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Suzanne Aultman

PE, FPCI, VICE PRESIDENT OF ENGINEERING, METROMONT CORPORATION, GREENVILLE, S.C.

Suzanne Aultman has worked at Metromont for nearly 20 years, where she manages standards and codes, research and development, sales engineering, engineering training, and provides oversight for the day-to-day engineering operations. She earned her BS and MS in Civil Engineering from Clemson University, and she is a licensed professional engineer in 20 states. She is active in PCI, serving on the Technical Activities Council, the R&D Council, chairing the Standards Committee, Design Standard Committee, Blast and Structural Integrity Committee, PCI Academy Advisory Board, and the Industry Handbook Committee.

She is active in ACI as a member and past chair of ACI 550 Precast Structures, a member of ACI 319 Precast Structural Concrete Code, ACI 318-P Precast & Prestressed Concrete, and ACI 362 Parking Structures committee. She is also a member of ASCE and was a judge of the National Concrete Canoe Competition in 2015. She is a member of NSPE, SCSPE, and the Piedmont Chapter of SCSPE.

Corey Greika

PE, VICE PRESIDENT & SALES MANAGER, CORESLAB STRUCTURES (INDIANAPOLIS) INC., INDIANAPOLIS, IND.

With 25 years in the precast, prestressed concrete industry, Corey Greika has held positions of QC technician, plant engineer, design engineer, engineering manager, sales engineer, and sales manager. He graduated from the Georgia Institute of Technology with a Bachelors of Civil Engineering (Structural) and a Bachelors of Science in Architecture. He has worked in the precast concrete industry in the Midwest and Southeast markets.

He is Vice Chair of the PCI Marketing Council and is a former member of the PCI Bridge Producers Committee and the QA 2020 Committee.

Kyle R. Knop

AIA, CSI, CDT, VICE PRESIDENT/ SENIOR PROJECT MANAGER, ZIMMERMAN ARCHITECTURAL STUDIOS INC., MILWAUKEE, WISC.

Bringing 25 years of technical and construction experience, Kyle R. Knop is an award-winning, licensed architect and project manager focusing on government and public institution projects. He has worked on a broad range of municipal, health care, corporate, commercial, industrial, and retail projects with precast concrete being a fundamental material for many of those developments. A collaborative leader, Knop has demonstrated a successful history building consensus with project stakeholders, engineering teams, and product manufacturers to find the best solutions that meet his clients' needs and budgets. Knop is a member of the American Institute of Architects and holds a bachelor's degree from the University of Wisconsin–Milwaukee.

All-Precast Concrete Solution Award and Bridge with a Main Span up to 75 Feet Honorable Mention

PROJECT TEAM:

Owner and Engineer of Record: New Mexico Department of Transportation, Santa Fe, N.M.

PCI-Certified Precast Concrete Producer: Castillo Prestress, Belen, N.M.

General Contractor: AUI Inc, Albuquerque, N.M.

Project Cost: $2.2 million

Project Size: 1,470 ft^2

NM 50 OVER GLORIETA CREEK

GLORIETA, NEW MEXICO

New Mexico Route 50 (NM 50) serves Glorieta, N.M., to the west and Pecos, N.M., to the east. The nearly 100-year-old crossing over Glorieta Creek exhibited severe deterioration and needed to be replaced. However, the closure of the bridge would force residents living east of the bridge to detour 18 miles to get to Santa Fe, N.M. In addition, the National Park Service had concerns that construction would disturb local flora and fauna and wanted to maintain the bridge's historic setting. An all-precast concrete structure helped the New Mexico Department of Transportation (NMDOT) to limit the closure time for residents and minimize the site impact.

"Given its ability to be quickly prefabricated off site and stored until needed, precast concrete was the best solution," recalls Richard C. Castillo, president and CEO of Castillo Prestress. "Speed was of the essence to minimize the economic impact on the community as well as the inconvenience."

The bridge is within the Pecos National Historical Park where the Battle of Glorieta Pass occurred during the U.S. Civil War. An adjacent historic well, witness trees, building, and stone wall from the Civil War era had to be protected during construction. Using a low-profile cross section reduced the visual impact of the bridge, and the aesthetic enhancements made in the design helped build community support for the project.

Construction was reduced to a narrow right-of-way, and the road closure was limited to seven weeks. "Precast concrete was selected to speed construction, minimize on-site formwork, and minimize the disruption to the historic and environmentally sensitive site," says Kimberly Coleman, PE, project engineer for NMDOT. "In addition, we needed a durable structure to withstand deicing chemicals and snowplows

"This project is in a visually stunning location with huge historical significance. To the traveling public, the newly constructed bridge seems to disappear into the landscape."
—Kimberly Coleman, New Mexico Department of Transportation

through the winters." Given its historic setting and environmental sensitivity, the bridge's surroundings had to be protected during construction. "The witness trees that date back to the Civil War on each side of the road were preserved," Coleman says.

TIGHT SITE

To limit the impact of construction, a 60-ft right-of-way was allocated for construction. Given the restricted access, crane swings, piece weight, and crane lifting capacity were all evaluated during design to ensure everything could be placed from one location. All demolition equipment for removal of the old bridge operated on the west side of the creek, opposite from the historic structures. The 1923 bridge was cut apart and lifted out from above to protect the environmentally sensitive stream below and the wetlands downstream. Existing abutments were left in place to preserve the flow characteristics of the creek, to preserve the existing aesthetics of the site, and to protect the new substructure.

