CONGRATS TO OUR 2022 WINNERS!

2022 PRIZE BRIDGE AWARDS

AISC AND THE NATIONAL STEEL BRIDGE ALLIANCE are proud to announce the winners of the 2022 Prize Bridge Awards.

"These projects demonstrate the creativity and skill of the structural steel design and construction industry," said AISC's president, Charles J. Carter, SE, PE, PhD. "This is our opportunity to celebrate the achievements of these project teams."

More than 600 bridges of all sizes from all across the United States have received a Prize Bridge Award since Pittsburgh's Sixth Street Bridge won the first competition in 1928. Some of those bridges, such as the Wabash Railroad bridge in Wayne County, Mich., which won a prize in 1941 and still carries railroad traffic more than 70 years later, have outlasted the companies that built them.

A team of four nationally recognized experts in bridge design and construction served as this year's jury:

- Domenic Coletti, principal bridge engineer, HDR Inc.
- Jamie Farris, bridge deputy director, Texas Department of Transportation
- Finn Hubbard, vice president, Fickett, Inc.
- Natalie McCombs, senior technical advisor, HNTB

Judges weighed each project's use of structural steel from both an architectural and structural engineering perspective, with an emphasis on: creative solutions to the project's program requirements; applications of innovative design approaches in areas such as connections, gravity systems, lateral load resisting systems, fire and/or blast protection; the aesthetic and visual impact of the project; innovative use of architecturally exposed structural steel (AESS); technical or architectural advances in the use of the steel; and/or the use of innovative design and construction methods. The program also recognizes the importance of teamwork, coordination, and collaboration in fostering successful projects.

New this year is the Bridge of the Year Competition. The 2022 World Steel Bridge Symposium in Denver (March 23–25) featured presentations from the teams behind the three finalists selected by our judges. Presenters outlined what made their bridges so noteworthy. The three finalists were:

- I-91 Interchange 29 Exit Ramp Flyover Bridge (medium span)
- Metro-North Railroad Bridge over Atlantic Street (short span)
- Green Street Pedestrian Bridge (special purpose)

The winner was I-91 Interchange 29 Exit Ramp Flyover Bridge.

Read on to learn more about—and see lots of great images of—all of this year's winners.

Major Span

- National Award: I-74 Mississippi River Bridge – Westbound Span
  Bettendorf, Iowa/Moline, Ill.
  submitted by Modjeski and Masters

Medium Span

- National Award: I-91 Interchange 29 Exit Ramp Flyover Bridge
  Hartford, Conn.
  submitted by CHA Consulting
  (also Bridge of the Year)
- Merit Award: Arlington Memorial Bridge
  Washington, D.C./Arlington County, Va.
  submitted by High Steel Structures

Short Span

- National Award: Metro-North Railroad Bridge over Atlantic Street
  Stamford, Conn.
  submitted by Atane Consulting

Rehabilitation

- National Award: Baker's Haulover Cut Bridge Rehabilitation
  Bal Harbour, Fla.
  submitted by TranSystems
- Merit Award: Hernando de Soto Bridge
  Memphis, Tenn./West Memphis, Ark.
  submitted by Michael Baker International

Special Purpose

- National Award: Green Street Pedestrian Bridge
  Winston-Salem, N.C.
  submitted by HDR, Inc.
- Merit Award: Dublin Link Pedestrian Bridge
  Dublin, Ohio
  submitted by Endrestudio and Kokosing Construction Co.

Modjeski and Masters

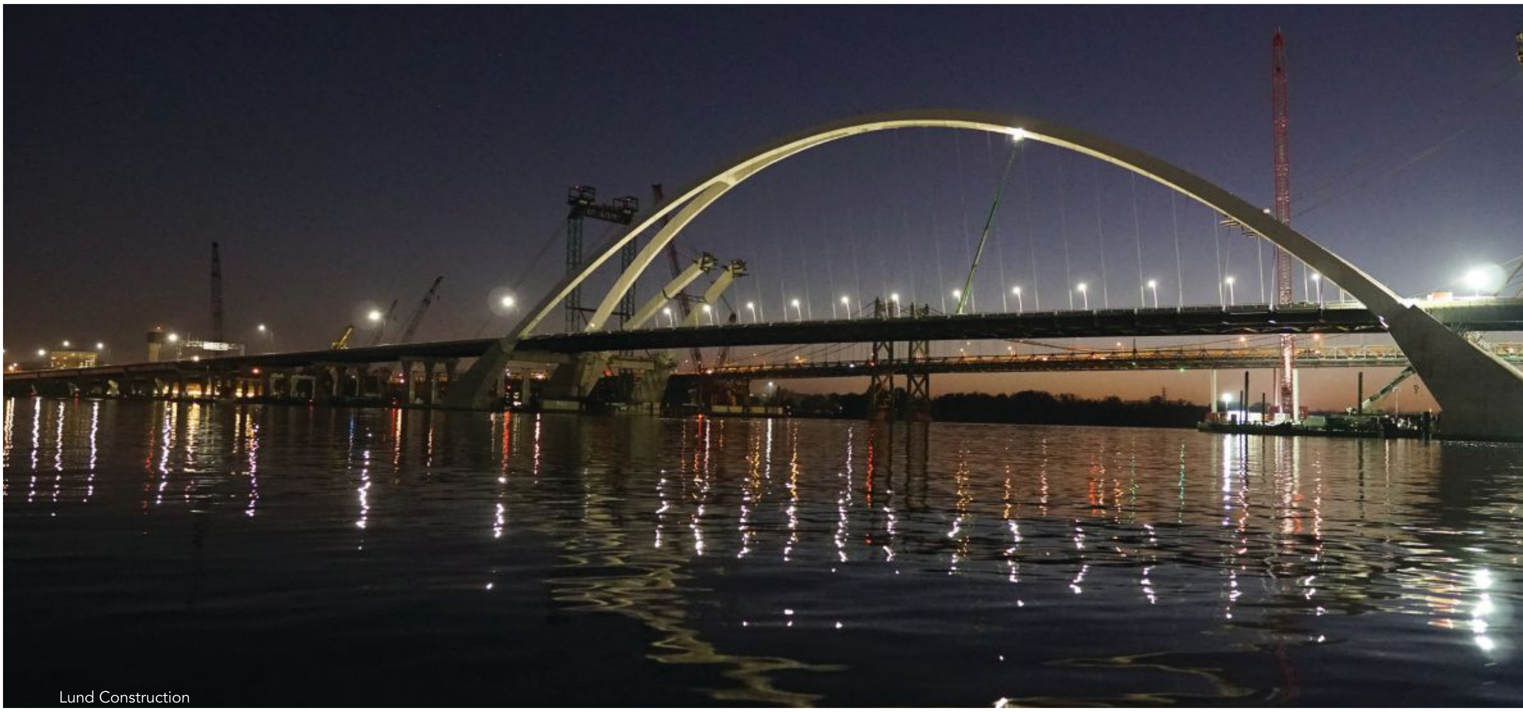
NATIONAL AWARD Major Span

I-74 Mississippi River Bridge—Westbound Span, Bettendorf, Iowa/Moline, Ill.

THE IOWA-ILLINOIS MEMORIAL BRIDGE was long known as the crown jewel of the I-74 corridor through the Quad Cities region.

The bridge spans the Mississippi River between Moline, Ill., and Bettendorf, Iowa, and is a vital inter-state link in the area. Recent economic growth in the region has led to ever-increasing traffic demands that have outgrown the corridor's existing infrastructure, and this vital stretch of I-74 had become a pinch point. The Iowa and Illinois Departments of Transportation developed an ambitious improvement plan to alleviate congestion along the corridor and sustain the regional economy. The plan encompassed several objectives, including increasing existing roadway capacities and designing new roadways and interchanges. Most notably, the strategy called for a new I-74 Mississippi River Bridge to replace the existing Iowa-Illinois Memorial Bridge. The new bridge would need to provide a long service life through improved materials and details, easy access for inspection and maintenance, and accommodation for the area's greatly increased traffic.

The westbound span opened in late 2020, and its eastbound twin opened this past December. The new bridge is more than twice as wide as the existing bridge, providing four lanes in each direction, and a multi-use path will connect to paths in Bettendorf and Moline on either side of the river. The geometric configuration of the basket-handled arches and the use of minimal arch rib bracing (two intermediate struts and a crown strut) offer a modern representation of the arch form, and the arch span marks the main navigation



Lund Construction

channel as vehicular travelers pass along the corridor between Iowa and Illinois. Because the new steel arch bridge is in a main navigational channel, it took substantial coordination during the construction phase to minimize impacts on river traffic as the arch segments were installed.

In order to achieve the precision necessary to set the initial arch sections on their foundations, field milling was specified for the embedded steel anchor plates, using techniques and equipment typically employed in the construction of movable bridges. The arch segments are anchored to the foundations using specialized, high-strength stainless steel prestressed anchor rods developed as part of a research project to identify a corrosion-resistant material for this type of application, and the design team chose a duplex stainless steel (grade 2507) with a minimum tensile strength of 116 ksi. After installation, the bars are grouted in their ducts to provide an additional corrosion barrier and bond them to the surrounding concrete. The project also used HPS 70W extensively, both in the arch ribs and the floor system, in areas where the high level of strength could be used to the best advantage.

