American Segmental Bridge Institute ASBI

2017

"ASBI Bridge Award of Excellence"

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

In the eighth biennial American Segmental Bridge Institute (ASBI) Bridge Award of Excellence competition, eight projects were selected as outstanding examples of segmental concrete bridge construction. Judging for the 2017 program was conducted via webinar.

All concrete segmental or cable-supported bridges located within the 50 United States and completed between January 1, 2015 and August 1, 2017 were eligible for the 2017 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

Matthew Chynoweth, Chair
Michigan DOT

Reggie Holt
FHWA, Office of Bridge Technology

W. Scott McNary
McNary Bergeron and Associates

BRIDGE AWARD OF EXCELLENCE WINNERS:

Awards will be presented to bridge owners' representatives during the 2017 ASBI Convention General Session, Tuesday, October 24, 11:00 a.m. – 12:00 p.m., at the Marriott Marquis, New York. Following are jury comments, project details, and participant credits for the winning entries (ASBI Members are noted in bold).

This $850M project is the first ten miles of concrete segmental elevated rapid transit guideway that connects West Oahu with downtown Honolulu and the Ala Moana Center via the Honolulu International Airport on Oahu, Hawaii. Honolulu Authority for Rapid Transportation (HART) developed the project to improve mobility, enhance reliability, and address the island's increasing congestion.

The guideway alignment consists of straight and curved sections with a minimum radius of 1,100′ for precast sections and 800′ for cast-in-place sections with a maximum vertical profile grade of 5.5%.

The superstructure is made of 5,238 precast and 129 cast-in-place trapezoidal segments that are 30′ wide with spans between 68′ and 151′ long. The top slab deck varies in thickness from 8″ to 15″. The length of precast segments (11′) maximizes the legal transporting limits on the roads, eliminating almost 10% of the precast segments that would have been required if typical 10′ lengths were used. The precast concrete spans are longitudinally post-tensioned typically using 3 or 4 external tendons that consist of twelve to twenty-seven 0.6″ diameter strands. The tendons are anchored in the expansion joint segments and all deviate in the span at about the third points of the span. The cast-in-place spans are longitudinally post-tensioned using internal tendons with twelve 0.6″ diameter strands. The top slab is transversely post-tensioned using tendons with two and four 0.6″ diameter strands.

Honolulu Rapid Transit Viaduct Phase 1 & 2

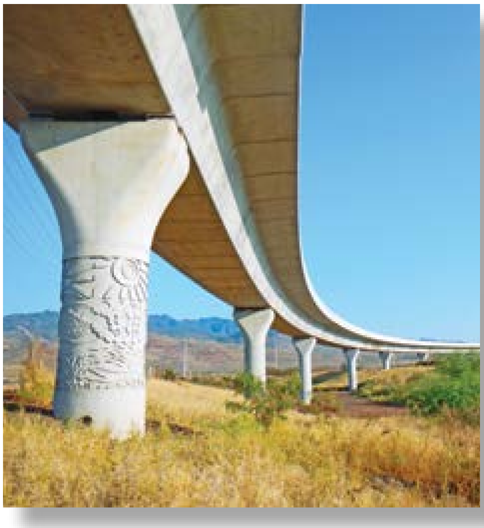
Category: Mass Transit/Rail Bridges

Innovation of Design and/or Construction

To maximize safety and mobility while rapidly constructing the project, the majority of its 5,238 segments were precast while road widening and substructure construction were in progress. The barriers were cast with each segment form saving time. The precast segments were erected using the span-by-span method with underslung girders supported on temporary pier brackets that rest on the top of the columns and leap-frogged forward as the girders launched. The structural system used simple spans of matchcast segments that only required epoxy at the joints. The structure was designed to support a crane so that it could be taken off the ground and eliminate any traffic disruption. The segments were typically delivered on the ground at night and lifted by deck-mounted crane and placed onto the girders. Then, the external post-tensioning was installed and stressed, temporary girders launched to the next span, and the crane moved forward to begin the erection of the next span. Most spans took one to two days to complete. Inside the superstructure, the team applied an innovative solution to mitigate against stray current. Wire connections were used between the top slab's reinforcing bar and post-tensioning anchors that were grounded to the drilled shaft reinforcing bar. This allows any stray current in the deck to be safely conducted to the ground.

Rapid Construction and Cost Competitiveness

The project was accelerated with the use of precast segments – typically a precast concrete trapezoidal box girder section 30' wide and 7' 2" deep cast approximately five miles from the project site. The team of Kiewit and FIGG proposed the segments be 11 feet long to take advantage of the maximum legal transporting limits. This change reduced shipping and construction time. Kiewit



used 6.5-ksi compressive strength concrete that allowed for quick stripping of the forms to accelerate fabrication. Cast off-site, they greatly reduced the duration of on-site construction, minimizing road user impacts. The erection method, repeated 5,238 times, benefited quality control. Spans were erected at maximum speeds of ten to twelve spans per week using three erection truss headings. The project has a total of 438 spans; 430 of which are precast. The remaining were cast-in-place.

The Team of Kiewit, HNTB and FIGG achieved the highest overall score for technical plus cost. The concrete segmental design and erection method used by Kiewit could be expected to greatly reduce road users' costs when compared to other structure types and means and methods. Additionally, concrete segmental guideway bridges are incredibly robust. This project's use of post-tensioning and high-quality concrete provide HART with a low-maintenance bridge with low life cycle costs.

Jury Comments

The use of precast segments allowed the project to take full advantage of the bridge's consistent girder cross-section and deliver a very long bridge in rapid fashion while minimally disrupting the traveling public. This is an aesthetically pleasing bridge which has become an integral compliment to the environment, considering its 10-mile length, and is an attractive bridge for light rail.

Aesthetics and/or Harmony with Environment

This project is in harmony with its cultural environment and the history of Oahu. The piers at each station location celebrate local culture with a visual representation of Hawaiian culture with artistic designs cast into the concrete. The segmental concrete structure provides a ribbon that undulates along the varied landscape between West Oahu and Honolulu International Airport in a uniform design.

Minimization of Construction Impact on the Traveling Public

Avoiding traffic impacts was very important on this project, as 7½ of its 10 miles of superstructure needed to be built over and along congested roadways and intersections.

Precasting the segments greatly reduced the amount and duration of work performed over and along roadways. Using precast concrete segments lifted from cranes positioned on top of the structure allowed the superstructure to be built from above without erection equipment in the roadway. To minimize the number of deliveries on the road, the team changed the length of the segments from ten feet to eleven feet. This eliminated almost ten percent of the segments that needed to be delivered. The Project Team's site-specific traffic management plans and strategies maximized mobility and enhanced safety for workers and road users. Thanks to segmental construction, they maintained the carrying capacity of the highway and kept roads fully open during peak hours keeping traffic moving.

Segmental concrete, both precast and cast-in-place, provided the best and most economical technical solution for building a 10-mile transit rail guideway through varied terrain and along and over active, congested roadways while keeping traffic moving.

CREDITS

Owner:
Honolulu Authority for Rapid Transit (HART)

Owner's Engineer: **CH2M**

Designer:
FIGG Bridge Engineers, Inc.

Design-Build Team:
Kiewit Infrastructure West Co./ HNTB Corporation/FIGG

Contractor:
Kiewit Infrastructure West Co.

Construction Engineering Services:
McNary Bergeron and Associates/ FIGG

Construction Engineering Inspection:
HNTB Corporation/FIGG

Precast Producer:
Kiewit Infrastructure West Co.

Formwork for Precast Segments:
EFCO Corp.

Post-Tensioning Materials:
Schwager Davis, Inc.