The project used accelerated bridge construction (ABC) methods such as all-precast concrete bridge elements, which included abutment caps, wing walls, slab beams, and approach slabs. With no staging area, all-precast concrete components were delivered on a just-in-time schedule. This was critical because haulers had to drive in reverse for the last mile approaching the site since there was no room to turn around.

"This project honed our skills for future ABC projects" says Castillo. "The bridge was completed on time due to the combined efforts of the project team, and collectively we developed design and constructability details that will enhance our ability to offer fast-track construction projects to the community." To achieve the project's durability goals, tight quality control in the precast concrete manufacturing plant was critical, and a high-strength, low-permeability concrete mixture design was specified.

Additional durability measures used to extend the life of the structure included the use of stainless steel reinforcement, which resists corrosion, and the use of ultra-high-performance concrete (UHPC) in the joints to further resist the deterioration of the deck. The all–precast concrete bridge required precise fabrication to ensure proper reinforcement and embed placement, piece dimensions, and installation tolerances. As a result of this project, NMDOT has revisited some quality assurance and quality control procedures to facilitate smoother assembly in the future. Similarly, Castillo Prestress is exploring the use of slender UHPC structural elements, which can bring further advantages to a project such as minimizing construction-site footprints, greater durability, longer spans, smaller bridge profiles, lower owner costs, and less economic impact on nearby communities.

***Photos:** James Hirsch, Environmental Analyst, New Mexico Department of Transportation and NMDOT Bridge Bureau and AUI, Inc.*

The unique engineering and construction challenges did not deter the project team. The result is a durable bridge with a projected long service life that was built quickly. Precast concrete was key to preserving the historic and environmentally sensitive project site. Because the abutment and superstructure elements were fully precast concrete, no formwork was required within the creek, construction vibration and traffic were minimized, and concrete pours were limited to the UHPC connections.

Harsh winter weather means this bridge will be repeatedly subject to deicing chemicals and snowplows. The low-permeability concrete mixture design coupled with controlled curing produced a quality finish that will limit infiltration of harmful salts and increase the durability and longevity of the bridge. Precast concrete was also key to achieving the tight construction schedule with the limited road closure window. Because the labor-intensive and time-consuming formwork and long concrete cure times required for traditional construction were eliminated, the road was reopened with one day to spare.

KEY PROJECT ATTRIBUTES

- **The all–precast concrete bridge was selected to minimize disruption to the site, the traveling public, and the national historic park that surrounds the structure.**
- **The limited time for road closure and the narrow right-of-way necessitated a quick and clean solution for this simple-span structure.**
- **For extra corrosion resistance, stainless steel reinforcement was used and UHPC connects the precast concrete elements.**

PROJECT AND PRECAST CONCRETE SCOPE

- **The bridge replacement included two abutment caps, four wingwalls, seven prestressed concrete slabs, and four approach slabs.**
- **Precast concrete erection took six days, and the road was closed for seven weeks, including demolition.**
- **Construction started in June 2021 and was completed in October 2021.**

Sustainable Design Award and Rehabilitated Bridge

PROJECT TEAM:

Owner: North Carolina Department of Transportation, Raleigh, N.C.

PCI-Certified Precast Concrete Producers: Eastern Vault Company, Princeton, W.Va.; Ross Prestress, Knoxville, Tenn.,

Engineer of Record: AECOM, Raleigh, N.C.

General Contractor: PCL, Denver, Colo.

Project Cost: $16 million

Project Size: 1125 linear ft

SWIFT ISLAND HISTORIC ARCH BRIDGE REHABILITATION AND WIDENING

ALBEMARLE, NORTH CAROLINA

Outside of Charlotte, N.C., the majestic Swift Island Arch Bridge spans the Pee Dee River. Its unique history harkens back to events that occurred before it was built. Just a few years earlier, in 1922, a three-span, open-spandrel concrete arch bridge had been erected to cross the river. Then, to make way for a dam and hydroelectric plant, the crossing was flooded to create Lake Tillery.

The new, higher-elevation Swift Island Arch Bridge was constructed to replace the original bridge, and the older bridge was destroyed. The original bridge's demise provided valuable information on bridge construction and demolition. In what would become known as the "Battle of Swift Island Bridge," the U.S. Army tried various techniques to demolish it. First, the bridge was overloaded with weight, then it was bombed from the air, and, finally, explosives were used to bring it down.

The new Swift Island Bridge opened in 1927, and a more modern parallel span was built downriver in the 1970s. In 2005, the Swift Island Bridge crossing was closed temporarily, so the second span had to carry traffic in both directions. Limited to only one lane of traffic, the 1927 bridge was slated to be replaced in 2003 when the second battle of Swift Island Bridge began in an effort to save its historic properties.

To address structural deterioration and weight restrictions, the bridge had to be widened and upgraded. The grand

"[The judges] saw a great benefit from the use of precast deck panels to improve the ease and speed of construction for the new floor system."
—Todd Lang, HDR Engineering

old structure was eligible for the Historic Register, and residents were keen on preserving it. Rather than replace the bridge and convert it into a bike and pedestrian facility, the project team opted to replace and widen the superstructure, using precast concrete girders, deck slabs, and fascia panels that replicate the original design.

