limestone cladding of the river wall included spalls, incipient spalls, cracks, deteriorated mortar joints, exfoliated/scaled limestone surfaces, and displaced limestone cladding. The majority of distress in the limestone cladding was the result of weathering (i.e., exposure to water and cyclic thermal changes) over time. As expected, the areas with the

greatest exposure to water (e.g., the fountains and wall adjacent to the fish ladder) exhibited the greatest levels of distress.

Figure 3: Deteriorated Limestone Adjacent to the Fish Ladder

Beyond the environmental conditions to which the stone was exposed, the sedimentary limestone used had many soft and weak planes as well as fissures. These characteristics are associated with its original formation by the sedimentation process of deposition in multiple layers or beds. By contrast, the Indiana limestone used at the top of the walls is known for its uniform density and color and lack of weak planes. The rough cut limestone cladding units, which were typically installed with the bedding planes positioned in the vertical direction (parallel to the exposed face) such as at the river wall, are more susceptible to deterioration from long term weathering, see Figure 3. Water is absorbed into the softer and more porous bedding planes and with time the bedding planes separate from the adjacent stone, see Figures 4 and 5. When the bedding plane is oriented parallel to the face of the wall, spalling, exfoliation and face shearing result. Typically, limestone units are laid up such that the bedding plane is positioned in a horizontal direction so that deterioration of individual units will be restrained by the surrounding units.

Figure 4: Overall View of Limestone Fountain

Figure 5: View of Deterioration of Stone at Fountain

CONCRETE RIVER WALL

Petrographic examination of the selected concrete core samples indicated the presence of light-colored, lightweight chert aggregate within the concrete mixture, making the concrete more susceptible to alkali silica reaction (ASR). The lack of air-entrainment within the concrete

samples also made the wall more susceptible to freeze-thaw damage; air entrainment was not widely accepted in local governmental projects at the time that the building was constructed. Core samples removed from the river indicated some localized deterioration at the outer face of the wall. Deterioration observed near the outer surface of core samples was determined to be the result of cracking due to combined ASR expansion and cyclic freezing and thawing in locally saturated conditions. Both freeze-thaw distress and ASR are the direct result of sustained exposure to moisture.

PLAZA SLAB

Original drawings indicate that the concrete plaza slab was to be connected to the concrete river wall with dowels. The dowels were intended to provide lateral strength and stability to the wall against pressure from soil backfill and surcharge loads from the plaza slab, pedestrians, and maintenance equipment. Removal of concrete core samples from the plaza directly adjacent to the wall indicated that dowels connecting the concrete wall to the plaza slab were not present.

CONCLUSIONS

Based on the evaluation performed of the existing river wall and plaza we concluded the following:

1. The quantity and widespread distribution of the spalling and other distress in the limestone cladding are indicative of a severely deteriorated wall cladding. As such it was recommended that the entire height of the wall (including the cut limestone parapets) be replaced.
2. Deteriorated concrete (i.e. spalled, delaminated, cracked, or scaled surfaces) was determined to be present at locations of continued water saturation throughout the river wall. The extent of damage was greater at locations which have had a higher exposure to moisture, e.g., areas adjacent to the fish ladder, fountains, and substructure. Repair of the concrete portions of the river wall were also necessary to maintain the structural integrity of the wall, as well as to provide a sound backup for the new limestone cladding.

SCOPE OF RESTORATION

Based on the work performed for the evaluation of the existing river wall and plaza the following scope of work was recommended:

1. Remove and replace the limestone cladding and handrail at the river wall from the Main Street Bridge north to the west stairway. Rebuild the existing fountain at this portion of the wall, as well as repair the concrete backup wall.
2. Remove and replace the fishing platform surface from the Main Street Bridge north to the stairway.
3. Remove and replace the limestone cladding and handrail at the remaining portion of the river wall. Rebuild the existing fountain at this portion of the wall, as well as repair the concrete backup wall.
4. Remove and replace the remaining portion of the fishing platform surface.
5. Remove and replace the existing stairway including the stone or precast concrete cladding.
6. Rebuild the viewing platform at the far north edge of the river wall and plaza
7. Remove and replace the plaza, replicating the original as-built condition.

REPAIR METHODOLOGY

Based on the design team's recommendation, the owner opted to revive Zook's original design intent for the plaza. The primary objective of the repairs was to use materials and techniques which would be sympathetic to the original design intent and perform well under the extreme environmental conditions at the site. The various components of the reconstruction project each presented unique challenges in design, construction, and durability.

PLAZA AREA

Based on the original design drawings, the plaza appears to have been intended to be paved with materials and patterns similar to the interior floor surfaces; however, these materials are not durable in Midwestern climates. The new plaza paving was designed to replicate the original design intent. Paving materials were selected to be durable with a color pallette consistent with the building floor. Based on these criteria, a 150 mm (6 in.) thick reinforced conventional air-entrained concrete slab-on-grade was selected. In order to achieve the desired colors, an integral color pigment was added to the concrete mixture. Numerous mock-ups of the integrally colored concrete, utilizing various proportions of gray and white cement, were made to evaluate color, texture, and jointing between colors. The integrally colored concrete was required to be jointed in a manner that would replicate the original pattern and provide clean transitions between colors. Approximately 190 cubic meters (200 cubic yards) of the integrally colored concrete, placed in more than a dozen pours, was required to achieve the as-designed pattern of the plaza slab and planters.

