NSBA 2016 Prize Bridge Awards

THE COUNTRY'S BEST STEEL BRIDGES have been honored in this year's Prize Bridge Awards competition. Conducted every two years by the National Steel Bridge Alliance (NSBA), the program honors outstanding and innovative steel bridges constructed in the U.S. The awards are presented in several categories: major span, long span, medium span, short span, movable span, reconstructed, special purpose, accelerated bridge construction and sustainability. This year's 16 winners, divided into Prize and Merit winners, range from a mammoth marquee Mississippi River crossing to the country's first steel extradosed bridge. Winning bridge projects were selected based on innovation, aesthetics and design and engineering solutions, by a jury of five bridge professionals.

This year's competition included a variety of bridge structure types and construction methods. All structures were required to have opened to traffic between May 1, 2013 and September 30, 2015.

The competition originated in 1928, with the Sixth Street Bridge in Pittsburgh taking first place, and over the years more than 300 bridges have won in a variety of categories. Between 1928 and 1977, the Prize Bridge Competition was held annually, and since then has been held every other year, with the winners being announced at NSBA's World Steel Bridge Symposium. The following pages highlight this year's winners. Congratulations to all of the winning teams!

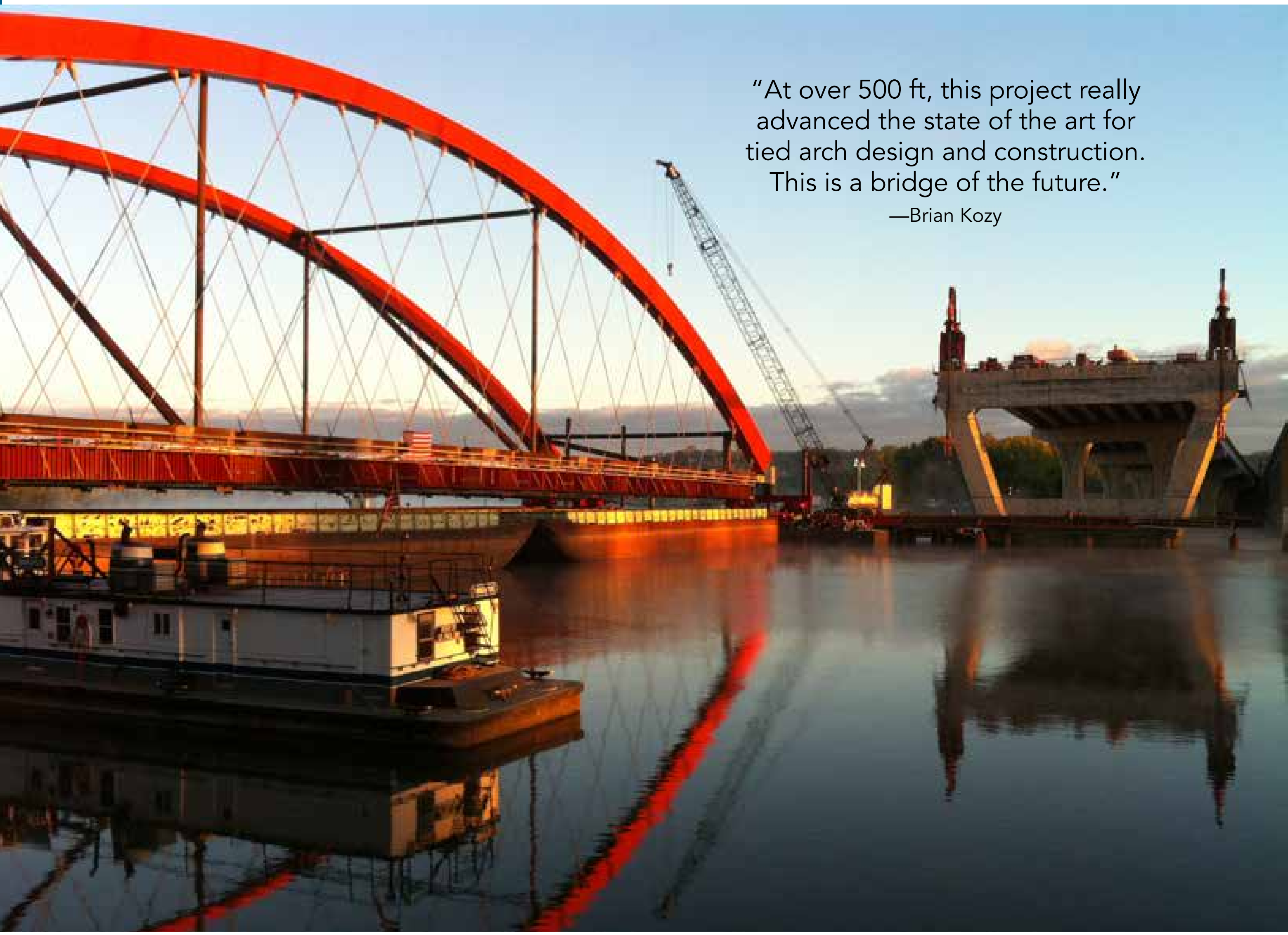
And check out past winners in the NSBA archives at **www.steelbridges.org**.