"The use of precast concrete helped to preserve the original arches rather than having to demolish the bridge and build a new conventional structure. This preserved an historic resource while providing significant cost savings for the North Carolina Department of Transportation (NCDOT)," says John Sloan, PE, North Carolina bridge program manager for AECOM. "To preserve the existing arches and piers without overstressing them, precast concrete added redundancy to the structural system and reduced bending moments in the original members in order to carry vehicular loads in a safe manner," he adds.

The design featured precast and prestressed concrete box girders and deck panels, as well as mild reinforced precast concrete fascia panels. The spread box girders simplified construction, and a simple closure pour allowed the box girders to be continuous from pier to pier over the spandrel bents. This design established full flexural continuity of the girders before the precast concrete deck panels were placed on the bridge, which relieved loading and flexural demands from the arch ribs. The precast and prestressed concrete deck panels facilitated construction by serving as a stay-in-place form for the cast-in-place deck. Placing the precast concrete deck panels on the bridge ahead of the deck placement also helped relieve and balance the load on the arch ribs.

DECONSTRUCTION

"The bridge was first deconstructed down to its arches and rebuilt with a wider bridge deck, so its architectural character and detail remained intact," says Kevin Fischer, NCDOT assistant state structures engineer, field operations. This process involved creating a four-dimensional model to accurately predict structure demands throughout construction and developing a construction sequence that would be beneficial for the original arches and piers. Those components had limited capacity, so a detailed construction sequence and structure articulation were provided to prevent overstress.

Further complicating schedule demands were the location of the structure and access limitations. "The remote location of Lake Tillery and the complex construction sequencing needed to avoid overstressing the arches warranted the use of precast concrete. Precast concrete beams reduced the construction timeline and improved constructability. The unique continuity details of the precast concrete beams allowed the elimination of several joints in the bridge to reduce future maintenance needs," says Fischer.

Photos: AECOM.

The project required a delicate balance to meet all the project goals, which were to complete the project as quickly as possible to minimize the inconvenience to those traveling by boat or car; keep the bridge in balance to avoid damage to the arches or foundation; tread lightly across the beautiful Piedmont area and Lake Tillery; and preserve the historic character of the existing bridge.

The team made every effort to preserve the architectural character by using precast concrete fascia panels. These panels were specified to facilitate construction, provide a durable solution, and be aesthetically pleasing. "The historic preservation team was pleased that the bridge could be preserved, and they were very satisfied that the aesthetics captured the architectural character of the original bridge," notes Sloan.

The original concrete arch foundation lives on through the efforts of the project team. "Not only did we save the department of transportation considerable cost and accelerate the completion of construction, but we also preserved the history of this structure," Fischer says. "It's gratifying to see the results, which provide a safer passage for local residents as well as an historic appearance."

KEY PROJECT ATTRIBUTES

- **Preserve the 95-year-old concrete piers and arches.**
- **Use precast concrete girders, deck panels, and fascia panels to replicate the original aesthetics.**
- **This design-build project was designed with a four-dimensional finite element model to accurately predict geometry and load demands for all precast concrete elements.**

PROJECT AND PRECAST CONCRETE SCOPE

- **The four arch spans are 210 ft each, and each arch span has 12 spans between spandrel bents.**
- **The project used 212 girders, 849 deck panels, and 132 fascia panels.**
- **The project was completed in May 2021.**

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Reggie Holt

SENIOR STRUCTURAL ENGINEER, FEDERAL HIGHWAY ADMINISTRATION, WASHINGTON, D.C.

Reggie Holt is a Senior Bridge Engineer and the concrete bridge specialist for the Federal Highway Administration (FHWA) office of Bridges and Structures at FHWA headquarters in Washington D.C. He is responsible for national policy and guidance on bridge design and analysis. Prior to his current position with FHWA, Holt worked for bridge design consultant T.Y. Lin International. He designed and managed multiple complex concrete bridge structures during his 15-year career at T.Y. Lin.

Holt holds a bachelor of science and Masters of Science degree in Civil Engineering from the University of Maryland. He is a registered professional engineer and member of multiple technical committees, including: ex-officio for the AASHTO T-10 Committee on Concrete Design, Transportation Research Board Concrete Bridges Committee, PTI Post-Tensioned Bridge Committee, PTI Grouting Committee, PTI Cable Stay Bridge Committee and the PTI/ASBI Grouted Post-tensioning Committee. Holt has participated on multiple research technical review panels and has served on multiple Blue Ribbon Panels and Expert Task Groups throughout his career.

Bijan Khaleghi

STATE BRIDGE DESIGN ENGINEER, WASHINGTON STATE DEPARTMENT OF TRANSPORTATION BRIDGE AND STRUCTURES OFFICE, OLYMPIA, WASH.

Bijan Khaleghi was State Bridge Design Engineer with Washington State Department of Transportation, and adjunct faculty at Saint Martin's University. He received his Master and Doctor of Engineering degrees from the National Institute of Applied Sciences, France. Khaleghi is a member of AASHTO Technical Committees T-8 Movable Bridges, T-10 Concrete, and T-20 Roadway Tunnels. He is a member of PCI and ASBI Bridge Committees, Chair of PCI Seismic Subcommittee, TRB Committees AFF30 Concrete, Aff50 Seismic, and International Road Association, PIARC. He has received IBC, PCI, ASCE, SEI, and TY Lin awards.

Todd Lang

PE, SE, SENIOR BRIDGE ENGINEER, HDR ENGINEERING, OMAHA, NEB.

