American Segmental Bridge Institute

2019

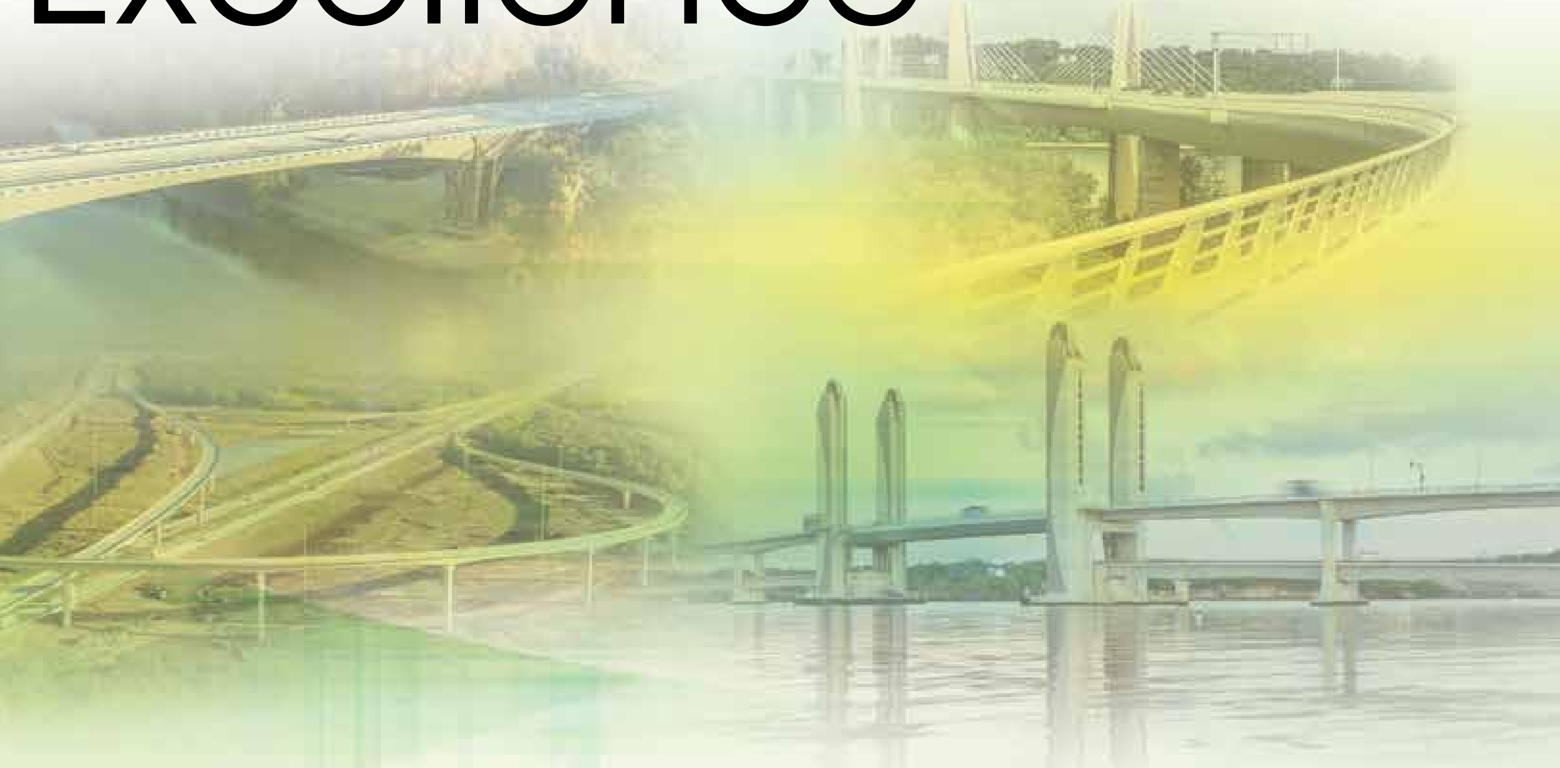
"ASBI Bridge Award of Excellence"

2019 Bridge Awards of

In recognition of the owners of bridges which exemplify concrete segmental bridge design and construction excellence.

In the 10th biennial American Segmental Bridge Institute (ASBI) Bridge Award of Excellence competition, seven projects were selected as outstanding examples of segmental concrete bridge construction. Judging for the 2019 program was conducted via webinar.

Excellence



All concrete segmental or cable-supported bridges located within the 50 United States and completed between January 1, 2017, and August 1, 2019, were eligible for the 2019 awards competition. Entrants in the competition were judged on the basis of the following criteria:

- **Innovation of Design and/or Construction**
- **Rapid Construction**
- **Aesthetics and/or Harmony with Environment**
- **Cost Competitiveness**
- **Minimization of Construction Impact on the Traveling Public** ***(when applicable)***

2019

Bridge Awards Jury

Carmen Swanwick, Chair
Utah DOT

Brett Pielstick
Eisman & Russo, Inc.

Benjamin Soule
SYSTRA International Bridge Technologies

BRIDGE AWARD OF EXCELLENCE WINNERS

Awards will be presented to bridge owners' representatives during the 2019 ASBI Convention Tuesday Luncheon, November 5, 12:00 p.m., at Disney's Contemporary Resort, Orlando, Florida. Following are jury comments, project details, and participant credits for the winning entries (ASBI Members are noted in bold).

Marc Basnight Bridge

Category: Bridges Over Water

Photo Courtesy of
PCL Civil Constructors, Inc.

Nearly three decades in the making, the new 2.8-mile, $252 million Marc Basnight Bridge is a remarkable achievement. Using first of-their-kind design and construction methods, the new bridge conquers the Oregon Inlet, minimizes environmental impacts in the crucial ecosystem, and provides a lifeline to Hatteras Island capable of withstanding the worst storms the Atlantic Ocean offers, while accounting for vessel collision and an unparalleled 84 ft of scour.

Innovation of Design and/or Construction

The 2.8-mile bridge is designed to provide a 100-year service life and, at 42 ft, 7 in. wide, the new bridge accommodates two 12-ft-wide traffic lanes and 8-ft-wide shoulders, providing a safer traveling experience over the inlet.

The segmental unit of the new Basnight Bridge features foundations designed to meet unprecedented design requirements of up to 84 ft of scour, 12-ft-per-second currents, 105-mile-per-hour winds, and vessel impacts up to 2,151 kips. To capture all the effects of tropical systems and nor'easters, the modeling effort included employing wind and pressure fields for inputs into both hydraulic and wave models, resulting in 100,000 storm simulations dating back 160 years.

The centerpiece of the new bridge is a 3,550-ft-long continuous segmental box girder unit, erected using the balanced cantilever method and supported by single, segmental hollow rectangular columns. Comprised of 264 precast superstructure segments, ranging in depth from 9 ft to 19 ft, and 62 rectangular precast column segments, the segmental unit gracefully arches 90 ft above the rolling waters of the Oregon Inlet. The bridge's nine, 350-ft-wide spans allow the channel to naturally shift along a 2,400-ft-wide navigation zone, minimizing dredging requirements relative to the old bridge and providing vertical and horizontal clearances of 70 ft and 290 ft, respectively.

The post-tensioned segmental design provided span lengths that accommodate required navigational clearances, while also providing the durability necessary to achieve the specified 100-year service life.

The increased durability, speed, and simplicity of post-tensioned segmental construction were carried beyond the navigation unit to the adjacent transition spans' substructure. In these regions of the bridge, 25 two-column bents, comprised of 96 post-tensioned, solid, precast segments up to 28 ft, 8 in. long with precast bent caps, carry the transition spans rising to meet the segmental unit.