2016 Prize Bridge Awards Jury

- **David Spires**, P.E.
  Senior Engineering Manager with WSP Parsons Brinckerhoff
- **Michael Culmo**, P.E.
  Vice President of Transportation and Structures with CME Engineering
- **Brian Kozy**, P.E., Ph.D.
  Structural Engineering Division Team Leader with FHWA
- **Steve Jacobi**, P.E.
  State Bridge Engineer for the Oklahoma Department of Transportation
- **Carmen Swanwick**, S.E.
  Chief Structural Engineer for the Utah Department of Transportation

PRIZE WINNER: MAJOR SPAN

Hastings Bridge, Hastings, Minn.



"At over 500 ft, this project really advanced the state of the art for tied arch design and construction. This is a bridge of the future."

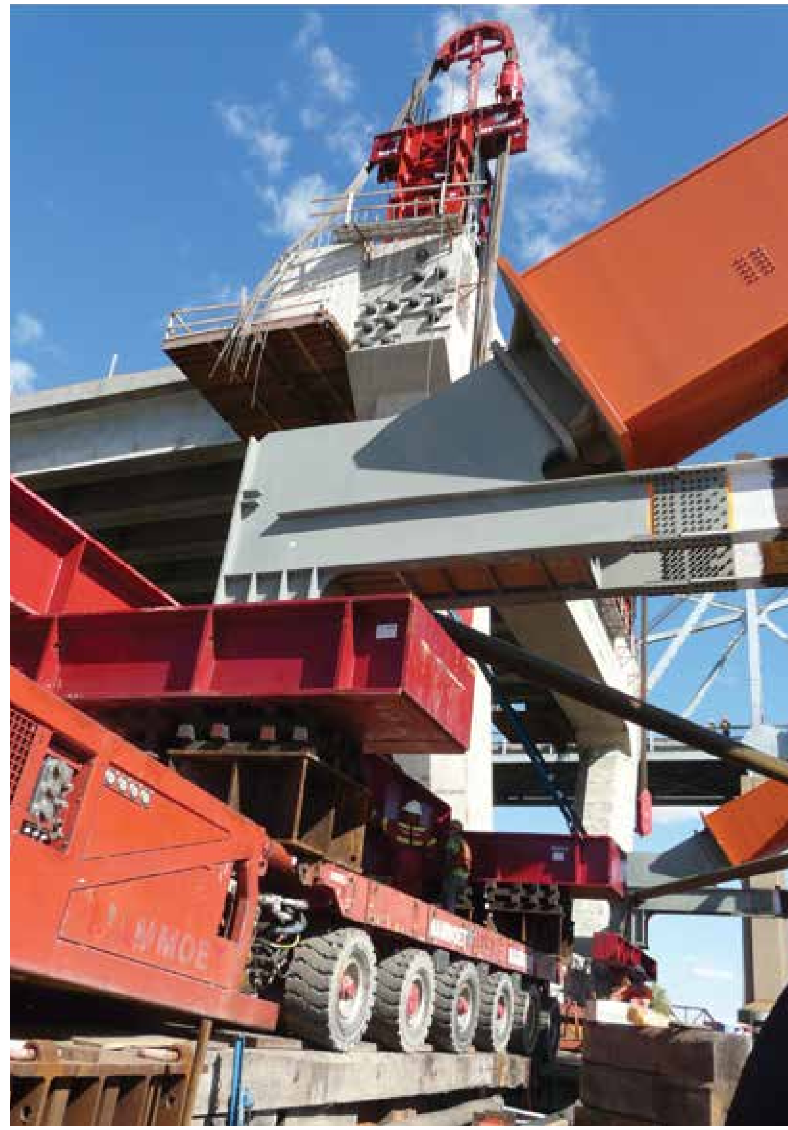
—Brian Kozy

THE HASTINGS BRIDGE over the Mississippi River in Hastings, Minn., is a record-breaker.

Built as a replacement for the functionally obsolete Hastings High Bridge (built in 1950), the new 1,938-ft-long bridge—with a 545-ft main span—is the longest freestanding tied-arch bridge in North America. The overall project was accelerated through MnDOT's Chapter 152 Bridge Improvement Program following the I-35W bridge collapse. MnDOT identified this route as critical to the mobility and commerce of Minnesota because it carried the highest daily traffic volume of any two-lane trunk highway in the state.

The bridge was constructed using design-build procurement and required accelerated bridge construction (ABC) technology to meet the demanding schedule and limit impacts on the travelling public. The tied-arch structural system is comprised of two freestanding vertical structural steel arch ribs with trapezoidal cross sections and variable depth. Post-tensioning steel strands were used to resist the arch thrust and encased in cast-in-place concrete tie girders and knuckles. The structural steel floor system consists of a grid of floor beams, full-depth longitudinal stringers and secondary longitudinal stringers all made composite with a cast-in-place concrete deck. The knuckles and deck are integral with the piers, creating a fully framed system. A network of structural strand hangers is used to suspend the floor system from the arch ribs.

All structural tension members are load-path redundant for fracture at any point in a single member or connection subject to tension under permanent loads and vehicular live load. Consequently, there are no fracture-critical bridge elements on the structure. The structure was analyzed for fracture of all tension members using a 3D time-history analysis to determine appropriate dynamic effects. The transverse floor beams and full-depth longitudinal stringers form a grid floor system, which allows load transferring in both the longitudinal and the transverse directions. This structural steel grid forms a redundant system with the primary load path through the transverse floor beams. The full-depth longitudinal stringers provide multiple supports, which minimize



deflections from the potential fracture of a floor beam and significantly reduce the resulting fracture energy release and dynamic impact.