Todd Lang is a project manager, senior bridge engineer and Professional Associate at HDR Engineering. He has a Bachelor's Degree in Civil Engineering from North Dakota State University and a Master's Degree in Civil Engineering (Structures) from Purdue University. He has 29 years of experience in the design, analysis and inspection of bridges and other transportation-related structures. His bridge experience includes designing concrete, steel, and timber bridges to carry vehicles and pedestrians over highways, railroads, streams, and major rivers. The concrete bridges include cast-in-place, prestressed, and post-tensioned structures. The steel structures include rolled beams, curved plate girders and, deck trusses.

Lang also has experience designing bridge rehabilitations, retaining walls, drainage structures, and wind turbine foundations. He has completed many bridge-related preliminary studies, including rehabilitation-versus-replacement studies, structure type studies and span arrangement studies.

Bridge with a Main Span Up to 75 Feet

ACCELER-8 I-90 BRIDGE REPLACEMENT PROJECT

SOUTHBOROUGH AND WESTBOROUGH, MASSACHUSETTS

PROJECT TEAM:

Owner: Massachusetts Department of Transportation, Boston, Mass.

PCI-Certified Precast Concrete Producer: JP Carrara & Sons Inc., Middlebury, Vt.

Engineer of Record: Gill Engineering Associates, Needham, Mass.

General Contractor: J.F. White Contracting Co., Framingham, Mass.

Project Cost: $55 million

Project Size: Eight bridges with span lengths from 35 ft 6 in. to 70 ft 9 in.

The Acceler-8 Interstate 90 (I-90) bridge replacement project outside of Boston epitomized rapid bridge-replacement and bridge-bundling techniques. The challenge was to replace eight bridges in eight weekends during the summer of 2021. The use of precast concrete components was essential to the successful completion of every crossing.

Initially, the Massachusetts Department of Transportation (MassDOT) considered prefabricated bridge units (PBUs) composed of steel beams with a precast concrete deck. However, the final design used Northeast Extreme Tee Deck (NEXT D) beams as an alternative technical concept along with precast concrete approach slabs and abutment caps.

"We chose an innovative solution and selected precast, prestressed NEXT D beams. NEXT D beams were more economical than the proposed PBU option from the base technical concept, due to lower material and fabrication costs, including reduced handling. PBUs require fabrication in both steel and precast concrete plants, whereas NEXT D beams require fabrication in only a precasting plant," says Joseph Gill, PE, president, Gill Engineering.

"Precast concrete helped to overcome challenges such as as the development of the design details to accommodate Accelerated bridge construction during the weekend closure. These details need to be simple, uniform as much as possible throughout the project and compatible with the contractors and schedule, and would provide a minimum of 75 year service life."
–Bijan Khaleghi, Washington State Department of Transportation

The use of a single-stem NEXT D beam was a distinctive feature of this project and allowed for a more efficient cross-section design. However, stability of the beam during storage, transportation, and erection needed to be addressed. NEXT D beams are extremely robust. Their beefy stems can tolerate significant deterioration before structural integrity is compromised. The fabricator also used a high-performance, self-consolidating concrete (SCC) mixture, which typically achieves 28-day compressive strength of 10,000 psi. The NEXT D beams were designed for a compressive strength of 8000 psi, and the additional strength will improve the structure's service life. This same SCC mixture was used in the abutment caps, approach slab panels, and moment slabs, all of which were designed assuming a 4000-psi strength. The NEXT D beams will also reduce maintenance costs by eliminating the need to repaint steel beams in the future.

LONG SUMMER WEEKENDS

To prepare for the targeted weekend road closures, cast-in-place concrete micropile foundations, abutment stems, and wing walls were constructed and backfilled under the existing approach spans in the months before the planned closures. The six superstructure replacements and the two bridge replacements were completed over six weekends of traffic diversion. During each weekend closure, all traffic was consolidated into one barrel of the roadway (eastbound or westbound), carrying two lanes in each direction. This traffic setup was implemented with crossovers and movable barriers. Typically, demolition would be completed by around 10:00 a.m. on Saturday, and after cleanup, precast concrete erection would begin around 12:00 noon and would be completed by approximately 6:00 p.m. Each completed bridge was reopened to traffic by 5:00 a.m. on Monday.

Each weekend project required 60 precast concrete pieces for the accelerated bridge construction. Some of the precast concrete pieces weighed more than 60,000 lb, so a heavy crane was required to hoist them into place. Trucks delivering precast concrete bridge components from the precast concrete producer's facility were dropped at a storage lot and during the weekend were staged along I-90 and local roads.

"One challenge was addressing the beam camber," says Gill. Because the design used an 8-in.-thick deck and no haunch, "all variations in the camber needed to be addressed with variable thickness of paving on the approaches and along the beams." The prestressed beams were surveyed after fabrication to determine the actual camber. The project team revised the seat elevations during construction by lowering the horizontal saw cuts in the rehabilitated abutments and lowering the seat elevations of the cast-in-place abutments, to ensure that the final beam position would properly conform to the roadway profiles. After final placement, additional surveying ensured that the non-structural asphalt overlay pavement would meet the final roadway profile and provide a smooth ride.

