2022 PCI
Design Awards

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Precast/Prestressed Concrete Institute

2022 PCI DESIGN AWARDS

Transportation AWARDS








JURY

Jim Fabinski

VICE PRESIDENT/GENERAL MANAGER, ENCON UNITED, DENVER, COLO.

Jim Fabinski works for EnCon United in Denver, Colo. Despite a distaste for committee work, Fabinski finds himself serving as chair of the Transportation Activities Council and as a member of the PCI Board of Directors, as well as the R&D, Bridge, and Bridge Producers committees. He also helps with various odd tasks for the institute. Fabinski has been involved with PCI since 2004 and barely completed the Leadership PCI program. He has worked in the prestress business in Colorado since 1994. He has an MBA from the University of Colorado Denver and an engineering degree from Michigan State University. Fabinski is a licensed engineer in several states, and a registered contractor in too many. He and his wife, Sterling, share four crazy kids and two obnoxious dogs. In what passes for free time Fabinski likes to road bike, ski, and wrench on motorcycles and old cars. His commitment to PCI is founded on the belief that this organization is essential for advancing the industry we all love so much. He has yet to visit a prestress plant anywhere in the world that is not in the flight path of an airport.

ZhengZheng (Jenny) Fu

BRIDGE DESIGN ENGINEER ADMINISTRATOR, LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT, BATON ROUGE, LA.

ZhengZheng "Jenny" Fu received a bachelor of science degree in mechanical engineering from Huazhong University of Science and Technology in China in 1984 and earned a master of science degree in civil engineering from Purdue University in 1991. Fu is the bridge design administrator in Louisiana Department of Transportation and Development, where she is responsible for bridge design–related activities. Fu is Louisiana's voting member on the American Association of State Highway and Transportation Officials' Committee on Bridges and Structures (COBS) and a member of the COBS executive committee. She serves as the chair for COBS Technical Committee T-8 (Movable Bridges) and is a member of the T-10 (Concrete) and T-11 (Research) committees. She also serves on the Long-Term Infrastructure Program Expert Task Group on Bridges.

Derek Soden

STRUCTURAL ENGINEER, FHWA OFFICE OF BRIDGES AND STRUCTURES TEAM LEADER, FHWA

Derek Soden is the structural engineering team leader in the Federal Highway Administration (FHWA) Office of Bridges and Structures and FHWA's principal structural engineer. Soden is responsible for planning and managing national-level programs targeted at improving the state of practice of structural engineering as applied to the planning, design, construction, and evaluation of highway bridges and structures. He leads a staff of highly qualified engineers who provide technical leadership and guidance to state departments of transportation, industry, and other FHWA offices.

Soden has worked for FHWA since 2009. He was the assistant division bridge engineer for FHWA's Florida and Puerto Rico divisions from 2009 to 2012 and a senior structural engineer with the FHWA Resource Center, where he provided technical assistance and training in the areas of bridge design, construction, and inspection, from 2012 to 2020. Before joining FHWA, he was a bridge design engineer from 1998 to 2009 for the Alaska Department of Transportation and Public Facilities, where he developed designs for new bridges and bridge repair, rehabilitation, and seismic-retrofit projects throughout the state. He received his bachelor of science degree in civil engineering in 1997 from the University of Alaska in Fairbanks (where he was born and raised) and his master of science degree in structural engineering in 1998 from the University of California, Berkeley.

2022 PCI DESIGN AWARDS

Bridge with a Main Span Up to 75 Feet

Middlebury Bridge and Rail Project

MIDDLEBURY, VERMONT

Every bridge project is affected by timing. Communities need these vital routes to be built or rehabilitated as quickly as possible to minimize traffic disruptions. For the town of Middlebury, Vt., the need for speed was especially critical, as the bridges and railroad in need of upgrades ran right through the middle of town.

The 20-ft-deep rail corridor, which was built in the 19th century, cuts through the center of Middlebury, with two bridges offering the only way for traffic to pass over it. In 2013, when the bridge design phase began, the railroad was plagued with drainage issues, clearance restrictions, and poor track conditions, which had contributed to a train derailment. The two bridges were also deteriorating.

The hazardous situation spurred the city to invest in the $80 million bridge and rail improvement project, which included replacing both bridges, updating the rail corridor, and increasing the overall vertical clearance for the railroad by more than 3 ft. The project would be difficult because of its location and the constant road and rail traffic.

"We knew that working around the railroad schedule was going to be a challenge," says Aaron Guyette, transportation lead for VHB. "Accelerated bridge construction [ABC] using precast concrete was the perfect solution to keep the project on schedule."

Even with the ABC approach, the project would still create traffic problems for everyone involved. The railroad ultimately agreed to a 10-week extended track closure, and the city agreed to a 10-week closure of all downtown streets. "The

KEY PROJECT ATTRIBUTES

- **The sealed precast concrete structure created a watertight tunnel.**
- **Galvanized reinforcing steel protects against deterioration and provides a 100-year service life.**
- **Each tunnel U-shape was cast monolithically and weighs over 30 tons.**

PROJECT AND PRECAST CONCRETE SCOPE

- **Build two bridges and update a deteriorating rail corridor.**
- **The project included 295 U-wall sections and 127 upper wall units.**
- **The project was completed during a 10-week rail and road closure period.**

decision to close all downtown streets essentially cut the downtown community in half," says Craig Rypkema, sales engineer for the Fort Miller Company. However, it was the most efficient solution for all stakeholders involved.

