1988 – 2013

ASBI 25

American Segmental Bridge Institute

2013

"ASBI Bridge Award of Excellence"

Foothills Parkway Bridge Two
Blount County, TN
Owner: National Park Service

1988 – 2013 ASBI 25

American Segmental Bridge Institute

"ASBI Bridge Award of Excellence"

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

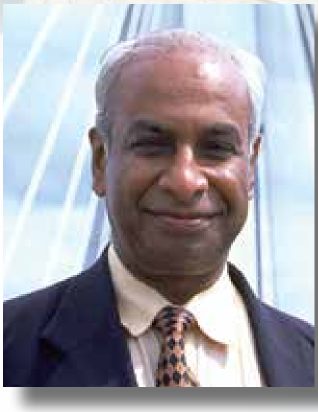
In the sixth biennial American Segmental Bridge Institute (ASBI) Bridge Award of Excellence competition, six projects were selected as outstanding examples of segmental concrete bridge construction. Judging for the 2013 program took place at the California Department of Transportation office in Sacramento, California, hosted by Barton Newton, State Bridge Engineer, Deputy Division Chief, California Department of Transportation—Division of Engineering Services' Structure Policy and Innovation.

All concrete segmental or cable-supported bridges located within the 50 United States and completed between January 1, 2011 and August 1, 2013 were eligible for the 2013 awards competition. The jury also considered international projects involving ASBI members. 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)**

Bridge Awards Jury

Joseph Hartmann
Federal Highway Administration, Office of Bridges and Structures



Vijay Chandra
Parsons Brinckerhoff

Barton Newton
Caltrans

BRIDGE AWARD OF EXCELLENCE WINNERS:

Awards will be presented to bridge owners' representatives during the 2013 ASBI Convention General Session, Monday, October 28, 9:00 a.m. at the Marriott Downtown Waterfront, Portland, Oregon. Following are jury comments, project details, and participant credits for the winning entries (ASBI Members are noted in bold).

REHOBOTH BEACH, DELAWARE

Delaware's new Charles W. Cullen Bridge is designed for long-term durability, structural integrity, sustainability and aesthetics.

State Route 1 (SR-1) runs north-south along a narrow barrier island popular with tourists. The critical link is a bridge across a man-made channel known as the Indian River Inlet. Since the Army Corps of Engineers first dredged the inlet in 1928, engineers have struggled to build bridges that can withstand the violent forces of sea, wind and shifting sands along the Delaware coastline. The first bridge was built in 1934, followed by new spans in 1940, 1952, 1965 and 1976, with none able to survive the harsh environs.

By the mid-1970s, tidal scour had increased the inlet's depth from 20 to nearly 35 feet, with the scour rate escalating about one foot each year. The extra channel depth and extreme, 100-foot scour holes threatened to undermine the bridge's two support piers. Seeking a permanent solution, in 2008 the owner agency awarded a $150-million design/build contract for a new bridge. The owner stipulated a 100-year life and no piers in the water, so the design/build team proposed a cable-stayed bridge as the most effective, economical solution.

Learning from the lessons of the inlet's five previous bridges, this new structure was built to last. Mother Nature has already tested the bridge, with two hurricanes, a nor'easter and an earthquake, but the bridge was designed to withstand this type of loading, and post-event inspections have shown no signs of damage. This new bridge — exemplifying balance, harmony, ingenuity and beauty — opened for traffic in January 2012

The Charles W. Cullen Bridge Over the Indian River Inlet

Innovation of Design and/or Construction

The resulting 2,600-foot long structure compensates for the unforgiving coastal environment. With four 248-foot tall pylons supporting a 950-foot long main span and two flanking 400-foot long side spans, the superstructure consists of a 106-foot wide, six-foot deep concrete deck supported by 152 cable stays.

Many innovative features were incorporated to increase design efficiency and constructability. The edge girders are designed to deviate around the pylons with a unique tension-and-compression concrete strut system. Each of the two continuous edge girders are six feet deep and five feet wide, with cable stays centered along the edge girders. The edge girders are configured to deviate around the pylons, allowing the girders to be aligned with the pylons and cable stays to remain in constant plane.

Another innovative solution was derived for erecting the bridge over the inlet. Since the severe scour, concerns over the existing bridge's stability and constant, four-knot currents prevented erection equipment from being used

Jury Comments

The public involvement in finalizing design details has resulted in a destination and a link between barrier islands. A bridge that looks to the future as much as the immediate needs, it should be an icon for generations of tourists as well as a capable steward of public investment.

in the inlet, a sophisticated traveling form run on rails was used to erect the bridge in cantilever. The main construction challenge – to prevent overloading the bridge during cantilever erection with a 300-ton form traveler weight plus another 350 tons of wet concrete and reinforcing steel – was met by using a temporary cable stay supported from the tops of the pylons that helped counterbalance the extreme 650-ton weight.

Rapid Construction and Cost Competitiveness

This project's total budget and actual cost were the same: $150 million lump sum, at an average cost per square foot of $478. The bridge was designed and constructed in just 39 months.

To expedite construction and enhance cost-efficiency, the pylons above deck level are not connected by cross struts, although conventional designs typically connect twin pylons for stability. By minimizing eccentric loading of the stays on the pylon cross section and improving the cross section's aerodynamic characteristics by using a slender shape with rounded corners, cross struts were able to be eliminated.