Bridge Stats

Crosses: Mississippi River

Span length: 800 ft

Total length: 3,405 ft (arch span and steel multi-girder approach structures)

Average width: 98 ft

Steel weight per deck area: 0.075 tons/sq. ft

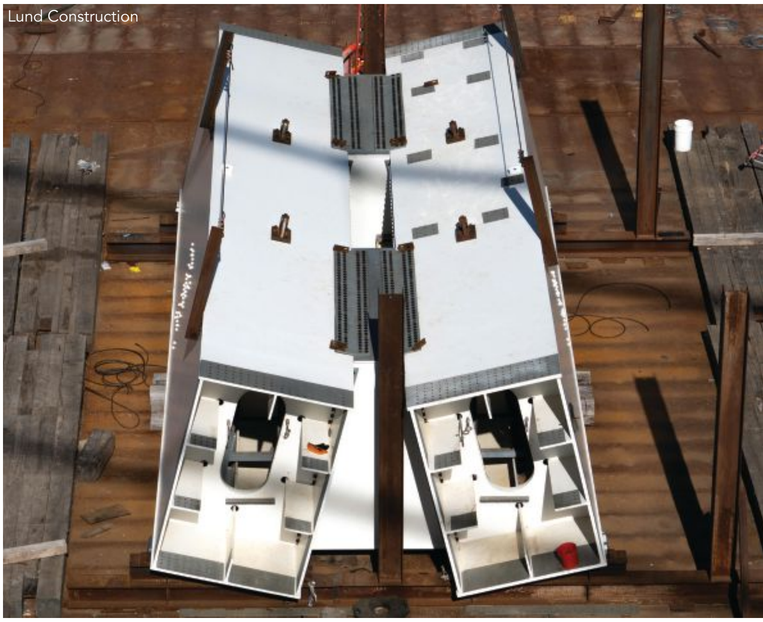
Total structural steel: 4,300 tons

Approximate cost: $34.5 million
(engineers' estimate for the superstructure)

Corrosion protection: Stainless steel high-strength prestressed anchor rods, stainless steel reinforcing steel, fluoropolymer paint system, uncoated weathering steel


HNTB


Modjeski and Masters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When it comes to maintenance, the system consists of an under-deck traveler that can access the entire floor system and includes a scissor lift that rides across the traveler and provides vertical access to the full depth of the edge girders and floor beams. Workers can access the arch ribs by an internal system of walkways and stairs, as well as external hatches and handrails that provide access to the top of the arches.

The concrete deck employs stainless steel exclusively, including in the barriers, to provide a long service life and minimize the need for extensive maintenance and frequent deck replacement. To prevent unwanted oscillations of the bridge in the wind, a system of winglets is installed along the edges of the suspended deck.

The nearness of bedrock to the surface in this area allowed for the use of a true arch bridge rather than a tied arch. This eliminated the long tension ties and the redundancy issues that sometimes accompany them. The slender, tapered arches are inclined toward each other, with minimal bracing between them. This framing scheme, together with the sheer size of the bridge, leaves an indelible mark on the river, signaling the importance of the region and the new crossing.

In addition, the bridge's lighting makes it a stunning nighttime focal point from up and down, and on either side of, the river and beautifully highlights the structural system. The improved highway geometrics and traffic capacity (the westbound arch alone has more deck width for traffic than both of the original suspension bridges combined) provide much-needed room for the region's ongoing economic expansion.

Owners
Illinois Department of Transportation
Iowa Department of Transportation

General Contractor
Lunda Construction Company

Structural Engineers
Modjeski and Masters, Inc. (superstructure)
Alfred Benesch and Company (substructure)

Steel Team

Fabricator
Industrial Steel Construction, Inc., Gary, Inc.

Detailer
Tenca Steel Detailing, Inc., Quebec, Canada

Bearing Manufacturer
R.J. Watson, Inc., Alden, N.Y.

BRIDGE OF THE YEAR

NATIONAL AWARD Medium Span

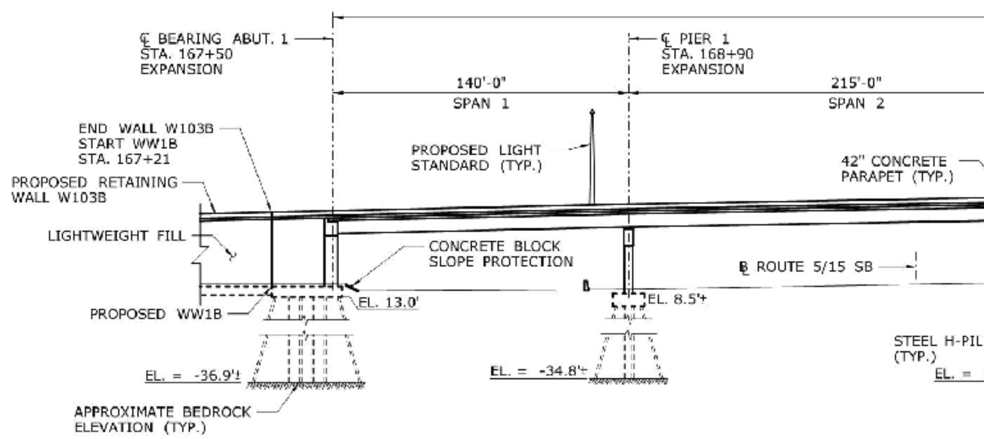
I-91 Interchange 29 Exit Ramp Flyover Bridge

Hartford, Conn.

FOR A LONG TIME, INTERCHANGE 29 in Hartford, Conn., was notorious for congestion.

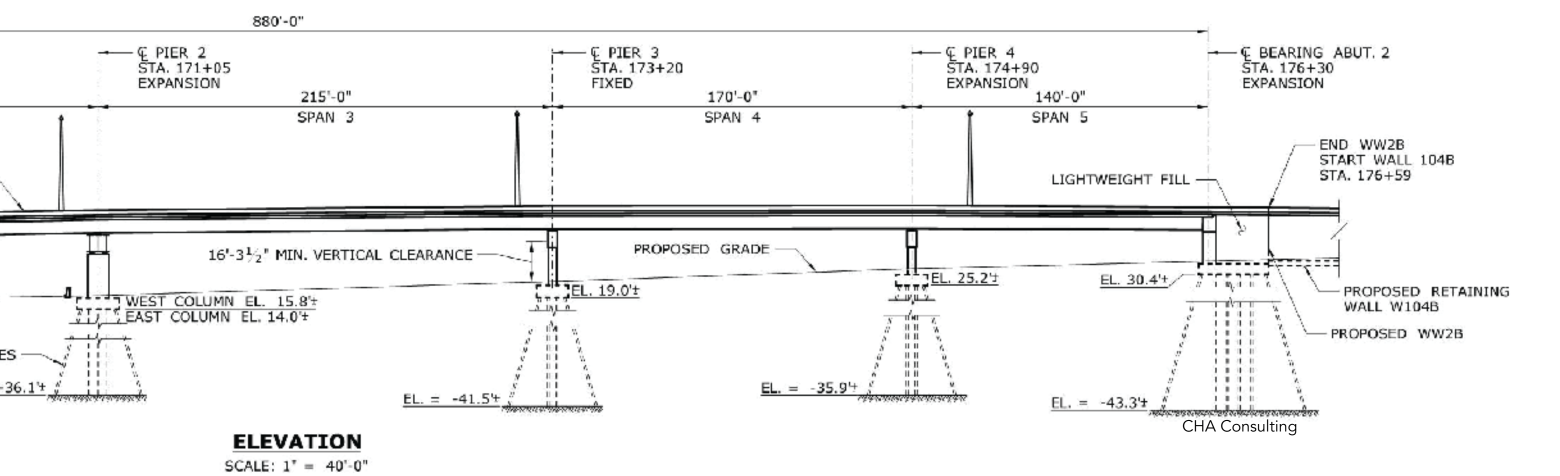
The interchange connects northbound I-91 with Route 5/15, the latter being the major connector between I-91 and I-84 in East Hartford. The original ramp was a single-lane ramp with a steep grade and a significant traffic weave at the intersection with Route 5/15 and saw significant daily back-ups on I-91 that led to numerous accidents and delays. Improvements to the interchange were one of the top priorities of the Connecticut DOT (CTDOT), and the reconfiguration of the interchange resulted in a new high-speed two-lane ramp that crosses over southbound Route 5/15 in a weave configuration.

The new ramp is a straight ramp that crosses a curved roadway at a very flat angle, resulting in significant geometric impacts on the roadway below. The vertical geometry of the roadway below the bridge limited the ability of vehicles to pass under the proposed hammerhead pier caps due to low vertical clearance at the hammerhead piers. There were three potential solutions: raising the bridge, lowering the roadway, or reducing the pier cap's width. The first two options weren't feasible, so the team moved forward with the plan of reducing the pier cap's width and implementing trapezoidal box girders. This solution allowed the design team to locate the bridge bearings closer to the centerline of the bridge, thereby reducing the width of the pier cap by 8 ft. The reduced cap width also reduced the cost of the piers by reducing the volume of concrete and the bending moments acting on the shorter cantilevers. The geometric layout of the bridge also improves its look, as the trapezoidal box girders without exterior stiffeners produce clean lines. When compared to vertical webs, the sloped webs have historically been the look of choice for bridge aesthetics, as the sloping webs draw the eye toward the single columns supporting the pier caps, demonstrating a flow of forces from the superstructure to the ground.