Rapid Construction

The project schedule benefited from simultaneous work along three different headings, each featuring unique characteristics, construction access, and methods. In the Oregon Inlet, segmental unit construction began at the center and worked in each direction using the balanced cantilever erection method. Using precast segments reduced reliance on concrete delivery to the remote construction site, permitted the segment fabrication while the foundation elements were being installed, and accelerated the erection process by installing up to two segments per day.

Simultaneously with segmental navigation span erection, cranes and equipment worked from the ground to construct the south approach spans over land. Meanwhile, the construction team built a 1,600-ft-long temporary work trestle to construct the 1.5-mile-long north approach units. By "leap-frogging" the work trestle, the team limited the total work trestle length and greatly reduced shading and other adverse impacts on over a mile-long stretch of environmentally sensitive submerged aquatic vegetation (SAV) habitat.

The Oregon Inlet can be a very inhospitable place to work in general, and particularly so for constructing large marine structures such as the Marc Basnight Bridge. During the three years of construction, 12 hurricanes, Nor'easters and major storms assaulted North Carolina's Outer Banks. However, thanks to a robust preparedness plan and a highly proactive approach to construction schedule management, the team encountered no major project setbacks and completed construction on schedule, opening the new bridge to traffic February 25, 2019.

Aesthetics and/or Harmony with Environment

Connecting two of the most environmentally vulnerable barrier islands in the country, the new bridge minimizes impacts on the area's 20 environmentally protected species, National Register of Historic Places-listed and eligible resources, and North Carolina's most extensive

Jury Comments

The clean, repetitive lines are well-suited to the site, with clear consideration to the impact to the community on many levels. Precast segmental construction along with the use of additional precast elements simplified erection activities and reduced construction times relative to other methods. Segmental spans to help accommodate the ever-shifting channel or "navigational zone" was a perfect application for Segmental Bridge Technology proving the desired horizontal and vertical clearance need to shift the navigational channel between different spans allowing nature to designate the natural flow of the inlet. This project also demonstrates the robustness and redundancy found in Concrete Segmental Bridges in one of the harshest environments with wave, wind, salt and scour all impacting the overall structure.

collection of seagrass beds. The navigation unit's slender, variable depth superstructure, with its long, open spans, results in an aesthetically pleasing and economical solution that accelerated the schedule and required fewer piers. This, combined with balanced cantilever erection, reduced temporary and permanent in-water construction. Meanwhile, in the north approach spans, an innovative "leap-frog" approach for the work trestle reduced its footprint throughout the nearly 1.5-mile-wide stretch of environmentally sensitive submerged aquatic vegetation beds. These tailored construction approaches, combined with extensive use of precast materials, minimized temporary environmental impacts and shortened the construction duration, much to the delight of stakeholders and agencies. Further, the old bridge will be deconstructed and sunk offshore to create new fish habitats.

The project also provides a vital lifeline for the residents of Hatteras and Ocracoke Islands. Products, services, and more than 2 million tourists cross the bridge annually — which also provides an evacuation route when hurricanes approach.

The project overcame lawsuits, channel migration, erosion, and a remote location to provide a safe, reliable, and navigable crossing. The team's proactive, partnering approach to design, permitting, and construction processes will prove instrumental in future projects.

Nearly three decades in the making, the new Marc Basnight Bridge is proof that unique and economical engineering solutions can solve environmental concerns while also meeting community needs.

Cost Competitiveness

The bridge's 100-year service life, like its reasonable cost and constructability, comes not only from cutting-edge technological advances but also from innovative combinations of proven, reliable methodologies.

Precasting proved more economical and reliable than trying to deliver cast-in-place concrete to the remote project site. Minimizing field construction work from barges and work trestle also led to much faster and safer construction.

At $399 per square foot, the final price of the Basnight Bridge is heavily influenced by the demolition and disposal of the existing Bonner Bridge, escalation related to nearly four years of litigation, and the significant foundation design requirements. However, at $215.8 million, the team's bid was 23% lower than the second place bid and more than $25 million less than NCDOT's estimate.

Minimized of Construction Impact on the Traveling Public

The Basnight Bridge is on a new alignment, so the majority of the project did not impact the traveling public. The use of balanced cantilever segmental construction significantly reduced the amount of work required in the channel and limited impacts on boaters.

Though the Outer Banks attracts millions of visitors each year, the Oregon Inlet is, from a construction standpoint, relatively remote — which challenged material delivery. Using precast concrete and delivering most elements 90 nautical miles by barge over the Atlantic Intracoastal Waterway minimized the quantity of materials transported over the narrow, two-lane NC Highway 12.

CREDITS

Owner:
North Carolina DOT

Owner's Engineer:
Pablo Hernandez

Designer:
HDR, Inc.

Design-Build Team:
PCL Civil Constructors, Inc.

Contractor:
PCL Civil Constructors, Inc.

Construction Engineering Services:
Corven Engineering, Inc.

Constructability Review/
Estimating Services:
Corven Engineering, Inc.
PCL Civil Constructors, Inc.

Construction Engineering Inspection:
North Carolina DOT
WSP USA, Inc.

Precast Producer:
Coastal Precast Systems, LLC

Formwork for Precast Segments:
Ninive Casseforme

Erection Equipment:
HCR Bridge Machinery

Post-Tensioning Materials:
Schwager Davis, Inc.

Bearings:
R.J. Watson, Inc.

Expansion Joints:
Watson Bowman Acme

Epoxy Supplier:
Pilgrim Permocoat, Inc.

Prepackaged Grout:
The Euclid Chemical Company

Photo Courtesy of HDR, Inc.

Photo Courtesy of Richard Tremblay

The Bayonne Bridge Navigational Clearance Project was substantially completed in February 2019, marking the first time that engineers built a new bridge deck above and through an existing roadway, while ensuring limited disruption to the traveling public. In 2006, the Panama Canal expansion project began to accommodate larger ships and absorb the growing demand of cargo. At 151 ft, the existing Bayonne Bridge was too low to allow these new "Post-Panamax" vessels access into New York and New Jersey ports. Instead of demolishing and building a new bridge, the solution was "Raising the Roadway" 64 ft. Providing access to newer, larger Panamax vessels, via the Kill Van Kull channel, the iconic arch remains a National Landmark.

Bayonne Bridge

Category: Bridges Over Water

Innovation of Design and/or Construction

The New York approach has 12 spans with a maximum span length of 272 ft, and a nominal bridge length of 2,379 ft. The New Jersey approach has a total of 14 spans with a maximum span length of 250 ft, and a bridge nominal length of 2,927 ft. The new main span arch deck required higher approaches on either side of the bridge. As a result, the design included a 5% rise in longitudinal slope, increasing the total length of each approach.

The Northbound bridge had to be built between the structural girders and columns supporting the existing bridge. The existing bridge constraint created the need for transverse eccentricity between the new Northbound deck and the sub-structure at the taller piers. This eccentricity created transverse over-turning moments and deflections that were mitigated by using a temporary pipe strut, shoring up the Northbound deck. Once the Southbound deck was built and the two pier caps connected, the pipe struts were removed, and the eccentricity effect was transferred as frame action between the two columns.

Consideration for the surrounding neighborhood and limited street access, led to one of the most important aspects of the design, which involved using precast segment lengths ranging from 5 ft to 10.75 ft. Coupled with a maximum segment weight of 110 tons, the varying deck widths of 65 ft for the Northbound bridge, and 51 ft for the Southbound bridge, simply meant steel super-structure was not a viable option. Precast segmental construction with overhead gantry was chosen, due to the height and length of the approaches, time constraints, and the minimal construction site space.

To aid in schedule, the construction team opted to crane-erect the pier-tables out ahead of the gantry with the same crawlers used for the substructure precast operation. The substructure included 513 precast units, including the capitals and caps, which weighed up to 125 tons. Column segments were epoxied together using temporary, post-tensioning bars. Once the pier cap segments were erected, loop tendons were installed and stressed, connecting the foundation to the pier cap.