All Photos Courtesy of AECOM

Additionally, conventional cable-stayed bridges use transverse girder spacing of 30 feet with a 12-inch thick deck. With this bridge, a unique spacing plan places floor beams at 12 feet and cable support points at 24 feet. This tighter transverse girder spacing allowed the deck thickness to be reduced to 8-½ inches, resulting in savings in concrete weight, along with approximately 17% savings in foundations and cable-stay quantity. To speed erection, both precast and cast-in-place concrete was used for the transverse girders.

Aesthetics and/or Harmony with Environment

The aesthetic objective was simple: create a graceful structure that enhances the pristine coastal landscape. The bridge's slender lines evoke a nautical theme, with semi-harped cable stays and soaring pylons replicating sails and masts of tall ships. At night, subtle blue lighting enhances the bridge's visual appeal without disturbing the natural habitat. Residents and vacationers have embraced the design, expressing appreciation for its elegant shape and panoramic views.

Minimization of Construction Impact on the Traveling Public

The new bridge was constructed approximately 125-feet west of the existing bridge, so the existing spans remained open throughout construction, providing uninterrupted travel on SR-1. Boat traffic was also uninterrupted during construction, as the new bridge's main span was built in cantilever over the inlet with a form traveler.

CREDITS

Owner: DelDOT

Designer: **AECOM**

Design-Build Team: **Skanska-AECOM**

Contractor: **Skanska USA Civil Southeast, Inc.**

Construction Engineering Services: **AECOM** (Erection Analysis) and **FINLEY Engineering Group** (Falsework)

Construction Engineering Inspection: **PB Americas, Inc.**

Precast Producer: **Bayshore Concrete Products**

Form Travelers for Cast-in-Place Segments: Strukturas

Post-Tensioning Materials: **Freyssinet, Inc.**

Stay Cable Materials: **Freyssinet, Inc.**

Bearings: **R.J. Watson** and **D.S. Brown Company**

Expansion Joints: **Freyssinet, Inc.**

Prepackaged Grout: **Sika Corporation**

Bridge Design: **International Bridge Technologies, Inc.**

Structural Steel Cable Stay Anchor Boxes: Cianbro

Wind: RWDI

Geotechnical: S&ME

Foothills Parkway Bridge Two

The Foothills Parkway was authorized by Congress in 1944 to provide beautiful vistas of the Great Smoky Mountains National Park from the Tennessee side of the park. The "Missing Link" of the Foothills Parkway is a particularly rugged 1.6 mile stretch of the Foothills Parkway traversing steep mountain sides that overlook Wears Valley, TN.

Foothills Bridge Two is located in Blount County, TN approximately 10 miles west of the North Entrance to the Great Smoky Mountain National Park. Construction of this bridge is instrumental to completing the Missing Link in that it crosses the most difficult terrain and is needed to access the construction of the Missing Link.

Innovation of Design and/or Construction

Site access only from the beginning of the bridge, and steep terrain along the entire length of the alignment required a new approach to construction that allowed various aspects of construction to be performed concurrently.

The resulting construction methodology incorporated a unique temporary work trestle that provided access along the entire bridge alignment. The work trestle was unique in that it could be reconfigured as work shifted from foundation and pier work, to superstructure segment erection.

In the superstructure erection configuration a specialized segment "walker" placed segments in balanced cantilever, significantly increasing erection speed over one-direction progressive placement methods. The segment walker moves by sliding pairs of support feet, with one of the sliding feet in each pair always tied to the work trestle. This continual fixity greatly improved the safety of construction on the steep bridge grade.

The supports of the work trestle were rigid frames comprised of two steel pipe columns and a transverse steel girder. Each pipe column was supported by three, 7" diameter micropiles and a precast triangular concrete footing. Longitudinal members of the temporary work trestle consisted of two rows of paired steel girders. The girder pairs were closely spaced and cross braced for torsional stability. The transverse spacing of the girder pairs could was adjusted depending on the configuration of the work trestle.

During trestle construction, the girder pairs were spaced closer together to support the tracks of the Manitowoc 777 crawler crane that erected the gantry. The spacing of the girder pairs was increased during superstructure segment placement to support the segment walker designed to walk past already constructed portions of the bridge.

Bridge construction began with the building of Abutment 1. From there, the trestle erection crane placed drilling equipment at the first work trestle support and micro piles were installed. The crane then placed the precast footings, support frames and longitudinal girders. Crane mats were placed over the longitudinal girders to form the deck of the work trestle. The crane then crawled forward, and this sequence was repeated until the 22 spans of the trestle were complete.

When work trestle construction had advanced beyond Pier 1, sections of the crane mat over Pier 1 were set to the side and a secondary, tire mounted 60 ton crane lowered excavation equipment to make the tiered cut for the sub-footings. When complete, the sub-footing was formed and cast. The secondary crane then lowered the equipment to drill the twenty, 9-5/8" micro piles that support the pier. The micro piles were drilled through the sub-footing concrete. Inclined tie-backs, used to provide slope stability were also drilled through the sub-footing (Piers 1 and 2 only). Footing construction followed the installation of the micropiles and tie-backs.

Jury Comments

A perfect blend of functionality and context sensitive construction. The bridge is a part of and compliment to the surrounding terrain.

