ICRI 2024 Project Awards

The International Concrete Repair Institute (ICRI) announced the winners of its 2024 Project Awards. This year, three finalists were chosen, and the winner was announced on October 24, 2024. ICRI presented the Project of the Year Award to Wiss, Janney, Elstner Associates, Inc., out of Minneapolis, MN, USA, for its 3rd Avenue Bridge Rehabilitation project. ICRI awarded four additional Awards of Excellence and eight Awards of Merit.

ICRI 2024 Project of the Year Award Winner

3rd Avenue Bridge Rehabilitation

The 3rd Avenue Bridge rehabilitation project in Minneapolis, MN, completed in 2023, stands out for its immense scale, the bridge's one-of-a-kind historic concrete arch construction and setting, the unusual composition and severe deterioration of the original 100-year-old concrete, and the innovative methods that were used to repair the concrete to extend the bridge's life for another 50 years. The condition assessment, alternatives studies, and repair design phases collectively took 3 years, and construction spanned another 3 years.

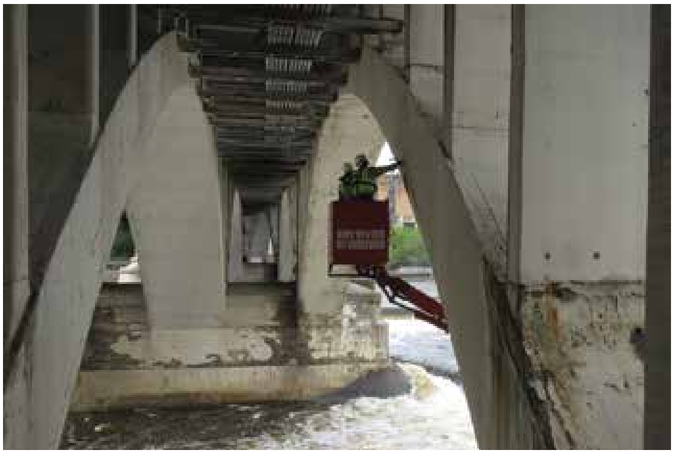
The bridge consists of seven original concrete arch spans in the river and approach spans on either end. Arch spans 1 through 5 consist of three arch ribs, while spans 6 and 7 consist of full width barrel arches, both of which support spandrel columns that in turn support the bridge deck. The bridge was constructed using the Melan reinforcing system, with no conventional steel reinforcing bars in the arches. Rather, the concrete arches are reinforced with internal steel trusses composed of double-angle chords connected with riveted steel gusset plates and diagonal cross braces.

Although the bridge had been rehabilitated before, first in 1939 and then with extensive repairs and a full deck replacement circa 1980, by the early 2000s, the bridge was again displaying significant concrete deterioration and structural deficiencies that needed to be addressed. The purpose of the recently completed rehabilitation was to address the bridge condition, raise the National Bridge Inventory (NBI) rating from 4 to at least 6, and achieve a target service life of at least 50 years.

Condition assessment

The condition assessment for the 3rd Avenue Bridge was performed in two phases. Phase 1 consisted of a close-up, element-level bridge inspection and representative sounding of 100% of the exposed surfaces. Distress conditions and condition states were digitally mapped on scaled drawings using tablets.

View of historic 3rd Avenue Bridge during rehabilitation

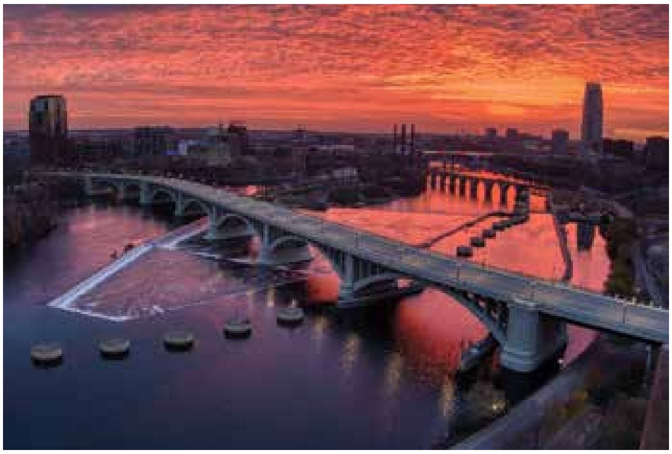


Hands-on inspection from under-bridge inspection unit, showing deterioration of arch ribs and pier bases