Due to the deck-to-column bearing connection, temporary pier brackets were required to provide stability to the deck pier-table during construction. These pier brackets provided all necessary stability until the three-legged overhead gantry could be launched forward. Once the bridge bearings were grouted, the gantry allowed for more rapid removal of the pier brackets, mitigating the demands of the balanced-cantilever construction on the tall, slender columns. The gantry was designed to withstand all balanced-cantilever construction loads, including accidental segment drop, thus omitting potential collapse and in turn protecting the traveling public.

Superstructure consisted of 1,079 precast concrete box girders, erected using the balanced-cantilever method by overhead gantry. Another construction method utilized, was a span-by-span system installed in the gantry used at all abutment and tower end spans, which eliminated false work.

Because construction took place above live traffic – access, fall protection, and dropped object protection became an especially critical focus.

Rapid Construction

After the construction contract was awarded, an effort by the design and construction team was made to expedite the construction sequence. This was done by introducing the pipe strut as a temporary brace to counter the superstructure eccentricity on the columns. This allowed for the Northbound and Southbound structures to be precast independently.

Jury Comments

This modification preserved this 1931 US National Landmark 1,675-ft arch span by providing the additional 64 ft of vertical clearance required for port to support the "Post-Panamax" ships. The segmental bridge approach provided the tools necessary to work in the confined spaces of the surrounding neighborhoods was key to the success of this project. This project is a spectacular engineering marvel where segmental bridge techniques were leveraged to meet the demands of this new landmark bridge. This is a very exciting segmental project and is a bold example of engineering and construction ingenuity. It also serves as an example of the strengths of segmental construction as we face the challenges of rebuilding our infrastructure. Extremely difficult construction and design details developed to fit the site constraints. Aesthetically pleasing to maintain the historic nature and national landmark.

The original design called for typical 8 and 10-finchest-long span segments. By increasing these lengths to 9 and 10.75 ft, the overall number of segments was reduced by 8%, fully expediting the casting and erection of the superstructure.

The base soffit form design included a parabolic soffit arch which required 18 segments, each with variable heights. The construction team proposed a tangent soffit that reduced the number of variable depth segments by 50%, as well as the overall post tensioning demands. This reduction allowed for a more accelerated schedule.

At the mid-point of each span, was a cast-in-place closure pour, which originally included permanent diaphragms for the future tendon profiles. The construction team was able to incorporate these tendon deviators into adjacent precast blisters, thus eliminating extensive, critical-path formwork from the closure pour cycle.

The construction team also optimized the temporary post tensioning in the substructure precast, by upsizing the bar diameter, which in turn eliminated a high percentage of permanent vertical post tensioning. The implementation of temporary erection post tensioning within the segment boxes, in lieu of the base design's deck-anchored system, will ultimately reduce the long-term maintenance requirements for the Port Authority. Incorporating temporary blisters within these segments eliminated thousands of deck penetrations that would otherwise lead to potential long-term maintenance issues.

Aesthetics and/or Harmony with Environment

The geometry of the precast pier cap and columns was created to replicate the architecture of the original Bayonne Bridge piers, while maintaining the efficiencies of repetitive geometry for precast construction. Taller columns were tapered to a 1:60 rate along the transverse direction for enhanced slenderness. Haunched box girders, used for the longer spans, provided an appearance of slim elegance. The final design included a mid-height pier cross-strut, that matched the bridge's original elevation — designed as a reminder of the original 1985 National Landmark.

Cost Competitiveness

Due to height and length of bridge spans, proximity to homes, and the right of way restrictions, the most feasible erection method was a balance cantilever method using an overhead erection gantry. Also, utilizing precast construction off-line in Southern Virginia, reduced on-site labor costs and aided in accelerating the overall schedule.

Minimization of Construction Impact on the Traveling Public

Maintaining traffic during peak hours meant maximizing on full closures during off-peak hours and weekends.

Increasing the span segment length to 9 and 10.75 ft impacted more than just the schedule. As a direct result of these designs, multi-axle haulers were able to make fewer, more maneuverable trips, reducing impacts to the public.

CREDITS

Owner:
Port Authority of New York and New Jersey

Owner's Engineer:
Port Authority Engineering Department

Designer:
HDR WSP, JV

Contractor:
Skanska, Koch, **Kiewit Infrastructure Company,** JV (SKK)

Construction Engineering Services:
Finley Engineering Group, Inc.
Kiewit Infrastructure Engineers
McElhanney Consulting Services

Constructability Review/ Estimating Services:
Kiewit Infrastructure Engineers

Construction Engineering Inspection:
Greenman Pederson Inc. (GPI)

Precast Producer:
Skanska – Bayshore Concrete Products

Formwork for Precast Segments:
Ninive

Erection Equipment:
Handan China Railway Bridge Machinery Co. Ltd (HCR)

Post-Tensioning Materials:
Schwager Davis, Inc.

Bearings:
mageba USA LLC

Expansion Joints:
mageba USA LLC

Epoxy Supplier:
Sika Corporation
Pilgrim Permocoat, Inc.

Prepackaged Grout:
The Euclid Chemical Company
Five Star

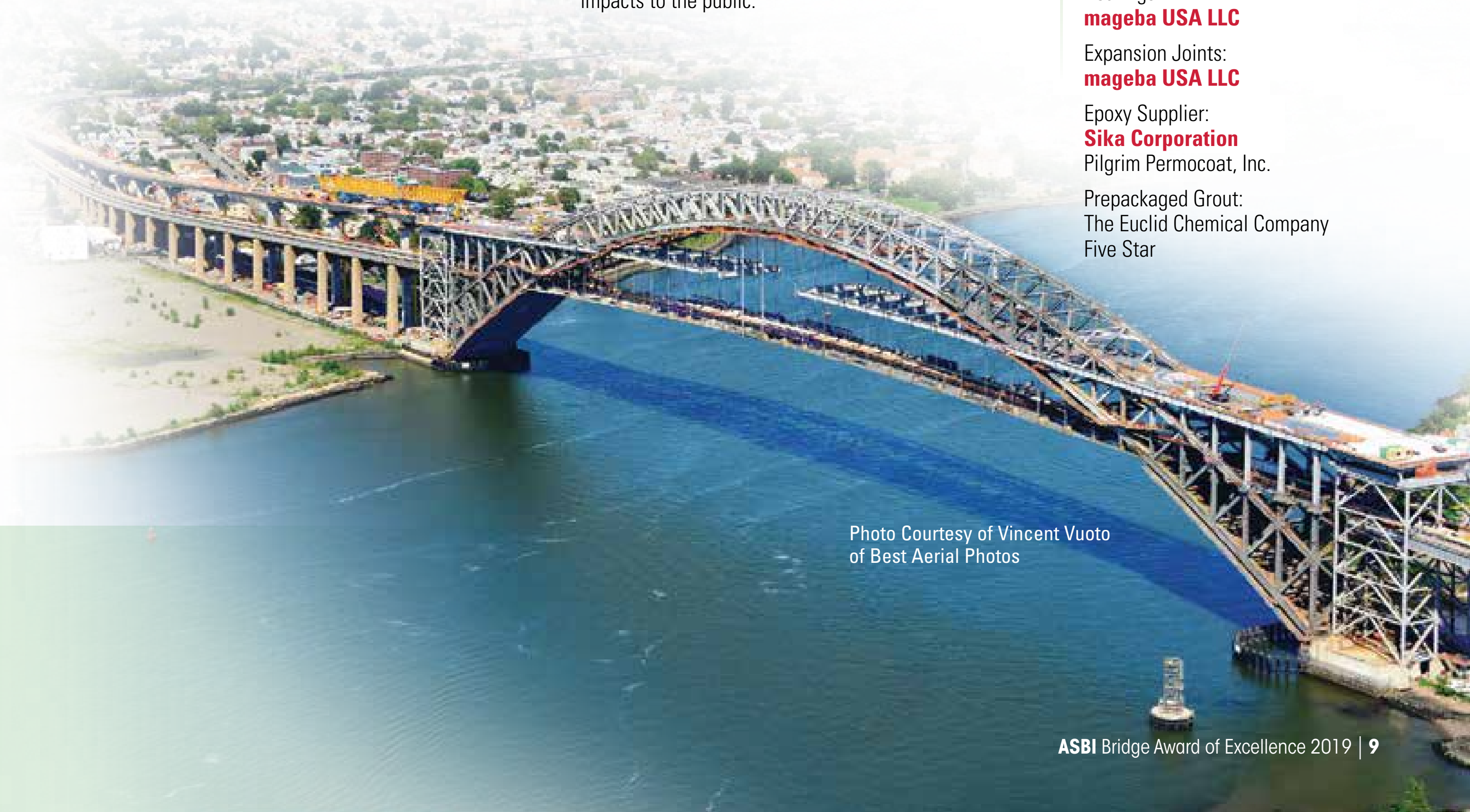
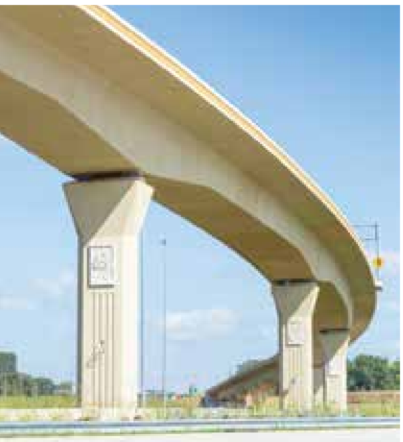