The choice of a precast concrete made the 10-week timeline possible, says Jon Griffin, project manager for the Vermont Agency of Transportation. "Fabricating each component prior to the bridge closure period saved an immense amount of time compared to traditional cast-in-place methods."

WATERTIGHT SYSTEM

One of the critical elements for the precast concrete producer on this project was ensuring that the pieces for the rail corridor could meet the tight tolerances necessary to make the system watertight. Each joint had to be within a specific range for the joint waterproofing materials to work properly.

The owner, designer, precast concrete producer, and contractor worked collaboratively to find a balance of fabrication tolerances, construction tolerances, costs, and functionality. They ultimately came up with the perfect design. "The constant collaboration helped make this project a success," Rypkema says.

The team used a precast concrete box structure that would permanently retain surrounding soils and support the existing roadways. The sealed structure was designed to keep groundwater out and convey stormwater from tunnel approaches.

The 345-ft-long concrete box section consists of a series of bottom U-shapes and top U-shapes that join with a keyway to form a clear opening. The tunnel was fabricated with tops and bottoms that could easily be placed together at the jobsite, with U-walls needed to extend upward more than 20 ft.

"It was a challenge to design elements that would be able to be transported to the jobsite and that would easily fit together in the field," Guyette says. To accomplish this, the design team post-tensioned the precast concrete panels to the U-shaped wall bases at the project site. Individual pieces were then connected longitudinally using galvanized "dogbone" hardware that could be quickly inserted and tensioned before the next piece was installed. As an added advantage, the box structures could be extended between the two existing bridge locations to create a tunnel and reconnect the historic town green.

"Precast concrete helped us achieve a project that was constructable within the project constraints," Guyette says. "This means that precast concrete made the schedule achievable, made the project affordable, and helped to achieve the 100-year design life." And for the first time in nearly 180 years, the town green—now a focal point of the downtown area—has been reconnected and developed into a beautiful community space.

Photos: VHB.

"This has been a transformational project that will have a lasting impact in Middlebury for generations to come."
— Aaron Guyette, VHB

PROJECT TEAM:

Owner: Vermont Agency of Transportation, Barre, Vt.

PCI-Certified Precast Concrete Producer: The Fort Miller Co., Inc., Schuylerville, N.Y.

Engineer of Record: VHB, South Burlington, Vt.

General Contractor: Kubricky Construction Corp, Wilton, N.Y.

Project Cost: $80 million

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Bridge with a Main Span From 76–200 Feet

Eisenhower Bridge of Valor

RED WING, MINNESOTA

The Eisenhower Bridge of Valor is a vital new piece of infrastructure spanning the Mississippi River between Wisconsin and Minnesota. The project fully replaced a cantilever bridge, which opened in 1960 and was recently determined to be "fracture critical."

The old bridge was the only river crossing for 30 miles and accommodated more than 13,000 vehicles every day, so the replacement process had to be minimally disruptive and cost effective. Those priorities drew the design team to precast concrete.

"Precast concrete I-girders are the bread-and-butter superstructure that MnDOT uses for a variety of reasons largely related to cost, simplicity in construction, durability, and low maintenance," says Ben Jilk, complex analysis and modeling engineer for the Minnesota Department of Transportation (MnDOT) Bridge Office. Additionally, the use of prestressed concrete helped the project meet federal environmental assessment standards, which required that the project not significantly affect the local environment.

KEY PROJECT ATTRIBUTES

- **Girders were erected during 45-minute windows.**
- **The 174-ft-long concrete girders were the largest in Minnesota at that time.**
- **Construction crews worked from barges to overcome staging obstacles.**

PROJECT AND PRECAST CONCRETE SCOPE

- **Replace an aging bridge over the Mississippi River between Wisconsin and Minnesota.**
- **The project included four 174-ft-long prestressed spans.**
- **Precast concrete erection was completed in two months, with five-hour road closures per span.**

The design features a seven-span precast concrete bridge composed of four spans of 174 ft 82 in., and 202,000-lb prestressed girders. At the time of production, the 174-ft-long concrete girders were the longest in the state. Their massive size and high-performance strength outmatched alternative materials and proved ideal for this substantial project, Jilk says. "The newer shapes allow us to span longer distances with our precast concrete bridges and help reduce the number of piers needed."

FROM JANESVILLE TO RED WING

To produce the long spans, crews had to perform production activities from elevated work surfaces, which required specialized scaffolds and lifts. Once cast, the precast concrete producer safely hauled the massive bridge girders 280 miles from Janesville, Wisc., to Red Wing, Minn. "The total length of loads reached 220 ft, combining the girder, truck, and six-axle rear-steer trailer," says Gary Courneya, plant operations manager for County Materials Corporation.

To minimize disruption to traffic, the new bridge was constructed next to the existing structure over a busy rail corridor and waterway. A 1000-ft-long causeway and 43-ft-deep cofferdam were created to access the site.

The spans were installed above the land leading up to the river, with three spans of steel tub girders, measuring 218, 432, and 292 ft, spanning the river. Crews worked from barges and performed frequent critical crane lifts to overcome staging obstacles.

To keep the project on schedule, two cranes were used to set prestressed girders during 45-minute windows, which dramatically minimized the need for road closures.

After two years of construction, the bridge opened for traffic in 2019. It features two travel lanes, wide shoulders, a shared-use biking and walking path, and 1640-ft-long spans. "This was a special project because it was built in an iconic town, and it provided a unique opportunity for MnDOT and the Wisconsin Department of Transportation to collaborate," Jilk says.