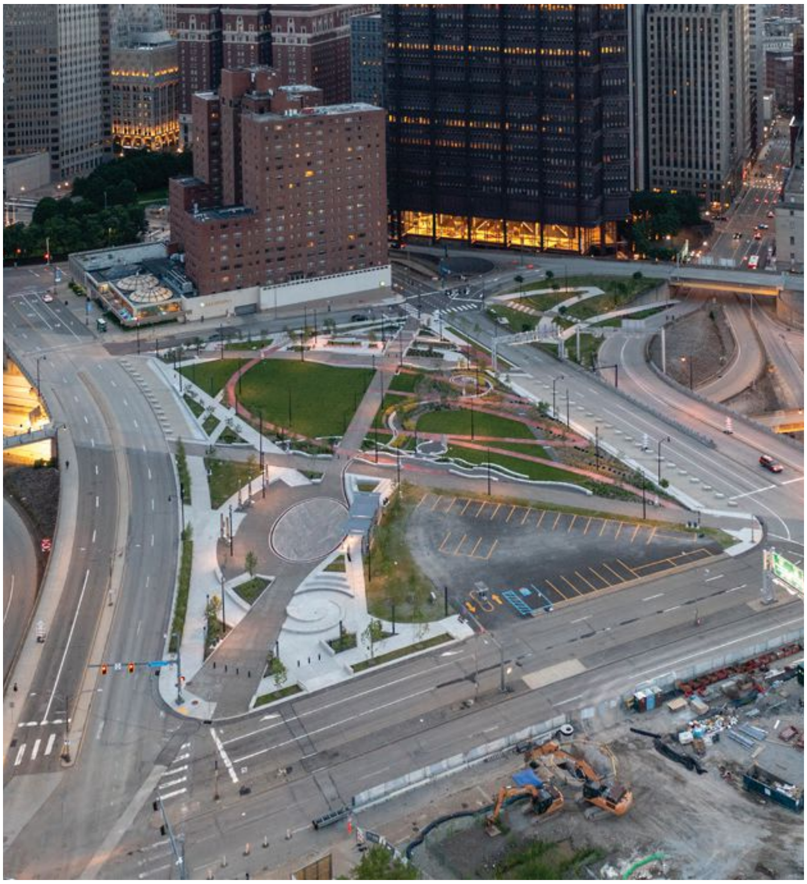
Photos: Gill Engineering Associates, Inc and Tetra Tech, Inc.

KEY PROJECT ATTRIBUTES

- **MassDOT bundled replacement projects for eight bridge structures over I-90 during the summer of 2021.**
- **Innovative construction techniques and precast concrete systems were used to upgrade the crossings between Worcester and Boston (which serve more than 100,000 drivers per day) while minimizing the project's impact on the traveling public and local residents.**
- **The use of a single-stem NEXT D beam was a distinctive aspect of the project and allowed for a more efficient cross-section design.**

PROJECT AND PRECAST CONCRETE SCOPE

- **Replace eight bridges in eight weekends over the Massachusetts Turnpike (I-90).**
- **The six superstructure replacements and the two bridge replacements were completed over six weekends of traffic diversion. Bridge demolition and reconstruction took place over 55-hour weekend closures.**
- **Each bridge had five NEXT D beams and one single-stem NEXT D beam as well as precast concrete abutment caps, approach slabs, and moment slabs. In total, 48 NEXT D beams were used.**



Non-Highway Bridge Co-winner

PROJECT TEAM:

Owner: City of Pittsburgh, Pa.

PCI-Certified Precast Concrete Producer: Northeast Prestressed Products, Cressona, Pa.

Engineer of Record: HDR, Pittsburgh, Pa.

General Contractor: Fay, S&B USA Construction, Pittsburgh, Pa.

Project Cost: $30 million

Project Size: 52,000 ft²

I-579 URBAN OPEN SPACE CAP

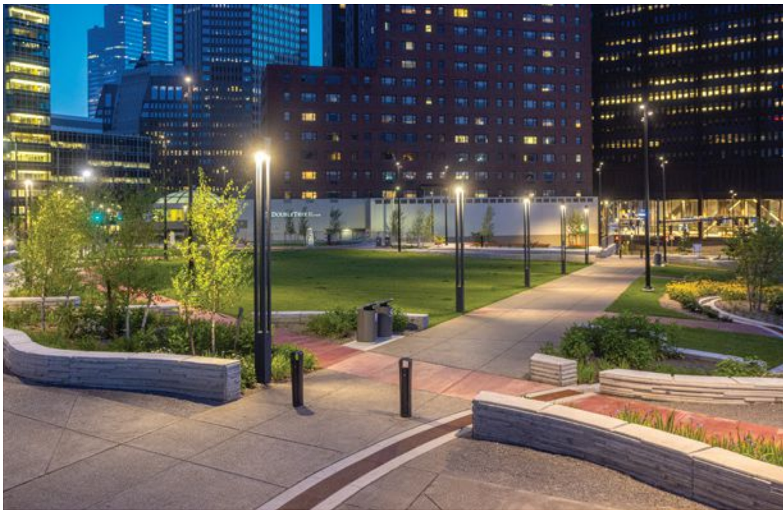
PITTSBURGH, PENNSYLVANIA

The construction of Interstate 579 (I-579) through Pittsburgh, Pa., more than 60 years ago separated the Hill District from the downtown. With the help of federal grant money from the Transportation Investment Generating Economic Recovery program, the Urban Open Space Cap project creates a new modern park with room for outdoor events and reconnects the disenfranchised district to the city's economic core.

The I-579 project functions as a "cap" over the interstate that provides a walkable link from the Hill District to the downtown. The new park includes art installations, story walls, outdoor classroom space, and an amphitheater, as well as bike and pedestrian pathways.