The secondary crane also placed the segments of the pier. Individual segments were epoxy-joined and stressed together with four, 1-3/8" diameter 150 ksi post-tensioning bars. All segments of the pier with the exception of the pier cap were erected at this time. Piers 2, 3, and 4 were constructed in similar fashion as construction of the work trestle was sufficiently advanced.

Pier cap placement and balanced cantilever construction began once all typical segments of Pier 1 were placed. The crane mat deck was removed and the longitudinal erection girders shifted outward to support the segment walker. The segment walker then placed the pier cap at Pier 1 and provided support for installing and stressing the four vertical 12 x 0.6" diameter 270 ksi post-tensioning tendons.

The segment walker next placed the 4-legged cantilever construction stability tower on the footing of Pier 1. A stability tower separate from the work trestle was used for improved safety. The superstructure pier segment was then placed on the pier cap, supported by shims, and stressed down with temporary post-tensioning bars. Segments 1Up and 1Down were then placed and the cantilever stability towers engaged by supporting jacks.

Cantilever construction continued until all 20 of the 8'-8" precast segments of the balanced cantilever were erected. The segments were epoxy-joined and stressed to the cantilever with three, 1-1/4" diameter 150 ksi post-tensioning bars. Two of the bars were anchored in blisters cast with the segments, and could be removed and reused. The bottom bar was internal and became a part of the permanent post-tensioning system. Once each segment was assembled, the cantilever post-tensioning consisting of two 12 x 0.6" tendons were stressed.

Superstructure continuity was made between cantilevers with a series of cast-in-place concrete closure joints and continuity post-tensioning tendons. Ten, 12 x 0.6" strand were stressed across each closure joint. End spans were completed by placing three additional typical segments and the abutment segments, casting closure joints, and stressing continuity tendons.

The diaphragms were designed with designated future jacking points for bearing maintenance or replacement. The segments also provide room for future tendons, if needed, by providing additional post-tensioning blocks.

Rapid Construction

Though pier and superstructure construction progressed as for a typical balanced cantilever bridge, the use of the temporary work trestle and Segment Walker shortened the overall construction by one year when compared to progressive segmental construction.

Aesthetics and/or Harmony with Environment

To protect the fragile mountainside, construction from above was utilized. Trees that were directly in the path of the bridge were topped. Root balls and top soil remained throughout the project except in the location of temporary and permanent foundations. The concrete of the piers and superstructure segments were tinted with pigment to match the natural rock outcroppings in the region. The abutments and footings were faced with granite, consistent with parkway standards. The project concluded with plantings and reforestation components.

CREDITS

Owner: National Park Service

Owner's Engineer:
Eastern Federal Lands Highway Division of FHWA

Contractor:
Bell and Associates Construction

Bridge Designer:
Corven Engineering, Inc.

Construction Engineer:
Corven Engineering, Inc.

Construction Engineering Inspection:
Corven Engineering, Inc.

Formwork for Precast Segments:
Southern Forms

Construction Estimating Services:
Armeni Consulting Services, LLC

Erection Equipment: **VSL**

Post-Tensioning Materials: **VSL**

Bearings and Expansion Joints:
Watson Bowman Acme - A BASF Company

Civil Engineer: Palmer Engineering

Geotechnical Engineer:
Dan Brown & Associates

Segment Erection: **VSL**

Post-Tensioning Bar Supplier:
Williams Form Engineering

Photo Courtesy of URS Corporation

The Miami Metrorail Airport Link or MIC-EH Connector is a 2.5 mile dual track-light rail elevated guideway structure that connects the Miami Intermodal Center (MIC) to the existing Metrorail Earlington Heights Station (EH). The project is located in the Greater Miami area just northeast of the Miami International Airport (MIA). The MIC facility connects local and regional transportation networks to MIA, including Tri-Rail, Amtrak, Intercity bus, Metrobus, taxis and tour buses. It also houses the airport's rental car facilities. A link between the MIC Metrorail Station and MIA is provided via an automated people mover sponsored by MIA. The MIC-EH Connector, also called Airport Link, has become part of the 25 mile Metrorail system in Miami-Dade County and is owned and maintained by Miami Dade Transit (MDT). The Airport Link project eases the severe congestion on adjacent expressways from increasing passenger travel to and from MIA and offers an alternative transportation mode between downtown Miami and MIA which is convenient, rapid and safe.

Miami Intermodal Center – Earlington Heights Connector

Innovation of Design and/or Construction

The innovation in the design and construction of the segmental portion of the guideway can be considered as follows:

- The integration of the superstructure and substructure as well as the use of variable sections allowed to comply with the project design criteria related to vibration control as well as it provided a slender and aesthetically pleasant structure,
- Special analysis were carried out to address issues of interaction between the train and the structure and the interaction between the continuous welded rail and the structure,
- The connection between the superstructure and substructure needed to carry large reactions due to train derailment loads and project required wind loads (120% higher than AASHTO loads) were especially challenging,
- Live loads as well as allowable stresses are more stringent that the ones for highway bridges and required an optimum arrangement of the post-tensioning tendons to accommodate the design forces.
- The use of a precast shell for the pier segments which are integral with the superstructure and only casting in place the diaphragms for connecting with the substructure was allowed to expedite the construction process.