Bearings:
D.S. Brown Company

Photos Courtesy of FIGG

I-5 Antlers Bridge Replacement

Category: Bridges Over Water

The existing steel truss Antlers Bridge had reached the end of its life and needed to be replaced.

The new bridge is a five-span continuous, post-tensioned, cast-in-place, segmental concrete box-girder bridge, 104-ft. wide and 1,942-ft. long, with a 591-ft. main span, all founded on 12-ft.-diameter drilled shafts.

Structural components include: 212 box-girder segments, 13 – 15 ft. long, 12 – 30 ft. deep; 63 x 104 x 36 ft. deep pier tables supported by 12-ft.-diameter drilled shafts; and a transversely post-tensioned, cast-in-place concrete deck.

Innovation of Design and/or Construction

New Design – Designers located the piers to miss the greatest depth of the lake and a recreational hot spot fronting the Antler's Shasta Lake public boat ramp. The result was a bridge with five continuous spans and a 591-ft.-long main span. Symmetry in the layout and the box girder dimensions helped to economize on equipment and formwork costs.

Design Challenges – Extra pier-table reinforcement was needed to meet Caltrans's Seismic Design Criteria.

Because of the statewide drought conditions, the designers sought a foundation type that was both constructible and visually appealing in either high or low water conditions. Potential high-water conditions precluded traditional cofferdams, and low water would make an eyesore and boating hazard out of any suspended pile caps. The design team used 12-ft.-diameter drilled shafts extending between 95 and 140 ft. to the superstructure. The shafts were a versatile solution, but constructing them required much time and money.

Durability for the Future – Transverse post-tensioning, epoxy-coated reinforcement, 2.5-in. concrete cover, and a polyester concrete overlay contribute to the durability of the new deck.

Rapid Construction and Cost Competitiveness

Since delivery and access to materials was not accessible nearby, the contractor built their own concrete plant on site.

The end spans were cast-in-place on steel falsework, and were founded on concrete shafts, drilled into the rock on the slopes.

To accelerate construction the bridges were cast-in-place with 4 form travelers in balanced cantilever method.

Heavy rains flooded the site and a combination of barges and even loftier trestles— up to 95 ft. tall— needed to be built.

Photos Courtesy of Caltrans

Jury Comments

This segmental structure combines the clean and simple elegance that balances with its natural environment, as well as the structural robustness needed to withstand an earthquake event in this seismically active region. This is a beautiful curved segmental bridge, with deliberate focus on aesthetics, fitting both the environment and the culture of the area. The bridge has a visually interesting pier table with aesthetics that deliver form and function.

After excavating within the construction casing, the contractor used reverse circulation drilling to advance the shaft up to 70 ft. into more competent rock. To reduce the risk of caving in the open-hole, several operations were conducted in quick succession after the drill string was removed. A sonic caliper assessed construction casings and access trestles were built when the lake was full but exposed when the lake is low. The hole for plumbness, and a miniature drilled shaft inspection device verified the bottom cleanliness. Prefabricated, 80-ft.-long reinforcing cages were then lowered into the shafts, followed by tremied concrete with a 6-ksi strength requirement. Caltrans tested the hardened concrete for homogeneity using gamma-gamma density logging. Of the 12 shafts, six contained minor anomalies that were repaired by grouting.

Pier Tables – After the foundations and columns were completed 63 x 104 x 36-ft.-deep pier tables were constructed. Just one of these massive elements would consume 4,350 cu. yds. of concrete from an on-site batch plant.

Architectural details required complicated, curving formwork. Brackets embedded in the bridge columns supported an impressive falsework system above the water line. Seismic design required nearly one million pounds of reinforcing steel in each of the main pier tables.

Segments – Once a pier table was finished, the contractor erected four 1,200-kip form travelers to support the cast-in-place concrete segmental construction. The 212 superstructure segments were 13 – 15 ft. long and weighed up to 400 kip.

- The cost ranges from $650/sf. – $1,350/sf. cost per square foot.
- Segmental bridge cost: $131 million.
- Total deck area: 203,000 sf.

Aesthetics and/or Harmony with Environment

Located in the Shasta-Trinity National Forest, the bridge incorporated several aesthetical and environmental details. The structure includes 16 bat houses under the pier table diaphragms.

With such a large structure, Caltrans thought it would be poor stewardship not to consider incorporating aesthetics into the design. The two large-mouth bass motifs on the webs of the pier table are part of the structure. These motifs were colored with a stain which is expected to require lower maintenance costs than painting.

Now, boaters, swimmers and water skiers who frequent the area can look forward to open water while motorists will enjoy an open road. Caltrans expects the new Antlers Bridge to last more than 100 years.

Minimization of Construction Impact on the Traveling Public

To minimize impacts to the traveling public and trucking routes, the existing bridge remained opened during construction of the new bridge. To improve safety, a 0.4-mile long section of highway south of the bridge was realigned.