PROJECT TEAM:

Owner and Engineer of Record: Minnesota Department of Transportation, Winona, Minn.

PCI-Certified Precast Concrete Producer: County Materials Corporation, Janesville, Wisc.

General Contractor: Zenith Tech, Waukesha, Wisc.

Project Cost: $63.4 million

Project Length: 1640 ft

"Prestressed concrete bridge girders were specified because of their unmatched life-cycle costs, longevity, and installation efficiency."
— Gary Courneya, County Materials Corporation

Photos: *County Materials Corporation.*

2022 PCI DESIGN AWARDS

Bridge with a Main Span More Than 201 Feet

70th Ave. E. Over I-5

FIFE, WASHINGTON

The 70th Avenue East Bridge project in Fife, Wash., replaced an outdated bridge that was delaying future construction on State Route 167. It was the first of six projects to support the Puget Sound Gateway Program, which will provide essential connections between the ports of Tacoma and Seattle, Wash., ensuring people and goods can move reliably through the region.

The Washington State Department of Transportation (WSDOT) chose precast concrete for this project because the material is durable and cost effective, and accelerates construction. During the design phase, WSDOT worked closely with the design-build contractors to make the final design even more efficient.

The original plan included prestressed concrete girders with intermediate piers, including one placed in the median of the heavily used Interstate 5 (I-5). However, the team at Guy F. Atkinson Construction offered an alternative technical concept that would adjust the bridge alignment and lengthen the girders to span I-5 without the need for intermediate bridge piers.

UNEXPECTED CURVATURE

The final design features 10 of the longest precast concrete girders ever used in bridge construction. The 222-ft, 3-in.-long girders were manufactured just a few miles from the bridge site by Concrete Technology Corporation, using a high-

KEY PROJECT ATTRIBUTES

- The project features some of the longest girders used in any bridge project.
- Unexpected curvature in the girders due to the lightweight concrete mixture was corrected with adjustable braces.
- WSDOT adapted its standard girder plans to offset flexibility issues on future projects.

PROJECT AND PRECAST CONCRETE SCOPE

- Build a replacement bridge in Fife, Wash.
- The project included ten 222-ft, 3-in.-long girders
- The girders were placed during two overnight closures in August 2020.

strength, lightweight concrete mixture, which allowed the transport loads to stay within the maximum allowable vehicle vertical forces. This design choice was necessary to ensure that transportation to the bridge site would be possible on specialized variable-axle trucks.

"The choice of single long-span girders was made to meet the site's geometric conditions and to eliminate the need for a pier in the freeway median," explains Kevin Dusenberry, senior project manager at Jacobs. "Using WF100G girders eliminated the need for falsework of any kind over the freeway and greatly reduced the amount of freeway and lane closures required." The elimination of a pier in the median also significantly reduced the project's carbon footprint and its environmental impact on the adjacent wetlands.

This long-span approach saved months of construction time and eliminated the need for multiple disruptive closures and realignment of I-5 during construction. "The bridge spans five lanes in each direction and accommodates the ultimate build-out of the freeway in the future," Dusenberry says.

Early in the project, the team had to adapt to an unexpected acceleration of the timeline to meet the fabrication schedule for the girders. "Jacobs worked closely with WSDOT for special 'over-the-shoulder' reviews and with Atkinson Construction and Concrete Technology to complete the girder design in record time and girder fabrication on schedule," Dusenberry says.

In August 2020, the ten girders were hoisted across I-5 to form the foundation of the new bridge during two overnight I-5 closures. After the girders were erected, the team discovered that nine of them had picked up a horizontal curvature, causing them to be out of plumb at the bearings. "The lightweight concrete girders were more flexible than anticipated, which allowed them to curve and twist more than standard-weight girders would have," Dusenberry explains.

The girders had been braced into this configuration, and most of a false deck had been placed between the bottom flanges of the girders. To fix the problem, the contractor replaced all the bracing with adjustable braces and incrementally moved individual girders while adjusting the bracing into the final configuration. "All the girders were adjusted to be well within tolerance, and there was no damage to the girders as a result of the adjustments made," says Dusenberry.

Most importantly, the girder adjustments were safely completed over live traffic on I-5, and no lane closures were necessary to resolve this issue. WSDOT has since made a change to Washington State's standard girder plans to implement a 5-ft-1-in.- wide top flange to offset the flexibility issue on future projects using lightweight concrete.

"The biggest benefit of using the long girders was the elimination of impacts to the traveling public. "
— Kevin Dusenberry, Jacobs

Photos: Washington State Department of Transportation Bridge & Structures Office.

PROJECT TEAM:

Owner: Washington State Department of Transportation, Olympia, Wash.

PCI-Certified Precast Concrete Producer: Concrete Technology Corp., Tacoma, Wash.

CPCI-Certified Precast Concrete Producer: MSE Precast Ltd., Qualicum Beach, BC, Canada

Engineer of Record: Jacobs, Bellevue, Wash.

General Contractor: Guy F. Atkinson Construction, Renton, Wash.

Project Cost: $40.9 million

Project Length: 225 ft

2022 PCI DESIGN AWARDS

International Transportation Structure

Lambor Bridge Crossing the Perak River

PERAK, MALAYSIA

The new Lambor Bridge connects two communities across the Perak River in one of the key districts in the state of Perak, Malaysia. One of the original goals for this project was to elevate the bridge over the 100-year flood level without creating an unacceptable grade of 9.25% in the approach road.