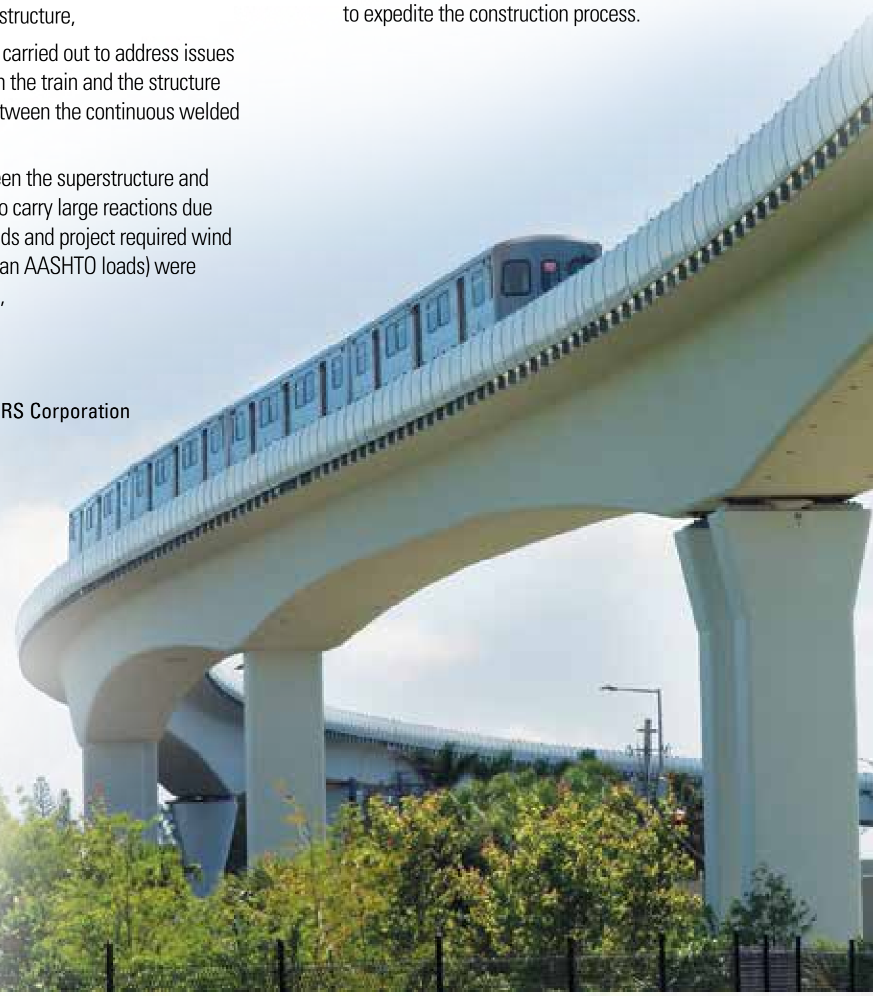


Photo Courtesy of URS Corporation

Jury Comments

A segmental bridge / structure that leverages all of the advantages of precast segmental construction.

Aesthetics and/or Harmony with Environment

There are several factors that make the MIC-EH connector guideway aesthetically very pleasant. At the highly elegant new Metrorail Station at MIC, the single guideway segmental box girders blends perfectly with the U-beam portion of the guideway and the station. For the long span units crossing the Miami River and SR 112 the slender piers integrated with the segmental superstructure, which is parabolically hunched, provide a sense of continuity between the superstructure and the substructure creating a aesthetically pleasant structure. Moreover, at the SR 112 crossing, the bridge reverse curvature enhances even further the aesthetics of the bridge.

Cost Competitiveness

The segmental system was selected because of its economy in direct construction cost and future maintenance cost in addition to its aesthetic value. The project bid and awarded cost (guideway structure and terminal building) was $358 million, only 1% smaller than the Engineer's estimate. The construction cost of the segmental portion of the guideway was $60.5 million not including the plinth pads and rail system or approximately $415 per square foot. This cost is very competitive for mass transit projects in which long span structures are required.

Minimization of Construction Impact on the Traveling Public

All the segmental units were designed and built using the balanced cantilever method of erection. The precasting yard was located at approximately 5 miles from the job site. The segments were delivered to the site on trucks and erected using a mobile lifting frame (beam and winch) system along with ground based cranes where possible. Either erection method accommodated the FAA's airspace requirements. Stability towers were used around columns supported on foundations and temporary footers. The selected erection scheme allowed the rapid construction of the bridge with minimum disruption to highway or railroad traffic.

CREDITS

Owner: Miami-Dade Transit

Owner's Engineers: **AECOM** / **Atkins** / EAC / **PB Americas**

Designer: **URS Corporation Southern**

Contractor: Odebrecht / Tower / Community JV

Construction Engineering Services: **McNary Bergeron & Associates**

Constructability Review/Estimating Services: Construction Engineering Consultants

Precast Producer: **Rizzani de Eccher USA, Inc.**

Formwork for Precast Segments: **Deal**

Erection Equipment: **Deal**

Segmental Specialty Engineer: **McNary Bergeron & Associates**

Construction Engineering Inspection: Pistorino & Alam, **HNTB Corporation**

Post-Tensioning Materials: **DSI**

Bearings: **R.J. Watson**

Expansion Joints: **D.S. Brown Company**

Epoxy Supplier and Prepackaged Grout: **Sika Corporation**

Photo Courtesy of Rizzani de Eccher

VIDIN (REPUBLIC OF BULGARIA) - CALAFAT (ROMANIA)

Photo Courtesy of
FCC Construccion S.A.