Photo Courtesy of Vincent Vuoto of Best Aerial Photos

I-49/I-220 Interchange Segment K

Category: Rural Bridges and Viaducts



Photos Courtesy of
PCL Civil Constructors, Inc.

Located in Caddo Parish, Louisiana, Segment K of the 36-mile I-49 North Corridor Interchange consists of a new section of four-lane interstate highway that stretches from I-220 in Shreveport to the Arkansas state line. Louisiana's economic growth by opening the state to new or expanded commercial opportunities. Segment K includes the design of the I-49/I-220 interchange and a partial cloverleaf interchange at Martin Luther King, Jr. Drive.

At a cost of $65 million for the ramp portion of the I-49/I-220 interchange, these bridges are the first post-tensioned, precast segmental bridges constructed in Louisiana. The three precast segmental bridge ramps consist of 700 precast segments, a deck area of 273,500 sq. ft. The three ramps present very complex geometry for an interchange in the middle of a relatively undeveloped locale, with each ramp having its own unique box girder width (varying from 30.5 ft to 64 ft wide), straddle piers, cantilever piers and horizontal curves down to a 550 ft radius.

Innovation of Design and/or Construction

A critical detail that greatly simplified the post-tensioning details was the use of 'Diabolos' to allow for a single form void in the segment deviators to accommodate the wide range of tendon geometry for the entire project. The use of diabolos greatly simplifies segment fabrication by eliminating the commonly used pre-bent steel pipes that require custom fabrication for each tendon's geometry and post-tensioning installation by allowing for a continuous external post-tensioning duct to be used between the anchorage diaphragms. This eliminates the duct splices that would be required with steel bent pipes and reduces post-tensioning duct installation costs. This simplified post-tensioning detail provides for better overall quality in the production of the precast segments and require fewer and more easily accessible fabrication and inspection points, reducing the overall effort required to produce each box girder segment.

Rapid Construction

The combination of precasting the superstructure segments and ground based cranes erection lead to rapid on-site erection of the superstructure. All three precast segmental bridge ramps were erected in balanced cantilever using ground based cranes. Cantilevers were stabilized using temporary towers supported directly on the permanent footings. Counterweight-segments were used to minimize out-of-balance longitudinal bending moments in the foundations. End span unit segments were erected on temporary falsework until closure with the adjacent cantilever was completed.

Aesthetics and/or Harmony with Environment

While the superstructure itself presents a well-proportioned structure that conforms to the "form follows function" philosophy that creates a superstructure that "looks right" when viewed by the travelling public. Aesthetic enhancements were incorporated in the project

Jury Comments

The first precast segmental bridge in Louisiana is aesthetically pleasing and a winner all around. A beautiful example of a segmental bridge in a rural area. With the wide-open spaces afforded in this rural setting, cranes were able to simply and efficiently erect the balanced cantilevers. This project clearly demonstrated the efficient and effective accelerated bridge characteristics of segmental bridge construction. At final bidding, only one contractor bid the steel alternate and the precast concrete segmental bridge won handily over the steel design.

by adding chamfered pier-columns with rustication panels on the longitudinal to minimize the "mass" effect of the substructure beneath the superstructure.

Cost Competitiveness

This project was bid with two bridge alternative designs; a precast concrete segmental alternate and a twin steel box girder alternate. At final bidding, only one Contractor bid the steel alternate and the precast concrete segmental bridge alternate won handily over the steel design. Below are the bid statistics:

- The average cost per sq. ft. = $238/sq. ft.
- Segmental bridge cost: $65 million dollars.
- Total deck area: 273,500 ft^2 (Ramp SE: 117,150 ft^2; WN: 21,350 ft^2; EN: 135,000 ft^2).

Minimization of Construction Impact on the Traveling Public

This interchange was an enhancement to the Interstate I-49/I-220 Interchange Shreveport, LA. The existing roads were two lane and therefore temporary alignment shifts were used to easily maintain traffic flow during construction of the new ramps. This project is good example of where the substantial benefit to upgrading the interchange was worth the minor inconvenience of the traffic shifts during construction.

Photo Courtesy of PCL Civil Constructors, Inc.

Photo Courtesy of PCL Civil Constructors, Inc.

CREDITS

Owner:
Louisiana DOTD

Owner's Engineer:
TRC Engineers, Inc.

Designer:
Finley Engineering Group, Inc.
(Ramps SE & WN)
TRC Engineers, Inc.
(Ramp EN)

Contractor:
PCL Civil Constructors, Inc.

Construction Engineering Services:
Corven Engineering, Inc.

Construction Engineering Inspection:
Louisiana DOTD
with Technical Support by
FIGG Engineering Group

Precast Producer:
PCL Civil Constructors, Inc.
(Self-Perform)

Formwork for Precast Segments:
DEAL/Rizzani de Eccher USA, Inc.

Erection Equipment:
Rental Manitowoc 2250
Bulldog Erectors, Inc.

Lifting Frame Design:
Construction Technologies
& Engineering, Inc.

Post-Tensioning Materials:
Schwager Davis, Inc.

Bearings:
R.J. Watson, Inc.

Expansion Joints:
D.S. Brown Company

Epoxy Supplier:
Pilgrim Permocoat, Inc.

Prepackaged Grout:
The Euclid Chemical Company

Photo Courtesy of FIGG

The new I-91 Brattleboro Bridge in Brattleboro, Vermont, is a three-span, 1,036 ft arching bridge with a 515 ft main span soaring 90 ft above the West River built utilizing segmental balanced cantilever construction. The new concrete segmental bridge (a first in the state) features landmark aesthetics and provides a 150-year service life. This signature bridge, which is the largest bridge in Vermont's history, creates a special gateway into the state.

The new bridge was opened to traffic on September 12, 2017, and replaced twin aging steel bridges that were built in 1958. The new bridge carries four lanes of traffic but has the capacity to carry eight lanes of traffic.

The Design/Build Team (FIGG Bridge Engineers, Inc., and PCL Civil Constructors, Inc.) worked closely with the community and VTrans on the aesthetic and functional design centered around a theme of "Vermont: A Bridge to Nature." This postcard-worthy bridge features viewing platforms for pedestrians, hikers, and visitors at the base of each pier overlooking the West River and mountainous valley.