CREDITS

Owner: **Caltrans**

Designer: **Caltrans**

Contractor: Tutor-Saliba Corporation

Construction Engineering Services: **Finley Engineering Group, Inc.**

Construction Engineering Inspection: **Parsons/Caltrans**

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

Form Travelers for Cast-in-Place Segments: **Schwager Davis, Inc.**

Post-Tensioning: **Schwager Davis, Inc.**

Bearings: Lubron Bearing Systems

Expansion Joints: Lubron Bearing Systems

Prepackaged Grout: **Sika Corporation**

Drilled Shafts: Force Drilling

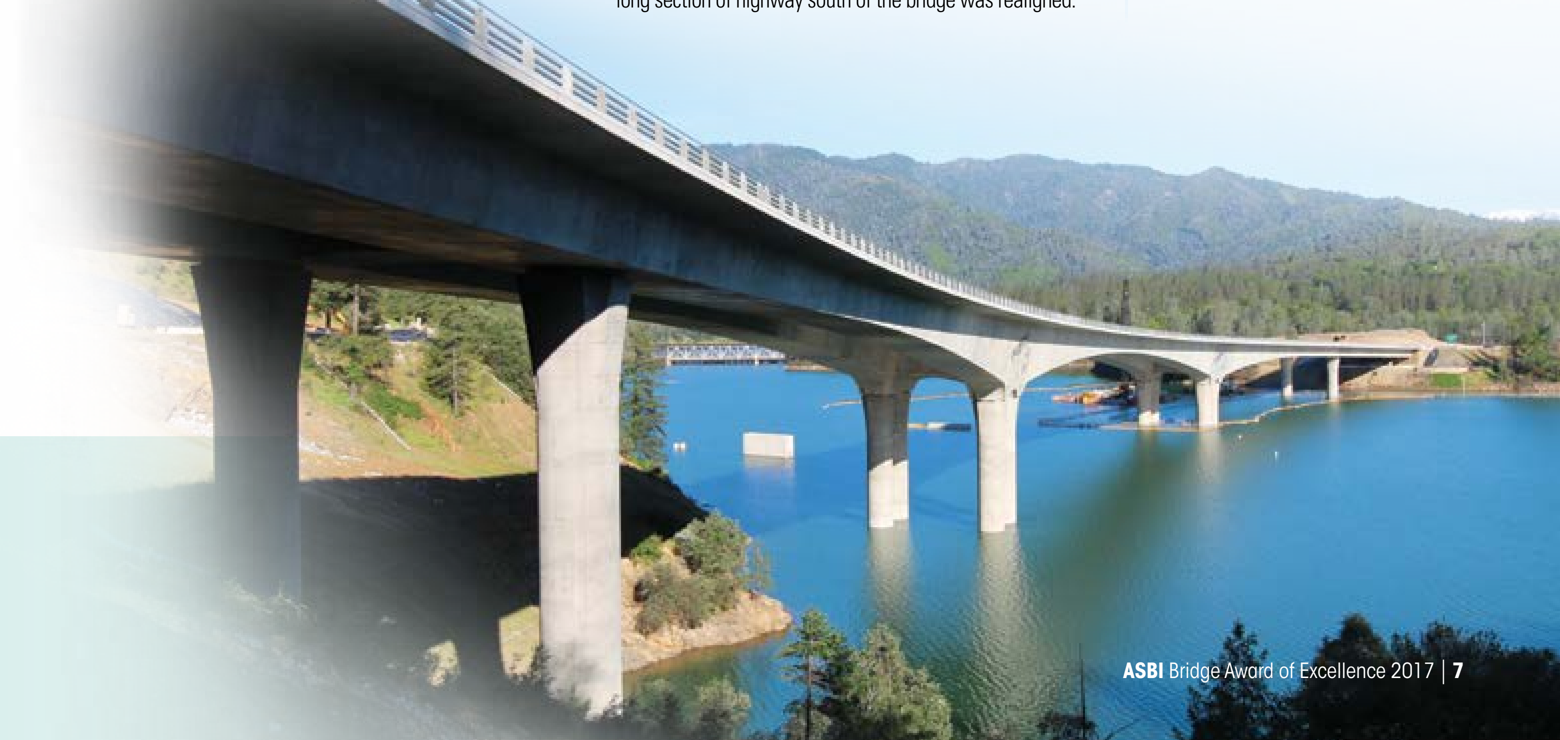
Reinforcement Steel: Harris Rebar

Electrical: Roadway Electric

Concrete Barriers: Vanguard

Polyester Overlay: American Civil Construction

Roadway and Asphalt: Stimple-Weibelhaus



The new I-90 Dresbach Bridge demonstrates how a concrete segmental solution creates a beautiful, efficient, long-span bridge while being built in sensitive environmental conditions, through harsh winter weather, at the same time achieving a new record span length for Minnesota. Its concrete segmental superstructures, with custom pier shapes, achieve context sensitive, signature designs while being economical and delivered ahead-of schedule. This innovative concrete segmental bridge solution met or exceeded all of Minnesota DOT's project vision, criteria, and goals for this new Mississippi River crossing.

The New Dresbach Bridge has wide shoulders providing ample space and is designed to exceed current structural and geometric standards. The new, modern, and ecologically conscious four-lane bridge features twin concrete segmental variable-depth box superstructures that vary in width between approximately 66′ and 45′. Over the main channel of the Mississippi River, the new four-span bridge consists of twin, post tensioned concrete segmental structures with record-setting dual 508′ main spans (longest concrete span in Minnesota), built from above with form travelers in balanced cantilever. Construction was kept to the smallest footprint to protect the environment, adjacent recreational facilities, and USCOE Lock and Dam No. 7 just upstream. The dual 508-foot-long main spans resulted in only one pier near the main channel of the river and provide a commercial navigation opening larger than the minimum required by the U.S. Coast Guard.

The New Dresbach Bridge

Category: Long Span and Cable-Stayed Bridges (Spans of 400' or Greater)

Innovation of Design and/or Construction

Design criteria was developed that met MnDOT's goal of exceeding the robust durability benefits of post-tensioned concrete segmental design and went beyond the typical criteria required by AASHTO. This resulted in implementation of the following innovative items:

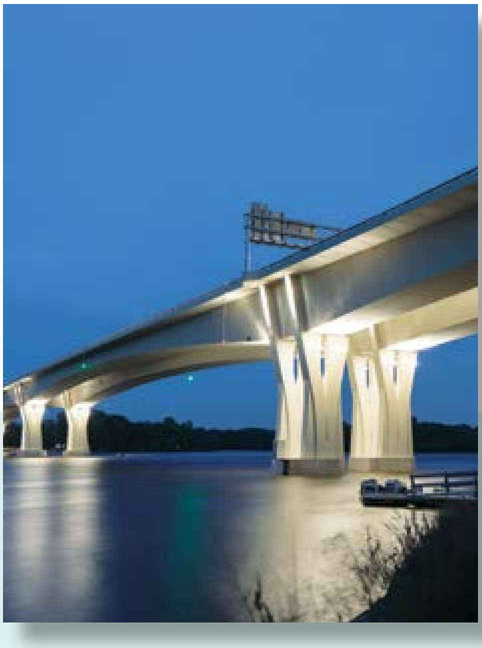
- The use of stainless steel reinforcing in the bridge decks. MnDOT continues to lead the industry in the development of specifications and details for the use of stainless steel reinforcing in all types of bridges.
- Polypropylene duct for post-tensioning tendons. Galvanized and epoxy coated anchors specified based on location to maximize durability.
- The use of post-tensioning tendon grout meeting the latest PTI specifications including current interims that do not permit the use of inert filler.
- Research, specifications, and in-place performance testing of innovative thin premixed polymer concrete deck overlay at discrete locations such as where temporary access holes were used during construction.
- Lower tensile stress limits than required by AASHTO.
- Requirement for long-term bi-directional compression across temporary construction access hatches in the deck.
- Finite element moment curvature analysis to determine refined substructure stiffness in lieu of AASHTO approximate methods.
- Site-specific thermal analysis representative of the local conditions in Minnesota.
- Force-pulse (statnamic) dynamic load testing of large diameter steel pipe piles to more accurately determine pile capacity and allow higher resistance factors reducing the number of piles required.
- 100-year service life for enhanced durability and low maintenance.

In addition, the New Dresbach Bridge is designed to accommodate a future pedestrian bridge suspended beneath and between the eastbound and westbound structures. A unique catenary-suspension bridge design was developed to the level needed to ensure that the bridge can accommodate resulting loads. Anchorages were fully designed and included in the new bridge. This is easy to accomplish using concrete segmental bridge design.

After cancellation of a WisDOT light rail project, it had a pre-purchased stockpile of H-piling. The New Dresbach Bridge east-channel foundations were designed for this specific piling, and the stockpile was transferred from WisDOT to MnDOT. Both agencies benefited: MnDOT through significant cost savings to the project and WisDOT by removal of the piling from its inventory.

Rapid Construction and Cost Competitiveness

The concrete segmental bridge design allowed means and methods that provided simple solutions to the complex site. To accelerate construction, this bridge was built in four directions at once, in balanced cantilever, from two piers at a time using two sets of form travelers. ASBI and PTI certified crews with experienced construction leadership cast an average



Jury Comments

This bridge's structural elements provide aesthetically pleasing shapes and forms with the capacity to deliver a record setting concrete span over a major waterway for its owner. It is a world class Mississippi River crossing bridge, inclusive of innovative approaches to design, materials, and rapid construction. The twin wall piers were nicely integrated in harmony with the Mississippi River crossing.

of four segments per week for the eastbound bridge, while the westbound bridge frequently produced six segments per week, without the need for a second or third shift. One hundred-foot-long sheet piling was used for the nearly 80-foot-tall cofferdams needed to install the main-span unit foundations. Due to the cofferdams, the contractor could construct all the piers but one within the first two construction seasons, keeping the project on-schedule despite heavy spring flooding and a difficult winter. Once the superstructure was complete, only the barrier operation remained before the structure was opened to traffic, saving schedule over non-segmental bridge types and allowing the river bridges to be off the project CPM critical path. At the peak of construction, 270 people worked on the project ensuring that the rapid construction delivered the project to Minnesota DOT ahead of schedule. The twin wall pier shapes provided the function of extra stability during cantilever construction without needing temporary supports in the Mississippi River. This enhanced speed of construction, cost efficiency and safety.