New Cross-Border Combined Bridge Over the Danube River

The New Cross-Border Combined (Road and Rail) Bridge over the Danube River, more commonly known as the Danube Bridge 2, or the Vidin–Calafat Bridge, is a road and rail bridge between the cities of Calafat, Romania and Vidin, Bulgaria. It is the second bridge on the shared section of the Danube between Romania and Bulgaria. The precast concrete segmental and cable-stayed bridge was built at the cost of € 226 million. It was officially opened on June 14, 2013.

The Danube Bridge 2 is part of the Pan-European Corridor IV. It is also part of European route E79, which runs from Miskolc (Hungary) to Thessaloniki (Greece), via the Romanian cities of Beisu, Deva, Petrosani, Târgu Jiu and Craiova. The Pan-European Corridor IV allows direct motorway access between Dresden in Germany and Turkey's largest city, Istanbul.

This is the biggest Bulgarian construction project ever. The project consists of a combined bridge for vehicular and railway traffic. At 1,951 meters long, it contains four lanes for vehicles, a single set of electrified rails, a bicycle lane, two pavements for pedestrians, and service uses plus necessary infrastructure for vehicle and train approaches.

Innovation of Design and/or Construction

The New Cross-Border Combined (road and rail) Bridge over the Danube River, commonly known as the Danube Bridge 2, can be considered a bridge of innovations. Several technical innovations in construction techniques improving long-term durability and performance of the bridge were incorporated. Innovations include vacuum grouting of tendons in precast segmental construction, precast segmental duct couplers protecting tendon enclosures, a new cable-stay saddle design removing saddle installation from critical path, and tight radius corrugated plastic duct at stressing blisters allowing an impenetrable envelope for the entire tendon length.

An initial post-tensioning challenge on site was getting the grouting technique approved. Lack of space within precast segments led to adoption of vacuum grouting without intermediate vents and re-grouting using thixotropic grout. Complete suitability testing and full-scale – 80m long – tests were performed successfully.

This led to an additional challenge of adapting the duct system for the segments to insure that duct joints are leak-tight (absolutely essential when working with vacuum grouting). Tendons 205m long with 40 segmental couplers each were grouted using this method – there were no voids in anchorage vents after 24 hours. Knowing that tendons are properly filled with grout gives the owners' confidence that the post-tensioning system satisfies their long-term durability needs.

Maintaining tendon duct continuity for vacuum grouting was essential on this project. Precast segmental duct couplers are successfully used throughout the project at all segment joints. Because of vacuum grouting there could be no crossovers or leakage through segmental couplers – each tendon enclosure had to remain integral – this innovation was an absolute success for the project.

By using the segmental coupler system providing a watertight barrier across segment joints, the owner has confidence that long-term durability of the post-tensioning system is maintained.

An adaptation of standard cable-stay saddles was necessary on the project due to scheduling constraints. A new "bundle" saddle was chosen which consisted of a bundle of bare strands grouted within the pylon and attached to cable-stays outside of the pylon. As the first ever installation of the "bundle" saddle, challenges had to be overcome, such as stressing 4m long "bundle" saddle tendons with up to 55 strands to 80% over the pylon.

Jury Comments

A visually striking structure. The bridge is the final link in the Pan-European Highway Corridor IV, replacing an inconsistent and costly ferry system, using innovative design and construction to ensure long-term performance.

Procedures allowed re-stressing strands from both ends to install shims compensating for load loss due to wedge penetration. Vacuum grouting from the top of the pylon of "bundle" saddle tendons was achieved.

The advantage of "bundle" saddles was that all saddles on one pylon were installed before starting cable-stay installation – removing saddles from the critical path. Even though the cable-stays are not very long or very big, four cable-stays per level had to be installed concurrently on the same day which would not have been possible with other bundles.

Tendon anchorage blisters are used throughout the project to stress tendons in precast segments. For design and construction flexibility, tendons are bent to severe angles at anchorage blisters. With corrugated plastic duct required throughout for durability, a specially formulated, proprietary composite of high-performance materials was developed to create a "tight-radius" plastic duct for use at anchorage blisters. Tight-radius plastic duct can be bent to more severe angles than standard plastic duct while still achieving the wear resistance requirements of Annex 7 of *fib* Bulletin No. 7.

Light-weight, corrosion resistance, pre-bent, and cut-to-length tight-radius plastic duct was easy to transport, handle and install. The tight-radius plastic duct maintains the corrosion protection of tendon enclosures from anchorage to anchorage and has the same bonding capabilities as standard corrugated plastic duct. The owners recognize that by using the tight-radius plastic duct they are receiving the complete, long-term benefits of plastic duct.

Aesthetics and/or Harmony with Environment

The Danube Bridge 2 is aesthetically unique and the low profile complements the surrounding landscape while delivering a road and railway bridge to connect the cities of Vidin and Calafat. The practicality of this bridge and the long-term durability designed into the project by the Project Team enhance its image within the local area and beyond.