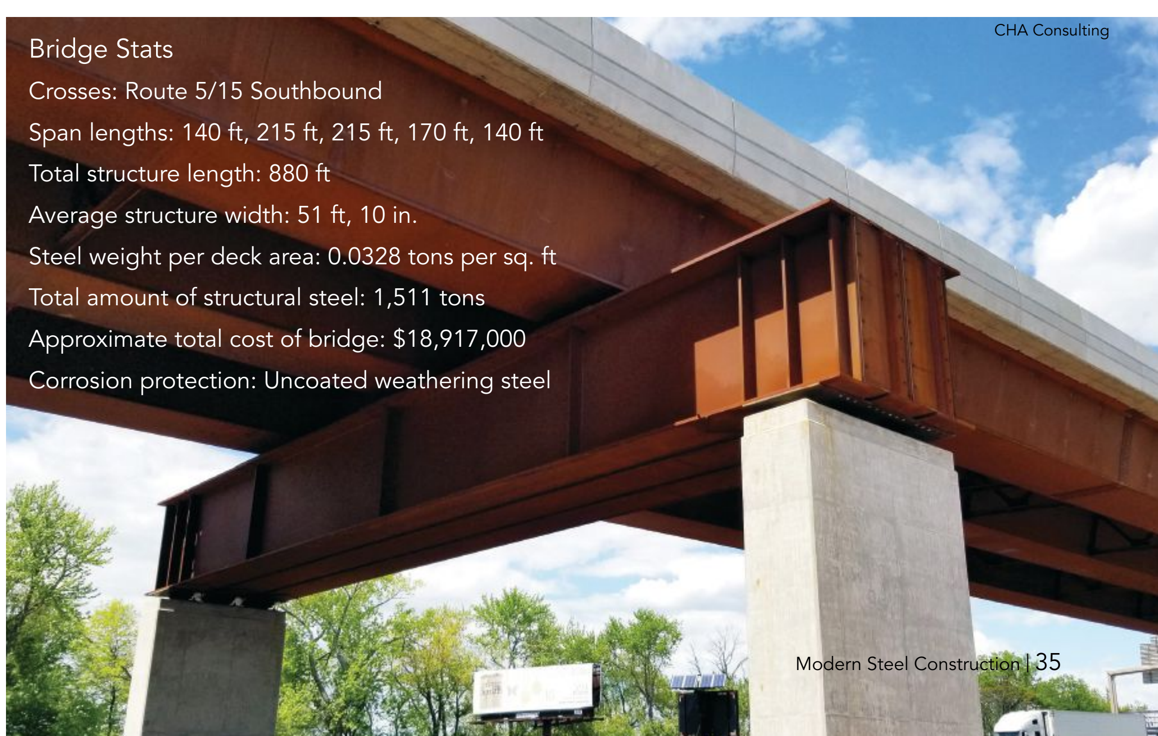
2022 BRIDGE OF THE YEAR

CHA Consulting



CHA Consulting

High Steel Structures



CHA Consulting

Bridge Stats

Crosses: Route 5/15 Southbound

Span lengths: 140 ft, 215 ft, 215 ft, 170 ft, 140 ft

Total structure length: 880 ft

Average structure width: 51 ft, 10 in.

Steel weight per deck area: 0.0328 tons per sq. ft

Total amount of structural steel: 1,511 tons

Approximate total cost of bridge: $18,917,000

Corrosion protection: Uncoated weathering steel

CHA Consulting

Another major factor that makes this bridge stand out is its innovative use of straddle bents. The goal was to design a redundant beam, and the team incorporated the load path redundant members (LPRM) approach. The team accomplished this by converting a typical single-cell box girder section into a three I-girder member. Plate diaphragms were designed using finite element analysis (FEA) to distribute forces equally to each girder and transfer the load should one girder flange fracture. The team also developed an "integral," or framed-in, straddle bent concept and a "stacked" straddle bent scheme with the superstructure on top. There was adequate vertical clearance at the straddle bent location to stack the members, leading to a simpler and more cost-effective design. The design team has developed similar details for an integral "framed in" design. Therefore, the triple I-girder design can be adapted to virtually any steel bridge configuration.

The straddle bent approach used for this project represents a game-changer in the world of steel bridges. To date, all steel straddle bents—again, typically single-cell box sections—have been classified as fracture-critical elements, which has significantly precluded the use of steel for straddle bents. The triple I-girder configuration can provide load path redundancy, thereby eliminating the fracture-critical designation and the related long-term inspection requirements. In addition, the girders can be designed for infinite fatigue life, essentially eliminating the potential for a fatigue crack to develop, let alone a fracture. The triple I-girder design also provides options to the contractor for shipping and handling. The straddle bent can be shipped and erected as one, two, or three pieces, which allows the contractor to achieve maximum efficiency when it comes to truck size and crane size, potentially eliminating an overweight permit, which can lead to reduced costs. This proved to be the case on the Interchange 29 ramp bridge, as the contractor chose to ship the straddle bent girder in two pieces. Once on-site, the two pieces were bolted together on the ground and erected as one piece.

The triple I-girder straddle bent concept offered another surprising benefit: It's a very economical section to fabricate. During design development, when considering fabrication costs, the design team initially felt that the fabrication of three members might be slightly more expensive than the fabrication of a single box girder. The idea was that while the total flange areas of the triple I-girder would be similar to the box girder, the triple I-girder would have three webs as opposed to two, which might increase costs. But the team moved forward with the triple I-girder option since the long-term savings in reduced fracture-critical inspections would offset the perceived initial cost.

Surprisingly, the design team was wrong. The fabrication cost for the triple I-girder turned out to be substantially less than the equivalent box girder, and the fabricator identified a couple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13	Tee Stem Up	MEAN DIA.	22" x $142\,^{1}/_{2}$# Tee
14	Angle Heel In	INSIDE DIA.	8" x 8" x 1" Angle
15	Angle Heel Out	OUTSIDE DIA.	8" x 8" x 1" Angle
16	Angle Heel Up	MEAN DIA.	8" x 8"x1" Angle
17	Square Tube	INSIDE DIA.	24" x $^{1}/_{2}$" Tube
18	Rectangular Tube The Easy Way (Y-Y Axis)	INSIDE DIA.	20" x 12" x $^{5}/_{8}$" Tube
19	Rectangular Tube The Hard Way (X-X Axis)	INSIDE DIA.	20" x 12" x $^{5}/_{8}$" Tube
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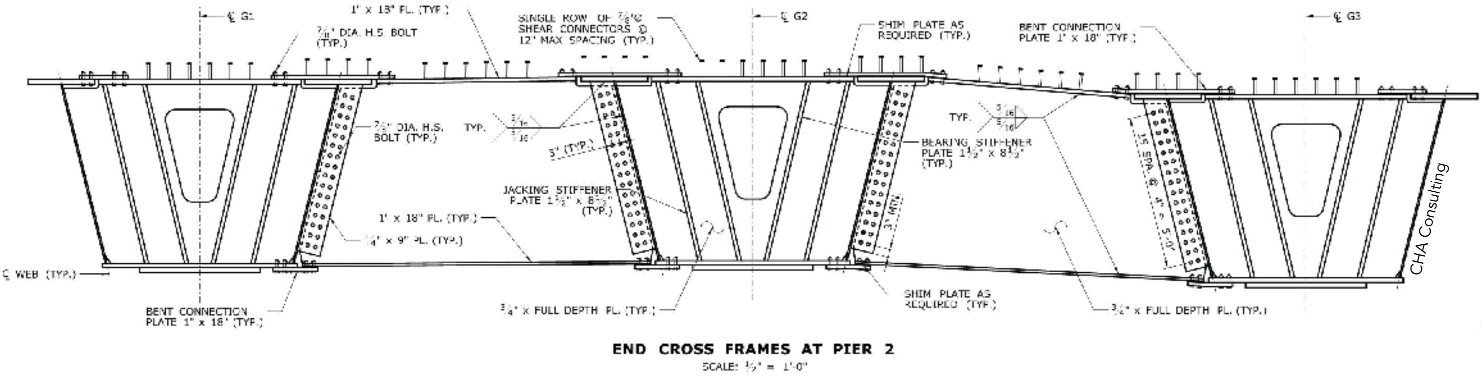

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of reasons why. Box girders typically require full-penetration groove welds between the webs and the flanges. In addition, some designers specify bolted connections for these locations to provide internal redundancy and obtain a fatigue Category B member. Groove welds and bolting can be very expensive and time-consuming to execute in the shop. Conversely, welding a web to an I-girder flange is a common shop process using conventional beam fabrication equipment, making it very cost-effective. Secondly, welding stiffeners and connection plates on the interior of a box girder is costly due to confined space work that is time-consuming and comes with increased safety risks. While the triple I-girder beams do require interior diaphragms with bolts, modern CNC machinery can quickly cut and drill the plates and holes for the diaphragm. The result of these factors is that the triple I-girder straddle bent can be as much as 50% less than the cost of an equivalent box section.

When it came to corrosion protection for the ramp's superstructure, CTDOT chose uncoated weathering steel. The department has a long history with uncoated weathering steel, dating back to the early 1960s, and recently completed a study of its performance. It found the performance of weathering steel bridges with quality details to be very impressive. In addition, some of the oldest uncoated weathering bridges are still in very good condition after more than 55 years in service, further reinforcing the state's commitment to this corrosion-protection option.

Word has spread about this design. The Texas and Georgia DOTs, two entities that traditionally use concrete straddle bents, have both agreed that the triple I-girder bent is acceptable for widespread use. In the case of the Georgia DOT, steel straddle bents were previously not even allowed for use. Their reversal on this matter is a testament to the design's significance and impact on the steel bridge industry, and these two states and others are looking to make this design a key tool in their steel bridge toolboxes.