I-91 Brattleboro Bridge

Category: Long Span and Cable-Stayed Bridges

Innovation of Design and/or Construction

The balanced cantilever method facilitated construction to rise above the site constraints on the ground below and allowed the long spans to be formed in a self-supported manner during construction. This was an important benefit for the unobstructed use of the West River and West River Trail for recreation throughout construction. Using self-advancing formwork (form travelers), segments of the bridge were cast-in-place 16 ft at a time, alternating from one side of the pier to the other, until each cantilever arm reached 257 ft. When the adjacent pier's cantilever was completed using the same process, a small closure segment was cast to connect the two cantilever arms and form the span. For the two cantilevers to meet at a precise mid-air target, surveying and geometry control were a full-time endeavor. Balanced cantilever construction also allowed crews to work throughout the harsh Vermont winter. Cast-in-place concrete segments were cured using the intelliCure Match curing system which matches the water temperature conditions of the cure box with sensors in the segments so concrete breaks accurately represented what was going on with segment curing.

The quad wall piers are comprised of four concrete columns that each curve outward in two directions symmetrically. This wall pier system provided stability and allowed for the balanced cantilever segmental construction of the bridge superstructure from above without temporary props in the river, preserving the West River and West River Trail.

The design team utilized sophisticated LARSA 3D finite element models with time dependent effects to design the bridge to not only withstand the appropriate standard loadings, but to also account for the time dependent effects on the concrete as it creeps and shrinks throughout the 150-year design life of the bridge.

To support the bridge deck width of 104'-8", a two-cell, three-web trapezoidal box girder was used. A variable depth profile was used for structural efficiency. Another unique feature to the box girder section is the vaulted bottom soffit that runs the full length of the underside of the bridge. This 20 ft wide, 4 ft deep barrel-like shape serves to add dimension to the soffit that would otherwise be a flat 55 ft width. Continuous mild reinforcement through segment joints and a grouted post-tensioning system create continuity through the cast-in-place segments. Top slab tendons were used during cantilever construction, while bottom slab and external draped tendons provided continuity after span closures. Transverse top slab tendons balanced the deck design. All tendons have multiple layers of corrosion protection including an integral wearing surface, concrete cover, low-permeability concrete, plastic ducts, and high-quality grout.

Rapid Construction

The concrete segmental bridge design allowed means and methods that provided simple solutions to the complex site. Balanced cantilever construction techniques were utilized to build the bridge from above continuously and without interruption throughout the year.

Aesthetics and/or Harmony with Environment

It was important to VTrans and the surrounding communities for the new bridge to serve as an icon and a gateway to Vermont. Its long spans provide openness, and its arching shapes enhance the bridge as a visual gateway.

Travelers along Route 30 experience this distinctive bridge from a side vantage point as they travel under the bridge. They see the vaulted soffit stained with a blue color like the sky. The arching, long span of the superstructure is half as deep as the former bridge and opens up views of the surrounding landscape. A permanent concrete earth-toned tan stain was applied to all sides of the bridge superstructure, matching the surrounding environment. The 60 ft tall piers were cast to a texture like Vermont stone, which creates a dramatic look with different natural colors along the height. The upper "fins" of the piers cradle the superstructure and

Jury Comments

The State of Vermont entered the family of states with segmental bridges in this spectacular example of the I-91 Brattleboro Bridge. The Bridge's 515 ft main span with its cast-in place variable depth span use the advantages of balanced cantilever construction to span the entire waterway. The innovative approach to sustainability with 150-year design life, the use of calcium nitrate, and stainless-steel reinforcement will ensure this bridge will be a destination for generations to come. The signature bridge is inspired by the natural beauty of Vermont and highlights both function and symbol with shape, color and stone. Balanced segmental cantilever construction techniques eliminated the need for temporary works and allowed construction to occur throughout the year.

Photo Courtesy of FIGG

were hand sculpted using shotcrete to match the stone texture below.

Observation platforms at the base of each pier provide access to view the Gallery of the Natural Habitat where visitors can walk between the massive quad walls. The platform space is formed from the top of each footing with a stone texture and a green pattern representing a white pine with 14 branches. This is inspired by the Vermont State Seal which features a white pine with 14 branches because Vermont was the 14th state. Standing on the observation platform and looking up between the stone textured columns of the pier gives the feeling of being in an outdoor cathedral. The bridge is both structure and symbol, both function and sculpture. Educational plaques honor Vermont's natural resources and history.

Cost Competitiveness

This project exemplifies the "Best Value" effectiveness of concrete segmental bridge structures.

This $60 million project has a bridge square foot cost of approximately $475/SF. A single bridge configuration was provided in lieu of a twin structure. The single structure configuration eliminated 50% of the major maintenance of traffic shifts and phases, providing savings during construction and reducing Owner costs.

Minimization of Construction Impact on the Traveling Public

The bridge was constructed with minimal impact to the traveling public on Interstate 91 and all traveling under the bridge including vehicles on Route 30 (a major route to ski resorts), kayakers on the beautiful West River, and hikers on the West River Trail. The segmental balanced cantilever construction with quad wall design eliminated temporary piers in the river and allowed for construction to be built from above, minimizing impact to the thoroughfares below. Concrete segmental construction was the most sustainable, environmentally friendly, and mobility maximizing method for this project.

A single bridge configuration, instead of twin bridges, eliminated a major traffic shift and cross-over section, resulting in better mobility for the traveling public during construction. This resulted in greater safety for Interstate 91 users due to shorter construction time and fewer traffic movements. Impacts on Route 30 were halved compared to a twin bridge design due to less hauling equipment, materials, and work overhead.

CREDITS

Owner:
Vermont Agency of Transportation

Owner's Engineer:
Corven Engineering, Inc.
(Segmental Review)
VHB

Designer:
FIGG Bridge Engineers, Inc.

Design-Build Team:
PCL Civil Constructors, Inc.
FIGG

Contractor:
PCL Civil Constructors, Inc.

Construction Engineering Inspection:
FIGG
Hoyle, Tanner & Associates, Inc.

Form Travelers for Cast-in-Place Segments:
MEXPRESA

Post-Tensioning Materials:
DYWIDAG-Systems International, Inc.

Bearings:
R.J. Watson, Inc.

Expansion Joints:
Watson Bowman Acme

Prepackaged Grout:
EUCO Cable Grout PTX

Photo Courtesy of FIGG

Lesner Bridge

Category: Urban Bridges (Within City Limits)

Photo Courtesy of RS&H

Construction on the $115 million ($78.7 million construction contract) Lesner Bridge project began in 2014 and reached substantial completion in December 2018. The primary component of the project involved the replacement of the structurally deficient existing bridges with twin pre-cast segmental box girder bridges. The bridges are on the Shore Drive corridor in Virginia Beach, Virginia, lying adjacent to the mouth of the Chesapeake Bay. Each new bridge is 1,575 ft long and provides a 45 ft navigational clearance over the Lynnhaven Inlet. The precast, segmental structures were built using the span-by-span and balanced cantilever erection methods. Each structure consists of 10 spans; nine at 150 ft with a channel span of 225 ft and include nine piers and two abutments. The new bridges greatly improve the corridor by providing wider lane widths, wider shoulders, new 10 ft multi-use paths in each direction, landscaping improvements, improved signalization, and decorative lighting for the new bridges.

Innovation of Design and/or Construction

Given the specified 100-year design life, the project incorporated innovative materials to achieve this standard. All reinforcing steel was either stainless steel or low-chromium/low carbon alloy to achieve the corrosion-resistant requirement. All concrete was designed to be low permeability concrete and superstructure concrete was designed to be 8,000 PSI.