The design-build team determined very early that the traditional methods of erecting the arch off-site on high towers and floating it in over the piers was too risky due to the high center of gravity and variability of river water elevations, which could delay move-in. Therefore, the team elected to erect the arch on land, transfer it onto barges with self-propelled modular transporters (SPMTs), float it in low, position it between the piers using a skid rail system and lift it into place with strand jacks on top of the piers.

The steel floor beams and longitudinal stringers were erected on land in the staging area by the river bank with temporary supports. A temporary tension tie system, consisting of two W36 sections to resist the thrust of each arch rib, was used to facilitate the erection and served to stabilize the floor system and support the formwork for the cast-in-place tie girder. A steel lifting connection served as a temporary knuckle connecting the arch rib with the temporary tie. Finally, the hangers were installed between the arch rib and the ends of each floor beam. The arch ribs were braced during erection, and the entire system was framed using the temporary rib bracing, floor system and the lower lateral bracing system.

After completing the steel member erection on land, eight 16-axle SPMTs were brought in and situated with two under each of the corners of the arch system. The vertical lifting ability of the SPMTs was used to lift each of the four corners of the arch in unison, bringing the arch off of its support towers and the floor system off the temporary supports. The total vertical lift was approximately 6 in. to account for the deflection of the arch and elongation of the tie as the arch picked up the weight of the floor system. The wheels of the SPMTs at one end of the arch were rotated 90° to allow them to roll with the elongation of the temporary tie girder. After a successful lift-off, the wheels were rotated back to prepare for the move down the slope to the river bank, while all the temporary supports and towers were taken down.

The SPMTs under the corners at each end were connected together to act in unison for moving the arch system transversely down to the river bank and over a trestle onto barges. Water level monitors at each corner of the arch were used to check the slope between the ends of each arch and the SPMTs were adjusted vertically to maintain a constant slope between the arches and avoid twisting the floor system as they marched the arch down a 3.5% slope to the river and onto the barges.

One barge was positioned at each end of the arch to allow each 104-ft-wide end to roll onto the barge from one end toward the center until both sides of the arch were positioned in the center of the two barges. The barges were constantly monitored and re-ballasted as the SPMTs rolled each end of the arch onto the barges. The total move onto the barges took about 12 hours.

The arch was floated down stream to the bridge site and positioned adjacent to the piers. Due to the curve in the river bank and the south piers' position on the river bank, the arch was skidded south off the south barge onto the river bank with a skid track system until it lined up with the horizontal skid rails that were positioned between the piers. Once in position on the south end, the support was transitioned from longitudinal to transverse skid shoes. The north end of the arch was unloaded off the barge onto the skid rails during the transverse slide with the help of SPMTs on the barge. Once positioned between the piers, the arch was ready for lifting.

The lifting frame supporting the strand jack system was anchored directly to the top of the pier. The strand jack system was connected to the arch system-lifting connection and hoisted 55 ft onto the top of the piers. Pier deflections were monitored and checked to ensure clearance after liftoff from the skid rails. Once in place, a support frame was moved into position under the temporary knuckle and the bridge was lowered into its final position. The lifting connection and support frame were cast into the permanent concrete knuckle. The concrete tie girder and knuckle were post-tensioned sequentially as the knuckle, tie and deck concrete were placed. To compensate for creep, shrinkage and shortening, the piers were jacked apart 6 in. before casting the knuckle, and the temporary arch bracing remained in place until the deck was cast. The deck was placed in a single pour, beginning at the center of the bridge. Hanger adjustments for geometry and stress were made by modifying the heights of the shim packs at each hanger. The float-in and lift process for the 3,300-ton arch steel structure was completed within a 48-hour window to limit the amount of time the Mississippi River navigation channel was closed.