"Under normal circumstances, the Malaysia Department of Irrigation and Drainage requires all permanent structures crossing rivers to have a minimum 1 m [3 ft] of freeboard between the 100-year highest flood level and the soffit level," explains Dr. Fairul Abas, senior bridge engineer, Malaysia Public Works Department.

In this case, the 100-year highest flood level was more than 18 m (59 ft). Therefore, the bridge and road would have to be built at an elevation of more than 21.25 m (70 ft) to meet the grade requirements. However, the road was at an elevation of just 12 m (39 ft).

The designer considered extending the bridge back to a local interchange, but this plan was too costly and would have required additional land acquisition, which could have taken up to two years to secure. Another concern was the aggressive heat and humidity, which limited the types of construction materials that could be used. To address the grade and climate challenges, the design team determined that an ultra-high-performance concrete (UHPC) was the best option.

KEY PROJECT ATTRIBUTES

- **Ultra-high-performance concrete increased durability, lowered costs, and made the bridge resilient to 100-year flooding.**
- **Spans were erected without launching girders, using a temporary bridge and scaffold system.**
- **This is Malaysia's first submersible bridge design.**

PROJECT AND PRECAST CONCRETE SCOPE

- **Build a bridge across the Perak River that addresses 100-year flood levels.**
- **The project included eight 166-ft-long spans.**
- **The project began March 5, 2018, and was completed September 4, 2020.**

"Lambor Bridge is Malaysia's first submersible bridge design, and probably also the first in the world."
— Dr. Fairul Abas, Malaysia Public Works Department

The use of UHPC meant the bridge did not have to be elevated; instead, it could be submerged in the event of extreme flooding because the impervious nature of UHPC would prevent intrusion of moisture and salt. Also, the near total elimination of reinforcing bar would significantly reduce the risk of corrosion and related maintenance costs.

"UHPC offered unparalleled benefits," says Yen Lei Voo, executive director and CEO of Dura Technology. It meant the final road finished level could be set to 16.3 m (53.5 ft), so that the gradient of the approach road from the junction is less than 5%. "Lambor Bridge is the first submersible bridge using UHPC where the bridge will be fully covered with water in the event of extreme flood," Abas says.

FULLY SUBMERSIBLE

The bridge surface is designed in a "boat" shape to optimize the hydraulics of water passing through it. The surface is completely smooth, which will accelerate water flow and reduce drag forces. "The boat-shaped bridge girder not only meets the technical criteria of the bridge functionality but also improves the aesthetics compared to normal T-beam or U-beam designs," Abas says. The extremely low porosity of UHPC increases the structure's impact resistance and durability in the instance of flooding.

The erection of the bridge presented some unique challenges. Because Malaysia does not have access to expensive launching girders that allow span-by-span construction of segmental bridges, the contractor chose a more practical approach. The first three spans were erected on a temporary steel bridge erected between permanent pier and abutment supports. The remaining five spans were erected on the ground using a scaffold system. In both cases, no span moving was required, and each span took about 13 working days to erect.

"The selected system is believed to be the first of its kind in the world," Lei Voo says. "Precast concrete is taken to a higher level while still being cost competitive and providing a long, maintenance-free life that is expected to exceed 300 years."

Photos: *Courtesy of Dura Technology Sdn Bhd.*

PROJECT TEAM:

Owner and Engineer of Record: Malaysia Public Works Department, Kuala Lumpur, Malaysia

PCI-Certified Precast Concrete Producer: Dura Technology Sdn Bhd, Chemor, Perak, Malaysia

Engineer of Record: Perak Public Works Department, Perak, Malaysia

General Contractor: Everfine Resources Sdn Bhd, Petaling Jaya, Selangor, Malaysia

Project Cost: $13.9 million

Project Length: 1326 ft

2022 PCI DESIGN AWARDS

Non-Highway Bridge Cowinner

Phoenix Sky Train Stage 2

PHOENIX, ARIZONA

Phoenix Sky Train Stage 2 is an extension project to connect the Phoenix Sky Harbor International Airport's existing elevated train to its consolidated rental car center and new ground transportation center. The goal of the extension was to streamline transportation for passengers and to support growth of the Arizona airport, which is expected to serve 58 million travelers by 2024. It also helped meet the airport's sustainability goals by reducing the daily vehicle count by 20,000.

The project included construction of more than 2.2 miles of elevated bridge, along with two aircraft taxiway bridges that will carry future airplanes over the below-grade portions of the guideway. Precast concrete was selected as the original design material for all of the bridge superstructures because the designers knew its use was the best way to meet the aggressive delivery schedule required for the 2022 opening.

"Precast concrete was cost effective, and it met the aesthetic goal of matching earlier sections of the project," says Mark M. Pilwallis, vice president at Gannett Fleming. "Most importantly, the speed at which precast concrete could be constructed was a big factor since we were working in a constrained airport environment where maintaining operations was critical."