Before erection began, a full-size grouting mock-up of a 150 ft tendon with vertical deviations matching the profile of some of the tendons in the bridge was constructed on site. The mock-up procedure required the use of the same equipment, personnel, same mixing procedure, and same grout that would be used during the actual bridge grouting. After the mock-up was complete and the grout had set the mock-up tendon was cut into sections and analyzed to ensure there were no voids, no segregation, and no bleed water from the grout was observed.

The superstructure utilized both span-by-span and balanced cantilever erection methods for superstructure construction, which is very unique. The project was designed this way to accommodate the 250 ft main span length that was drastically longer than the standard 150 ft long typical spans. The design still allowed the use of the overhead gantry to erect all spans without any additional crane support.

Rapid Construction

With a vehicle count of 20,000 ADT, the Lesner Bridge was required to be constructed without reducing capacity during temporary operations. This requirement inhibited construction duration. To help offset longer construction, three of the four abutment foundations were changed from the designed 4 ft diameter, 100+ ft depth drilled shafts to driven piles, a change that resulted in fewer days to construct the foundations and footings and no additional cost. Additionally, footings in the water were constructed using pre-cast seal slab bottom forms. The pre-cast nature of the footing falsework expedited formwork and helped reduce the eight footing installation durations.

Aesthetics and/or Harmony with Environment

Given the prominent location and role as signature structures, aesthetics served an important factor in the design and construction. Residents and visitors to Virginia Beach will immediately notice the inherent aesthetic value of the trapezoidal box girders and additional aesthetic features including:

- Individually programmable, multi-color LED lights located in the piers, superstructure, and walkways. These lights allow the City to regularly change the appearance of the bridges to fit the seasons all year long.
- A signature piece of artwork commissioned by the City based on public input and installed on the new eastbound bridge.
- A custom, decorative wave pattern for the bridge handrails.
- Over $1 million worth of landscape improvements.
- A painted finish coating for the superstructure and substructure whose color was chosen to match the beach sand that surrounds it.

Cost Competitiveness

The new bridges, completed at a cost of approximately $350/sf, provide a signature structure for the City of Virginia Beach and the surrounding community. Cost control was balanced with the aesthetic desires of the Owner and the community as a whole. Prior to bidding, a Value Engineering Workshop was held to discuss cost savings options for the project. One initiative included performing a load test of the proposed foundations to improve the design to allow for fewer drilled shafts. This initiative resulted in fewer shafts, and shorter shafts which translated to a construction cost saving of greater than $100,000.

Jury Comments

The Lesner Bridge is visible throughout the Virginia Beach community, as well as Southbound on the Chesapeake Bay Bridge and tunnel, making this a prime location for a segmental bridge. The simple, but eloquent lines of this structure flow naturally with the town's skyline and the natural beauty of the Lynnhaven inlet. A well-executed bridge at a modest scale that compliments the site. The aesthetic choices are sound and clear priority was given to the functional needs during construction. Precast segmental construction utilized both span-by-span and balanced cantilever erection methods to minimize impacts, reduce on-site construction, preserve the environment and maintain access for waterway users.

Photo Courtesy of FIGG

By using the highest quality materials, the latest technology, and the latest most comprehensive specifications, the quality and minimal maintenance for these bridges was valued highly by the Owner. By achieving such high-quality and low maintenance, the true cost of the project (short-term and long-term) is significantly more competitive than other options.

Minimization of Construction Impact on the Traveling Public

The Virginia Beach economy depends heavily on tourism, with additional concerns related to the freedom of movement for military personnel present in the project area as well.

This crossing of the Lynnhaven Inlet serves as the gateway to the ocean front tourism center and is also an important route for the United States Military. Route 60, which is part of the US Strategic Highway Network (STRAHNET), connects two important military installations that routinely use this corridor. Additionally, the only alternative to this corridor would require a more than 20-mile detour. For these reasons, the contract requirements dictated by the City of Virginia Beach required the existing four lanes of traffic throughout the corridor to be maintained for the duration of the project.

The design of the twin bridges, and the project phasing, dictated that the first structure be designed and built to accommodate all four lanes of traffic, while the existing bridges were demolished, and the second new bridge was constructed. A unique barrier wall concept was needed as the wall had to be placed in a temporary location during construction from where it would be permanently. It had to meet safety standards, without the ability to install full-depth anchor bolts into the deck because of the presence of transverse post-tensioning. A special temporary wall detail was found from the Maryland DOT and was successfully utilized on the project.

Significant coordination throughout the project was needed for marine traffic as well. Located within the project limits and continually accessing the waterways under the bridges are the Virginia and Maryland Pilots Associations. These organizations, whose history dates to the mid 1700's, are tasked with navigating all cargo ships that enter the Chesapeake Bay en route to the Port of Virginia and the Port of Baltimore. Each ship engaged in foreign trade coming to port is required to take on a local ship handling specialist, known as the Pilot, to navigate the vessel safely into port. Pilot boats had to cross under the Lesner Bridge continually, day and night, every single day for the entirety of the project. Access to the channel could not be interrupted, at any time, because of the Pilots.

Photo Courtesy of RS&H

CREDITS

Owner:
City of Virginia Beach

Owner's Engineers:
RS&H, Inc.
Clark-Nexsen

Designer:
FIGG Bridge Engineers, Inc.
(Bridge Designer)
Clark-Nexsen
(Project Lead Designer)

Contractor:
McLean Contracting Company, Inc.

Construction Engineering Services:
McNary Bergeron & Associates

Constructability Review/
Estimating Services:
FIGG Bridge Engineers, Inc.

Construction Engineering Inspection:
RS&H, Inc.
FIGG

Precast Producer:
Atlantic Metrocast

Formwork for Precast Segments:
EFCO

Erection Equipment:
DEAL/Rizzani de Eccher USA, Inc.

Post-Tensioning Materials:
Freyssinet, Inc.

Bearings:
R.J. Watson, Inc.
Scougal Rubber

Expansion Joints:
D.S. Brown Company

Epoxy Supplier:
Pilgrim Permocoat, Inc.

Prepackaged Grout:
The Euclid Chemical Company

Photo Courtesy of FIGG

Sarah Mildred Long Bridge

Category: Mass Transit/Rail Bridges

This project centered around the community's theme: "Local Simplicity of the Working Waterway," features over 2,803 ft of precast segmental bridge for vehicles above a 1,795 ft precast segmental heavy rail bridge. Design was performed by the FIGG/Hardesty & Hanover Joint Venture, with FIGG accomplishing the segmental approach bridge spans and Hardesty & Hanover designing the segmental lift towers.

The project is the result of a partnership between Maine and New Hampshire's Departments of Transportation; the two states equally shared the costs of replacing the bridge. MaineDOT led the project on behalf of both states, with support from the Federal Highway Administration. The bridge is the largest project in Maine's history.

Long open span lengths of 320 ft for the vehicle bridge were built in balanced cantilever construction. The heavy rail spans of 160 ft tie with the columns of the vehicle bridge and have interim foundations. These spans were also built using the balanced cantilever method. The lift span towers are made of precast concrete segments with hollow sections shaped to accommodate the lift span counterweight and maintenance access stairs.

The 2,434 ft precast segmental vehicular bridge provides two 12 ft lanes (one in each direction) with 5 ft shoulders and bridge railings for cyclists. The Portsmouth approach consists of a 1,552 ft, six span bridge unit, and the Kittery approach consists of an 882 ft, four span bridge unit. Span lengths for the 37 ft wide bridge vary from a 132 ft end span to a 320 ft interior span.

The 1,437 ft precast segmental railroad bridge provides a heavy rail line that serves the Portsmouth Naval Shipyard. The rail system is supported by stone ballast on the precast segmental superstructure. The Portsmouth approach consists of a 786 ft, six span bridge unit, and the Kittery approach consists of a 651 ft, five span bridge unit. Span lengths vary from 69 ft end spans to 160 ft typical interior spans.