Owner

Minnesota Department of Transportation, St. Paul

Designer

Parsons Corporation, Chicago

Contractor

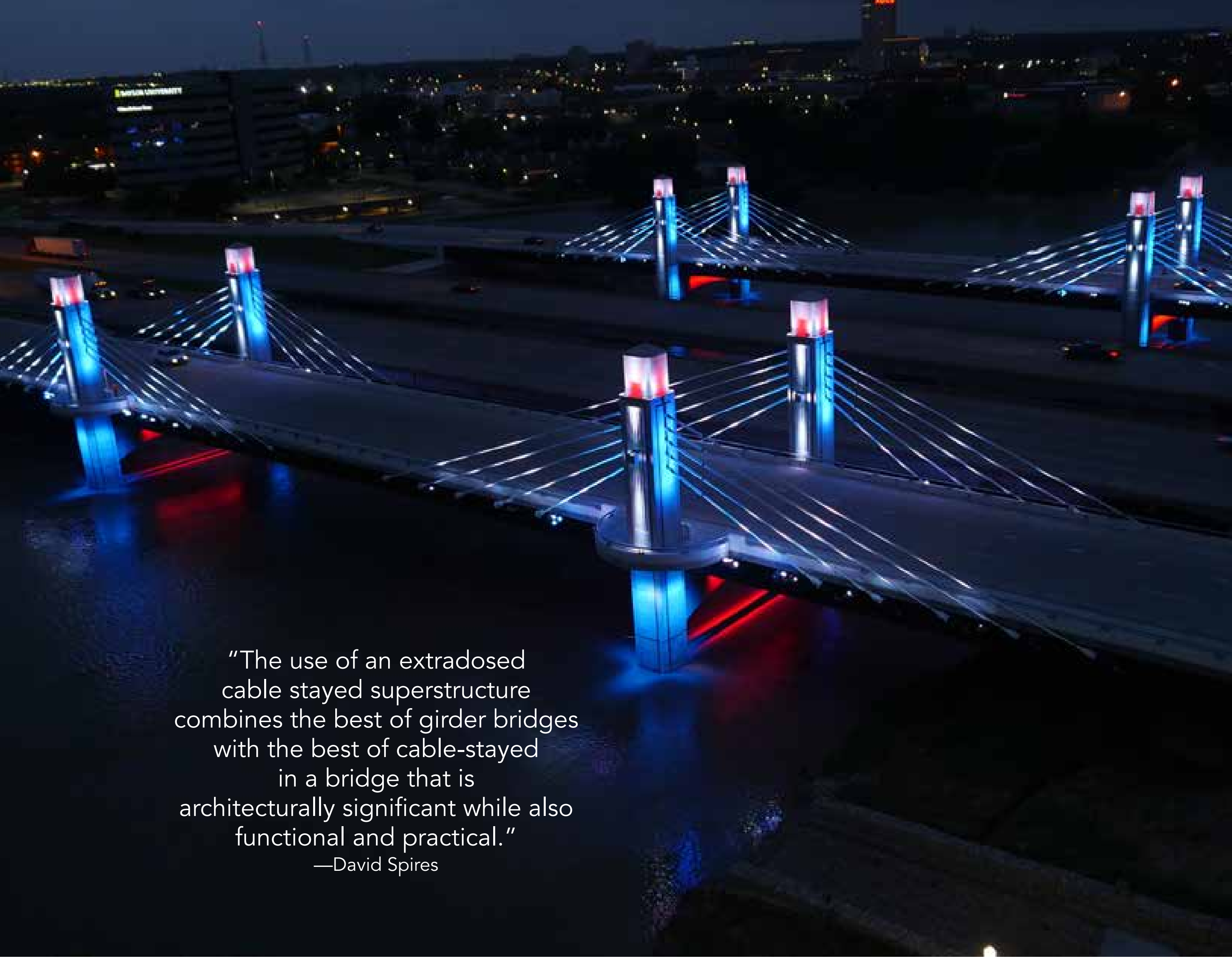
Lunda Construction Company, Rosemount, Minn.

Steel Fabricator

Veritas Steel, Eau Claire, Wis.

Steel Detailer

Candraft Detailing, Inc., New Westminster, B.C., Canada



"The use of an extradosed cable stayed superstructure combines the best of girder bridges with the best of cable-stayed in a bridge that is architecturally significant while also functional and practical."
—David Spires

PRIZE WINNER: LONG SPAN

IH-35 Bridges over the Brazos River, Waco, Texas

TEXAS, LIKE MANY OTHER SOUTHERN STATES, has seen substantial population growth recently.

This growth is one of the key drivers for expanding Interstate capacity, particularly in cities like Waco. I-35 meanders through the east Texas city, home of Baylor University, and the Waco District of the Texas Department of Transportation (TxDOT) wanted to do more than just add capacity with the $17.3 million IH-35 frontage road bridge project. It wanted to make a statement. By pioneering the application of extradosed bridges in the U.S., the city of Waco and TxDOT did just that (see sidebar for a description of extradosed bridge design).

Spanning the Brazos River and parallel to the existing mainline I-35 bridges, the new IH-35 frontage road extradosed bridges are 620 ft long and are the first extradosed cable-stayed bridges in the U.S. to use a steel superstructure. Traffic on each bridge is one way, with the new bridges placed to the outside of the mainline bridges. The existing mainline bridges will soon be replaced with new steel box-girder bridges as part of the IH-35 corridor improvements. In the final configuration, both the northbound and southbound frontage road bridges will be separated horizontally some 60 ft from the corresponding mainline bridges.

The roadway for each frontage road bridge carries three traffic lanes with shoulders, as well as a 10-ft, 6-in.-wide sidewalk for pedestrians and cyclists. In addition, scenic overlooks providing unobstructed river views are incorporated into the pylons to enhance the bridge experience for pedestrians. Each of the new twin structures is a three-span bridge with a 250-ft center span and 185-ft side spans. Matching the span configuration of the proposed new mainline bridges, this configuration aligns the piers within the river for all the bridges in their final condition.

Each bridge's superstructure consists of 6-ft, 6-in.-deep steel trapezoidal box edge girders, 3-ft, 6-in.-deep steel-plate I-girder floor beams and 10.5-in. cast-in-place concrete deck. Transverse floor-beam spacing varies from 13 ft, 3 in. in the end region of the side spans to 15 ft in the regions near the pylons. The trapezoidal box edge girders are composed of ¾-in. web plates, with 2-in.-wide top flange plates and a 5-ft-wide bottom flange plates. Top flange plate thickness varies from a

An Extra Dose of Strength

Unlike traditional cable-stayed bridges, extradosed bridges use a combination of superstructure as well as cable stays to support the loads. These bridges have a distinguishing feature from traditional cable stayed bridges in that the tower height is much shorter in proportion to the main span. While cable-stayed bridges typically have tower heights around one-fourth to one-fifth of the main span length, extradosed bridges have tower heights equal to approximately one-tenth of the main span length. The shorter tower height results in shallower cable angles that in turn increase the axial compression in the superstructure and decrease the vertical stay forces that act as supports in a conventional cable-stayed bridge. In other words, cables on an extradosed bridge serve a prestressing function.