After evaluating several options, the design team selected adjacent precast concrete box beams for several reasons: The beams are strong enough to support the unique park loading, including up to 5 ft of soil. Locally available bridge elements were economical. And precast concrete box beams were ideal for the urban site because they could be delivered with minimal site disturbance and lifted from adjacent parcels to minimize the impact of the construction on the highway below.

"This project utilized a precast prestressed box beam solution to provide the needed strength, resilience, and aesthetics for a three acre urban park that was constructed over top an active interstate."
– Reggie Holt, Federal Highway Administration



Photos: *Courtesy of HDR © 2022.*

Because the structure is located over the interstate, minimizing future bridge maintenance was a high priority. The precast concrete beams do not need to be painted and will be durable. The beams also provide a smooth soffit for aesthetics under the bridge, and they offer a consistent surface for attachment of the under-bridge lighting system.

The highway spanned by the new structure varies in width due to the presence of four ramps merging and diverging from the main roadway. Several of these ramps include retaining walls on spread footings, and it was important to ensure that the project would not have an adverse impact on these components. Very little gore area was available between the roadways to accommodate piers for the new structure. The new structure and park also had to tie into the existing sidewalks, which involved 20 ft of elevation change.

The design team for the bridge structure and park addressed these challenges, and others, through innovative structural and landscape design solutions. New abutments were constructed behind the existing retaining walls, which were trimmed to accommodate the new beams. These abutments were supported by over 200 drilled micropiles, which were used to minimize disturbance to the existing walls. Adjacent prestressed concrete box beams were used for the superstructure, which was divided into three units to allow transverse post-tensioning of the beams, and better match the span configurations of the adjacent structures. An 8-in.-thick cast-in-place concrete deck slab was placed on the beams to act compositely and achieve full load-sharing among the beams. The deck contained two layers of reinforcement steel in each direction to provide a robust system. The cast-in-place concrete deck included redundant waterproofing features to protect the entire superstructure. New piers were founded on drilled shafts that could be installed in narrow gore areas and transition directly into slender multicolumn bents, to limit impact to the roadway template. Compatibility with requirements of the Americans with Disability Act was established for the significant grade change across the park through walkway switchbacks into the tiered raingardens at the northwest corner.

BRIDGING THE GAP

"Of all the challenges this project faced, developing a viable structural solution for the bridge was the greatest hurdle. The new bridge had to 'fill the gap' between the two existing vehicular bridges, while maintaining the required vertical clearance above the interstate and carrying sufficient soil depth to sustain plantings on the surface," says Nicholas Burdette, PE, Northeast Region bridge lead, HDR. The project team developed the preferred precast concrete adjacent box-beam solution to minimize initial costs, limit the bridge's impact on existing structures and interstate traffic, and use low-maintenance components.

The complexity of the constrained urban site was exacerbated because there are no standard design codes for bridges carrying a park. The project team developed specific criteria to meet the demands associated with the intended use of the park area. They evaluated both the final in-service condition of the bridge and the construction loadings associated with placing the fill and amenities on the bridge.

Working within the congested urban core was a major challenge and required careful planning. This project included 14 phases of traffic for demolition, substructure construction, and superstructure construction work, including installation of more than 1 million lb of reinforcing bars; 126 box beams, each weighing 140,000 lb; 1800 ft of curved architectural walls on top of the deck structure; 50,000 ft^2 of reinforced architectural sidewalks; and 14,000 ft of micropiles to support the abutments.

KEY PROJECT ATTRIBUTES

- **As Pennsylvania's first park over an interstate, this urban, 3-acre green space reconnects Pittsburgh's historic Hill District with the city's downtown.**
- **The precast concrete adjacent box-beam superstructure is both economical and strong enough to support the unique park loading, including up to 5 ft of soil.**
- **The precast concrete beams also support the hanging lighting for the vehicular tunnel below.**

PROJECT AND PRECAST CONCRETE SCOPE

- **The project used 12,190 linear ft of 48 × 66 in. precast, prestressed concrete box beams.**
- **The maximum span length is 121 ft.**
- **Erection of the 126 precast concrete adjacent box beams took 38 days, and the entire project was completed in November 2021.**

Non-Highway Bridge Co-winner

PROJECT TEAM:

Owner: San Diego Association of Governments, San Diego, Calif.

PCI-Certified Precast Concrete Producer: Oldcastle Infrastructure, Perris, Calif.

Precast Concrete Specialty Engineer: Oldcastle Infrastructure, Fontana, Calif.

Engineer of Record: WSP USA, San Diego, Calif.

Design Oversight Engineer: TY Lin, San Diego, Calif.

General Contractor: Mid-Coast Transit Constructors, joint venture of Stacy and Witbeck and Herzog and Skanska

Construction Management/Contract Administration/Quality Assurance/Field Engineering: Kleinfelder Construction Services, San Diego, Calif.

Project Cost: $2.17 billion

Project Size: 5570 ft in length, 197,604 ft^2

MID-COAST EXTENSION OF THE UC SAN DIEGO BLUE LINE TROLLEY

SAN DIEGO, CALIFORNIA

As one of San Diego's most important transportation projects, the Mid-Coast Extension of the University of California San Diego (UCSD) Blue Line extends the San Diego Metropolitan Transit System with 11 miles of double tracks. This light-rail addition goes from downtown San Diego to the campus of UCSD. It provides an alternative to congested freeways and connects the corridor with areas served by the existing trolley system.