KEY PROJECT ATTRIBUTES

- **The precast concrete producer modified its forms to cast a 78-in.-deep U-girder section.**
- **Two spans erected over an existing building required lengths up to 197 ft 8 in.**
- **Embedded steel corbels allowed for vertical adjustment with shim plates and a simple field connection.**

PROJECT AND PRECAST CONCRETE SCOPE

- **Build a 2.2-mile-long addition to the Phoenix Sky Harbor International Airport's elevated train and two taxiway bridges.**
- **The project included 296 precast concrete elements.**
- **Construction was completed between April 2018 and June 2020.**

"The prestressed girders made it easy to meet the limited live-load deflection criteria of the system for passenger comfort."
— Mark M. Pilwallis, Gannett Fleming

CORBEL BRACKETS AND DROP-IN GIRDERS

To support the new guideway bridge superstructure, precast concrete U-girders were placed on cast-in-place columns and caps. The taxiway bridges were designed using precast concrete voided rectangular box girders. A facilities access road bridge was also constructed using precast concrete voided slab girders.

The U-girders maintain the overall aesthetic of the guideway structure while meeting all of the structural and serviceability requirements, Pilwallis explains. The precast concrete producer modified its forms to accommodate a deeper U-girder section, allowing for continuous spans up to 197 ft 8 in., and to maintain the standard web slope with filler forms to increase the versatility of the forming system.

Erecting the post-tensioned U-girder was the biggest obstacle the project team faced, as the unit spanned over an active airport terminal building during construction. "The challenging site constraints and the operational need to have small- to medium-size aircrafts taxi below our guideway led us to use longer-than-typical bridge spans for precast concrete," Pilwallis says. "We used spliced precast concrete girders to extend the spans and fit the site."

The tight site conditions did not allow the team to use temporary falsework supports in the span adjacent to the terminal building, so the precast concrete specialty engineer designed embedded corbel brackets to support the drop-in girders from the adjacent pier girders. The corbels allowed for vertical adjustment with shim plates and a simple field connection of two bolts per corbel. With this accelerated construction method, the girders could be erected in the four-hour time slots allotted for the work.

Given the splice location and pier geometry, several of the post-tensioned pier girders did not have a large enough factor of safety against overturning during intermediate stages of construction prior to casting splices and applying the post-tensioning. To ensure the girders remained stable and to maintain worker safety, the precast concrete producer and precast concrete specialty engineer worked together to design and cast temporary ballast blocks to sit inside of the U-girders during the intermediate construction stages. The girders were erected with the ballast in place to ensure stability when the cranes were disengaged from the girders. After the cast-in-place splices were cast and the girder stability was ensured, the ballast blocks were removed.

To further accelerate delivery, the precast concrete producer installed electrical conduits on the exterior girder webs at the precast concrete plant before girders were shipped. This allowed for easier access with the girders at ground level and saved the contractor weeks of field installation. It also created a safer work environment by eliminating the need to install thousands of feet of conduit, which would have required laborers tied off in man lifts to work in an active traffic zone at an airport.

"The project is the latest segment of a multiphase transit system that creates significantly more landslide capacity at the airport, while reducing congestion and greenhouse gases," Pilwallis says. The train is scheduled to open to the public in early 2022.

Photos: Modjeski and Masters.

PROJECT TEAM:

PCI-Certified Precast Concrete Producer: TPAC, Phoenix, Ariz.
Precast Concrete Specialty Engineer: Modjeski and Masters, Littleton, Colo.
Engineer of Record: Gannett Fleming, Phoenix, Ariz.
General Contractor: Hensel Phelps, Phoenix, Ariz.
Project Cost: $320 million
Project Length: 2.2 miles

2022 PCI DESIGN AWARDS

Non-Highway Bridge Cowinner

UC San Diego Mesa Housing Pedestrian and Bicycle Bridge SAN DIEGO, CALIFORNIA

The University of California San Diego is set in a breathtaking location, nestled on 1200 acres of coastal woodland near the ocean. However, at the university's center is a canyon that separates the main campus from student housing and the East Campus Medical Center, and historically, this separation created long travel times for pedestrians and bikers. The new $10 million Mesa Housing Pedestrian and Bicycle Bridge solves this problem, improving access between the neighborhood and campus.

"The bridge design is inspired by the canyon it spans and the long-standing San Diego tradition of pedestrian and bike bridges that span from one mesa to the next," says Eric Naslund, project architect for Studio E Architects. "The simple and elegant spans of the concrete beams make a perfect foil for an organically shaped deck that morphs as it arrives at either landing."

Several bridge types were considered for this project, including steel truss, steel girder, precast concrete girder, and stress ribbon. The designers ultimately settled on a three-span, precast concrete spliced-girder bridge with a 190-ft-long middle span. The design was selected for its combined aesthetics, durability, and cost effectiveness.

"Use of precast concrete was the option with the highest cost savings, resilience, and durability, and the least maintenance," says Sami Megally, project engineer for Kleinfelder. "Use of precast concrete girders allowed the addition of all aesthetics features that make this bridge an architectural icon of the UC San Diego campus."

KEY PROJECT ATTRIBUTES

- **Long span girders were spliced in-air to avoid use of temporary supports.**
- **The bridge's serpentine design and curved overhangs mimic the canyon below.**
- **Two-tone glass-seeded Lithocrete finish distinguishes paths for pedestrians and bicycles.**

PROJECT AND PRECAST CONCRETE SCOPE

- **Build a pedestrian and bike bridge over a protected canyon.**
- **The project included eight California wide-flange girders (6 ft deep).**
- **Total time to erect all bridge girders was five working days.**

An extensive analysis of the precast concrete design demonstrated its constructability amid adjacent project construction and steep grades, and proved that it could accommodate environmental restrictions in the canyon, which is home to a protected wetland and coastal sage scrub and gnatcatcher habitats. "Permanent and temporary supports could not be used within the canyon," says Keith Gazaway, project manager for Kleinfelder. "The 190-ft span length was the minimum feasible length to avoid encroaching into the environmental 'no-touch' zone."