Also, due to the additional support of the cables, an extradosed bridge may have a shallower superstructure depth relative to a traditional girder bridge. The span-to-depth ratio of extradosed bridges is typically on the order of 35-to-1 versus approximately 20-to-1 to 25-to-1 for typical girder bridges. However, an extradosed bridge still acts as a girder bridge, so the superstructure depth is greater than a conventional cable-stayed bridge, with a typical span-to-depth ratio of approximately 100-to-1. In addition, due to an extradosed bridge's relatively stiff superstructure, which resists a majority of live-load forces (rather than having the stays carry the load), these bridges also are often characterized by low live-load stress ranges in the stay cables.

typical 1 in. up to 3 in. for the regions over the bearings at the pylons, and the bottom flange plate varies from a typical 1¼ in. to 3 in. over the pylons. The box edge girders are continuous for the entire length of the bridge, supported on single disc bearings at the abutments and pylons. The transverse I-girder floor beams consist of ½-in. web plates with 1-ft, 6-in.-wide by 1-in.-thick top and bottom flange plates. Each H-shaped pylon consists of two 9-ft, 3-in. by 9-ft, 3-in. rectangular towers with a haunched 5-ft, 3-in.-wide crossbeam that supports the superstructure.

The project team chose a steel-girder composite cross section for the design. While a concrete cross section is typical for extradosed bridges, TxDOT preferred steel girders with concrete decks because of its familiarity with this superstructure scheme. In addition, structural engineer AECOM evaluated the use of a cast-in-place concrete box girder superstructure but determined it to be economically untenable. In addition, the project team used a steel trapezoidal box section for the edge girders, rather than a steel-plate I-girder section more commonly used on composite cable-stayed bridges, in order to provide greater superstructure stiffness and less reliance on the cable stays. The team also wanted to visually match the new mainline bridges, which will be steel box-girder bridges. The cable system consists of a single plane of five cable stays at each pylon supporting the edge girders (a total of 20 stays for each bridge). The cable stays are anchored at the deck level to the web of the steel box girder and pass through cable saddles in the pylons. With 12 strands per cable, the stays are composed of 0.62-in.-diameter, seven-wire, low-relaxation strands. For improved corrosion resistance, each strand is coated with wax and encapsulated inside high-density polyethylene (HDPE) sheathing. The strand-bundled stays are further protected by an outside HDPE pipe.

Since an extradosed bridge has two load-carrying systems, cable support can be provided for only a portion of the span. Consistent with the geometry of many extradosed bridges, the first stay for the IH-35 frontage road bridges is offset from the pylon by approximately 20% of the main span. From this first stay, the cable support points are spaced 14 ft, 9 in. along the edge girder, for a total of 59 ft. This results in approximately 50% of the main span being cable supported, which is consistent with most existing extradosed bridges that have cables distributed across approximately 60% of the span.

Due to the use of the relatively more flexible steel superstructure (supported at the pylons by bearings), the resulting live-load stress range in the stays was greater than the Post-Tensioning Institute's (PTI) limit that would allow the stays to be designated as low-fatigue. The stress variation caused by live loads (AASHTO HL-93 live load with no pedestrians) varied up to approximately 15 ksi versus the 6.75 ksi limit for the stays to be considered extradosed. So the stays were designed accordingly, using the same provisions in the PTI manual as for conventional cable-stayed bridges.

A complete erection scheme was also developed during the design of the bridge to inhibit both cracking of the concrete deck during construction and slippage of the stay strand through the saddles. Further, the cable-stay and saddle system chosen was specified to allow for the installation and replacement of stay strands on an individual strand-by-strand basis. This was no small consideration since the ability to replace strands on an individual basis will allow future bridge maintenance workers to pull and inspect strands without needing to replace the entire stay. Stay strands will be placed within individual holes in the cable saddle, significantly reducing the risk of fretting corrosion and facilitating strand-by-strand replacement. Although using saddles is a common practice elsewhere in the world, it is relatively new in the U.S. and only a few bridges have been designed with this system.

Not only was this the first use of a steel extradosed bridge in the U.S., but the project also had to content with heavier-than-usual deadline pressure thanks to Baylor announcing that it would be constructing its new Lane Stadium football facility adjacent to the bridges, with an opening date of August 31, 2014. Nevertheless, the bridges were delivered 4.5 months ahead of the original schedule and opened to traffic that July.