Based on the Phase 1 inspection, small study areas across the bridge were selected to represent the full range of conditions present. Phase 2 consisted of field testing and materials sampling at each study area, with the primary goal being to identify the severity and the mechanisms of deterioration occurring in the concrete for each element type. The study areas were spatially distributed across the bridge to represent the range of conditions and types of materials present.

Field testing methods at over 100 study areas used on the 3rd Avenue Bridge included half-cell potential surveys, corrosion rate measurements, resistivity testing, carbonation testing, and ultrasonic thickness testing of steel truss members. Lab testing of material samples taken from the bridge, comprising over 80 concrete cores and 10 steel samples, included testing for mechanical properties of

Access to the substructure required complicated suspended scaffolding and dewatered cofferdams *(photo courtesy of Joe Szurszewski Photography)*



View of the 3rd Avenue Bridge after completion of rehabilitation *(photo courtesy of Trey Cambern Photography)*

concrete and steel materials, chloride content profiling, and petrographic analyses of numerous cores to identify vulnerabilities specific to the concrete in this structure. Service-life projections were developed for each element type, which were used to inform the development of rehabilitation alternatives and life-cycle cost comparisons.

Concrete rehabilitation and construction

After analysis of the rehabilitation alternatives with various service-life projections, the alternative that would achieve a service life of at least 50 years was selected, which became the design criteria for the concrete repairs.

Rehabilitation of the bridge required complex engineering and construction sequencing. Access from below using barges was limited due to the multi-tier falls and adjacent power station. This necessitated a top-down approach, but loading on the superstructure had to be limited to avoid overloading the existing arches which, due to their shallow profile, experience high bending stresses under unbalanced loads. A series of tower cranes were constructed within the bridge piers to accomplish the deck and column replacements, with assistance from smaller mobile cranes. Access to the substructure required complicated suspended scaffolding and dewatered cofferdams in the fast-moving river.

Concrete repairs

Based on the inspection, concrete surface repairs were specified for all locations where delaminations, spalls, and previous repairs were present, and repair details were developed for each typical location. Unique details were provided to address the severe corrosion-related distress at the arch rib corners, longitudinal cracking at the tops and bottoms of the arch ribs, and areas where freezing-and-thawing damage was particularly deep. The concrete repair specifications were designed to allow the contractor freedom to choose form-and-place, form-and-pump, or shotcrete methods with either prepackaged or ready mixed concrete for each type of repair. Applicable material properties and quality control requirements were included for each repair method and material.

Freezing-and-thawing damage was present below drain discharges or at arch springlines where water collects. Based on petrographic examination of core samples, most of the surface repairs were anticipated to be no more than 6 in. (152 mm) deep, but repair details were provided for depths up to 12 in. (305 mm), which was the deepest damage observed in the core samples. Even deeper freezing-and-thawing damage was present at the pier bases, near the waterline, and below drain discharges. Maximum concrete erosion was up to 17 in. (432 mm), and freezing-and-thawing damage up to another 8 in. (203 mm) was present beyond that.

Rather than removing all the freezing-and-thawing damaged concrete, the repair details required removal of a uniform 12 in. of concrete to reach what was defined as an "intact concrete substrate." Deeper removals were performed in localized "pockets" to reach an intact surface. Longer epoxy-anchorages were installed deeper into the sound material beyond the removal depth, and a new grid of stainless-steel reinforcement was installed near the surface.

Crack repairs and coating

Research showed that the 3rd Avenue Bridge had various surface treatments in its history. The original concrete is non-air-entrained and chloride-contaminated, and therefore extremely vulnerable to future deterioration and loss of historic fabric if water penetrates. After discussions between historians and technical experts, it was agreed that crack repairs and a high-performance, film-forming, and water-resistant coating would be applied to all historic concrete surfaces. A relatively thin acrylic-based coating product was selected so as not to mask the original form-board lines. It can be removed, which is important for historic structures, and it enhances the appearance of the concrete by masking multiple generations of different colored patches.