Minimization of Construction Impact on the Traveling Public

Prior to completion of the Danube Bridge 2, there was a terrible burden on the public to travel from Vidin to Calafat. There was a ferry shuttle service between the cities running day and night but the ferry only ran when it was fully loaded – this sometimes made for a long wait. During dry summer months, low water levels of the Danube can cause the ferry to get stuck at the loading ramp, making waiting times even longer. And during winter the Danube sometimes freezes completely, making ferry traffic impossible. In a modern age this was a critical reason for the bridge to be constructed.

CREDITS

Owner: Ministry of Transport – Republic of Bulgaria

Owner's Engineer: Ingerop/High-Point Rendel JV

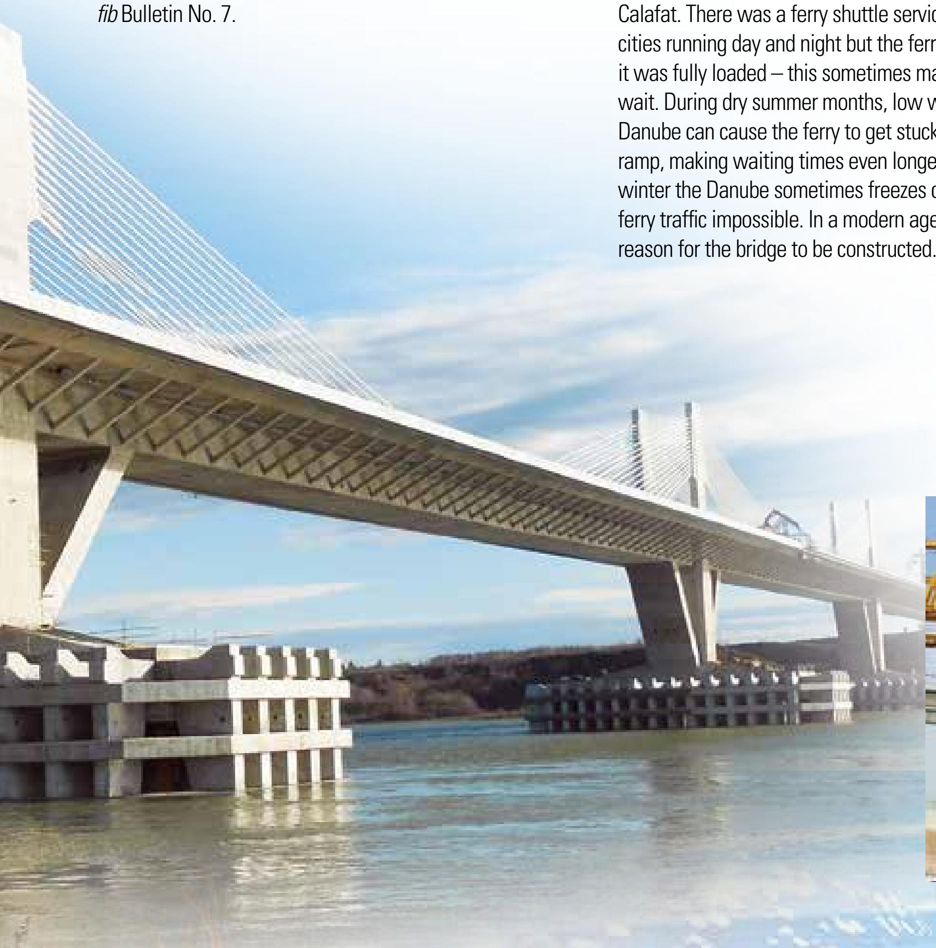
Designer/Contractor: FCC Construccion S.A.

Design Subcontractor: Carlos Fernandez Casado S.L

Post-Tensioning Materials: BBR Pretensados y Tecnicas Especiales

Stay Cable Materials: BBR Pretensados y Tecnicas Especiales

Plastic Post-Tensioning Duct, Tight-Radius Duct, and Precast Segmental Duct Couplers: **General Technologies, Inc.**



All Photos Courtesy of FCC Construccion S.A.

South Norfolk Jordan Bridge

The new South Norfolk Jordan Bridge linking Chesapeake and Portsmouth, Virginia opened to traffic in October 2012, providing faster connections, more capacity, bigger clearances, and breathtaking views to enhance the quality of daily life in surrounding communities. This new, modern concrete segmental bridge was built in less than 2 years to replace a structurally deficient steel lift span bridge that was closed to traffic. Since there was no funding available to repair or replace the aging bridge, the City of Chesapeake had no choice but to close it to traffic, resulting in greater congestion on routes many miles away. The new segmental bridge was accomplished using 100% private funds.

Precast segmental technology was used to construct both the full superstructure and substructure of the new bridge. Each element of the bridge, the foundations, piers, and superstructure were manufactured in local precasting facilities and then assembled on-site. Precasting offered many benefits including speed of construction, multiple construction headings, and factory-like quality control. Precast balanced cantilever construction accomplished the long (385') span over the river's navigation channel. Typical spans (150' long) were built using span-by-span construction with segments delivered over previously completed portions of the bridge. The final bridge layout is 5,375 feet long, with a total of 35 spans. The bridge segmental approaches consist of typical spans that are 150' long.

Innovation of Design and/or Construction

After extensive analysis, engineers achieved a bridge layout that provides the required navigation clearance of 145' (vertical) and 270' (horizontal), gentle grades for pedestrian access, appropriate rail clearances, while also integrating the bridge seamlessly into the existing transportation network including I-464.