Owner
Texas Department of Transportation, Austin

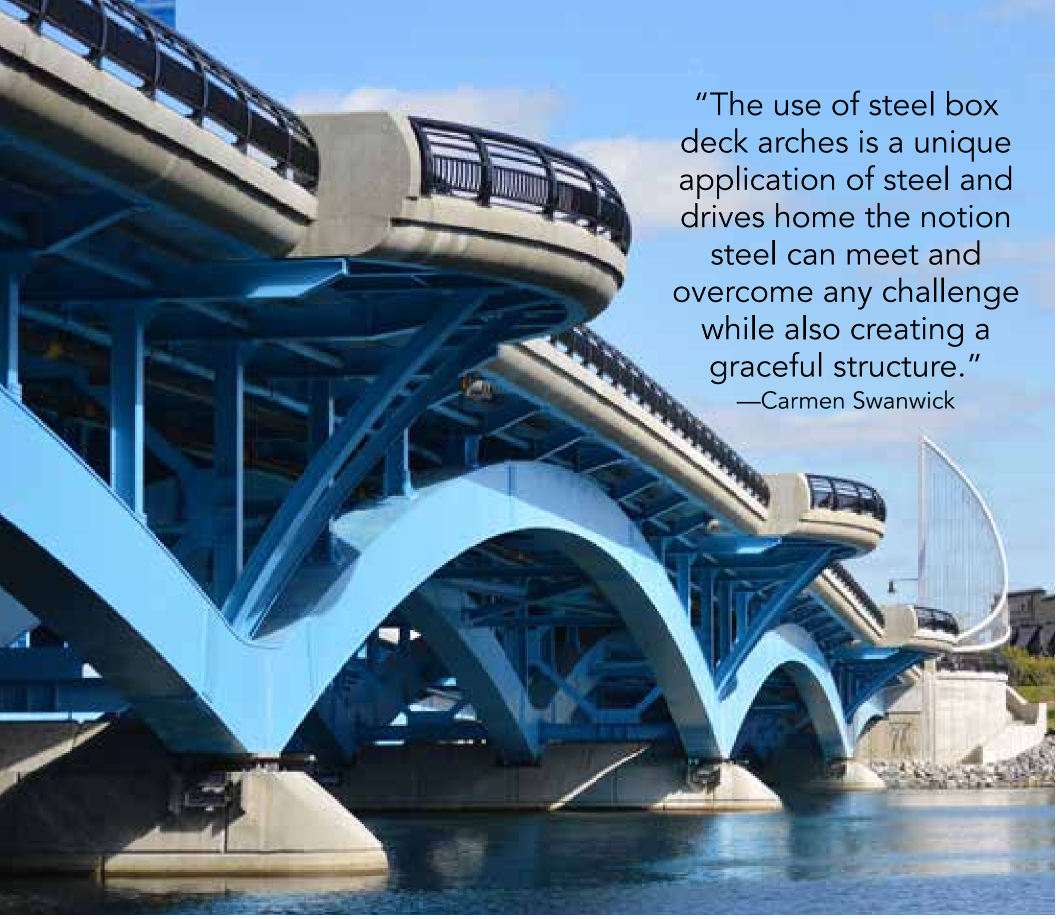
Designer
AECOM, Glen Allen, Va.

Contractor
The Lane Construction Corporation, Lorena, Texas

Steel Team

Fabricator
Hirschfeld Industries, San Angelo, Texas

Detailer
ABS Structural Corp., Melbourne, Fla.



"The use of steel box deck arches is a unique application of steel and drives home the notion steel can meet and overcome any challenge while also creating a graceful structure."
—Carmen Swanwick

PRIZE WINNER: MEDIUM SPAN

Kenneth F. Burns Memorial Bridge, Worcester/Shrewsbury, Mass.

AFTER NEARLY A CENTURY OF USE, the Kenneth F. Burns Memorial Bridge had run its course.

The multi-span concrete deck arch was an appreciated part of the landscape, but it had become too narrow for modern traffic needs and was deteriorating and due for retirement. Replacing it are two separate bridges, carrying eastbound and westbound traffic, that reflect on the old bridge's grace, but with a modern update using sweeping, sleek, steel box deck arches in place of concrete framing.

Construction staging required maintaining traffic flow on the original bridge, which carries Route 9 over Lake Quinsigamond between Shrewsbury and Worcester, while the new bridge was built around it. The design team developed a unique solution for the new low-rise arch spans: full-bridge-length post-tensioned arch ties. The bridge was designed and constructed as a tied deck arch. Tension ties were placed at the deck level and included full-length bridge post-tensioning, with two ducts per steel box beam. Post-tensioning was performed twice during construction to balance moments and compression forces.

To reduce impacts at the approaches in Worcester and Shrewsbury, vertical grade changes on Route 9 were minimized, which led to a relatively low rise. The resulting arch structures behaved as hybrid arch/continuous beams structures. The team optimized the design by balancing moments, axial compression and tension, using the post-tensioning to reduce maximum moments and carefully coordinating and iterating the analysis with construction staging.

The piers are comprised of steel pipe piles, with a precast soffit and cast-in-place concrete formed above the soffits. The construction of perched piers largely out of the water avoided the need for difficult and expensive sheeting and dredging in Lake Quinsigamond, and improved requirements for environmental permitting in the lake, resulting in better water quality and less disruption for boaters.

The design team developed a complex construction staging model using CSI Bridge, augmented by customized pre-processors and post-processor programs and sheets developed specifically for the project. The staging model matched construction means and methods and was frequently called upon to evaluate conditions in real time during construction. The model was verified during construction by matching predicted deflections with actual measurements at various stages of the work. In addition to the global model, detailed finite element models of complex steel connections were prepared to evaluate special conditions and framing.

Animation was used extensively to evaluate bridge aesthetics. For example, the team was concerned that the post-tensioning ducts on the fascia box beams might look like hanging utility pipes. It was initially thought that shadows from the overhanging decks might minimize the problem, but an animation with sunlight angles estimated from the end of December (with the most direct southern light) clearly showed otherwise. Based on this result, the team moved the ducts up onto the fascias, requiring special steel framing details but greatly improving the appearance of the bridge.