Saving long-term agency costs on maintenance, the bridge provides a highly-redundant river crossing with an enhanced lifespan of more than 100 years. Furthermore, the use of concrete spurred the local economy by using local labor and materials, increased local employment and wages, and allowed tax dollars to be invested back into local businesses and communities for continued economic growth.

This project exemplifies the cost-advantages of concrete segmental bridge structures. MnDOT awarded the project for a low bid of $81.5M (bridge only). With a per square foot cost of $305, the new Dresbach Bridge provided a cost savings to MnDOT compared to other similar state projects while achieving a record concrete span for Minnesota. The New Dresbach Bridge is the perfect example of how concrete segmental bridges provide a durable, low-maintenance, and sustainable solution for the lowest life cycle costs, which is a goal for funding-challenged transportation systems.

Aesthetics and/or Harmony with Environment

Located within the Upper Mississippi River National Wildlife and Fish Refuge, the New Dresbach Bridge serves as a model for how a grand bridge can be developed to exist harmoniously with, and honor, the landscape and environment. The design inspiration for the new river bridge came from the natural, picturesque landscape of the surrounding area. The portion of the bridge crossing the main channel of the Mississippi River requires functionality and contextual aesthetics both within the environment and at a pedestrian level. The aesthetic details of this bridge were selected by members of the community through a series of meetings, including pier shape, railing details, bridge color, and abutment and retaining wall treatments.

Minimization of Construction Impact on the Traveling Public

The twin wall piers created engineering balance during the superstructure construction without any temporary supports in the river, keeping maritime traffic moving. Since it was built from above, there was no need for large ground- and water-based equipment, allowing unrestricted river traffic during construction which met a critical need for the USACE Lock and Dam No. 7 located just upstream.

CREDITS

Owner:
Minnesota Department of Transportation (MnDOT)

Designer:
FIGG Bridge Engineers, Inc. (FIGG)

Contractor: Ames Construction

Construction Engineering Services:
Finley Engineering Group, Inc.

Constructability Review/
Estimating Services:
Armeni Consulting Services, LLC

Construction Engineering Inspection:
WSB and **FIGG**

Form Travelers for Cast-in-Place Segments: **Schwager Davis, Inc.**

Post-Tensioning Materials:
Schwager Davis, Inc.

Bearings:
D.S. Brown Company

Expansion Joints:
D.S. Brown Company

Prepackaged Grout: US SPEC

Photos Courtesy of FIGG

The New Winona Bridge

Category: Bridges Over Water

This $78M segmental bridge provides mobility between Minnesota and Wisconsin over the Mississippi River with a 2,300' context-sensitive concrete segmental bridge alongside a historic bridge. It currently provides one-lane of vehicular traffic in each direction, as the existing bridge is being rehabilitated. Once that is complete, the new bridge will have two southbound lanes and a pedestrian path and the existing bridge will have two northbound lanes, adding needed capacity. This bridge was Minnesota's first to be delivered with the Construction Manager/General Contractor (CM/GC) method. The team used concrete segmental construction, and leveraged CM/GC to achieve a 15-month time savings, $18M cost savings, value-added aesthetics, and meet the needs of the river community.

The bridge was designed for easy access for inspections, maintenance and utilities. With an integral wearing surface, stainless steel reinforcing bar in the deck, bidirectional post-tensioning, high strength-concrete, and the fewest possible joints and bearings, it has exceptionally low life-cycle costs and a design life of over 100 years.

Acceleration of the project was necessary – the original, adjacent bridge was closed for gusset plate repair, resulting in a 65-mile detour that impacted emergency responders, commuters, and the local economy. From each of the two pier tables, construction proceeded in two directions at once for a total of four simultaneous operations.

Its 7,000 psi concrete mix design resulted in a high-performance, low permeability concrete and curing temperatures were closely monitored through all construction seasons.

Innovation of Design and/or Construction

Minnesota DOT is a leader in technical innovation and project delivery. Minnesota DOT utilized CM/GC for its first time on this project. A concrete segmental bridge design, allowed work to progress simultaneously under multiple work packages. Overlapping segmental construction and design eliminated 15 months from the project schedule. The following innovative items were incorporated:

- Eco-friendly wintertime work over the river that resulted in the team developing a wintertime best practices manual for working in the river which will be used by MnDOT for years to come.
- The use of stainless steel reinforcing bar in the bridge decks. MnDOT continues to lead the industry in the development of specifications and details for the use of stainless steel reinforcing.
- Polypropylene duct for post-tensioning tendons. Galvanized and epoxy coated anchors were specified based on location to maximize durability.
- The use of post-tensioning tendon grout meeting the latest PTI specifications including current interims that do not permit the use of inert filler.
- Research, specifications, and in-place performance testing of innovative thin premixed polymer concrete deck overlay at discrete locations such as where temporary access holes were used during construction.
- Lower tensile stress limits than required by AASHTO.
- Requirement for long-term bi-directional compression across temporary construction access hatches in the deck.
- Finite element moment curvature analysis to determine refined substructure stiffness in lieu of AASHTO approximate methods.
- Site-specific thermal analysis representative of the local conditions in Minnesota.
- Force-pulse (statnamic) dynamic load testing of large diameter steel pipe piles to more accurately determine pile capacity and allow higher resistance factors reducing the number of piles required.
- 100-year service life for enhanced durability and low maintenance.

Rapid Construction and Cost Competitiveness

MnDOT's project goal of completing the new Winona Bridge over the Mississippi River as expeditiously as possible was accomplished with a concrete segmental bridge, multi-directional construction, and overlapping

Jury Comments

This project demonstrated how combining concrete segmental bridge design with innovative project delivery can result in reduced construction costs and time without sacrificing bridge quality and aesthetics. The bridge has a graceful haunched superstructure with elegant twin wall piers and aesthetic scenic lookouts. An amazing feat of engineering considering the winter construction. Nice form and function with overlooks that blend with the environment.

design and construction through CM/GC. Traffic was maintained on the historic Winona Bridge while constructing the new bridge. Once the new bridge was complete, one lane of northbound, one lane of southbound traffic, and a pedestrian path was moved onto the new bridge while rehabilitation on the historic bridge is underway.

The concrete segmental design facilitates rapid construction of the superstructure. From each of the two pier tables, construction proceeded in two directions at once for a total of four simultaneous operations. Despite the cold Minnesota winters, the rapid segmental construction methods allowed the project to be completed over two months ahead of schedule.

Cost competitiveness of the Winona Bridge Project was significantly enhanced through the CM/GC process. The team **provided MnDOT with over $18M in cost savings through innovative construction practices and project resource optimization**.

The CM/GC approach, allowed optimization of the design, improved quality, reduced risk, and cost management as the project moved through final design to construction.

Aesthetics and/or Harmony with Environment

The location of the bridge, in downtown Winona, offers multiple grand views of the bridge framed by downtown, the river, and Latsch Island. The long, graceful spans are supported by piers which visually blend into the superstructure with main span quad wall piers composed of slender shapes with maximum openness. Energy-efficient LED lighting accentuates the main channel piers and reflects in the water in the evening hours. The lighting system is programmable and has a marine radio control system that allows river pilots the ability to temporarily turn off the aesthetic lighting when navigating under the bridge during the night.

The light buff color chosen for the bridge was meant to work with the historic bridge concrete colors and complement the downtown native stone colors. The north and south abutments contain textured concrete finishes that provide visual forms like the organic tree movements on Latsch Island.

Views from the bridge were considered a high priority by the river community. Thus, an open pedestrian railing inspired by surrounding area elements was chosen along the west edge for the full structure length so pedestrians can enjoy open vistas of the surrounding landscape while crossing over the bridge. The east edge barrier is composed of solid concrete.