At a cost of more than $2 billion, the extension is one of the largest infrastructure projects in the San Diego area. In addition to the new tracks, this project encompassed eight bright crossings, several miles of aerial viaduct structures, five at-grade stations, and four aerial stations. At five of these stations, an additional 1170 parking spaces were added.

GENESEE VIADUCT

For the viaduct constructed within the median of Genesee Avenue, the original design called for another building material, but the project team opted to splice precast concrete girders on site. The resulting viaduct is the first curved, spliced precast concrete U-girder light-rail transit bridge in Southern California. By constructing this viaduct, the project

> *"Efficiency with which the segments could be erected and spliced together, minimized traffic interruptions and impacts to adjacent land uses, and shortened the overall construction duration of the project while producing a durable, long-lasting final project."*
> **– Todd Lang, HDR Engineering**

Photos: MCTC.

team has provided new techniques for future infrastructure projects that can be useful in minimizing traffic disruptions. The Genesee Viaduct is the result of a collaborative process in which team members used innovative design techniques, limited construction costs, and an optimized schedule. It was critical to maintain local traffic and minimize the impact on the surrounding community, and these priorities were the primary drivers as stakeholders selected the structure type and construction methods. Only nighttime closures of major intersections on Genesee Avenue were considered.

Precast concrete U-girder construction was selected for most of the viaduct to minimize falsework. "The falsework design would have to be continuous, which means the major intersections at which the viaduct crossed would be completely cut off for the duration of the construction through each intersection," says Vladimir Kanevskiy, PE, engineering manager, WSP USA.

Precast concrete girders were fabricated off site and transported to the construction site. There, the precast concrete girders were spliced together with a cast-in-place (CIP) closure pour for continuity under the final loading condition. This girder layout reduced hauling costs, limited the girder weight to under 100 tons, and removed the need for specialized hauling equipment.

Three frame types of assorted construction techniques, girder assembly, and splicing operations were used on the viaduct design. Nine precast concrete girder frames consisted of precast concrete U-girders (Caltrans "bathtub" girders) spliced by one- or two-stage post-tensioning. Girders for spans over intersections were spliced in a staging area away from traffic. On both sides of the intersection sat temporary shoring towers, where the spliced segment was lifted and placed. To splice the girder segments on the shoring towers that did not cross traffic, a second post-tensioning tendon was used. A second stage of post-tensioning was performed after all individual girders were spliced, which connected all the segments. This technique created continuity between the expansion joints. The four frames that were left were spliced and tensioned in one stage.

Crossing over La Jolla Village Drive sits the longer span part of the viaduct, which was 225-ft-long. Due to its length, it could not be lifted and placed in one piece onto temporary shoring towers. The project team used a hybrid precast concrete/CIP superstructure, which reduced the spliced length while still using the girder construction in adjacent spans. The CIP girder segments were connected to precast concrete girder segments by post-tensioning and closure pours.

Two aerial side-platform stations – each station within a single structural frame – are served as the Genesee Viaduct. Transverse beams connected to superstructure girders support the side platforms. Single-stage post-tensioning was performed at all station frames.

Three superstructure types addressed the different types of loading and frame construction. Two 96-in.-deep U-girders connected with a 9-in.-thick CIP deck were used as the cross section at the precast concrete girder frames. Superstructure depth is constant in all precast concrete girder frames.

The Mid-Coast Extension is recognized as the most important transportation improvement project in San Diego for expanding capacity and accommodating future travel demands in the region. The extension provides a direct link from the United States/Mexico border to University City and is a great addition to the region's public transit system.

KEY PROJECT ATTRIBUTES

- **The light rail runs along the center of Genesee Avenue, which is critical for providing vehicle access to the University of California San Diego campus, residences, hospitals, retail, schools, and employment. One project requirement was that major intersections must be kept open and operational throughout construction.**
- **Full closure of intersections where precast concrete girders crossed over live traffic was permitted only for short periods, one intersection at a time.**
- **Precast concrete girders were spliced at a staging area near the construction site and then transported to the site. The spliced segments were placed on shoring towers during the nighttime closure.**

PROJECT AND PRECAST CONCRETE SCOPE

- **After girders were spliced together, the 35 spans ranged in length from 138 to 192 ft.**
- **The precast concrete Caltrans U-girders have a 10-in.-thick webs and a 9-in.-thick bottom flange.**

Transportation Special Solution

PROJECT TEAM:

Owner: Baltimore Gas and Electric, Windsor Mill, Md.

PCI-Certified Precast Concrete Producer: Coastal Precast Systems, Chesapeake, Va.

Engineer of Record: Sargent & Lundy, Elkridge, Md.

Structural Engineer: Moffatt & Nichol, Baltimore, Md.

General Contractor: McLean Contracting Company, Glen Burnie, Md.

Project Manager: Burns & McDonnell, Windsor Mill, Md.

Project Cost: $5.1 million

Project Size: 67 precast concrete pile caps and 62 precast concrete panels

KEY CROSSING RELIABILITY INITIATIVE

BALTIMORE, MARYLAND

One of Maryland's largest electric utility providers, Baltimore Gas and Electric (BGE) owns and operates a high-voltage transmission grid. Most of BGE's 230-kV lines circling Baltimore are aboveground; however, at the Key Bridge, the utility has underwater lines, which were put into the riverbed in the 1970s. The 2.5-mile-long portion of the line that crosses the Patapsco River through the main shipping channel is located approximately 10 to 15 ft below the riverbed. Having been in service for over 50 years, this portion displayed signs of deterioration. Given that this section was critical for the resiliency of the grid system, BGE planned to replace it with a new transmission line crossing.