Owner

Massachusetts Department of Transportation, Worcester

Designer

Stantec, Boston (formerly FST)

Contractor

The Middlesex Corp, Littleton, Mass.

Steel Fabricator

Casco Bay Steel Structures, Inc., South Portland, Maine

PRIZE BRIDGE: SHORT SPAN
ACCELERATED BRIDGE CONSTRUCTION COMMENDATION

Wampum Bridge, Lawrence County, Pa.

IN AN ALL-TOO FAMILIAR STORY, a bridge in Wampum Borough of Lawrence County, Pa., had fallen on hard times and wasn't going to get better.

The severely deteriorated existing concrete arch carried SR 288/Main Street over Wampum Run and provided a vital connection for both residents and the local trucking industry. The failing structure had previously been reduced from two lanes to one bidirectional lane, and its weakening condition would have eventually warranted a full closure in the near future, thus requiring a 22-mile detour that was viewed as both costly and extremely inconvenient for local travelers. Either way, the bridge would need to be repaired or replaced.

Conventional phased construction methods for maintenance of traffic were considered but would have required extensive and costly repairs to the arch, thus prompting both the Pennsylvania Department of Transportation (PennDOT) and designer Johnson, Mirmiran and Thompson (JMT) to take the replacement route. Project stakeholders wanted a reduced construction time frame and minimal inconvenience for travelers following the lengthy detour, and JMT and PennDOT agreed that this could be accomplished by using accelerated bridge construction (ABC) techniques.

Preliminary design began with research and discussions with engineering professionals from various states with bridges successfully built using ABC. JMT reviewed these other states' standards and special provisions, and discussed design and construction methods used on their successful ABC projects. As a result of this research, JMT presented a report concluding that a cost-effective structure could be completed in less than a month.

Various superstructure options were considered including multi-girder bridges with full-depth precast concrete decks, partial-depth precast concrete deck panels, adjacent butted beam superstructures, modular prefabricated superstructures and parallel beam superstructures with a conventional deck. PennDOT District 11-0's preference was to avoid post-tensioning and construct a joint-less structure using integral abutments. All stakeholders agreed that the best option was a 78-ft steel beam structure on integral abutments. The pile caps, wing walls, cheek walls, back walls, approach and sleeper slabs were designed to be precast units while the steel beams were to have the deck and barrier cast to them off-site using conventional methods to create three modular units. The initial construction schedule for this structure type was estimated to take 15 days to construct.

The geotechnical findings showed that the piles could be driven, but they would have to be re-struck after 48 hours. Due to the uncertainty of the foundation of the portions of existing arch structure that were left in place, predrilling was required to avoid striking the remnants of the arch during the pile driving operation. Adding predrilling and the waiting period of the re-strike affected the initial schedule, and several production activities were rescheduled to occur during the re-strike waiting period to maintain efficiency. The changes to the schedule increased the allowable timeframe to 17 days. Confident that the bridge could be open to traffic within this time frame, Road User Liquidated Damages (RULDs) were calculated and an incentive/disincentive of $36,000 per day was added to the construction contract.

Due to the accelerated design schedule, coordination with the railroads and limiting impacts to the adjacent railroad property were critical for the project's success. Both CSX and Norfolk Southern have property within the project limits, and the roadway tie-ins were designed to ensure the required right-of-way was minimal on the CSX property and was not necessary on the Norfolk Southern property. Additionally, through coordination with CSX, the necessity for flaggers was eliminated by providing construction fence to prevent the contractor from accessing railroad property.

Another challenge was coordinating the relocation of Columbia Gas Transmission's line in a narrow time window. The existing gas transmission line crossed the roadway less than 15 ft behind the existing abutment, and because the gas line was so close to the structure and the project used integral abutments, it was impossible to avoid impacting the line. It had to be relocated prior to construction and the design had to be expedited in comparison to a typical project due to the condensed design schedule. Through extensive coordination between JMT and Columbia, a relocation route was developed, avoiding the proposed abutments, drainage structures and guiderail posts as well as roadway excavation. The roadway was closed for seven days, the new bridge was constructed in 7 days and the overall project was open to traffic on August 24, 2014, well ahead of the September 21, 2014 milestone date.