Owner
Connecticut Department of Transportation

General Contractor
O&G/BHD, JV

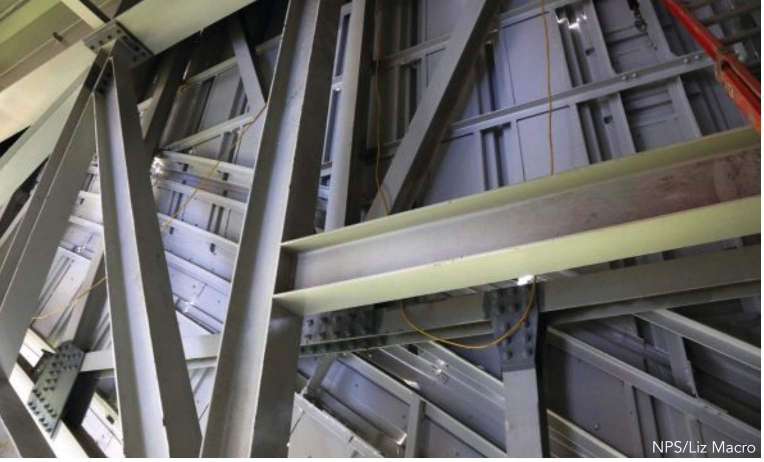
Structural Engineer
CHA Consulting, Inc.

Steel Team

Fabricator
High Steel Structures AISC CERTIFIED FABRICATOR, Lancaster, Pa.

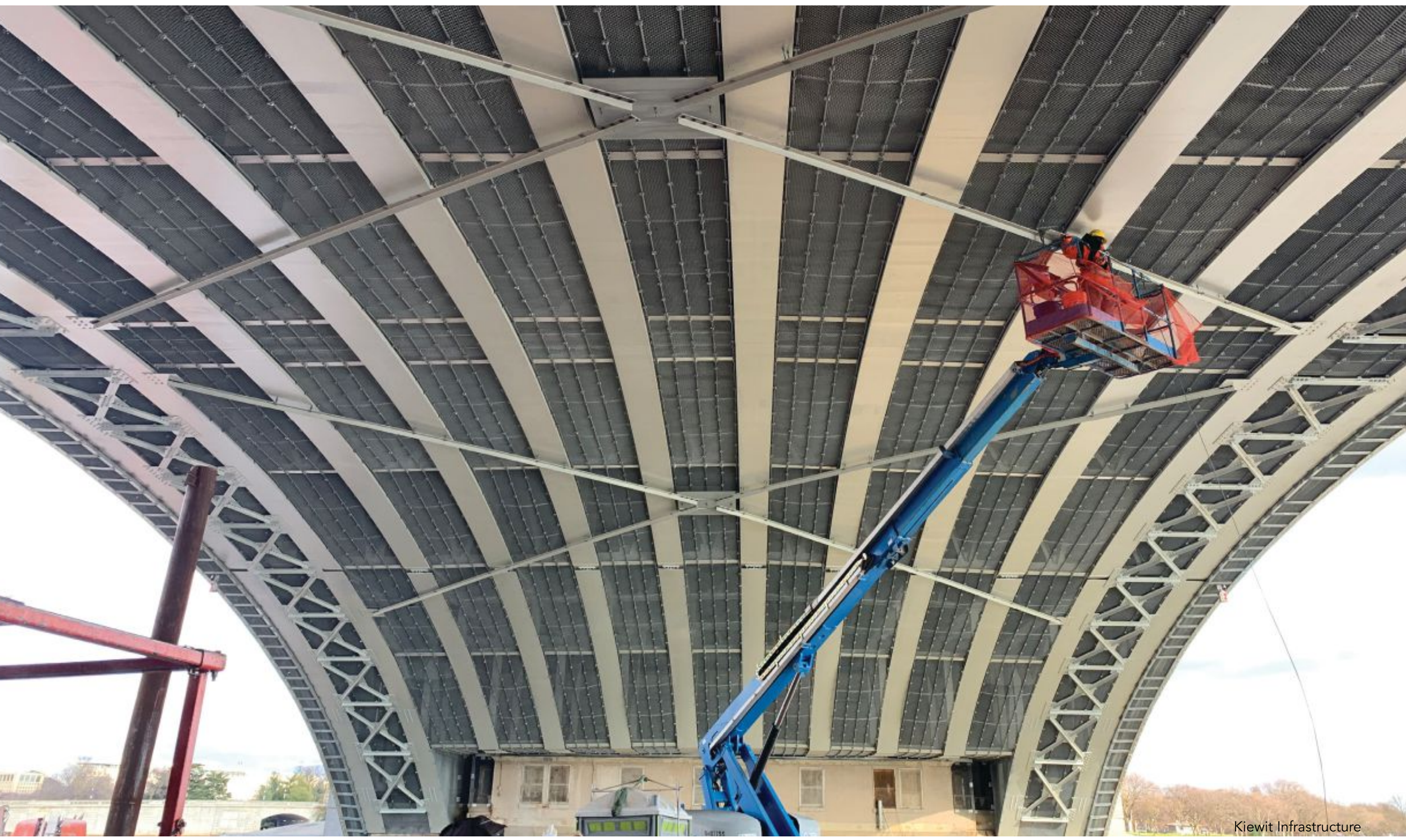
Erector
Hartland Building and Restoration Company AISC CERTIFIED FABRICATOR & ERECTOR, East Granby, Conn.

Detailer
ABS Structural Corporation AISC DETAILER, Melbourne, Fla.



NPS/Liz Macro

NPS/Jonathan Shafer



Kiewit Infrastructure

Kiewit Infrastructure

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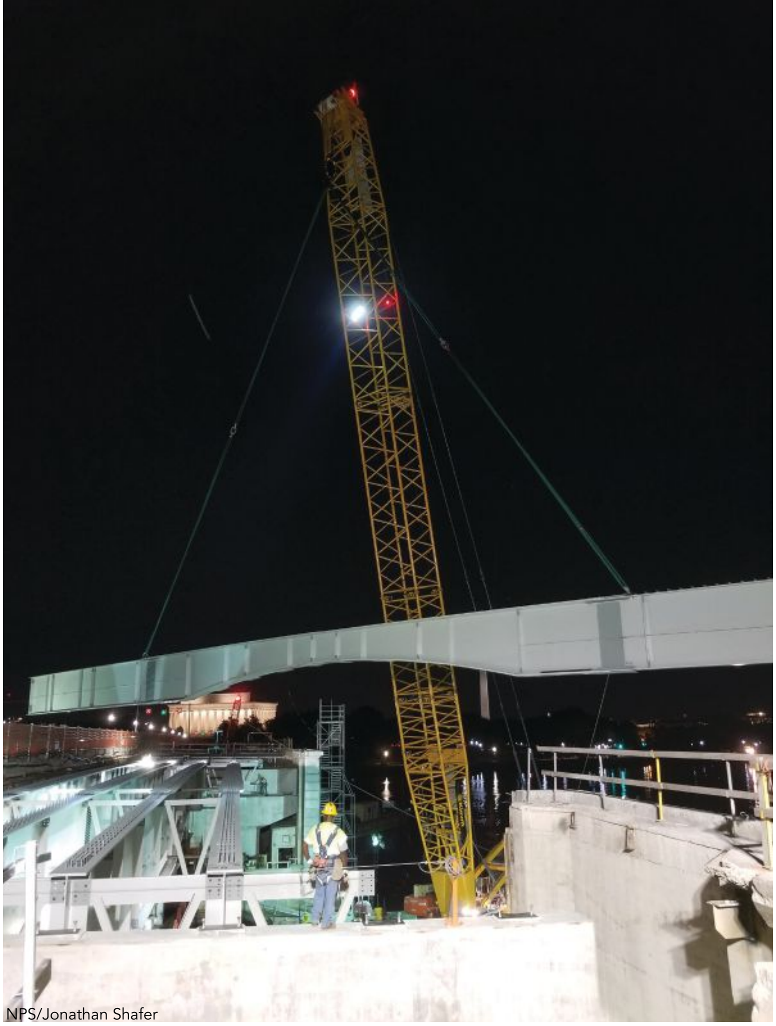


NPS/Jonathan Shafer

NPS/Jonathan Shafer

MERIT AWARD Medium Span

Arlington Memorial Bridge

Washington, D.C./Arlington County, Va.

THE STRUCTURAL REHABILITATION of Washington, D.C.'s 90-year-old Arlington Memorial Bridge was one of the largest transportation projects in National Park Service (NPS) history and gave new life to the capital's ceremonial entrance while respecting its character, history, and national significance.

A critical link in the region's transportation network used daily by over 65,000 motorists, cyclists, and pedestrians, the bridge is positioned over the Potomac River on a line of sight between Arlington House, the former home of Robert. E. Lee, located in Arlington National Cemetery, and the Lincoln Memorial, the landmark structure is both a cultural monument to the sacrifices and valor of our nation's military personnel and symbolic of the reunification of the North and South following the Civil War.

The bridge's original design comprises ten reinforced concrete arch spans and a center double-leaf steel bascule span. The Chicago-style bascule span's novel design hid the equipment, machinery, and counterweights all below deck, with each leaf concealed by ornamental pressed-metal fascia panels that were carefully designed to blend the span into the overall structure's aesthetic. The bascule span was in active operation from 1932 to 1961 and was permanently closed in the fixed position in 1965 because of a lack of marine traffic.

From 2018 to 2020, the National Park Service and Federal Highway Administration completely rehabilitated the bridge, extending its service life by 75 years. The project included replacing the historic bridge's bascule span, in which the design team paid homage to the original structure in such a way that the new span resembles the original. First established on the renderings during the environmental assessment, the new design was chosen to balance historic preservation goals with constructability, maintenance, and costs.