SPLICED IN THE AIR

Each line of girders in the bridge consists of three segments: two segments over the bents and end spans, and a middle drop-in segment. To accommodate the limiting site requirements, the precast concrete girders for the end spans were designed to be erected before the main span, and to span over the bents and into the main span. Partial construction of the deck slab was then completed, so that the main span girders could be spliced in the air—an arrangement that avoided the need for temporary supports. To further minimize the project's impact on the environmentally sensitive area, the team located bridge supports outside of the wetlands' limits during and after construction.

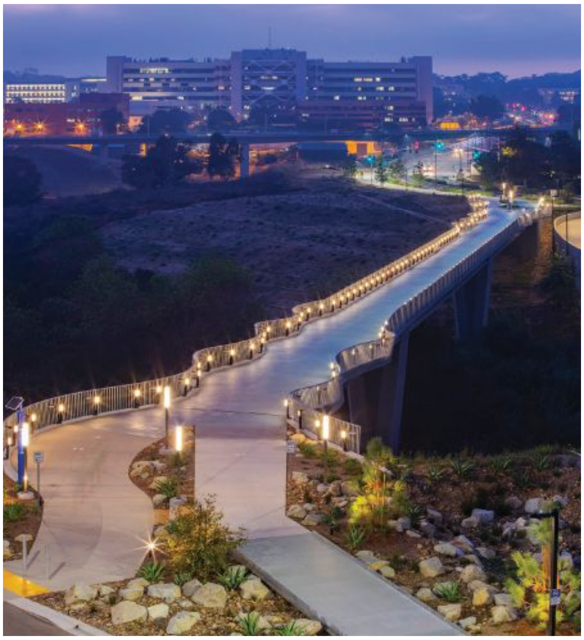
During construction, a survey error resulted in the bridge being 6 ft longer than originally planned. "This was a challenging situation, especially when using precast concrete," Gazaway says. His team solved the problem with a rapidly deployed abutment retrofit scheme, keeping the project on schedule.

The finished design features significant curvatures in the edge of the deck, with varying inclination of metal railings along the length of the bridge to create a more compelling visual experience. Shallow precast concrete girders were used to reduce crane-lifting requirements and to accommodate architectural features. To enhance the experience of bridge users, paths for pedestrians and bicyclists were distinguished from each other through the innovative use of a two-tone glass-seeded Lithocrete finish with two different colors.

By bringing innovative ideas and solutions to the bridge design and construction process, the project team achieved a balance of safety, functionality, environmental sensitivity, community value, aesthetics, and cost savings. The bridge enhances access and connectivity between the university and the surrounding community, and it encourages walking and biking by providing a significantly shorter, safer route to almost every part of the campus.

Gazaway believes this project demonstrates how a precast concrete girder bridge project can evoke a positive image of engineering excellence in terms of architectural design and structural feasibility. "The project also is a testimony to the fact that precast concrete girders with extended span limit can be used for architecturally innovative bridge crossings over areas where conventional formwork is not feasible or too costly."

Photos: *Jesse Marquez, John Durant, and Keith Gazaway.*



"The voluptuous edges allow for lingering and viewing of the canyon along the way without impeding the flow of traffic."
— Eric Naslund, Studio Architects

PROJECT TEAM:

Owner: University of California San Diego, La Jolla, Calif.

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

Architect: Studio Architects, San Diego, Calif.

Engineer of Record: Kleinfelder, San Diego, Calif.

General Contractor: Granite Construction Company, Carlsbad, Calif.

Project Cost: $10 million

Project Length: 465 ft

2022 PCI DESIGN AWARDS

Rehabilitated Bridge

The Arlington Memorial Bridge Rehabilitation

WASHINGTON, D.C.

The Arlington Memorial Bridge is not just another transportation route for locals and tourists. It is an iconic element of the entrance to the nation's capital. The neoclassical bridge spans the Potomac River, linking the Lincoln Memorial in the District of Columbia to the Arlington National Cemetery in northern Virginia and serving an estimated 68,000 vehicles daily.

After nearly nine decades of dedicated service, the bridge needed a major rehabilitation to extend its service life. In 2017, the National Park Service (NPS), in coordination with the Federal Highway Administration (FHWA), solicited proposals for the rehabilitation project through a two-phase, design-build process. The project was awarded to Kiewit Infrastructure Company in partnership with AECOM.

The goal of the project was to restore the bridge's structural integrity while protecting and preserving its memorial character and significant design elements. The designers used precast concrete bridge elements in the design to help meet all of the project goals.

"The use of precast concrete deck panels was a requirement and essential to the success of this project," says Stephen Matty, project manager in the bridge

KEY PROJECT ATTRIBUTES

- **The use of precast concrete will extend the life of the bridge for another 75 years.**
- **Closure pours used UHPC with a minimum 28-day compressive strength of 21,000 psi.**
- **HPC was used in the sidewalks, approach slabs, cross walls, beams, caps, columns, and precast concrete deck panels.**

PROJECT AND PRECAST CONCRETE SCOPE

- **Rehabilitate a historic 70-year-old bridge between the District of Columbia and northern Virginia.**
- **The project included 450 deck panels and 82 precast concrete beams.**
- **The project began in March 2018 and was completed in December 2020.**

"The rehabilitation kept this bridge in service for the local community and for visitors from all over the world."
— Joseph Fabis, FHWA

design group for AECOM. The use of precast concrete deck panels facilitated rapid construction while minimizing disruptions to the traveling public, and it provided a cost-effective approach to achieving the durability and service life requirements in the contract.