The New Sarah Mildred Long Bridge was opened to traffic on March 30, 2018. It links Kittery, Maine, and Portsmouth, New Hampshire, and provides a critical back-up route in case of disruption on the nearby Interstate 95 High-Level Bridge or Memorial Bridge lift-span in downtown Portsmouth. It is a significant transportation link to the Port of New Hampshire, Portsmouth Naval Shipyard, and roadway networks. The bridge crosses the challenging Piscataqua River, with tidal waters that vary by 8 ft and have tidal flows that rank within the top six highest velocities in the United States.

Innovation of Design and/or Construction

Coined "three bridges in one," this ingenious vertical lift bridge solution serves two modes of transport (rail and roadway) that approach the moveable span with double-decker spans. The moveable span lifts from the normal roadway position to allow passage of tall vessels underneath and lowers to railroad track level, allowing trains to pass on the rail in the roadway median of the lift span. A benefit of this innovative double stacked new bridge is the drastic reduction in the number of bridge openings needed for ships. Since the new bridge has a 56 ft vertical clearance when in its "resting" position at the vehicular level, there will be 68% fewer bridge openings compared to the previous bridge. This significantly reduces the number of traffic delays due to stopped traffic.

Railroad live loads were quite different than the live loads used to design the vehicular bridge due to the Cooper E80 loading and Alternate Navy Load requirements. For efficiency, the reinforced concrete shaft railroad piers were spaced approximately one-half that of the vehicular bridge piers to keep the railroad bridge superstructure elements the same size as the vehicular bridge superstructure elements.

A total of 355 precast concrete superstructure segments were cast off-site and transported 174 miles by tractor-trailer to the bridge site. Once on-site, the segments were erected by the balanced cantilever construction method. The precast segmental design allowed for segments to be erected at multiple locations simultaneously with land-based cranes and

Jury Comments

This ingenious design serves three modes of transportation; vehicular, train, and water-born vehicles. An outstanding example of integrated design with shared use of lift span for this unique location. An engineering marvel of technology and practical application. This is an exciting new use of segmental construction, with an interesting and well-conceived concept for harmonious approaches to the functional lift span. The new bridge creates an aesthetically pleasing solution using segmental technology.

a barge-mounted ringer crane. Erecting the railroad bridge first provided access and support for construction of the vehicular bridge directly above.

Construction challenges included the Piscataqua River itself, which is one of the fastest flowing tidal rivers in the United States. Tidal swings of up to 8 ft and a river flow velocity of up to 4.5 miles per hour were routinely encountered. River depths at the main channel are over 70 ft. Due to these river characteristics, temporary trestle bridges were used to access and construct the river piers.

Rapid Construction

MaineDOT's project goal of completing the new Sarah Mildred Long Bridge as expeditiously as possible was accomplished with a concrete segmental bridge, multi-directional construction, and overlapping design and construction through CM/GC project delivery. Construction began in the Winter of 2015 and was completed in the Spring of 2018. The precast segmental design allowed for segments to be erected at multiple locations simultaneously with land-based cranes and a barge-mounted crane. The approach pier footing tubs, lift towers, lift tower footings, vehicular approach superstructure, and railroad approach superstructure were all built using precast elements.

Photo Courtesy of FIGG

Aesthetics and/or Harmony with Environment

Carefully engineered and aesthetically pleasing, the 200 ft tall lift towers fully encase the counterweights and related lift mechanisms to provide both function and beauty. The top circular sheaves rotate as the span moves. The glass along the vertical towers provides natural light in the tower by day and accent lighting from inside by night. The dark gray stains on the precast concrete towers reflect the sails of large ships and symbolically point to the navigational channel.

The new bridge's concrete segmental vehicular structure is stacked over its concrete segmental railroad structure. The bridge has long open spans and 11 fewer piers than the previous bridge to provide enhanced vistas for residents and motorists and minimize impact on the river and surrounding environment.

Minimization of Construction Impact on the Traveling Public

The new concrete segmental approach bridges are located northwest of the previous crossing and provide an improved approach to the navigational channel. The new alignment also allowed a more direct flow of vehicular traffic to the existing bridge during construction, reducing local congestion, minimizing retaining walls, and increasing residential privacy during construction. The new span layout not only enhanced vistas for residents and motorists, but it also enabled the new bridge to cross Market Street without a pier in the median and serve as a gateway entrance into the historic downtown Portsmouth, New Hampshire.

The selected foundation types were drilled shafts for piers in the water and spread footings for substructure on land.

CREDITS

Owner:
Maine DOT

Owner's Engineers:
FIGG/Hardesty & Hanover JV

Contractor:
Cianbro Corp.

Construction Engineering Services:
McNary Bergeron & Associates

Constructability Review/
Estimating Services:
HDR, Inc.

Construction Engineering Inspection:
FIGG
Lamb-Star Engineering, L.P.

Precast Producer:
Unistress Corp.

Formwork for Precast Segments:
Ninive

Erection Equipment:
Cianbro Corp.

Post-Tensioning Materials:
Structural Technologies VSL

Bearings:
R.J. Watson, Inc.

Expansion Joints:
Watson Bowman Acme

Epoxy Supplier:
The Euclid Chemical Company

Prepackaged Grout:
The Euclid Chemical Company

Photo Courtesy of FIGG

Photo Courtesy of HDR, Inc.

A rare vertical-lift highway bridge spanning the St. Croix River, the Stillwater Lift Bridge has long outlasted its useful life for vehicular crossings. With the original crossing built in 1931, talks of a new bridge began as early as 1951, when flooding forced its closure. Successive flooding and growing use of the two-lane bridge by interstate commuters to Minneapolis hastened debate over building a new and bigger bridge — which city leaders saw as their salvation.

Delayed for decades due to lack of funding, it wasn't until 1985 that a formal environmental review began, and it was another decade before a decision was made. Finally, after several lawsuits, an Act of Congress, a Presidential signature, and five years of construction, the St. Croix Crossing is complete.

St. Croix Bridge

Category: Long Span and Cable-Stayed Bridges

Innovation of Design and/or Construction

Chosen to minimize the environmental impact and reduce visual impairments to the native area, the extradosed bridge combines segmental box girder and cable-stay bridge designs. As the largest public works bridge project in Minnesota, the unique design was chosen to ensure pier heights remain below the river bluff line. The supporting towers rise only 67 ft above the bridge surface, so the entire bridge fits into the river valley as naturally as possible.

The mile-long bridge features five towers. It includes slender, reed-like piers, with pier blades that resemble cattails. A stringent visual quality requirement resulted in the entire bridge structure being rounded or tapered. In fact, there are only two flat surfaces on the entire bridge — the roadway surface and the bottom of the box girders.

This is the first bridge in the country to require an Act of Congress and a Presidential signature to receive an exemption from the Wild and Scenic Rivers Act. At the forefront were residents trying to ease congestion in Stillwater and encourage economic growth in western Wisconsin, pitted against environmentally concerned organizations seeking to protect the waterway and prevent urban sprawl. With the act approved — and an exhaustive list of mitigation requirements — many of the protected waterway's features were improved upon as a result of this project.

The final design for the mainline approach spans consists of four separate units: units 1 and 2, east and west. Both units 1 and 2 are composed of continuous spans of post-tensioned box girders, with the unit 1 box girders being precast concrete segments erected using balanced-cantilever method and unit 2 box girders constructed with cast-in-place concrete on falsework.

Aesthetics and/or Harmony with Environment

Constructed in 1931 and listed on the National Register of Historic Places, the Stillwater Lift Bridge had served its purpose for nearly 90 years. It long outlasted what designers thought would be its useful life and, over the years, caused congestion throughout historic Stillwater.