NPS and FHWA required a design that would protect and enhance the bridge's historic appearance across all facets of the project. Replacing the bascule span was not necessary because other fixed bridges below the Arlington Memorial Bridge prevent tall marine traffic from traveling up the Potomac River. NPS instead worked with engineers and architects to design a new

Bridge Stats

Crosses: Potomac River, George Washington Memorial Parkway, Ohio Drive SW

Span length: Main spans: 31 ft, 11.25 in., 216 ft, 31 ft, 11.25 in.

Total structure length: 2,162 ft (including concrete approach spans)

Average structure width: 94 ft

Steel weight per deck area: 0.048 tons per sq. ft (steel spans only)

Total amount of structural steel: 1,258 tons

Approximate total cost of bridge: $227,000,000

Corrosion protection: Three-coat paint system

NPS/Liz Macro

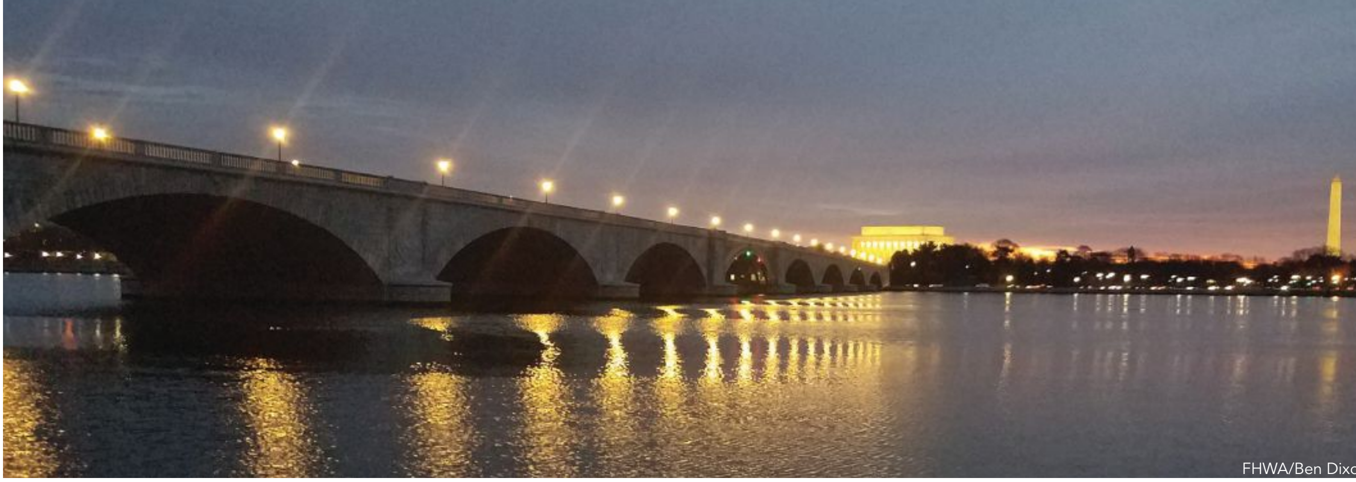
fixed steel superstructure with an under-truss structure that looked similar to the former drawbridge. The new aesthetic features fixed steel plate girders in the main span enhanced by architectural steel components to resemble the bracing in the original bascule design. In addition to the new superstructure, the original look of the span was further achieved by preserving and reusing the bridge's original pressed metal fascia panels.

The new superstructure design uses variable-depth steel plate girders, and the 216-ft-long main span's 12 girder lines feature a curve fabricated into the middle of the web and bottom flange, which fits into the arch shape of the span. The main span steel girders are connected on each end to 31-ft, 11¼-in. rolled beam (W27×84) back spans that traverse over the previous counterweight area. The main span girders were fabricated as three pieces each, then field assembled on a barge at a nearby staging area prior to erection.

The superstructure combines the use of AASHTO M270 (ASTM A709) Grade 50 and AASHTO M270 (ASTM A709) Grade HPS70W. HPS70W was used in the bottom flange (3 in. by 28 in.) in the middle field section due to the reduced depth at the main span. The steel is protected by a three-coat paint system, the color of which was chosen to closely match the bridge's granite stone. After completing structural steel erection, the architectural under-story truss was pinned to the bottom flange of the girders. Then, the restored metal fascia panels were attached to the new superstructure's facia girders using structural steel members with high-strength bolts.

The variable depth under-story truss was used to provide an aesthetic that resembled the original shape of the bascule truss-girders. The new steel superstructure, in combination with the reinstallation of the metal fascia panels, pays homage to the original aesthetic and allows the span to blend in with the adjacent concrete arch spans.

Erection work for the bascule replacement was performed from barges in the Potomac



FHWA/Ben Dixon

River, and a key challenge was maintaining three lanes of traffic on half of the bridge during construction. Since the original bascule span design consisted of edge truss girders and transverse floor beams, the floor beams required support at the center cut line. This was accomplished using an in-water shoring system in combination with a support system under the counterweights.

This support system consisted of interlocked barges, supported by a perimeter of pipe piles, with a series of shore towers supporting each floor beam. The pipe piles were fitted with a series of high-strength threaded rods/rock anchors and jacks that lifted the barges up above the waterline so that the load from the bascule span was transferred from the shore towers to the pipe piles. The temporary shoring remained in place for approximately 12 months during construction, supporting both the weight of the existing bascule steel and live traffic.

Owner
National Park Service

Primary Engineering/Construction Contract Administration
U.S. Department of Transportation
Federal Highway Administration

General Contractor
Kiewit

Structural Engineer
AECOM

Bridge Engineering Consultant
Hardesty and Hanover (bascule span)

Steel Team

Fabricator
High Steel Structures, AISC Certified Fabricator, Lancaster, Pa.

Detailer
DBM Vircon Services, AISC Detailer, Vancouver, Canada

Bender-Roller
Greiner Industries, Inc., AISC Associate, Mount Joy, Pa.

Bearing Manufacturer
Scougal Rubber, AISC Certified Fabricator, McCarran, Nev.

NATIONAL AWARD Short Span

Metro-North Railroad Bridge over Atlantic Street, Stamford, Conn.

TRAFFIC CONGESTION, railroad inefficiencies, low bridge clearance, roadway flooding, an aging bridge structure, and impacts on future economic development added up to a "perfect storm" of transportation infrastructure problems in Stamford, Conn., one of the Northeast Corridor's most heavily traveled and densely populated areas.

The replacement of the Metro-North Railroad (MNR) Bridge along the New Haven Line provided some relief. But it also came with some challenges, the most prominent being how to maintain uninterrupted train service along the primary commuter route between Connecticut and New York while replacing the five-track structure.

The bridge crosses Atlantic Street, one of Stamford's most important connectors to the downtown area. The thoroughfare is directly east of the Stamford Transportation Center, which houses the Stamford/MNR Station, the CT Transit bus station, commuter parking garages, taxi stands, and corporate shuttle facilities. Interchange access ramps to/from I-95 and multiple one-way east/west streets surround Atlantic Street in the area of the bridge, adding to congestion during peak commuter hours.

The original plate girder bridge, designed by W. H. Moore, was built in 1896. Over the years, most of the legacy railroad bridge crossings along the line have been replaced using traditional construction methods and staged construction, and Atlantic Street and its adjacent crossings within Stamford are the last on the line in Connecticut to be replaced. Incorporating accelerated bridge construction (ABC) techniques provided the confidence that the bridge could be replaced without creating major long-term reductions in service for all commuters. By combining these techniques with careful planning, the bridge was demolished and replaced over a nine-day span without disruption to train service.

The project involved the off-site construction of the new replacement bridge elements, construction of retaining walls to accommodate the future Track #7 and platform for local train service, and widening of Atlantic Street to accommodate new pedestrian walkways, bike lanes, and three northbound and three southbound lanes. Atlantic Street was lowered to increase bridge clearance to 14 ft, 6 in. to allow emergency and commercial vehicular travel. The roadway underpass was reopened to vehicles and pedestrians in a matter of months, whereas traditional construction would have caused years of service disruptions.

The permanent superstructure was divided into three sets of two spans, each carrying two tracks over the permanent structure. "Jump spans" (short temporary spans) were installed in the railroad embankment behind each of the original bridge abutments. These spans were framed with steel beams and supported on steel-encased micro-piles. With the spans in place, the railroad embankment was excavated and the new abutments were constructed beneath live rail traffic. Concurrently, each 700-ton span (750 tons with added ballast) of the new superstructure was constructed off-site at separate assembly areas north and south of the existing bridge. Over a nine-day period, the existing bridge was demolished and the new superstructure rolled in using self-propelled modular transporters (SPMTs). At least two tracks of rail traffic were maintained at all times during the roll-in.

Construction of the center pier also benefitted from an ABC mindset. While the micro-pile-supported, cast-in-place pier footing could be constructed ahead of time, the columns could not be installed until after the existing bridge was demolished. The columns would also be subjected to heavy loads from the superstructure and railroad almost immediately after installation. Steel plate columns were chosen since precast concrete columns would have required cure time for splice sleeves—time that was not available during the nine-day roll-in period. The steel columns were designed with bolted connections that doubled as leveling bolts, allowing vertical adjustment and plumbing of the columns to account for construction tolerances.

While replacing railroad bridges using SPMTs or other ABC techniques has become more common, the "bottleneck" location of the bridge within the line's busiest interlock and in proximity to MNR's Stamford Storage Yard presented its own challenges. Accommodating the traveling public on I-95, city roadways, and the railroad, including pedestrians and bicyclists, required innovations that considered the specific transportation needs of each affected group. Conventional construction techniques would have required more extensive closures and service disruptions. MNR operational impacts were of importance as more than 300 trains pass over Atlantic Street each day, and the bridge is located inside a critical interlock at CP 234, which contains five separate track crossovers between Stamford Station and the Stamford Storage Yard or ten individual switch tracks. These crossovers allow the railroad to control traffic in and out of the station. With operational capacity reaching limits during peak hours, each track out of service would restrict rail operations and limit access to the Stamford Storage Yard just east of the project limits. The project was required to maintain uninterrupted service during all phases of construction, including the bridge demolition and replacement stages.