Minimization of Construction Impact on the Traveling Public

The new post-tensioned concrete segmental bridge was built from above with form travelers using the balanced cantilever method of construction to protect the environment, maintain river mobility, and allow rapid construction in all weather conditions.

The New Winona Bridge is made of concrete from its very own city of Winona. This reduced delivery distances, minimized emissions from delivery vehicles, and bolstered the local economy.

Opening the new bridge put an end to a 65-mile detour that affected emergency responders, commuters, and the local economy when the historic bridge needed to be temporarily closed for repairs.

CREDITS

Owner: **Minnesota Department of Transportation (MnDOT)**

Designer:
FIGG Bridge Engineers, Inc.

Contractor: Ames Construction

Construction Engineering Services:
FIGG Bridge Engineers, Inc.

Constructability Review/ Estimating Services:
Armeni Consulting Services, LLC and ICE

Construction Engineering Inspection:
FIGG Bridge Inspection and **MnDOT**

Form Travelers for Cast-in-Place Segments:
Structural Technologies VSL

Post-Tensioning Materials:
Schwager Davis, Inc.

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

Expansion Joints:
D.S. Brown Company

Prepackaged Grout: US SPEC

Photos Courtesy of FIGG

Photo Courtesy of
Brayman Construction

The existing Ironton-Russell Bridge, a cantilever structure, was opened in 1922 as the first highway bridge along the Ohio River between Parkersburg and Cincinnati. It was retrofitted in the 1970s and later posted with restrictions, having become inefficient for traffic and economically impractical to maintain. In 2000, the Ohio Department of Transportation (ODOT) determined the bridge was functionally obsolete and structurally deficient, and recommended a full replacement.

Unlike the original bridge, which connects downtown Ironton with downtown Russell, the new bridge connects downtown Ironton directly with US 23 and KY 244 within the city limits of Russell just south of downtown. This bridge is a major river crossing that provides a main route for trucking and transportation for Ohio. The new bridge opened on Wednesday, November 23, 2016, with a ceremony and parade through Ironton and Russell that included crossing both the new and original structures.

Oakley C. Collins Memorial Bridge

Category: Long Span and Cable-Stayed Bridges (Spans of 400′ or Greater)

Innovation of Design and/or Construction

The new 2,616-ft.-long Oakley C. Collins Memorial Bridge is comprised of a 900-ft. cable-stayed main span and two 370-ft. cable-stayed side spans, two 326-ft. tall towers and two anchor piers on the river's edge. The structure is cast-in-place with 22,500 cy of reinforced concrete (5.8 million lbs. of rebar), utilizing the cable stays to construct the bridge by the one-directional cantilever method. Foundation units consist of 22 large, 96-inch diameter drilled shafts.

The 900-ft. main span is the longest span ODOT has ever built. Construction began in March 2012 and was completed November 2016.

There were several key modifications to the means and methods and design optimizations, most notably:

- Alternative construction sequence.
- Casting of the back spans in place using specially designed falsework.
- Land access to build the main span area.
- Precast concrete girders for floor beams on side spans.
- Precast stay anchor blocks.

Minimizing Water-Based Work – During the pre-bid phase, the Team wanted to minimize water-based work since this adds substantially to cost, schedule and safety risk, especially since the river can rise over 20 ft. in this area.

Constructing the back spans on falsework simplified construction, reduced construction time, increased project safety, and reduced the amount and size of equipment required for the cable-stayed portion of the project. The falsework was designed as a modular system, allowing it to be used for both the Kentucky and Ohio approaches and reducing the number of travelers from two to one. This, along with precast concrete girders for floor beams on side spans, allowed the Contractor to have land access to build the main span area.

These modifications to the construction sequencing saved costs and time, as well as providing a much safer work environment. Project officials concur that minimizing water work was a wonderful success. With an average of 50 workers on-site, on a daily basis, there was no lost time incidents on this project.

Precast Where Possible – The Team evaluated and identified elements that could be precast rather than poured in place, allowing items to be pre-manufactured under controlled conditions, while other work was able to continue. The use of precast cofferdams greatly reduced the amount of tremie concrete required, as well as provided a sacrificial form for the tower footing.

Precast tubs were used for footings at Pier 3 and Pier 4, eliminating the need for pile coffer cells, effecting schedule and cost savings. The precast tubs were tied into the drilled shafts, reducing its footprint, minimizing excavation and its impact on the environment, footing form costs and schedule time. In addition, floor beams were precast and stay-in-place deck forms were used on the side spans.

Precast Stay Anchor Block System – The design of an innovative precast stay anchor block system simplified stay cable anchorage placement, accelerated the construction schedule and simplified the form traveler system by eliminating the need for a temporary stay anchorage.

Rapid Construction and Cost Competitiveness

While the original design specified the use of two form travelers, the modifications allowed the main span to be cast-in-place in a segmental, one-directional cantilever method. It allowed the integration of the design and

Jury Comments

This project demonstrated how segmental concrete provides multiple options to a designer and contractor to design and construct a long-span bridge fast and economically. ODOT's longest span bridge is an amazing technical and aesthetic achievement. Use of precast stay blocks and backspan falsework was innovative and saved substantial construction time.

fabrication of the traveler through one stay supply and installation provider.

The cost was $655 per square foot. The design optimization and changes to the construction method resulted in a winning bid approximately 4% below the state's final estimate of $84.6 million.

Aesthetics and/or Harmony with Environment

The grand opening ceremony of the new Oakley C. Collins Memorial Bridge took place on November 23, 2016, in Ironton, Ohio, and hundreds of people turned out for the opening ceremony. A parade featured classic cars and local groups, including the Russell and Ironton High School bands.

The bridge creates a safer route for the traveling public, as well as a safer route for the navigational channel.

The iconic cable-stay bridge is a type popular for the past couple of decades for its combination of aesthetic good looks, projected long life span, and low-maintenance cost.

Minimization of Construction Impact on the Traveling Public

The original bridge remained open during construction until the new bridge was completed. The innovative and first use of a precast stay anchor block system in the United States simplified stay cable anchorage placement, accelerated the construction schedule and simplified the form traveler system by eliminating the need for a temporary stay anchorage.

CREDITS

Owner:
Ohio Department of Transportation

Owner's Engineers: **AECOM**

Designer: **AECOM**

Contractor:
Brayman Construction Corporation

Construction Engineering Services:
Finley Engineering Group, Inc.

Construction Engineering Inspection:
FIGG

Precast Producer:
Carr Concrete/Brayman Precast LLC

Form Travelers for Cast-in-Place Segments: **Structural Technologies VSL**

Formwork Tower Leg Forms:
PERI Formwork Systems, Inc.

Post-Tensioning:
Structural Technologies VSL

Stay Cable Materials:
Structural Technologies VSL

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

Expansion Joints:
Watson Bowman Acme

Epoxy Supplier:
Pilgrim Permocoat, Inc.

Prepackaged Grout:
The Euclid Chemical Company

Photo Courtesy of AECOM

Pearl Harbor Memorial Bridge

Category: Long Span and Cable-Stayed Bridges (Spans of 400′ or Greater)

With a span of 515 feet, the main span unit of the new Pearl Harbor Memorial Bridge (PHMB) is the first extradosed cable-stayed bridge constructed in the United States, fully utilizing extradosed pre-stressed cable-stayed technology.