Targeted cathodic protection at arch corners

The deterioration in the arches was concentrated at the arch corners, where exposure is the worst due to direct runoff and two-side exposure to moisture and freezing-and-thawing cycles. Corners that were distressed were repaired using a custom detail that included reinforcement to control cracking and maintain tight perimeters and bond, as well as continuous cathodic protection anodes to protect portions of the Melan angles that were not exposed, cleaned, and coated. To mitigate future deterioration along the arch corners where there was no current distress, a targeted cathodic protection approach was implemented. Discrete, two-stage anodes were field located based on half-cell potential testing performed during the construction phase.

Restoration of historical features

The 3rd Avenue Bridge is on the National Register of Historic Places. Preservation of original materials to the extent possible and restoration of the original bridge aesthetics were primary considerations. The project was reviewed and approved by historic preservation agencies.

The intricate profile of the monumental piers was reproduced in the pier jackets using field-built formwork and self-consolidating concrete. Shotcrete repairs in areas most visible to the public were hand-finished to match the board-form lines in the adjacent original concrete. Pier walls that were replaced were constructed using form liners to replicate the board form finish. The surface coating applied over the entire bridge was color-matched to the original colors. For each type of concrete repair, mockups were required so that both quality and aesthetics could be confirmed.

The rehabilitation also provided an opportunity to restore several original aspects of the bridge. For example, the curved ends of the original cap beams were reproduced in the new precast cap beams, and new streetlamps mimicking the original historic lighting on the bridge were installed. The aluminum railings installed circa 1940 were cleaned and reinstalled, including augmentation to meet current code requirements.

Rehabilitation was completed and the bridge was opened to traffic in October 2023. Total construction cost was approximately 150 million USD. Over 100,000 ft^2 (9290 m^2) of concrete surface repairs were installed by shotcreting, and over 10,000 cathodic protection anodes were placed.

Project Credits: Submitted by Wiss, Janney, Elstner Associates, Inc., Northbrook, IL, USA; Owner, Minnesota Department of Transportation, Saint Paul, MN; Engineer, Wiss, Janney, Elstner Associates; Contractor, RH Ward & Associates, Inc., South Chicago Heights, IL; and Material Supplier, Vector Corrosion Technologies, Lexington, KY, USA.

ICRI 2024 Project of the Year Award Finalist

Baltimore Design School

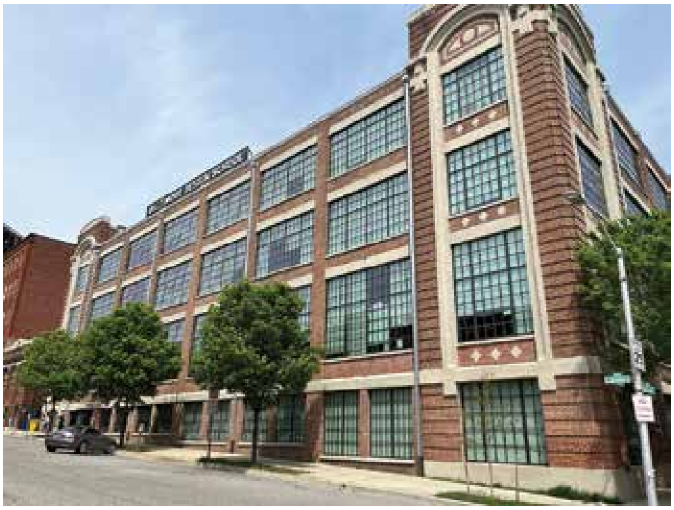
The Baltimore Design School is a combined public middle and high school dedicated to students interested in architecture, graphic design, and fashion. It is in the North Central Historic District in Baltimore, MD, USA, and is the first area in the city as an arts and entertainment district listed on the National Park Service's National Register of Historic Places. The school was founded a few years ago; but its current home, a 110,000-ft^2 (10,219-m^2) facility, was a former clothing factory.