In addition, the use of ultra-high-performance concrete (UHPC) closure joints with a minimum 28-day compressive strength of 21,000 psi minimized the number of expansion joints required for the project.

HIGH PERFORMANCE, LOWER COST

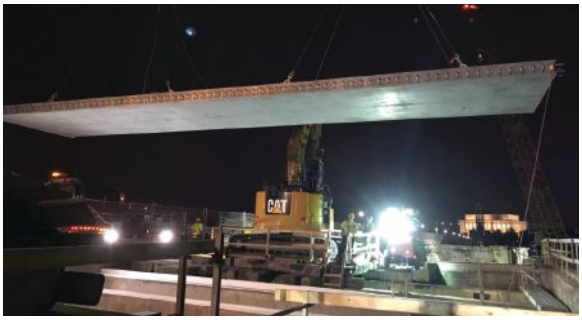
The project involved the rehabilitation of the concrete arch approach spans, including replacement of the existing cast-in-place reinforced concrete deck, and design and construction of the replacement of the moveable bascule span with a fixed steel girder span.

For the first phases of the project, designers used 450 precast concrete deck panels and replaced all of the internal concrete beams and columns on top of the piers. The later phase included replacement of the existing cast-in-place deck with precast concrete deck panels and link slabs to minimize open joints. Ten reinforced concrete arch approach spans and a multigirder steel center span were placed over the navigable channel, with eight arches spanning directly over the Potomac River.

The precast concrete deck panels were about 10 ft long and 42 to 44 ft wide, and were connected at each cross wall using 5-in.-wide UHPC closure joints. The 82 precast concrete beams were about 44 ft long and 2.5 ft deep. Each precast concrete beam was connected together along the center of the bridge using 8-in.-wide UHPC closure joints to form a continuous transverse floor beam.

High-performance concrete (HPC) was used in the sidewalks, approach slabs, cross walls, beams, caps, columns, and precast concrete deck panels, with 28-day compressive strengths ranging from 4500 to 6000 psi.

"The precast concrete deck panels with HPC, UHPC closures, and stainless-steel reinforcement provide a level of protection to the supporting structure that will extend the life of the bridge for another 75 years," Matty says. "The partnership between the FHWA and NPS was key to the success of this project," adds George Choubah, FHWA lead structural engineer. "Everyone on the team worked very hard to make sure that the fast-paced design and construction schedules were met without jeopardizing the quality of the final product," he notes.



Photos: FHWA.

PROJECT TEAM:

Owner: National Park Service, McClean, Va.

PCI-Certified Precast Concrete Producer: Pennstress, Roaring Spring, Pa.

Engineers of Record: AECOM, Glen Allen, Va., and FHWA, Ashburn, Va.

General Contractor: Kiewit Infrastructure Co., Hanover, Md.

Project Cost: $201 million

Project Length: 2162 ft

2022 PCI DESIGN AWARDS

Transportation Special Solution and Harry H. Edwards Industry Advancement Award Honorable Mention

Veterans Drive Seawall

ST. THOMAS, U.S. VIRGIN ISLANDS

Veterans Drive in St. Thomas, U.S. Virgin Islands, is a 2-mile-long seaside road that offers breathtaking views of the harbor and sea and serves as an anchor point for the city of St. Thomas.

In 2017, American Bridge Company contacted WSP USA to provide value-engineering design services to improve a half-mile seawall portion of the road, which was badly in need of repair. The project included road widening, pavement reconstruction, seawall construction, and related work as part of a larger revitalization of the St. Thomas Waterfront and Downtown Charlotte Amalie.

The owner originally proposed a stacked, precast concrete block design, but the team determined that such a structure would be too risky and too expensive. Also, the supply of materials at the time was undependable. After considering several alternative options, the team selected a precast concrete counterfort wall design that could be produced and transported from Coastal Precast Systems in Virginia.

"The precast concrete counterfort gravity wall design incorporated all of the benefits of the design-build process by tailoring a unique design to meet the owner's requirements, the contractor's abilities, and the budget," says Justin Berglund, project manager for American Bridge Company.

KEY PROJECT ATTRIBUTES

- **Production of full-height units reduced crane picks from 6600 to 251.**
- **Underwater GPS attached to an excavator was used to guide the precast concrete pieces into place.**
- **Some excavations extended 15 ft deep before seawall footings were placed.**

PROJECT AND PRECAST CONCRETE SCOPE

- **Replace an aging seawall using a precast concrete counterfort wall design.**
- **Precast concrete modular wall units were made out of marine-grade concrete.**
- **The precast concrete design solution cut nine months from the project timeline.**

GPS REPLACES DIVERS

The design features individual, standard precast concrete wall units composed of a tapered base slab, a wall stem, and single or double counterforts based on height of soil retained; some counterforts were as tall as 16 ft. The precast concrete producer developed the piece-wise layout of the units in the plant to ensure they would fit the exact alignment of the project site.

"The overall design and fabrication of the pieces allowed some flexibility in trimming portions of top of the precast concrete modules to fit the site conditions," Berglund says.