The PHMB (locally known as the Q Bridge) is the centerpiece of the Connecticut Department of Transportation's (CTDOT) larger I-95 New Haven Harbor Crossing Corridor Improvement Program. The new PHMB carries I-95 over New Haven Harbor at the confluence of the Quinnipiac and Mill Rivers. The project was initiated because of the need for operational and safety upgrades to the I-95 corridor through this area due to the volume of traffic and the structural deficiencies of the previous bridge. The project included replacing the entire mile long bridge viaduct structure, increasing the current six-lane configuration to (10) ten lanes and providing full shoulder widths. The new bridge provides operational and safety improvements designed to reduce traffic congestion and to minimize delays on I-95 through the New Haven area. The new bridge replaces the previous 1958 structure that was designed for 40,000 vehicles per day; adding critical capacity to accommodate the more than 140,000 vehicles per day now traversing the adjacent I-95/I-91/Route 34 Interchange, one of the busiest in the nation.

Innovation of Design and/or Construction

The choice of an extradosed pre-stressed bridge type for the PHMB, was a creative segmental concrete solution to the challenging site conditions, and represented the first application of this new bridge type in the United States. The 515-foot main span length was desirable for navigation clearance, but structural depth was limited by profile constraints required to meet the grades tying into the adjacent interchange, and precluded a conventional girder type bridge. A nearby airport constrained tower height that would have been necessary for a conventional cable stayed bridge solution. The extradosed pre-stressed design allowed the desirable span, while staying within structural depth constraints and keeping the towers below the aviation clearance surface. The all-concrete design also provided a highly durable bridge solution to meet the 100-year service life design requirement.

Rapid Construction and Cost Competitiveness

The PHMB is located on a heavily traveled section of I-95 connecting Boston and New York. There was a fundamental requirement that no reduction in lanes or capacity was permitted during construction. In response to this requirement, the bridge was sequenced to first construct the northbound roadway then shift both northbound and southbound traffic onto the newly completed bridge. This configuration resulted in no reduction in the number of travel lanes from the existing condition. In the next major phase of construction, the existing bridge was removed and the southbound bridge constructed on essentially the same alignment. In order to minimize construction duration, four erection travelers were required so that the balanced cantilevers off of each of the towers could progress simultaneously. After the northbound bridge was completed, these travelers shifted to construct the southbound bridge. To further facilitate rapid construction, an advance construction contract included construction of work bridges below each of the side spans to allow good construction access for foundation, tower and superstructure access. The project was completed on schedule and under budget as the largest single construction contract and the first electronic submittal of contract documents in CTDOT's history.

The PHMB was procured using a conventional design-bid-construct model. To spur competitiveness, two complete designs were offered for competitive bidding – a segmental concrete extradosed option and a steel composite extradosed option. When the bids were opened, the concrete segmental option was the lowest price option.

Aesthetics and/or Harmony with Environment

The extradosed bridge type met the fundamental project goal to provide a signature span worthy of the memorial

Jury Comments

This first ever extradosed bridge in the United States met all the demands of this challenging project and is a shining example of all the benefits that this bridge type can provide. This is an amazing memorial bridge, and the first of its kind. This is a bridge that was built to last with capacity to support 140,000 vehicles per day.

CREDITS

Owner: **Connecticut Department of Transportation**

Owner's Engineers: **AECOM**

Designer: **AECOM**

Contractor: **Walsh-PCL JV II**

Construction Engineering Services: **Buckland-Taylor/COWI**

Construction Engineering Inspection: H.W. Lochner, Inc. and **FIGG Bridge Inspection, Inc.**

Form Travelers for Cast-in-Place Segments: **Schwager Davis, Inc.**

Post-Tensioning Materials: **Schwager Davis, Inc.**

Stay Cable Materials: **Schwager Davis, Inc.**

Bearings: **R.J. Watson, Inc.**

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

Epoxy Supplier: **Sika Corporation** and Pilgrim Permocoat, Inc.

Prepackaged Grout: The Euclid Chemical Company

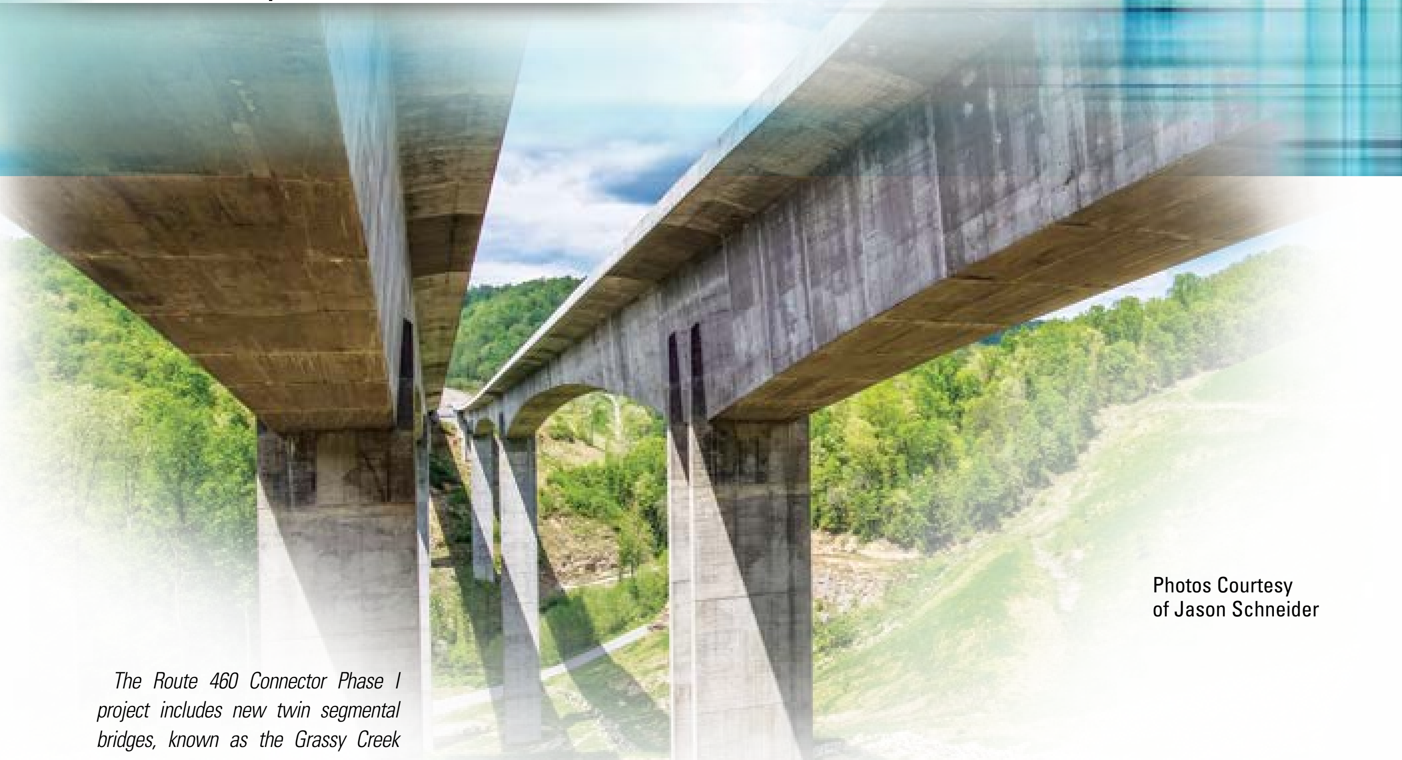
character of the crossing. The towers are strong, simple oval cylinder shapes, similar to what one might see on a ship. The outer webs of the girders are sloped to visually minimize the depth of the structure and provide a good balance between the visual mass of the girders and towers, and the superstructure is variable depth, which makes it clear of the girder's strong role in supporting the span. Aesthetic lighting provides a gentle wash lighting of the towers and cables with white light. During bird migration seasons, the color is shifted to a soft green or blue light. As a special feature, for patriotic holidays such as Memorial Day, Independence Day, Pearl Harbor Day and Veterans Day the aesthetic lighting provides a dramatic red, white and blue illumination of the three tower legs and stay cable planes. As a remembrance of those fallen, light cannons shine upwards to the heavens from the two center tower legs.