2024 Awards of Excellence

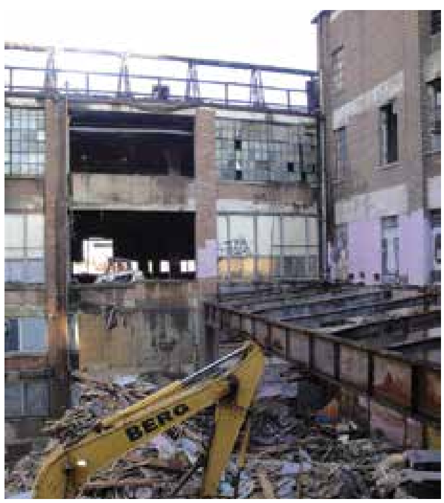
- Historic Category—City of Westminster, Maryland Historic Clocktower Rehabilitation, Westminster, MD, USA; submitted by Concrete Protection & Restoration, Inc.
- Parking Structures Category—Hartsfield-Jackson Atlanta International Airport North and South Domestic Terminal, Atlanta, GA, USA; submitted by Walker Consultants
- Parking Structures Category—The Granite Club Garage Rehabilitation Project, Toronto, ON, Canada; submitted by WSP Canada
- Transportation Category—A Testament to Longevity: Yaquina Bay Bridge Cathodic Protection Rehabilitation, Corvallis, OR, USA; submitted by Vector Corrosion Technologies

2024 Awards of Merit

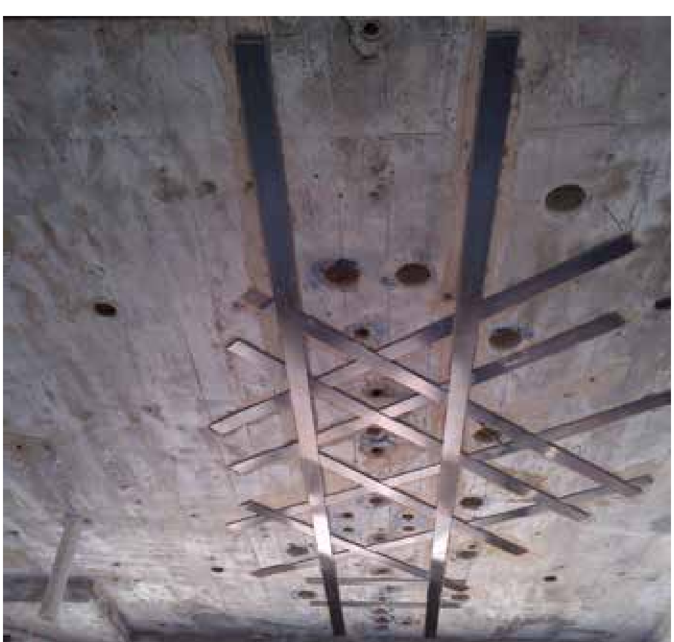
- Historic Category—Reviving Heritage: Surfside's Journey from Historic Landmark to Luxury Haven, Ft. Lauderdale, FL, USA; submitted by Kline Engineering and Consulting
- Historic Category—Conservation of Constantino Nivola's Concrete Play Horses, New York, NY, USA; submitted by Jablonski Building Conservation, Inc.
- Historic Category—Jackson Lake Lodge Façade Restoration, Moran, WY, USA; submitted by Bulley & Andrews Concrete Restoration
- Masonry Category—Historic First Baptist Church – Exterior Masonry Repairs, Asheville, NC, USA; submitted by WxTite LLC
- Parking Structures Category—Repairs and Waterproofing of CBD Parking Garage, Malden, MA, USA; submitted by Simpson Gumpertz & Heger
- Special Projects Category—West Virginia Capitol Stairs, Charleston, WV, USA; submitted by Structural Group Inc.
- Special Projects Category—Stegeman Coliseum Concrete Ceiling Structural Repairs, Athens, GA, USA; submitted by United Restoration and Preservation, Inc.
- Transportation Category—Vancouver International Airport (YVR) Runway Dowel Bar Retrofit Project, Langley, BC, Canada; submitted by CanWest & Westcoast Slot Cutting JV