Bridge foundations consist of 24" square prestressed concrete piles for land piers, 54" diameter prestressed concrete hollow cylinder piles for piers in the water, and 66" diameter concrete cylinder piles for the bridge fender system. Engineers selected pile foundations with above ground footings to avoid excavation of potentially contaminated soil in an existing superfund site along the west bank of the river.

Each of the concrete box segments for the columns were precast adjacent to the bridge site. The column segments were cast in two precasting beds using self-consolidating concrete with a compressive strength of 5,500 psi. The precast box column segments were stacked in place and then post-tensioned to build piers ranging in height from 18'-9" to 144'-10" tall at the main span.

The bridge's superstructure consists of both constant depth segments for the 32 approach spans and variable depth segments for the main span unit that range from 9'-2" at mid-span to 18'-5" at piers. All of the segments are 51'-8" wide to accommodate the bridge's two 12' travel lanes, two 8' shoulders, and an 8' barrier protected pedestrian sidewalk. Superstructure segments also include a 1.5" integral concrete wearing surface for enhanced durability. Concrete compressive strengths of 6,000 psi and 8,000 psi were specified by design with well over that strength achieved for the produced precast superstructure segments.

Span-by-span construction with twin underslung trusses was used to build each of the 32 approach spans. Segments were delivered over the completed bridge, loaded onto the truss, and then post-tensioned together. The bridge's smallest horizontal curve radius of 750' was achieved with span-by-span construction and underslung twin temporary triangular trusses.

The main span unit over the river was built using balanced cantilever construction which required close coordination with the United States Coast Guard to keep vessels in the channel moving, including the nearby Norfolk Naval Shipyard. Segments were barged to the bridge site and then lifted into place.

Rapid Construction

Total construction time on the South Norfolk Jordan Bridge was less than two years, minimizing the construction and environmental impact, traffic and noise. Precasting of the bridge elements allowed for construction of the piers, approach spans, and main spans simultaneously. Pier erection started on the west end of the bridge while superstructure segments were continuing to be cast, working toward the east. To allow for delivery of precast segments, approach span construction also proceeded from west to east, following pier erection. At peak production, crews achieved two approach spans per week and erected six variable depth main span segments per day.

Jury Comments

Bridge leverages segmental construction for both the superstructure and substructure to complete the 17-story, one mile long structure in two years – outstanding!

CREDITS

Owner: United Bridge Partners

Owner's Engineer: **FIGG Bridge Builders**

Designer: **FIGG**

Contractor: **FIGG Bridge Builders** and Lane Construction

Construction Engineering Inspection: **FIGG Bridge Builders**

Precast Producer: Atlantic Metrocast

Formwork for Precast Segments: **Southern Forms, Inc.**

Post-Tensioning Materials: **VSL**

Bearings: **D.S. Brown Company**

Expansion Joints: **D.S. Brown Company**

Epoxy Supplier: Pilgrim

Prepackaged Grout: Euclid

Aesthetics and/or Harmony with Environment

The curves of the segmental bridge create interesting and unexpected views from underneath and atop the structure. Landscaped areas along the bridge approaches and park areas with new amenities provide a gateway to the area and new gathering areas for the community to enjoy. Additional areas are now accessible to the public as the new bridge gracefully soars over the expanded Elizabeth River Park and Boat Launch under the bridge in Chesapeake. Pedestrians can walk to the top of the bridge for a spectacular bird's eye view of their community and the entire surrounding Hampton Roads region, including distant views of Norfolk and Virginia Beach.

One of the most innovative aspects of the new bridge is the emphasis on environmental responsibility:

- The use of local materials and labor not only boosted the local economy, it also meant a lesser effect on air quality through the elimination of long travel times.
- Placement of precasting beds near the construction site meant that construction traffic was contained to the general area, reducing travel times and comingling with regular commuter traffic. This also meant lower noise coming from the construction site radiating in to the local community.
- The new bridge includes a nanotechnology coating applied to the concrete barriers that removes pollutants from the air and provides a self-cleaning surface through a photo catalytic reaction with the sun's light.
- The bridge is lit at night using low maintenance, low energy LED lights.

Cost Competitiveness

Through the use of innovative partnerships this new bridge was accomplished with 100% private funds. The bridge is privately owned, operated and maintained, and supported through user fees (tolls). This innovative arrangement is an example for future efforts in replacing the country's deficient bridges quickly and cost-effectively using precast concrete segmental technology.

All Photos Courtesy of FIGG

Photo Courtesy of T.Y. Lin International

The existing bridge was built in 1954 and served as the primary connector between Interstate 295 and Portland's waterfront carrying more than 22,000 vehicles a day. Complicating the replacement effort were the Pan Am and Amtrak railroad mainline tracks running under the existing bridge, the presence of major telecommunication fiber optic data lines on the existing bridge, and the significant traffic volume on the bridge and adjacent roadways.

The new roadway and bridge layout uses an innovative alignment that allowed the existing bridge to stay in service during the construction of the new bridge, essentially eliminating maintenance of traffic issues; minimizing interaction with the railroad; minimizing impacts to telecommunication lines; shortened the new bridge overall length by 800'; and saving the project and taxpayers $6 million. The design eliminates one of the approaches of a congested, poorly aligned intersection on the Portland side of the bridge and significantly improves the operations and safety for all modes of transportation in this area. A Context Sensitive Solutions process was used to finalize aesthetic treatments to blend the bridge into the surrounding area, to provide a multi-use path, with three overlooks on the bridge and two overlooks just off the bridge, paying tribute to Maine's veterans.