Various alternatives were analyzed, with due consideration given to cost, design complexity, environmental impact, stakeholder preferences, permitting complications, and interruption of shipping. In 2015, the project team selected overhead lines incorporating tall towers in the river as the preferred solution, and final design was completed by the end of 2019.

The crossing includes eight towers, with heights that vary between 160 and 400 ft. The tallest towers are in the water adjacent to the shipping channel to provide a minimum of 230 ft of clearance for ship traffic. The towers in the water required independent vessel collision protection structures to prevent ships from striking the towers or their foundations. A detailed, probabilistic vessel-collision risk analysis

"The increased durability achieved with using precast components constructed in a plant environment were able to meet the project's 75 year service life requirement in this harsh marine environment."
– Reggie Holt, Federal Highway Administration

was performed per requirements set forth in the American Association of State Highway and Transportation Officials' *AASHTO LRFD Bridge Design Specifications*. The protection structures have a continuous concrete ring around each foundation, the largest being 14 ft wide, 7 ft deep, and 633 ft long in perimeter. Both the foundation and protection structures are composed of layers of precast and cast-in-place (CIP) concrete, supported by steel pipe piles.

Precast concrete was incorporated into the earliest design concepts and was a dominant technology in all over-water construction, reducing the construction time of the in-water structures, improving the design life of reinforcement, reducing the amount of CIP concrete formwork, and improving the accuracy of perimeter fender bolt placement.

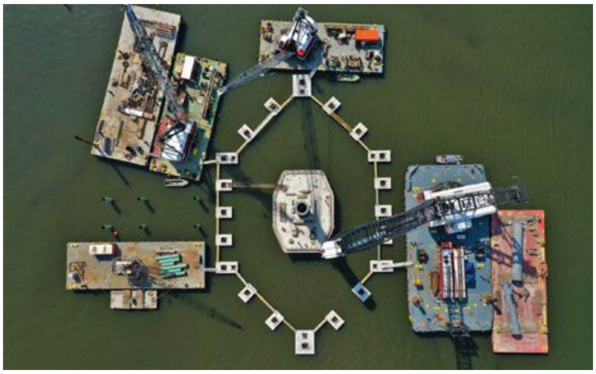
For the work over water, the use of CIP concrete would have been complicated and time-consuming. All concrete elements directly above open water were designed and detailed as precast concrete. Only narrow CIP closure pours between precast concrete planks were required over water. Most precast concrete elements were rectangular, but trapezoidal and bent-angle shapes were also used for unique structural boundaries. "Considering that all precast concrete pile caps and panels over water were 2-ft thick, the avoidance of horizontal formwork avoided significant effort," says Mehedi Rashid, structural engineer, Moffatt & Nichol. "With so much work to be performed in an accelerated construction schedule, precast concrete was the most effective method to achieve a successful on-time completion of the project."

CHANNEL CROSSING

Of the eight towers required to cross the Patapsco River, tower 1 is located at BGE's Hawkins Point substation, towers 2 through 6 are in the water, and towers 7 and 8 are located at Sollers Point. The largest span (2200 ft in length) crosses the Fort McHenry channel, which is the primary shipping channel entering the Baltimore Harbor.

The precast concrete configuration consists of precast concrete caps installed on top of the piles, with precast concrete planks spanning between the caps to form a continuous precast concrete working surface over the water. A total of 67 pile caps and 62 panels were used for the project. The precast concrete pile caps range in weight from 8 to 47 tons.

The contractor's substitution of a single, monolithic precast concrete foundation piece at three of the towers produced a massive square precast concrete pile cap weighing 164 tons. The project used marine concrete to provide a 75-year design service life and conducted strict quality control measures along with field and production testing to achieve the design objectives.



Photos: Ben Frank, McLean Contracting, and Mazi Chiles, McLean Contracting.

Stakeholders for this significant infrastructure project were cognizant of environmental sensitivity issues, budget concerns, and the project's economic impact on the community. Compared with the underwater option, which would have required jet-plowing submarine cable through the river bottom, the overhead option was more environmentally sound. Also, building underground cables would have cost approximately twice as much as the overhead project. Furthermore, installing overhead lines had less impact on operations in the Port of Baltimore than the underground option would have had.

KEY PROJECT ATTRIBUTES

- **New transmission towers and 2 miles of high-voltage power lines cross the Patapsco River next to the Francis Scott Key Bridge, improving the reliability of utility delivery for customers.**
- **The contractor's innovative use of pile-driving templates enabled the installation of large-diameter piles within tolerance, and accelerated construction.**
- **The use of precast concrete for all work over water reduced safety risks and shortened the project schedule.**

PROJECT AND PRECAST CONCRETE SCOPE

- **The 2-ft-thick precast concrete piles range in size from 8 ft × 8 ft 6 in. single-pile caps to 19 ft × 16 ft 6 in. double-pile caps.**
- **Precast concrete panels spanning between pile caps are 2-ft-thick trapezoidal shapes and range in size from 12 ft × 8 ft to 29 ft 6 in. × 14 ft.**

PCI
Precast/Prestressed
Concrete Institute