The Baltimore Design School



A massive clean-out operation had to be carried out to remove equipment, furniture, and litter from over the years



Carbon fiber plates were installed for strengthening

This building was constructed in 1914. The four-story structure was the machine shop for a global supplier of bottle caps before housing a clothing manufacturer. Constructed of reinforced concrete, the building was the first in Baltimore to use a "beamless floor system", also known as flat-slab construction, that did not require structural beams to span between columns. Expansive industrial steel-sash windows totaled over 60% of the surface area of the building's exterior skin.

Condition assessment and site preparation

Once the decision was made regarding the site selection, a design and construction team was assembled to perform condition assessments. Unoccupied and lacking maintenance for over a quarter of a century, the building was in extreme disrepair. Due to the lack of concrete cover, lower quality concrete, and advanced carbonation, corrosion had spread throughout the exterior reinforced elements and interior columns. Ceilings and spandrel beams were heavily damaged from advanced corrosion. Testing revealed that the concrete had a 2000 psi (13.8 MPa) compressive strength. The steel reinforcement was smooth and uncommonly placed diagonally to column alignment. Severe corrosion diminished the capacity of the reinforcement, making it necessary to use structural strengthening in addition to the repair and protection work.

A massive clean-out operation had to be carried out to remove equipment, furniture, and litter that had accumulated through the years. Abatement had to be performed to ensure protection for all the construction workers and staff.

Repairs

Upon completion of the assessment, it was clear that an extensive and multi-faceted approach would be required to meet the complex challenges induced by decades of neglect. The following was the agreed and employed strategy of the design and construction team.

Cracks that were not corrected during the extensive spall repair operations were individually classified as structural or non-structural cracks. The structural cracks were repaired by means of low-pressure injection with high-modulus, low-viscosity epoxy resin. Non-structural cracks were addressed by routing and sealing with low-modulus polyurethane sealant for adhesion, flexibility, and overcoating benefits.

All major methods of concrete repair techniques were incorporated into the overall strategy. This included hand-applied, machine-applied, form-and-place, and form-and-pump applications. The method of installation was selected based on the orientation, the size of the repair, and the predicted productivity of the technique.

Any surviving smooth reinforcing bars in the repairs were thoroughly cleaned and coated with a corrosion-resistant primer that also increased adhesion with the repair material. However, there was a large amount of reinforcement throughout the structure that was terminally corroded and had to be replaced with new reinforcing bars or complemented with additional strengthening. New reinforcement was required for all spandrel beam repairs.

The hand-applied method was chosen for both the smaller more isolated repairs on columns and ceilings and for the more complicated architectural features such as with the exterior arches. Machine-applied repair mortar was used to repair some large ceiling sections. This method was selected to improve production while providing a very dense material. Flowable repair mortars and concretes were predominately used in larger surface area repairs to the columns varying from shallower to deeper thicknesses. Prepackaged, self-consolidating concrete was used to repair the vast volume of spandrel beams at the windows. The limited width and depth of the repair, combined with the quantity of and size of the required reinforcement, plus the expansive length of spandrel beams, dictated special consideration to the application and material.

Roof slabs of the building had extreme section loss requiring new reinforcing. Supplemental reinforcement was also used to bring slabs back to their safe load bearing capacity. Carbon fiber plates were installed to strengthen these areas as well as at locations of new penetrations needed for mechanical, electrical, and plumbing systems. A low-modulus polyurethane sealant was used for sealing of joints in concrete and masonry surfaces, and a silicone sealant was applied at glass substrate related connections.

Corrosion mitigation and protective coatings

As the destructive nature of the carbonation-induced corrosion was on display throughout the interior and exterior of the structure, strategic effort had to be employed to avoid covert corrosion that had yet to reveal itself. A penetrating surface-applied corrosion inhibitor was sprayed to the underside of the roof slab, all exterior surfaces, and all interior areas within 4 ft (1 m) of the exterior.