Minimization of Construction Impact on the Traveling Public

No reduction in the number of travel lanes or capacity was permitted during construction. In response to this requirement, the bridge was sequenced to first construct the northbound bridge offline from the existing bridge then shift both northbound and southbound traffic onto the newly completed bridge resulting in no lane reductions from the existing condition. The original bridge was demolished and replaced by the new southbound bridge on essentially the same alignment.

Governor Dannel Malloy said, "This is one of the largest projects in Connecticut DOT history, and it's been completed eight months ahead of schedule and on budget…the Pearl Harbor Memorial Project is a demonstration of what can be done when people work together."

Photos Courtesy of Connecticut Department of Transportation



Photos Courtesy
of Jason Schneider

The Route 460 Connector Phase I project includes new twin segmental bridges, known as the Grassy Creek Bridges, which are each over 1,700-feet long with a deck width of 43-feet, a maximum height of over 250-feet, and a longest span of length of 489-feet. Rising over Grassy Creek, the over 250-feet vertical clearance of the segmental structures makes these bridges the tallest in the Commonwealth of Virginia. The new roadway and bridge approaches are literally "carved out of a mountain," with extensive blasting and excavation necessary, given the mountainous environment. Constructed between January 2011 and September 2015, the Route 460 Phase I Project is a critical component of the larger expressway, which will be identified as U.S. Route 460 Corridor Q. The route will provide a modern, safe, and efficient highway through southwestern Virginia. U.S. Route 460 is expected to help boost commerce and tourism, with the states of Kentucky, Virginia, and West Virginia yielding benefit from the new route. The new expressway will link Kentucky and rural areas in southwest Virginia to I-64 and I-77, and will be designated as part of the national highway system.

Route 460 Connector Phase I – Grassy Creek Bridges

Category: Rural Bridges and Viaducts

Innovation of Design and/or Construction

The Route 460 Connector Phase I Project was delivered using the design-build contracting method. One of the biggest challenges associated with this project was the mountainous terrain in which it was constructed. The cast-in-place segmental bridges, built by the balanced cantilever method, proved to be a cost-effective solution to address the access issues and allowed for a main span of 489-feet. Each bridge structure consisted of over 2.6 million pounds of reinforcing steel, 150 miles of post-tensioning strand, and over 16,000 cubic yards of concrete. The construction of the bridges utilized new specifications and requirements related to segmental bridge durability and quality, as well as a mock-up test construction to test the performance of several different cable grouts to select the most appropriate one for construction.

Rapid Construction and Cost Competitiveness

In order to fast-track the completion of the project, the design-build contract method was selected. In addition to the advantages derived from this method, the Design-Build Team took steps to ensure the project was completed in a rapid manner. The contractor established an on-site concrete batch plant, which allowed them to receive concrete on-demand (without yielding to the schedule of a concrete producer), eliminating potential issues with concrete procurement that would have had to come from nearly one hour away. The concrete plant was able to produce up to 120 cubic yards of concrete per hour. With an insulated water source and water lines, the plant was able to produce concrete when outside temperatures were below freezing. Additionally, the bridge contractor worked at multiple locations throughout the project site at one time, such as working on the superstructure at Pier 4, the column at Pier 3, and the footing at Pier 2 simultaneously.

Jury Comments

The segmental CIP balanced cantilever method chosen for this project provided the owner with a bridge type that easily navigated the site's mountainous terrain as well as overcame the numerous obstacles with construction in a very remote location. Given the challenges, it's amazing such a beautiful, tall, slender structure is the result. The tall piers presented unique construction challenges that were solved using segmental construction.

The cast-in-place segmental construction was the most economically feasible alternative and proved to be the lowest design-build cost at an original construction cost of $90 million. At a final construction cost of approximately $95 million, the twin bridges were built at a cost of approximately $341 per square foot.

Aesthetics and/or Harmony with Environment

The twin bridges utilize variable depth segments, ranging from 30-feet deep at the piers to 12-feet deep at the mid-span closures. They provide a longer span length to the variable depth segments as well as an aesthetically pleasing arch to the bridge spans. The top down construction method utilized on the project allowed for only five pier locations and minimized the need for additional foundations, which would have further impacted the environment.

Minimization of Construction Impact on the Traveling Public

The cast-in-place segmental construction proved to be key to minimizing construction impacts to the traveling public. Had this construction method not been utilized, it would have been necessary to establish a temporary traffic shift, which would have been difficult, given the terrain. Since the segmental construction took place overhead, there was minimal impact to the traveling public and all nearby roads were able to remain open.

CREDITS

Owner: Virginia Department of Transportation – Bristol District

Owner's Engineers: **RS&H, Inc.**

Designer: **Janssen & Spaans Engineering, Inc.** (Lead Structures Designer) and Stantec (Substructure Designer)

Design-Build Team: Stantec, **Janssen & Spaans Engineering, Inc.**, Bizzack, CJ Mahan (Bridge Subcontractor), and AMT

Contractor: Bizzack (Prime Contractor) and CJ Mahan (Bridge Construction Subcontractor)

Construction Engineering Services: AMT on Behalf of the Design-Build Team and **RS&H, Inc.** as Owner's Representative

Constructability Review/Estimating Services: Virginia Department of Transportation

Construction Engineering Inspection: AMT

Form Travelers for Cast-in-Place Segments: **Structural Technologies VSL**

Post-Tensioning: **Structural Technologies VSL**

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

Prepackaged Grout: The Euclid Chemical Company

SR 520 Evergreen Point Floating Bridge and Landings Project

Category: Bridges Over Water

The State Route 520 Floating Bridge and Landings Project is one of several large construction projects along the SR 520 corridor in Washington's Central Puget Sound region. The bridge project enhances traffic safety, improves travel reliability, relieves congestion and expands the public's transportation options by:

- *Replacing an old, structurally vulnerable four-lane floating bridge with a stronger, six-lane bridge.*
- *Adding dedicated HOV/transit lanes in each direction.*
- *Adding a separate bicycle and pedestrian path on the bridge to give the public a new option for commuting between major employment centers on either side of Lake Washington.*
- *Creating a bridge design that can accommodate future light rail.*
- *Elevating the bridge superstructure's roadway so wind-whipped waves no longer crash over vehicles and the roadway, and bridge maintenance crews have access to the pontoons below the roadway deck without disrupting traffic.*
- *Adding shoulders on the roadway to minimize traffic disruptions from disabled vehicles.*
- *Eliminating the need for a drawspan due to higher, 70-foot clearance for boat passage under the new bridge, eliminating traffic delays on the bridge for boater drawspan openings.*

Innovation of Design and/or Construction

Replacing the world's longest floating bridge was understood to be a technically challenging assignment, but also challenging was gaining public consensus on what, if anything, was to be built. In 1997, the owner started the long and difficult task of planning the replacement of this key part of the transportation system in Seattle.

Public discussion, debate, and planning continued for 14 years, looking at many alternative alignments and crossing types, concluding with a Final Environmental Impact Statement in 2011. Challenges included technical issues such as wind/wave analysis and wave interaction with a long floating structure, an active seismic area, a deep lake with unstable soils for anchor placement, a suitable pontoon-construction site, navigational requirements, maintenance of traffic during construction, and many others.