Solutions focused heavily on planning the most invasive operations for periods of reduced usage, scheduling temporary construction to allow train service to operate during foundation and substructure work, and using off-site and on-site precast components to reduce assembly times. The project worked with railroad staff to identify periods of historically lower ridership, which has traditionally been the week of July 4, when ridership is about 25% lower than other times of the year. The nine-day period surrounding a midweek July 4, 2019, holiday was chosen years in advance of the actual bridge roll-in.

Owner
Connecticut Department of Transportation

Structural Engineer
AECOM

Construction Engineering/Inspection Consultant
Atane Consulting

Steel Team

Fabricator
STS Steel, Inc., AISC CERTIFIED FABRICATOR, Schenectady, N.Y.

Bearing Manufacturer
R.J. Watson, Inc., AISC CERTIFIED FABRICATOR, Alden, N.Y.

Bridge Stats

Span lengths: 70 ft – 70 ft

Total structure length: 146 ft 9⅛ in.

Average structure width: 77 ft 3 in.

Steel weight per deck area: 0.16 tons per sq. ft (superstructure), 0.165 tons per sq. ft (total)

Total amount of structural steel: 1,785 tons in superstructure, 61 tons in pier plate columns

Approximate total cost of bridge: $48,069,356

Corrosion protection: Hot-dip galvanized

All photos: CTDOT

NATIONAL AWARD Rehabilitation

Baker's Haulover Cut Bridge Rehabilitation, Bal Harbour, Fla.

THE BAKER'S HAULOVER CUT BRIDGE is set to live its (next) best life.

Originally constructed in 1948 and previously rehabilitated in 1992 and 2000, it underwent another rehabilitation recently, with a goal of minimizing future maintenance, project cost, and impacts on a highly used roadway linking Miami Beach and the affluent Bal Harbour neighborhood to northern Miami-Dade County over Haulover Cut. The waterway provides access to and from the Atlantic Ocean from the Atlantic Intracoastal Waterway and sits at a location favored by recreational boaters.

The 13-span, 1,255-ft-long bridge, which consists of nine haunched steel riveted girder floor beam main spans and four steel multi-beam approach spans, carries four lanes of traffic, two in each direction. Rehabilitation work included steel repairs and selected member replacement, main span bearing replacement, selected replacement of approach span bearings, concrete repairs, seawall replacement, and painting of all structural steel.

The project came with several challenges from multiple directions. For starters, the road that the bridge carries, SR-A1A/Collins Avenue, is the only north-south thoroughfare running up the barrier islands that are separated from the mainland by the Atlantic Intracoastal Waterway. Any detour of the heavy vehicular, bicycle, and pedestrian traffic would have significant impacts on the overall congested traffic network of Miami-Dade County. Secondly, Baker's Haulover Cut is a major outlet from the protected waters of the Atlantic Intracoastal Waterway to the Atlantic Ocean. It is the primary route for sport fishing and pleasure craft from dockage to the ocean in the northern half of Miami-Dade County, and reduction of vertical clearance in the main channel between bridge fenders was not allowed by the U.S. Coast Guard. Also, water currents through the cut are significant during the majority of the day, making in-water work difficult in all but short periods of slack tide each day.

In addition, the bridge carries infrastructure for eight different utilities, including electric transmission and distribution lines, a water main, cable television, and gas. The electric transmission line, in particular, was vital to the service provided to the affluent Bal Harbour neighborhood on the south side of the bridge, as the electrical network could not put that line out of service and still provide power to the residents, hotels, and other businesses in the area. Therefore, jacking the bridge to replace the bearings and repairing and painting the bridge near these elements would be tricky. Finally, seawall replacement within the Florida DOT (FDOT) right-of-way had been completed adjacent to existing seawalls at both shorelines. At the south shore, a beach and access road for the neighboring hotel needed to be maintained directly adjacent to the seawall, and any settlement of that roadway could not be tolerated. And at the north shore, an electric power facility just north of the seawall extended into the FDOT right-of-way such that care needed to be taken to ensure no damage to that facility. At both shorelines, any repairs for the portions of the walls under the bridge needed to be able to performed with limited available headroom.

As a project funded with bridge maintenance dollars, it was important that the work be done within the construction funds budgeted by the FDOT. In order to tailor the design scope to the available funding and be as cost-effective as possible, a thorough inspection of the bridge was completed to ascertain conditions and take field measurements, and a full list of needed work was prepared, in order of importance, to address deterioration that reduced the safety and capacity of the bridge, and then work items were pulled from that list to fit the project budget.

In order to determine the deteriorated areas that needed repair on the steel members to improve capacity and to determine the need to maintain the three-span continuous girder-floor-beam-stringer spans bottom flange bracing, which had widespread losses, a complex finite element analysis (FEA) model was prepared in order to analyze these spans. Structural repairs included adding bottom flange cover plates to the floor beams to provide necessary increases in member capacity and girder web repairs at selected gusset plate locations where holes and section loss were present. The analysis results allowed the design team to effectively identify discrete areas that required repair and determine that the bracing was not required. In consultation with FDOT, it was decided that only bracing members with significant section loss and that had the potential to fall from the bridge would be removed. This decision removed more than $1 million from the construction budget, and the remaining bracing was left in place, cleaned, and painted.

Replacing the girder bearings on the three-span continuous steel spans posed its own set of challenges. The existing piers were not much larger than the masonry plates the bearings sat on, so there was no straightforward way to install temporary jacking assemblies under the girder flanges. Jacking the bridge from the floor beams was not possible due to load capacity issues and conflicts with the utilities mounted on the bridge, and a conventional system of jacking towers would have been very difficult to construct in the fast-moving waters of the Haulover Cut. As a result, the contractor proposed jacking the span at each pier using a very stiff saddle that rested on the pier cap between the girders and extended out from the caps and under the girder lines. An equal-displacement jacking system was used to

Bridge Stats

Crosses: Baker's Haulover Cut

Span length:
- Span 1: 50 ft, 2 in.
- Spans 2 and 3: 49 ft, 11¼ in.
- Span 4: 5 ft, 4 in.
- Spans 5 through 7 total: (three-span continuous unit) 351 ft, 5⅜ in.
- Spans 8 through 10 total: (three-span continuous unit) 351 ft ,9⅝ in.
- Spans 11 thru 13 total: (three-span continuous unit) 351 ft, 2⅜ in.

Total structure length: 1,255 ft

Average structure width: 70 ft, 6 in.

Steel weight per deck area: 0.02057 tons per sq. ft

Total amount of structural steel: 1,447 tons

Approximate total cost of bridge: $8,900,000

Corrosion protection: Organic zinc-rich epoxy primer, polyamide epoxy intermediate coat, aliphatic polyurethane appearance coat, and UV-resistant clear finish coat


Courtesy of Bolton Perez

ensure even jacking of the span to avoid racking that could cause deck damage. The FEA model allowed the team to accurately estimate the jacking loads and determine the potential stresses in the top of the deck when a single bearing line was jacked. It also confirmed that jacking the bridge one pier at a time, and not the entire three-span unit at once, was feasible and would not cause unwanted damage.

In order to minimize traffic impacts, these jacking events were scheduled at night in 15-minute durations when traffic loads weren't on the bridge. Local law enforcement was used to block the bridge ends when the contractor had all equipment ready, then the bridge was raised ¼ in., enough for the existing bearing to be slid out. Once the span was shimmed and the load on the jacks released, traffic reopened.

The piers exhibited cracking and spalling near the bridge bearings due to the existing bearings being partially frozen and not adequately accommodating the movement of the superstructure. The old steel fixed and roller bearings on the continuous spans were replaced with high-load multi-rotational (HLMR) bearings in order to accommodate rotational deflections and expansion and contraction in both directions. The new bearings were much shorter than the existing ones, so new pedestals were required to be poured. Base plates were designed so that the new anchor rods could be drilled and grouted into the pier cap prior to jacking the bridge due to inadequate headroom for drilling equipment if jacking was done through the pedestal. The anchor rods were terminated with couplers at the pier cap level so that the pedestals could be formed and poured with the anchor bolt extensions in place once the old bearing had been removed.

As work proceeded, the team worked closely with the construction inspectors when previously inaccessible areas revealed locations with advanced section loss. Members were analyzed to determine adequacy as section losses were discovered by the construction inspectors. In most cases, the members were found to be adequate, which eliminated the need for extra work or change orders.

The bridge bulkheads had significant deterioration caused by constant exposure to the extremely aggressive coastal environment. Fill was eroding through the open joints of the concrete sheet pile walls, causing large settled areas behind the cap. In order to replace the wall within FDOT right-of-way, temporary construction easements were obtained to install temporary sheet piling on adjacent properties to avoid damage, and the area in front of the wall was cordoned off with temporary sheet piling to minimize water current and tidal impacts to the wall during construction. The existing sheet pile wall with deadmen was removed, and new steel sheet piles were installed with sheet pile deadmen, with the concrete facing strengthened with glass fiber reinforced polymer (GFRP) rebar to provide protection for the sheet piling and provide a uniform appearance with the adjacent walls. The facing extended 3 ft below the channel bottom to provide long-term protection for the steel sheet piling, with minimal future maintenance anticipated since nonmetallic reinforcement was used in the concrete facing.