Careful deliberation was given for the selection of an interior coating. Historic consideration and the impact of maintaining the original feel of the building were factors. Conversely, the effects of ongoing dusting and the results of unhindered carbonation demanded a coating. Research and site-applied samples forged consensus to use a clear, breathable, anti-carbonation coating that would halt the carbonation process, bind up and seal in the dust, and preserve the historic appearance.

Project Credits: Submitted by Sika Corporation, Lyndhurst, NJ, USA; Owner, Baltimore Design School, Baltimore, MD; Engineer, Columbia Engineering, Inc., Columbia, MD; Contractor, Southway Builders, Inc., Baltimore, MD; and Material Supplier, Sika Corporation.

ICRI 2024 Project of the Year Award Finalist

NEIU Parking Structure

The Northeastern Illinois University (NEIU) Parking Structure, located on the campus of NEIU, Chicago, IL, USA, is a five-level parking structure that provides student and faculty parking. The first level is constructed with cast-in-place, slab-on-ground concrete, while the upper four levels are constructed with precast, prestressed concrete. The building is approximately 300 ft (91 m) in the east-west direction and 250 ft (76 m) in the north-south direction. Originally built in 2005, the parking structure accommodates approximately 1150 vehicles. The open-air parking structure was designed without the need for mechanical ventilation or fire suppression systems, in accordance with the building code requirements at the time of construction.

The structural framing for the parking structure is comprised of pre-topped, precast double-tee floor structure elements supported by precast concrete beams, walls, and columns. The double tees span approximately 50 to 60 ft (15 to 18 m) and are connected by weld plates, forming a floor diaphragm that braces the structure and resists lateral loads. The perimeter of the structure has architectural precast panels with thin brick to match the adjacent buildings.

Problems that prompted repair

In February 2017, a car fire occurred on the third floor of the parking facility, damaging the underside of the level four precast double tees. The extreme heat compromised the structural integrity of the precast concrete flange and stems of the level four double tees. The concrete corbels and precast walls at the supporting ends of the double tees were not exposed to the high temperatures. In addition to the repair and replacement of the double-tee components that were exposed to fire, the project also included the following repairs to the parking structure:

- Concrete corbels;
- Precast connections;
- Double tee stems top and underside concrete spalls;
- Vertical concrete spalls on wall surfaces;
- Joint sealant replacement between precast concrete members;
- Flanged expansion joint replacement;
- Silane sealers; and
- Cast iron drainpipe repairs and replacement.

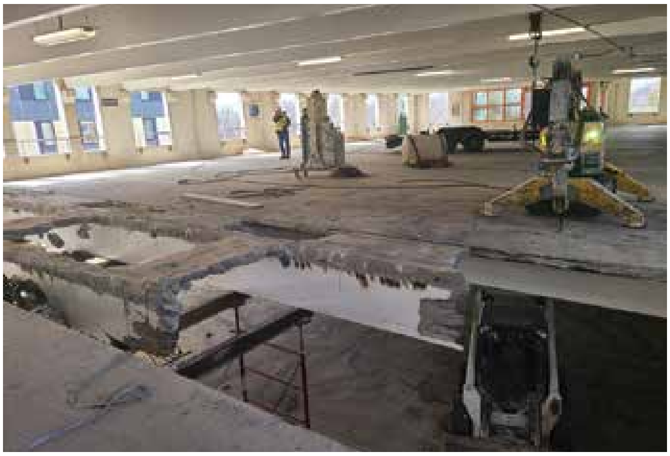
NEIU parking deck after repairs

Inspection/evaluation methods and results

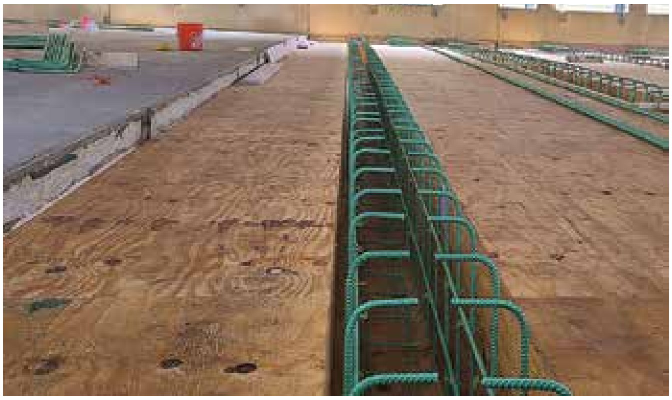
The concrete surface was chain dragged from the top side of the deck, and a delamination sounding roller was used from the underside to evaluate the extent of the damage from the fire. Large areas of unsound concrete and delaminated concrete were observed in the area directly above the fire, which played a crucial role in determining the final repair method.