WSP worked with the precast concrete producer to define element shapes and sizes and provide input for fabrication, shipping, handling, and installation. To meet aesthetic goals, the seawall pieces feature a pigmented face and a troweled finish that was achieved through the inclusion of a special precast concrete formliner. To meet the stringent design life and durability requirements, the precast concrete producer used a high-quality marine concrete mixture and stainless steel reinforcement.

Once cast, the pieces were shipped via ocean barge from Virginia to St. Thomas and placed for storage on the seabed in the vicinity of the final installed location.

The use of full-height units counterfort wall pieces instead of quay wall blocks reduced the number of crane picks from 6600 to 251. "This approach allowed us to reduce the wall installation time frame by nine months," Berglund says. It also eliminated the need for divers to set the blocks, which was a deemed a significant safety issue. Instead, the team used underwater GPS equipment attached to an excavator to guide the precast concrete pieces to the correct height and alignment.

The first half of the wall required excavation of the existing foundation soils, which were replaced with crushed gravel prior to placing the seawall footing. "This excavation would have proved very difficult if we had used the original wall design, as the risk of the wall footing washing out prior to backfilling would have been a real concern," Berglund says. By using the precast concrete counterfort wall option, the crews were able to place the wall segments to full height with one crane pick followed immediately by backfilling.

"The precast concrete module concept was an effective and elegant solution to the seawall design and construction for Veterans Drive widening project," Berglund says. "The concept can be considered to be a viable option for shallow piers, wharves, and other shore-protection projects where durability, resiliency, and aesthetics are critical requirements."

Photos: *WSP/American Bridge.*

"Veterans Drive Phase 1 is the largest public infrastructure project in the history of the U.S. Virgin Islands, and this wall system was instrumental in the successful completion of the project."
— Justin Berglund, American Bridge Company

PROJECT TEAM:

Owner: U.S. Virgin Islands Department of Transportation

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

Engineer of Record: WSP USA Inc., Federal Way, Wash.

General Contractor: American Bridge Company, Tampa, Fla.

Project Cost: $42 million

Photo: Caltrans.

BRIDGE WITH A MAIN SPAN UP TO 75 FEET

21ST AVENUE UNDERCROSSING

SACRAMENTO, CALIFORNIA

PROJECT TEAM:

Owner and Engineer of Record: Caltrans, Sacramento, Calif.

PCI-Certified Precast Concrete Producer: Con-Fab California, LLC, Lathrop, Calif.

General Contractor: Bridgeway Civil Constructors, Inc., Vacaville, Calif.

Project Cost: $3.5 million

Project Length: 51 ft

KEY PROJECT ATTRIBUTES

- Route 99 was shut down for 94 hours, instead of 6 months of partial lane closures.
- Each girders was erected in less than 10 minutes.
- UHPC provides a superior joint connection to prevent longitudinal cracking.

PROJECT AND PRECAST CONCRETE SCOPE

- Replace a deteriorating bridge using accelerated bridge construction methods.
- Project included 35 precast concrete girders.
- All of the girders were placed within 4 hours.

The 21st Avenue undercrossing bridge, which carries Route 99 traffic over 21st Avenue in Sacramento Calif., is a notable example of the benefits that precast concrete and accelerated bridge construction (ABC) bring to a community.

The original bridge, built in 1958, consisted of two single-span cast-in-place reinforced concrete cored slab bridges on strutted abutments, which were later linked by a cast-in-place prestressed cored slab. The bridge deck was showing severe signs of distress in the form of heavy pitting, abrasion, cracks, and spalls, indicating it had to be replaced. However, the high volume of traffic on Route 99 meant the project design had to be completed quickly and with as little disruption as possible.

The California Department of Transportation (Caltrans) proposed replacing the existing voided slab deck with precast, prestressed concrete adjacent box girders using ultra-high-performance concrete (UHPC) connections to provide a superior joint connection and prevent longitudinal cracking. The design included 35 precast, prestressed concrete box girders, roughly 51 ft long, 4 ft wide, and 2.25 ft in height, with UHPC placed in the keyways between the girders to form the transverse connection.

The project followed an ABC method, which dramatically reduced traffic disruption.

100-HOUR PROJECT

Typically, a project of this scale would require a single lane closure for six months, as crews worked incrementally to build one side of the bridge then the other. Instead, Caltrans opted to shut down Route 99 completely for four days, to demolition the bridge and erect the replacement.

It was difficult to convince internal and external stakeholders to shut down the busy highway, but the project team persuaded them that the comparatively brief shutdown was a better alternative. It was the first high-profile ABC bridge project in California that used precast concrete elements to replace a bridge in such a short time.

With the route closed, the existing bridge superstructure was demolished, the tops of the abutments were leveled, a ½-in. thick elastomeric pad was placed on the abutment seats, and then the girders were erected. Each girder was placed in less than 10 minutes over the course of 4 hours. Then UHPC was placed in the keyway joints and cured, a 1-in. thick polyester concrete overlay was placed, and the median barrier was constructed.

The bridge reopened to traffic on Tuesday, June 15, at 11:00 p.m. — 6 hours ahead of schedule. A conventional cast-in-place construction would have taken six months to do this job. The designers believe many more bridges will be replaced using precast concrete girders and ABC methods in the future.

2023 PCI DESIGN AWARDS
CALL FOR ENTRIES

The PCI Design Awards recognize not just design excellence but also projects with outstanding use of precast concrete. PCI looks for projects that push the envelope and advance the precast concrete industry. **The PCI Design Awards program will showcase the winning projects in multiple ways:**

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