RIVER WALL

Various options for restoration of the river wall cladding, parapet walls, and stair enclosure were studied. As a result of these studies, the following solutions for each portion of the river wall were implemented:

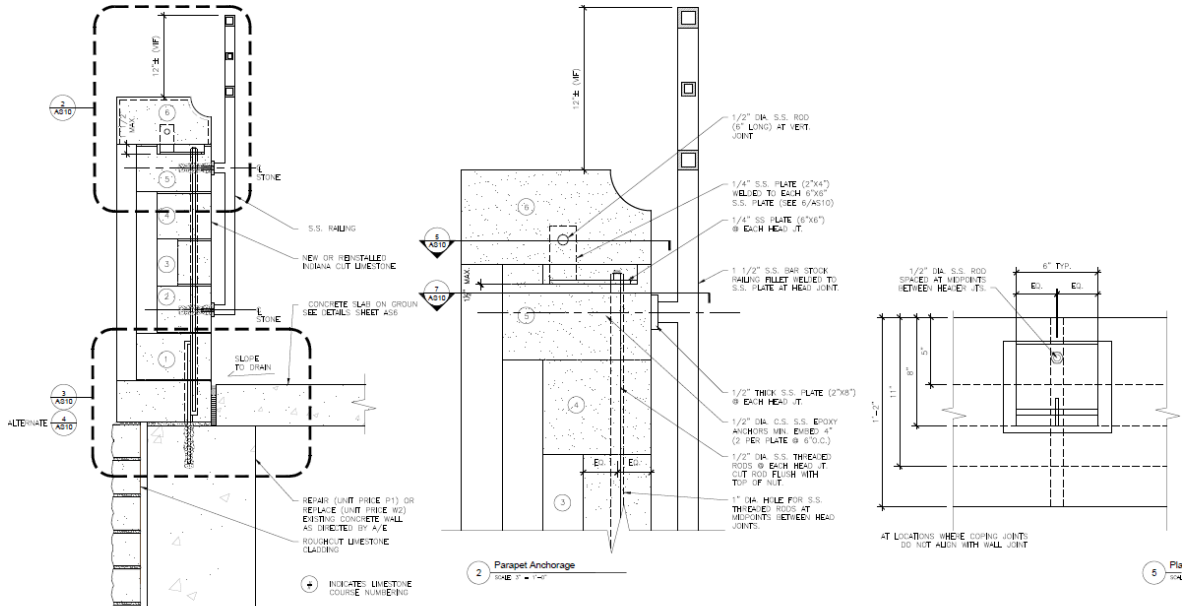

Figure 6: River Wall Construction Details

RIVER WALL AND CLADDING

Extensive deterioration of the northern portion of the concrete river wall, directly adjacent to the dam, required that it be removed and rebuilt. The rebuilt wall consisted of a 200 mm (8 in.) thick conventionally air-entrained concrete wall reinforced with epoxy-coated steel reinforcement. The new wall was anchored to the existing dam abutment structure with 25 mm (1 in.) diameter rock anchors embedded 1m to 1.75 m (3 to 5 ft.) into the existing structure. Additional concrete patching was required throughout the remainder of the wall. The concrete repairs were typically 4 inches deep, requiring that the repair materials be placed into formwork. The patches were anchored to the original base mix concrete with embedded epoxy-coated steel dowels.

Each piece of the existing Lannon limestone cladding was digitally identified and documented prior to disassembly. Salvageable units were retained and reinstalled in their original position. New matching Lannon limestone units were used to replace deteriorated units. The new wall cladding was anchored to the repaired concrete back-up wall with regularly spaced stainless steel anchors. Physical testing and petrographic examination of samples of the new Lannon limestone cladding material were performed to determine if there were any inherent weaknesses in the new material that would lead to premature failure.

PARAPET WALL

The west and north edges of the plaza are defined by the cut Indiana limestone parapet wall that extends above the Lannon limestone-clad river wall. Previous modifications to the plaza raised the elevation of the pavement, causing the height of the parapet wall to be less than that required by the current building code. The design team and Owner opted to install a stainless steel railing in lieu of significantly altering the look and configuration of the existing parapet wall, see Figure 6. Introduction of a stainless steel railing is a clearly distinguishable element and therefore consistent with accepted preservation approaches. By introducing the stainless steel railing, the required guardrail height was achieved, the visual impact was minimized, and a degree of transparency was maintained.