The bridge work required careful coordination with utility agencies to ensure that repairs, span jacking, and painting operations did not create problems or damage the utility infrastructure. The electric utility removed its facilities from the bridge, relocating them using a directional bore, well below the channel bottom. For the other utilities, hangers were lowered slightly to accommodate

Courtesy of Bolton Perez

Copyright Alex Menendez/Courtesy of TranSystems

superstructure jacking operations. Abandoned utilities were removed from the bridge prior to cleaning and painting.

The south side of the bridge is located in a parking area maintained by the town of Bal Harbour and also provides the only access to and from the hotels and condominiums in the area—and access could not be closed off at any time. Construction was organized in six phases to facilitate traffic flow through the still-open section of parking. This allowed the contractor to use closed parking in sections in order to repair and install containment for cleaning and painting. Existing pavers in areas where work below-ground was to take place were carefully removed and stored for restoration at the end of construction. This was done to avoid color differences between any new lots of pavers that would have been required to be purchased.

Owner
Florida Department of Transportation, District 6

General Contractor
Kiewit Infrastructure South Co.

Structural Engineers
TranSystems
Colliers Engineering and Design

MERIT AWARD Rehabilitation

Hernando de Soto Bridge

Memphis, Tenn./ West Memphis, Ark.

ON MAY 11, 2021, a partial fracture of a tie girder on the arch span of the Hernando de Soto Bridge over the Mississippi River between Memphis and West Memphis, Ark., was discovered during a fracture-critical inspection, requiring immediate closure of highway and river traffic.

The challenge was to stabilize the bridge and have construction crews safely repair it to allow traffic to resume. The team used a three-phase approach and conducted nondestructive testing on all tie girder welds to determine other locations for retrofit while the first two phases were ongoing. The three phases were stabilization, member repair, and overall tie girder repair, with the design and construction of each overlapping. This required the collaboration of two owners, two engineers, a contractor, and multiple fabricators. All parties adjusted the approach to meet daily needs and changing conditions. Activities progressed 24 hours a day, supported by extended shifts, for several weeks, and the bridge reopened in just 83 days.

Design, fabrication, and construction were all-day efforts. The design of stabilization repairs was completed within days of testing, then fabrication and construction commenced immediately. The project included three fabricators providing steel, all synced to the contractor's schedule, and the design was tailored for materials available "on the floor" from shops that had advised on the best materials to aid with efficiency. There were no significant RFIs, a testament to design quality and fabricated structural steel.

To reduce the costly closure time, repair plans were designed around available materials. Michael Baker worked with NSBA and the fabricators to locate the HPS70 steel to replace 100-ksi material for Phase 1 and Phase 2 repairs. Simplifying the bolted splice details and the use of high-performance steel led to efficient fabrication and erection, resulting in the shortened closure, and similar details were repeated during Phase 3 repairs to other identified locations in the bridge.

Owners

Tennessee Department of Transportation
Arkansas Department of Transportation

General Contractor

Kiewit Infrastructure South Co.

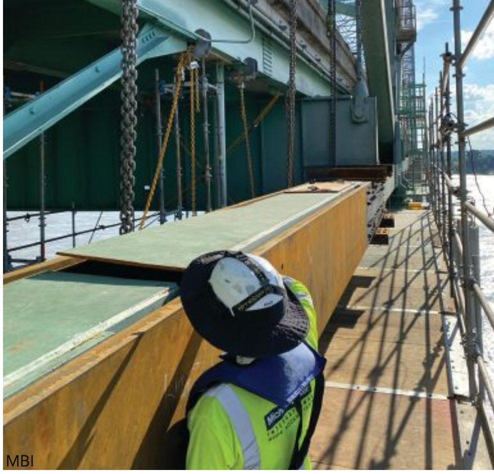
Structural Engineer

Michael Baker International, Inc.

Steel Fabricators and Detailers

W&W | AFCO Steel AISC CERTIFIED FABRICATOR Little Rock
Stupp Bridge Company AISC CERTIFIED FABRICATOR Bowling Green, Ky.


TDOT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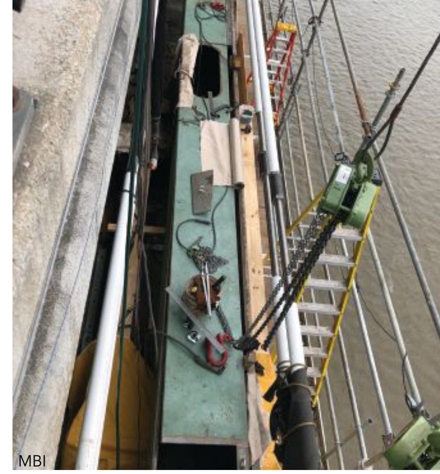

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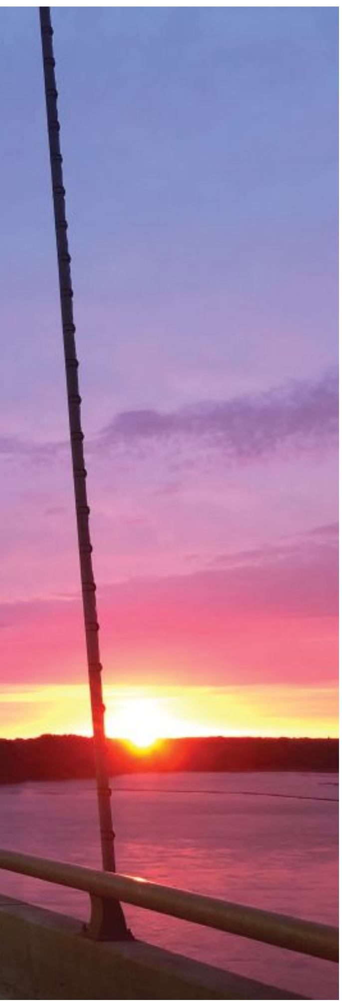
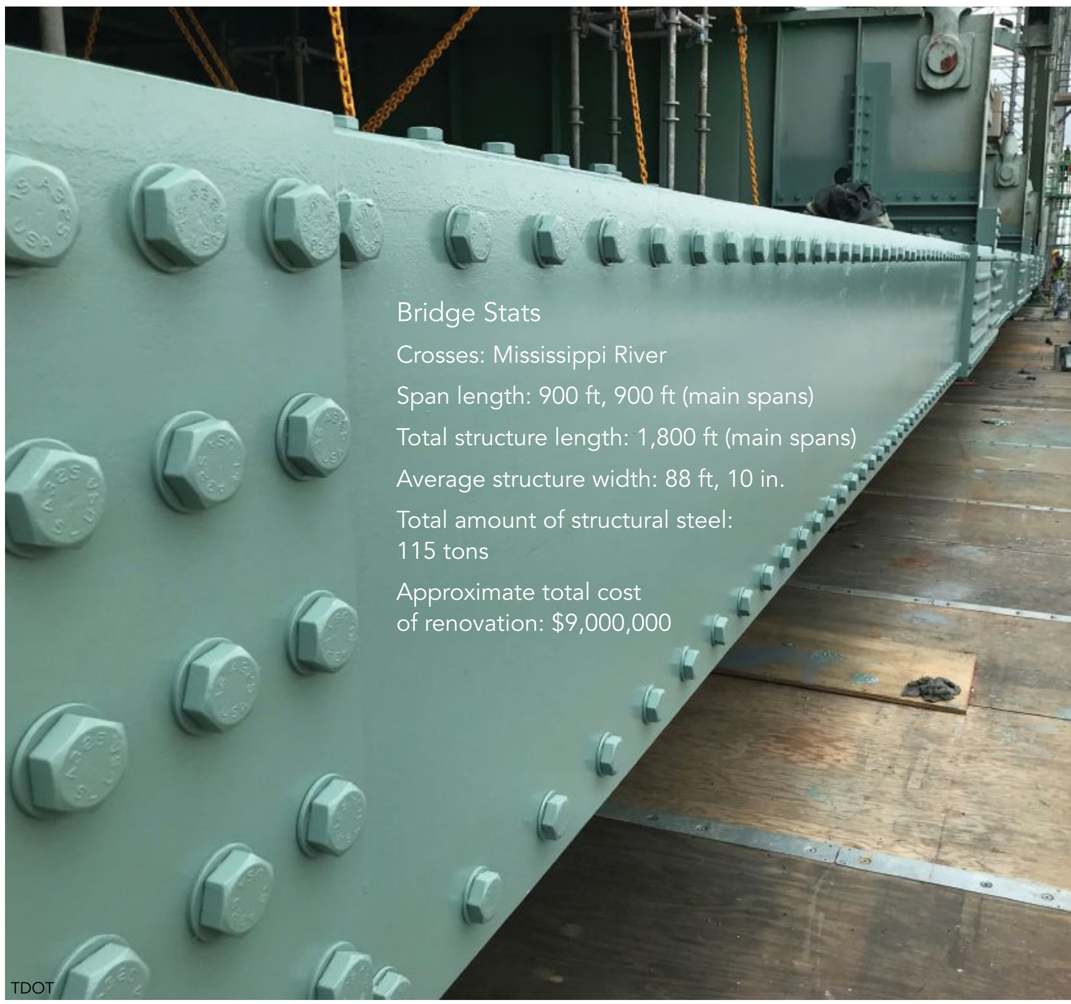




Bridge Stats

Crosses: Mississippi River

Span length: 900 ft, 900 ft (main spans)

Total structure length: 1,800 ft (main spans)

Average structure width: 88 ft, 10 in.