The use of precast and cast-in-place concrete on the approach spans and the extradosed unit on the new bridge was essential in meeting the goals of the visual quality manual prepared by MnDOT.

These include:

- The parts of the bridge look as if they were found in nature, or shaped by natural forces.
- The vertical pier forms are reed-like; the girders are rounded and tapered like bones or tree branches; and walls, barriers and railings are curved and blended into the larger forms.
- Transitions are gradual and smooth; edges are soft and curved; and colors are unified and natural expressions of their materials.

The curved "organic" nature of the girder webs are clearly exposed from both viewing directions and visually provide for consistent leading edges on both sides.

Jury Comments

With its multiple 600-ft extradosed supported spans, the St. Croix Crossing is a testimony of the versatility of segmental bridges to adapt to the surrounding environments. The flexibility of segmental construction allowed the use of balanced cantilever and cast-in place framework to construct the bifurcated approaches. The aesthetics inherent to the segmental bridge come together in a perfect blend between structure and the surrounding nature. Given the unparalleled complications, challenges and requirements the St. Croix Crossing project shines. The bridge is well-conceived and is clearly a new favorite for the local population.

The St. Croix River is protected under the U.S. Wild and Scenic Rivers Act. It is surrounded by tree-lined bluffs and pristine shorelines. With 16 ponds, the new system filters out sand, sediment, gravel and nutrients, while also reducing the quantity of phosphorus entering the St. Croix River from stormwater by nearly 25%.

Due to highly erodible soils on the Wisconsin bluff, construction crews used less-invasive techniques that included constructing the drainage structure by hand, operating small machines and equipment, and using a temporary trestle system that reduced impact to the bluffs below Pier 13 and the east abutment.

To minimize work on the Wisconsin bluff line, the new bridge was aligned with an existing ravine, reducing the need to cut into the bluff and creating a smooth transition from highway to bridge.

The project took extra care to protect nature around the site and prevented disturbing an active bald eagle nest by maintaining a 300 ft perimeter — later to observe that three eaglets were hatched in the spring, instead of the normal one hatchling.

Further, the project required that Higgins eye pearly mussels that lived in the construction area be relocated. These native mussels were eventually transplanted back into the river and other tributaries. In Wisconsin, seeds of the endangered Dotted Blazing Star flowers were gathered from flowers and stored for future planting before crews relocated the flowers.

While the light brown paint matches the adjacent bluff, painters opted to roller-apply the paint over the waterway instead of spray it on. This eliminated overspray from paint guns, which would have ended up in the water. The contractor utilized a series of checks and balances including curtains and tarps to ensure no items were dropped into the river during construction.

Cost Competitiveness

The extradosed bridge type was selected by the stakeholder group based on many decision points, cost being one of them. While other bridge types would have been more cost competitive, the extradosed bridge type provides a strikingly beautiful structure that fits into the scenic St. Croix River and will be enjoyed by the public for decades to come.

The early foundation and superstructure as-bid contracts totaled $370 million, an average of $645 per sq. ft.

Minimization of Construction Impacts on the Traveling Public

The St. Croix Crossing is on a new alignment, so the majority of the project did not impact the traveling public. The bridge crosses Trunk Highway (TH) 95 in Minnesota, and at least one lane in each direction was provided for the duration of the project. Traffic was staged to allow safe segment erection and other construction activities.

Temporary ramps from TH 95 to TH 36 were maintained around the on-site casting yard. The biggest impact was to the boating public, which traveled through a no wake zone that was implemented to minimize impacts to floating construction equipment.

CREDITS

Owner:
Minnesota DOT
Wisconsin DOT

Owner's Engineer:
Kevin Western, Minnesota DOT

Desinger:
HDR, Inc.
COWI

Contractor:
Lunda / Ames JV (Superstructure)

Construction Engineering Services:
McNary Bergeron & Associates
Corven Engineering, Inc.

Constructability Review/
Estimating Services:
Armeni Consulting Services, LLC

Construction Engineering Inspection:
Parsons Transportation Group

Precast Producer:
Lunda/Ames JV

Formwork for Precast Segments:
Southern Forms
EFCO

Erection Equipment:
Structural Technologies VSL

Post-Tensioning Materials:
Freyssinet, Inc.

Bearings:
mageba USA LLC

Expansion Joints:
Watson Bowman Acme

Epoxy Supplier:
Sika Corporation

Prepackaged Grout:
The Euclid Chemical Company

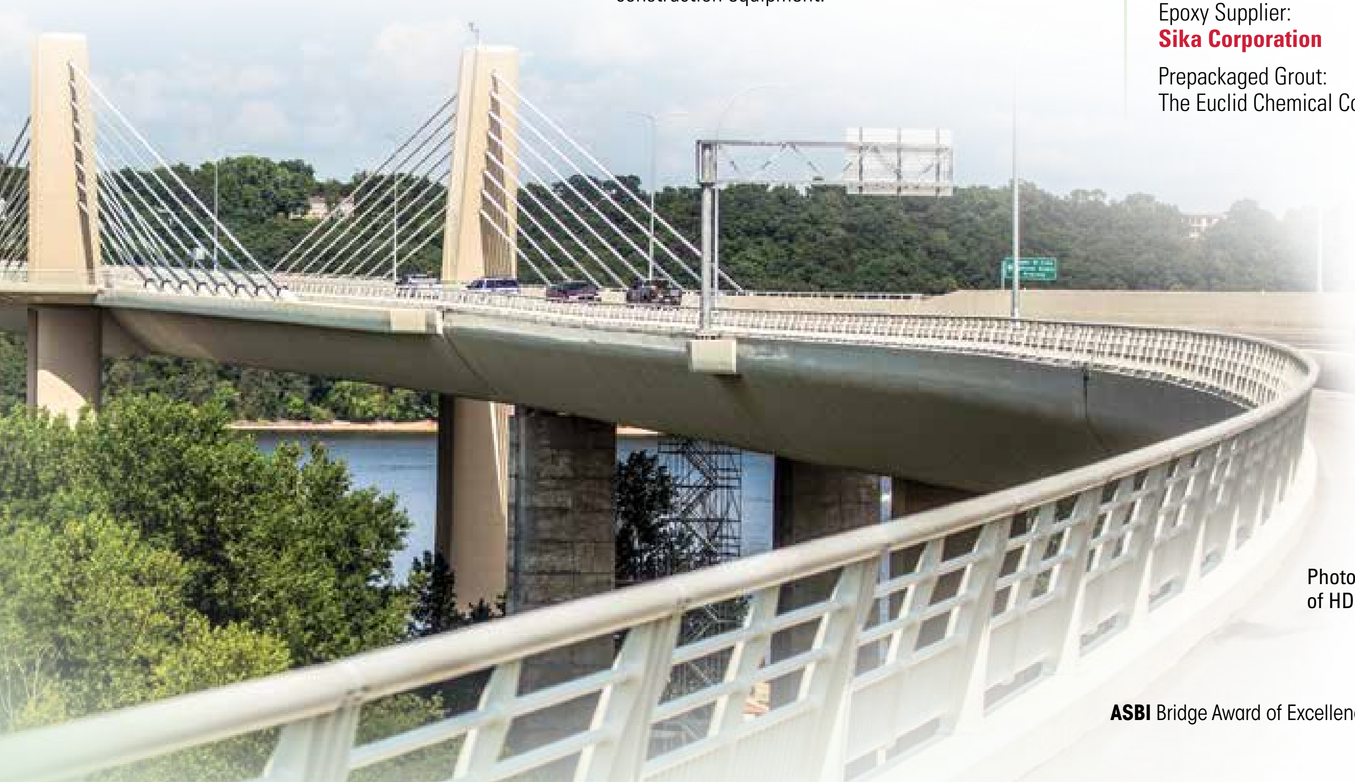


Photo Courtesy of HDR, Inc.

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