The pieces of the existing cut Indiana limestone parapet that were salvageable were reinstalled along the north side of the plaza with stainless steel anchorage, essentially replicating the original carbon steel anchors which had corroded and caused significant damage to most of the Indiana limestone. Remaining pieces of the salvaged cut limestone, not used in the reconstruction of the north parapet wall, were retained by the Owner for future maintenance repairs. Along the west edge of the plaza, the design team and Owner opted to recreate the parapet wall utilizing precast concrete panels simulating the look, color, and texture of the original cut limestone parapet wall. Numerous mockups and submittals were required by the precast concrete subcontractor to develop and fine-tune the concrete color, finish, and jointing so that the final precast concrete members matched the cut limestone. Use of epoxy-coated steel reinforcement, air-entrained concrete, and stainless steel connections were specified to help increase the durability of the precast concrete members.

As with the parapet wall along the west side of the plaza, the design team and Owner decided to recreate the original cut limestone cladding of the stair using matching precast concrete. Again, use of epoxy-coated steel reinforcement, air-entrained concrete, and stainless steel connections were specified to help increase the durability of the precast concrete members.

FISHING AND VIEWING PLATFORMS

The fishing and viewing platforms had been altered geometrically and physically from the original design intent. These features are less significant as they relate to the river wall and the plaza, since they are physically separated and have minimal visual impact. The design team and Owner chose to retain the viewing platform to maintain the connecting link between the plaza and the river walk to the north. As such, the fishing and viewing platforms were restored with special attention paid to incorporating details correlating with the original designer's intent and expression.

The extent of deterioration of the original concrete structures of the fishing and viewing platforms required that they be completely removed and rebuilt. The reconstructed platform structures utilized modern concrete construction practices, such as epoxy-coated steel reinforcement and air-entrained concrete, to help increase the durability of the structure. At the fishing platform level, 25mm (1 in.) diameter rock anchors, embedded 1 m (3 ft.) into the existing bedrock below the river bed, were installed at approximately 1 m (3 ft.) on center to anchor the new structure.

LIGHTING

The original lighting had been removed. One of the fixtures was retained and on exhibit at a local museum. The Owner commissioned a local artist to recreate the fixtures.

CONSTRUCTION

The work site presented the contractor with many challenges including a small site with difficult access, particularly for delivering, storing and setting new materials, placing large volumes of concrete, maintaining egress for the functioning Municipal Building, and the need to perform extensive repairs from the Fox River. In order to accomplish the work from within the river, the contractor utilized a portable dam system creating a semi-dry condition around the repair areas. The dam system was in place for approximately four months during the reconstruction. The limitations of the site often prevented concrete trucks from being able to be positioned near the site of the required concrete pours. In order to efficiently place the concrete, the contractor utilized pumps and buckets attached to a crane.

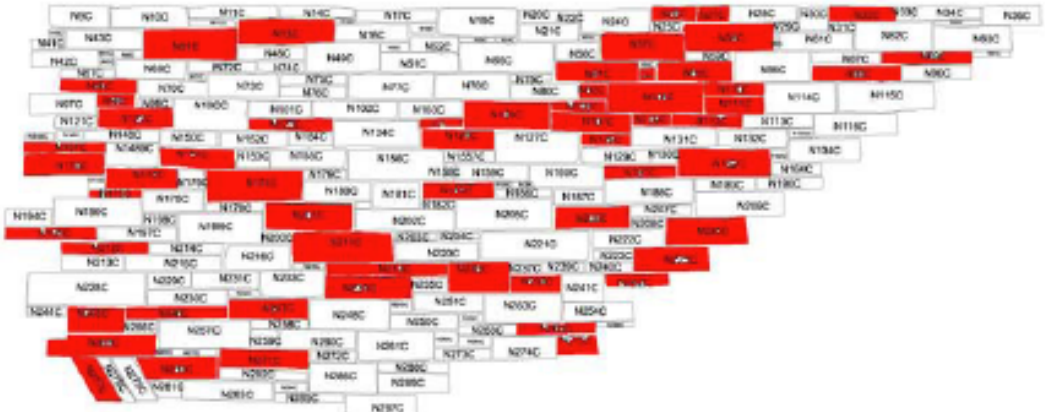

Figure 7: Representative Digital Scan of Stone. Replacement Units are Designated in Red.

Figure 8: Overall View of Construction

Figure 9: Installation of Integrally Colored Concrete

In order to replicate the original configuration of rough cut limestone, the contractor made a digital scan of the wall prior to demolition, see Figure 7. Using the scan, each unit was numbered. Units exhibiting signficant damage or face bedding were identified and replaced with new units. Having a sense of the size and quantity of the damaged or deteriorated units, the contractor was able to reduce waste and pre-size many of the units.

Figure 10: View of Plaza from South Following Completion of Reconstruction

SUMMARY

The restoration of the St. Charles Municipal Center River Wall presented many unique challenges. Performing the work adjacent to a river, see Figure 8, as well as on a site with limited staging areas, required coordination among many local, state and Federal agencies, see Figure 9. In spite of extensive investigation including investigative openings, the extent of concealed deterioration required expanding the scope of repair work. With the completion of the terrace restoration, the building is once again a focal point of local pride-- a unique example of Art Moderne style, and Harold Zook's work in particular, see Figure 10.