Veterans Memorial Bridge Replacement

Innovation of Design and/or Construction

Complicating the replacement effort were the Pan Am and Amtrak railroad mainline tracks running under the existing bridge, the presence of major telecommunication fiber optic data lines on the existing bridge, significant traffic volume on the bridge and adjacent roadways – all of which needed to be maintained in service throughout the construction – as well as being located in a harsh salt water and cold weather environment.

A number of existing materials and techniques were selected and uniquely combined to develop a system that exceeds the design life of each individual element and exceeds the project's 100 year design life requirement.

- Specifications included a concrete compressive strength of 7,000 psi, along with 20% fly ash additive, to decrease concrete permeability to below 1,000 coulombs at 120 days per AASHTO 277. For the superstructure elements, 5.5 gal/cy of calcium nitrite corrosion inhibitor was added to the concrete mix. Inclusion of a high performance waterproof deck membrane and 3" thick modified asphalt bituminous overlay will result in less chloride penetration of the concrete deck.
- The precast concrete segmental superstructure is post-tensioned in both longitudinal and transverse directions and the deck is designed for a minimum of 250 psi longitudinal compression under permanent loads and zero tension under live load. Post-tensioning tendons are protected within grout-filled polyethylene ducts.
- The design eliminated the need for intermediate deck joints, which provides a more integral deck surface and less opportunity for water penetration of the deck and into the lower portions of the superstructure.
- All substructure elements exposed to salt water also utilize 5.5 gal/cy of calcium nitrite corrosion inhibitor and 4" of concrete cover.

Aesthetics and Harmony with Environment

Because of the bridge's location at the western end of the Portland peninsula and its highly visible location from the Western Promenade, Fore River Parkway, and I-295, it was very important that the replacement bridge provide an iconic gateway structure that harmonizes with the environment and facilitates the safe and efficient movement of vehicles, pedestrians and bicyclists.

One of the most notable aesthetic treatments on the bridge are the "Accent Poles" which are gently curved poles intended to reflect the natural marshlands in the surrounding area and add interest to the sizeable overlooks.

The three, 20 ft. wide scenic overlooks provide seating and interpretive panels detailing facts about the city's history and the surrounding environment.

Memorials are located at both ends of the bridge which honor Maine's armed forces and Merchant Marine veterans. Floral beds, seating areas and attractive landscaping around the memorials ensure a pleasant and fitting tribute to our veterans.

The project received excellent public support and rave reviews at the bridge opening ceremony.

Photo Courtesy of Reed & Reed, Inc.

Jury Comments

This project demonstrates the use of integrated decision making of design and construction but also future maintenance to achieve a long lasting durable asset for the public.

Photo Courtesy of Kimberly Brooks

The longer term social and economic benefits of the design include:

- An alignment that introduces gentle curvature at each end of the new bridge helping to reduce traffic speeds, improve traffic safety and provide a more boulevard type experience.
- The incorporation of wide, paved shoulders for bicyclists and the 12' wide separated multi-use path on the new bridge to vastly improve the operation and safety of bicycle and pedestrian access between Portland's West End and Cash Corner in South Portland. The project includes extending a sidewalk from the South Portland end of the bridge to Route 1 in South Portland to provide a complete and safe bicycle/pedestrian facility.
- The addition of three bridge overlooks with interpretive panels, each highlighting the natural environment, the area's marine and industrial history, and current transportation modes.
- Revised intersection design on the Portland side featuring significantly better traffic operations and safety with fewer delays, and better access for the adjacent Mercy Hospital.
- Using a concrete segmental bridge with longer spans resulting in a more open and graceful structure with fewer piers in the water/mudflats and less environmental impact.

Cost Competitiveness

The winning alignment saved MaineDOT and taxpayers $6 million dollars by shortening the bridge overall length by 800 feet; eliminating one of the approaches at an existing intersection; and allowing the old bridge to stay in service during construction thereby virtually eliminating maintenance of traffic issues.

On this relatively small project, segmental bridge construction was made cost competitive by early partnering with the precaster and designing the segments to re-use existing forms. Further economies of scale were realized by advancing the standardization of cross-sections and forms.

Minimization of Construction Impact on the Public

The new alignment design resulted in a dramatic decrease in the disruption to the traveling public normally associated with these types of projects. It allowed the old bridge to stay in service during construction thus essentially eliminating maintenance of traffic issues.

It also eliminated one of the approaches of a congested, poorly aligned intersection on the Portland side of the bridge and significantly improves the operations and safety for all modes of transportation in this area.

CREDITS

Owner: Maine DOT

Designer: **T.Y. Lin International**

Design Build Team: **T.Y. Lin International** / Reed & Reed, Inc.

Owner's Engineer: **T.Y. Lin International**

Contractor: Reed & Reed, Inc.

Construction Engineering Services: **McNary Bergeron & Associates**

Constructability Review: **McNary Bergeron & Associates**

Precast Producer: **Unistress Corp.**

Formwork for Precast Segments: **EFCO Corp.**

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

Bearings: **D.S. Brown Company**

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