The consulting engineer retained a third-party testing agency to perform a petrographic examination using ASTM C856/C856M, "Standard Practice for Petrographic Examination of Hardened Concrete." A petrographic analysis of a concrete core taken from the level four precast double tee, which was exposed to fire, revealed a horizontal crack approximately 1.5 in. (38 mm) from the bottom of the core. The crack was determined to have formed due to prolonged exposure to extreme heat—exceeding 573°C (1063°F). The petrographic analysis also revealed dehydration of the cement paste and microcracking of the quartz particles and other siliceous fine aggregate particles near the bottom third of the flange.

Fire damage to the underside of the level four precast double tees



Remote-controlled demolition



Partial reinforcing bar detail with formed repair

Repair system selection

The chosen repair system was significantly influenced by site constraints and the petrographic analysis conclusions. The extreme heat had caused concrete delamination over a large area of the fourth level double tees, necessitating an extensive range of removal and replacement of the concrete. The Grade 270 (1860 MPa) prestressing steel and mild reinforcement, also exposed to extreme heat, required extensive testing to ensure the integrity was not compromised. Removal of welded connections and temporarily displacing the roof double tees (directly above the fourth level) was deemed impractical, so the design team decided to replace the fire-damaged double tees with cast-in-place concrete reinforced with mild steel. The new beams and slab were formed and placed using precambered edge and bottom forms. After removing the forms and temporary supports, connection plates cast in the new concrete beam and slab system were welded to the adjacent precast components on all sides.

Site preparation and demolition

The exterior of the parking facility was constructed with precast concrete panels with 4.5 ft (1.4 m) wide openings centered on each of the double tees. Concrete was delivered to the fourth level using a pump truck, and it was moved into position using a concrete buggy. The weight of the fresh concrete and the equipment used to place the concrete required shoring and reshoring down to the levels below. Maintaining partial access for students and faculty was crucial to the owner, making it essential that the parking structure remain partially open.

Before demolition could begin, all welded connections around the fire-damaged double tees had to be severed. The contractor chose to implement a remote-controlled demolition machine equipped with a hydraulic breaker to chip away the concrete into more manageable pieces for removal from the parking structure. To protect the double tees below from damage, loose concrete was collected on the level beneath using tires and plywood to dissipate the impact load, ensuring the deck remained undamaged. A skid-steer loader was then used to gather the loose concrete debris and safely transport it out of the parking structure.

Temporary shores were strategically placed around the demolished area to stabilize the structure until the new cast-in-place floor system was completed. Temporary shoring and reshoring were also coordinated with the contractor in areas that exceeded the capacity of the surrounding precast components.

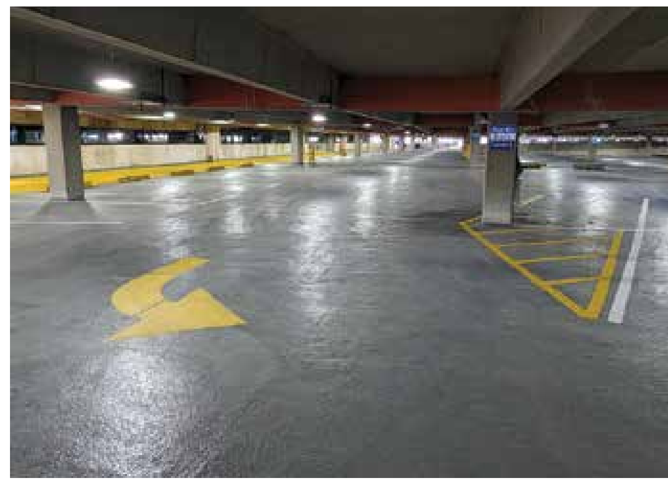
After demolishing the damaged double tees, all exposed flange connectors between the existing double tees became visible. There were fewer connections than expected, prompting the team to devise a plan to add connections to adjacent double tees for better load distribution. This involved fabricating additional connectors before placing the new cast-in-place system, ensuring they were ready for welding after removing the temporary shores. Some existing connections and embeds could not be salvaged during demolition, necessitating further coordination between the designer and contractor to fabricate new steel connections.