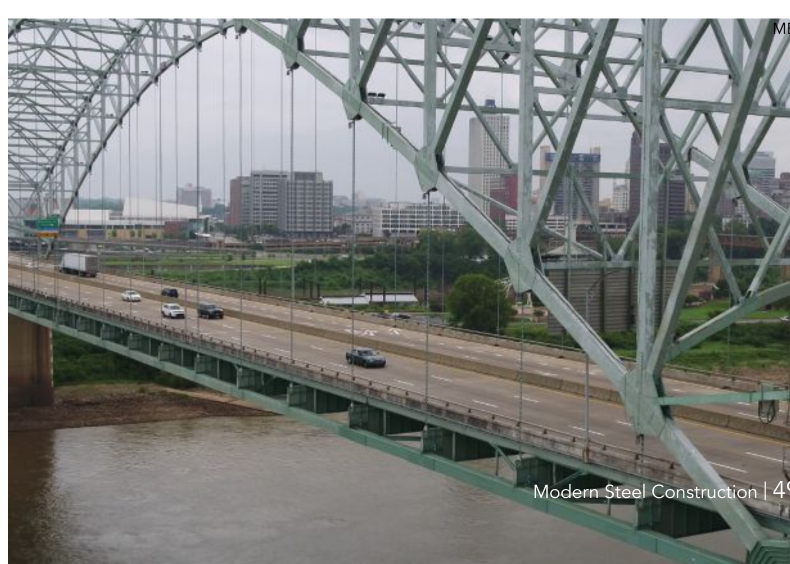
Total amount of structural steel:
115 tons

Approximate total cost
of renovation: $9,000,000

TDOT

W&W | AFCO Steel

TDOT



MBI


HDR


HDR

HDR

NATIONAL AWARD Special Purpose

Green Street Pedestrian Bridge, Winston-Salem, N.C.

THE NEW GREEN STREET PEDESTRIAN AND BICYCLE BRIDGE is a unique multi-ribbed, unbraced, tied-arch structure spanning the newly reconstructed Salem Parkway.

Located in the downtown area of Winston-Salem, N.C., it reconnects the West Salem neighborhood with the city's multi-use path, a nearby baseball stadium, and new developments planned for the area. The arching structure serves as an artful, iconic gateway into downtown that inspires economic development and symbolizes Winston-Salem's 21st-century aspirations.

The North Carolina Department of Transportation (NCDOT), along with Winston-Salem's Creative Corridors Coalition, provided a bridge concept and aesthetic requirements. Without a design precedent to rely upon, the team took the aesthetic vision and transformed it into a viable design. The team collaborated with stakeholders and the City's Creative Corridors Design Review Committee to understand and meet expectations on the bridge's unique features, including geometries, arch shape, hanger rod arrangement, and connection details.

The 32-ft-tall pair of inner arches incline 13° outward from a vertical plane and primarily carry the bridge's dead load. The lower pair of outer arches reach a height of 16 ft and incline 30° outward, supporting pedestrian live loading while carrying a smaller portion of the dead load. Each rib contributing to the overall bridge structure's primary load path required a strategic design approach and a multi-phased staged structural analysis.

Cambered 6 in. at mid-span, the gently-curving bridge deck is supported by a series of radially aligned, stainless-steel hanger rods—nine hanger rods to each arch rib for a total of 36 hangers. For each arch, the plane of the hanger rod group is offset from the centerline plane of the arch rib to provide a constant deck cross section and avoid outriggers. This approach improves the structural stability of the unbraced arch ribs by providing a restoring force against the outward torsional tendency of the ribs' self-weight. Shop-welded upper gusset plates are aligned longitudinally along each steel arch rib and connect the high-strength stainless steel hanger rods to the arches using forks and spherical bearing assemblies. Embedded at the deck level, gusset/base plate anchorages accommodate the dual arch rib configuration. These hanger anchorages uniformly align along each of the bridge's concrete edge beams and provide connection points for the stainless-steel hanger rods between the arch ribs and the bridge deck through forks and spherical bearing assemblies.

The bridge also employs concrete pilasters aligned to accommodate the varying arch rib base plates, which anchor to the pilasters through tension rods. The pilasters were critical aspects since all the arch ribs terminated at this location to tie the deck and foundations

NCDOT

HDR

together. The unique pilaster geometry was driven by the arch rib geometry and the need to simplify steel fabrication at the base plate ends. The pilaster became a geometric nexus that accommodated a wide range of complex geometries, force transfer, and anchor rod alignments in a central location. Combining augmented reality, real-time 3D model viewing, and even a 3D printed model, the team achieved stronger design communication.

HDR's structural engineer developed a powerful centralized parametric bridge design model that was leveraged to balance geometric complexity and design risk and improve confidence in the structural concept. The parametric model allowed for early insights into the structure that would not have been possible any other way due to the geometric complexity and direct influence on design elements. By automating structural models, the team could explore, evaluate, and optimize structural design aspects in ways never previously achieved. The model was beneficial in the staged analysis of the structure and proved to be an efficient way to understand the behavior of the different unique bridge elements and effectively generate production data.

Leveraging state-of-the-art structural engineering tools, signature bridge expertise, and strong technical collaboration between multiple stakeholders, the Green Street Pedestrian Bridge's design tackled aesthetically driven complexities and constructability implications head-on. The team delivered the client's vision through a design that employed structural innovation and ingenuity by leveraging a centralized parametric design approach, expertise, collaboration, and a drive towards practicality for construction.

Owner
City of Winston-Salem

General Contractor
Flatiron Corp.

Structural Engineer
HDR

Steel Team

Fabricator
King Fabrication LLC (AISC Certified Fabricator)
Houston

Bender-Roller
Bendco (AISC Associate), Pasadena, Texas

MERIT AWARD Special Purpose

Dublin Link Pedestrian Bridge

Dublin, Ohio

THE DUBLIN LINK presents an iconic form while simultaneously evoking a feeling of weightlessness for pedestrians and cyclists as they cross above the Scioto River riparian corridor.

In addition to tying together the eastern and western sides of Dublin, Ohio, it is a destination in its own right. The formal aesthetic and structural methods were developed simultaneously to create a single coherent vision. The resulting sinuously curving, structurally unique suspension bridge binds together cultural and economic additions to the city, including a new public library, a dramatic riverbank park, and multiple new entertainment, retail, and office projects at both ends. The structurally innovative locus for the city's ambitious program of urban renewal is also the longest S-curve single-side suspension bridge in the world.

The Scioto River bisects the town, causing a shift in the urban fabric from east to west. The offset between Bridge Park Avenue and West North Street became the impetus for the bridge's S shape. This form has its historical precedent in the S-bridges used to efficiently cross streams in eastern Ohio during the construction of the National Road in the early 19th Century.

The sculptural form is rooted in stress-shaping operations and optimization, and the bridge is supported by an expressive central eye-of-the-needle pylon that the bridge deck passes through, conceptualized as the gateway between the historic town center and the newly developed mixed-use district on the east bank. This central pylon aligns with the main cable at the top, twists down to the eye-of-the-needle (which is perpendicular to the steel bridge deck), and continues twisting to minimize drag and scour from the river at the flood stage.

The triangular steel box girder also morphs throughout the main span, and the single-side stay-cable attachment points shift in order to align the stay cable line of action with the cross-section's shear center. This minimizes the induced torsion in the box-girder. Any incidental torsion is resolved by balancing each side of the S-curve across the central pylon support.

Bridge Stats

Crosses: Scioto River

Span length: Four 65-ft-long approach spans, 500-ft-long suspension span

Total structure length: 760 ft

Average structure width: 14 ft

Steel weight per deck area: 0.04 tons per sq. ft

Total amount of structural steel: 412 tons

Approximate total cost of bridge: $23,000,000

Corrosion protection: Organic zinc-rich primer, epoxy intermediate coat, and top coat

Cory Klein/City of Dublin

Cory Klein

Endrestudio

Cory Klein/City of Dublin

Cory Klein

Because of the lightness and slenderness of the bridge deck, it was critical to have horizontal vibration controls. A combination of tuned mass dampers in the bridge transition zones and a pendulum-tuned damper at the main cable termination point created significant damping of the structure.

Lateral vortex shedding was also found to be a potential problem during wind-tunnel testing. The addition of an inverted vane helped to stabilize the bridge from wind-induced vibrations and also provided a natural place to run deck lighting to highlight the underside of the bridge deck.

The complexity and required precision of the central tower for both aesthetics and structural performance posed one of the biggest challenges to construction. Hundreds of precisely milled CNC form inserts were created from the digital model and installed in a reusable outer form. The design team used the model to precisely lay out every piece of rebar for the central tower and speed up placement during construction. The contractor developed its own model independently, which was compared directly to the design team's model as part of the quality control program.

In addition to the integrated modeling, significant sequencing coordination was required between the assembly of the prefabricated steel box girder sections, the site works for the approach spans and the central pylon, and the routing of electrical and communication lines through the triangular section of the bridge. The fully locked main cable and shifting attachment points of the stay cables also demanded an exceptional level of precision in the erection and finishing of the iconic bridge.

The Dublin Link was designed to be an icon. From the initial competition to its final completion, each aspect of the bridge was conceived simultaneously as a sculptural form, an elegantly efficient structure, and a surprising, dramatic experience for visitors and residents alike. ■

Owner
City of Dublin, Ohio

General Contractor
Kokosing Construction Company, Inc.

Architect/Design Engineer
Endrestudio

Structural Engineer
T.Y. Lin International

Steel Team

Fabricator and Erector
Tampa Steel Erecting, Tampa, Fla.

Detailer
Tensor Engineering Co.,
Indian Harbour Beach, Fla.

Bearing Manufacturer
R.J. Watson, Inc., Alden, N.Y.