The new bridge consists of a floating bridge structure – at 7,710 feet, the longest in the world – with fixed approach and transition structures on the east and west ends connecting land based structures with the floating bridge. The owner furnished 33 of the floating structure's pontoons; the design-builder constructed 44, along with bridge anchors and anchor cables. All 77 pontoons were towed to Lake Washington from casting basins in Grays Harbor (Pacific Ocean route) and Tacoma (Puget Sound route). Bridge assembly involved joining 21 longitudinal pontoons, 2 cross (end) pontoons, and 54 supplemental stability pontoons to form the floating bridge substructure. The superstructure that carries the roadway deck was installed on top of the pontoons. A new bridge maintenance facility, dock and crew access was constructed beneath the east approach structure. The old floating bridge and approach structures were removed from the lake.

To address the stringent requirements, a solution maximizing the versatility of segmental bridge technology was developed for two significant segments of the project. Precast segmental ribbed-slab segments were used for the 1-mile long low-rise section of the floating-bridge superstructure; and a three-span 630-foot cast-in-place segmental box-girder bridge was used for the two east approach structures to connect the bridge to land. Several noteworthy features of these structures included:

Jury Comments

Both traditional balanced cantilever and innovative thin ribbed-slab segmental applications were used by this project to address the unique challenges for this world record-setting floating bridge. The innovative segmental ribbed-slab allows for a very slender superstructure, supported by innovative floating pontoons. Clean use of cast-in-place segmental for approach structure.

An Innovative Effort to Turn a "Marine" Job Into a "Land" Job Wherever Possible – Land-based construction and precast segmental technology provided a safer environment, mitigated potential negative environmental effects to the lake, simplified access for material and personnel, improved construction consistency and quality, allowed for standardization of equipment, shortened the project schedule, and greatly reduced costs.

Reduction of In-Water Work – Through the relocation of the east approach bridge footing to the shoreline. Originally planned to be placed within lake Washington, the proposal design moved this footing to shoreline. This eliminated in-water construction in a critical salmon-spawning lakeshore gravel bed.

Increased Maintenance Access on the Pontoon Deck – The thin structural section of the precast segmental ribbed-slab segments increased the vertical clearance to 10-feet, which exceeded the 7-foot-6-inch minimum and greatly enhanced maintenance access and mobility on the pontoon deck, key to bridge preservation activities.

Elimination of Exposed Steel Elements in the Bridge Superstructure – The final design provides an all-concrete superstructure; this eliminated the RFP concept of exposed steel, providing a much more durable structure with greater performance in the difficult conditions of Lake Washington.

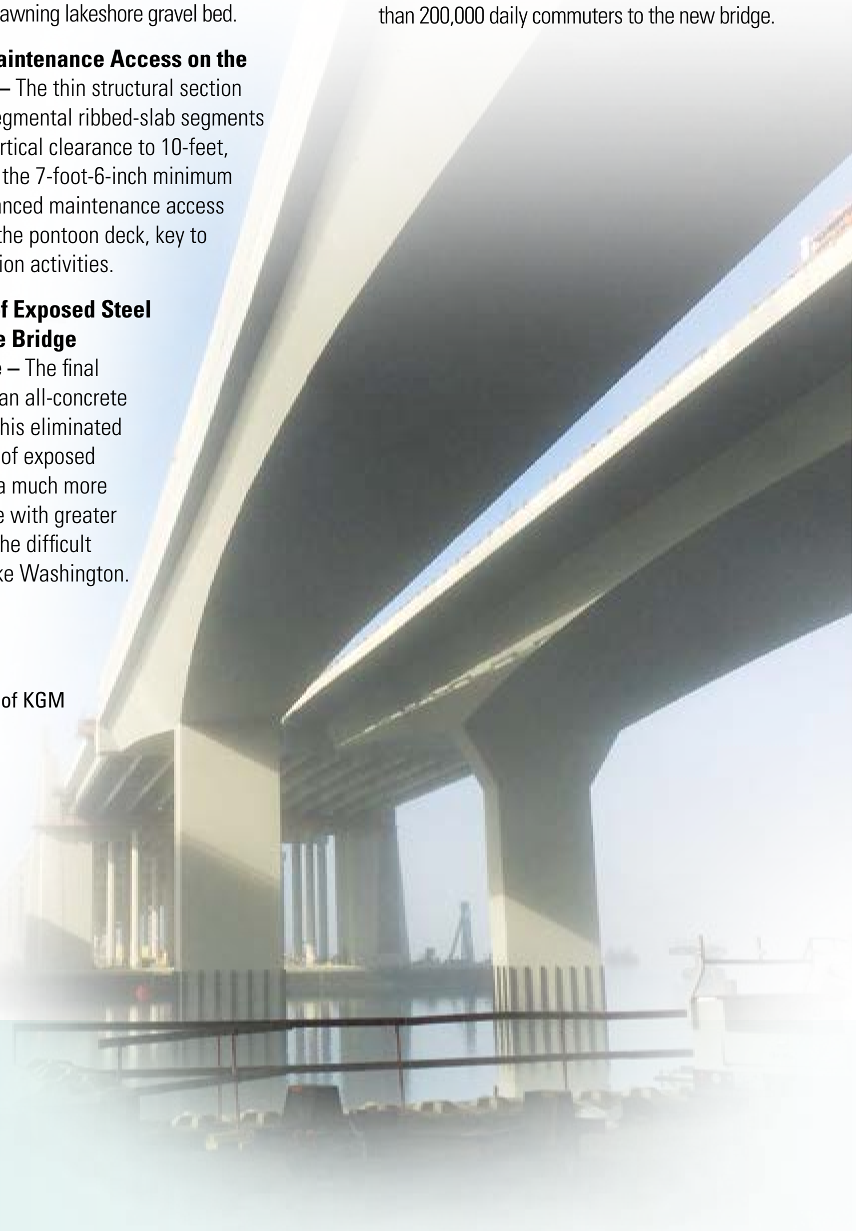
Rapid Construction and Cost Competitiveness

The use of segmental bridge technology allowed the project to be delivered within 56-months.

The $750 million project was delivered at a cost 10% lower than the next highest bid with the use of segmental bridge technology.

Minimization of Construction Impact on the Traveling Public

The new bridge was constructed adjacent to the existing floating bridge allowing it to remain in full service throughout construction. Only two weekend closures were required at the conclusion of the project to transfer more than 200,000 daily commuters to the new bridge.



Photos Courtesy of KGM

CREDITS

Owner: **Washington State Department of Transportation**

Owner's Engineers: **HDR, Inc.**

Designer: KPFF, BergerABAM, **International Bridge Technologies, Inc.**

Design-Build Team: **Kiewit**/General/Manson, A Joint Venture (KGM), KPFF, BergerABAM, **International Bridge Technologies, Inc.**

Contractor: **Kiewit**/General/Manson, A Joint Venture (KGM)

Construction Engineering Services: KPFF, BergerABAM, **International Bridge Technologies, Inc.**

Constructability Review / Estimating Services: **Kiewit**/General/Manson, A Joint Venture (KGM)

Construction Engineering Inspection: **Kiewit**/General/Manson, A Joint Venture (KGM)

Precast Producer: **Kiewit**/General/Manson, A Joint Venture (KGM)

Formwork for Precast Segments: Helser Industries

Form Travelers for Cast-in-Place Segments: **Structural Technologies VSL**

Erection Equipment: Derrick Crane M24

Post-Tensioning: **Schwager Davis, Inc.**

Bearings: Scougal Rubber Corporation

Expansion Joints: **mageba USA**

Epoxy Supplier: The Euclid Chemical Company

Prepackaged Grout: US SPEC

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