Special features

The precambered cast-in-place system performed exceptionally well. Precise calculation of the precamber from the designer was used, which was crucial to ensure that the new cast-in-place slabs deflected and aligned with the adjoining precast structure as the contractor lowered the shores. The design used a T-section analysis to calculate the deflection at the different stages. The dropped beams and slabs were cast monolithically, with reinforcement detailed to tie them together and form the composite section. After removing the shores, immediate inspection revealed no visible cracks in the new cast-in-place concrete beams and slab components. Site visits were periodically performed to visually inspect the new cast-in-place concrete.

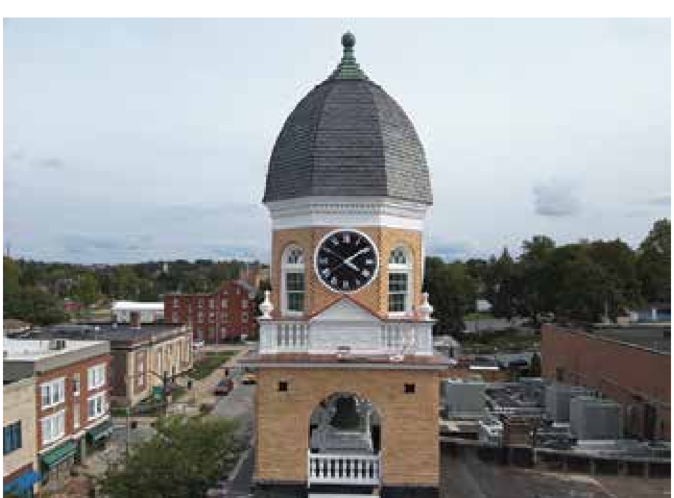
Throughout the during the design, detailing, and repair processes, the design team referenced ACI and ICRI manuals, design guidelines, and specifications. Lastly, the design team and contractor collaborated to develop and implement a long-term solution that would satisfy the owner and minimize disruptions to the campus.

Project Credits: Submitted by GRAEF, Milwaukee, WI, USA; Owner, Northeastern Illinois University, Chicago, IL; Engineer, GRAEF; Contractor, LS Contracting Group, Inc., Chicago, IL; and Material Suppliers, Ozinga Bros., Inc., Chicago, IL, and McCann Industries, Inc., Addison, IL.

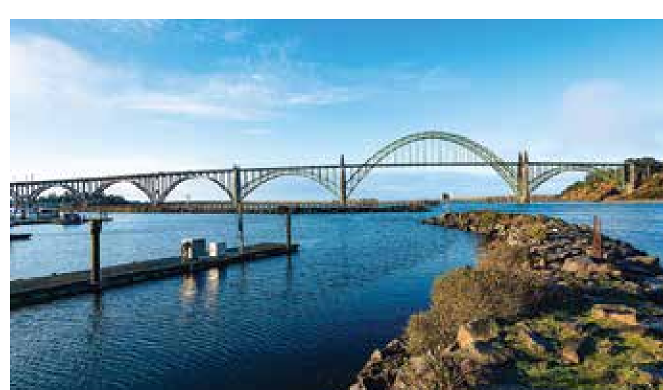


Hartsfield-Jackson Atlanta International Airport North and South Domestic Terminal

The Granite Club Garage Rehabilitation Project



City of Westminster, Maryland Historic Clocktower Rehabilitation



Yaquina Bay Bridge Cathodic Protection Rehabilitation