Owner

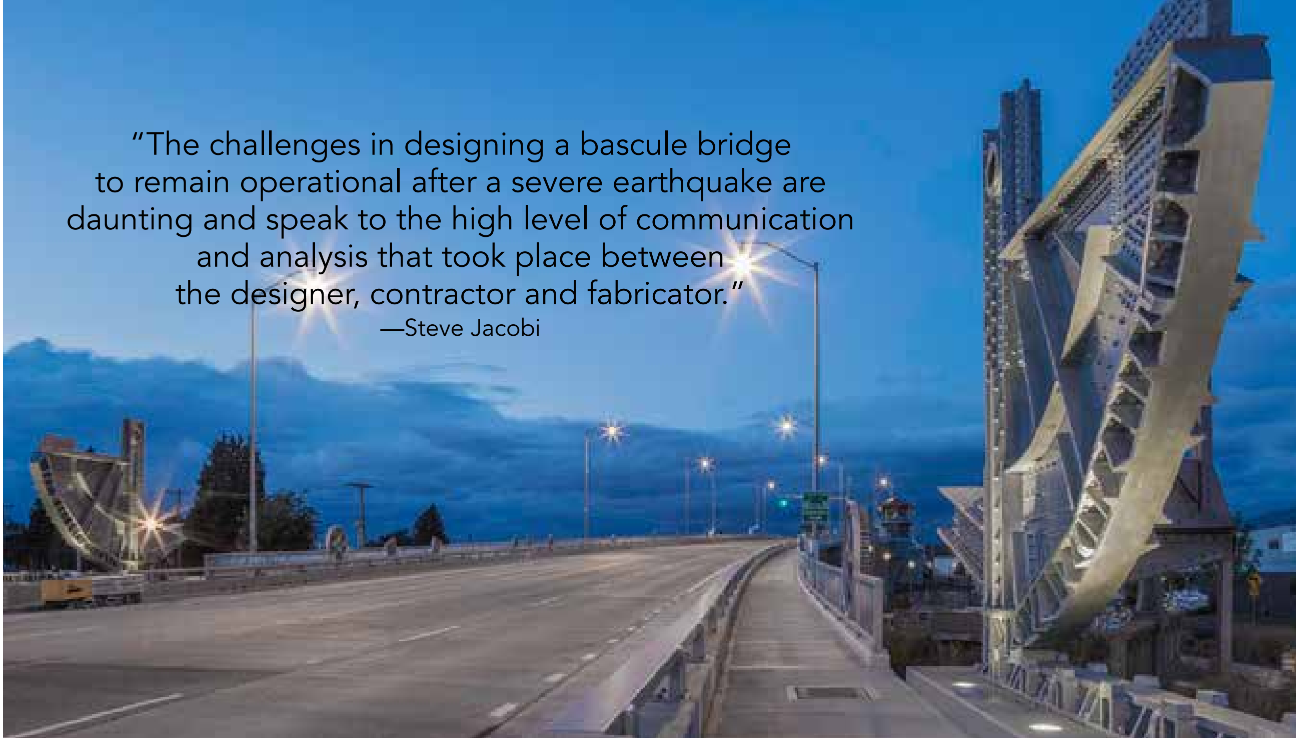
Pennsylvania Department of Transportation, Bridgeville

Designer

Johnson, Mirmiran and Thompson, Inc.,
Moon Township, Pa.

Contractor

Joseph B. Fay Company, Tarentum, Pa.



PRIZE BRIDGE: MOVABLE SPAN

South Park Bascule Bridge Replacement, Seattle

THE SOUTH PARK BRIDGE is a first-of-its-kind "trussed" plate girder design.

Designed and built to survive a major seismic event with minimal damage, the replacement bridge is a community lifeline, improving freight mobility and providing better regional access to downtown Seattle and the adjacent industrial area.

The original bridge was one of the few working examples of a rolling lift bascule Scherzer bridge. There was significant public agency and community interest in preserving its character and significance, as it was listed on the National Register of Historic Places and officially designated a historic landmark by the King County Landmarks Commission. The new bridge was designed to emulate the overall look and feel of the original bridge by incorporating truss-like features in the girders without incorporating the disadvantages of a traditional truss design. The fascia girder treatments off the main span were selected to honor the approach trusses on the original structure and to improve aesthetics. Economy in the design of the girder yielded a shallower structure, providing the desired waterway clearance improvements while minimizing the overall height of the bridge so it did not appear to tower over the surrounding community.

While a beloved community landmark, the original bridge's gusset-plated joints were numerous and sizable. Multiple large plates and fasteners intersecting at various angles created geometrically complex regions at every panel point. These joints acted like pockets, accumulating dirt, debris, moisture, guano and other substances detrimental to the steel bridge's long-term reliability. Designer HNTB's innovative main girder design of a continuous welded plate eliminated the problem-prone areas of traditional gusset-plated joints and two time-consuming steps common in its construction: match-drilling and field installation of thousands of bolts. With those steps gone, the "trussed" plate girder design—the first known use of this girder type—sped fabrication, shop assembly alignment and erection.

The bascule leaves are connected at the tips by span lock bars that will keep the leaves together vertically and transversely during a seismic event. However, there are no longitudinal restraints between the two leaves. During a seismic event, the joint will experience separation and closure of up to 18 in. of total movement. If the leaf superstructure was allowed to collide longitudinally, the impact load would have been very large, and the loads would have been transferred back to the span-supporting trunnion frames, requiring a more robust frame.

HNTB's solution was to design the draw span superstructure with 19 in. of separation and include a collapsible center joint. During a seismic event, only the leaf tip joint assemblies would collide, thus preventing large load transfers back to the trunnion frames. The collapsible joint was detailed so that steel components on tapered shims would shear off when displaced, resulting in damage that would be easily detectable and repairable.

Several solutions were incorporated in order to meet stringent seismic performance requirements, including sunken caisson foundations, isolated trunnion frames and a collapsible center joint on the lift spans. The bridge was designed to remain fully functional in the aftermath of an Operational Earthquake Level (108-year return period), and only moderate, but repairable, damage was permitted as the result of a Design Earthquake Level (975-year return period).

A citizens advisory group of diverse stakeholders met often and conveyed an important public perspective, which was incorporated into the bridge's design during the eight-year environmental documentation phase. One of the more notable action items was the group's request to include many of the original bridge's architectural details in the new bridge's design, as well as to salvage and display more than 100 original bridge parts at the project site. Gears from the operating machinery were artistically incorporated in the sidewalk railing. The track-and-rocker assemblies, the historical features from the original Scherzer bridge were transformed into gateway monuments at each end of the bridge. The decorative light posts, decorative railing panels, cast concrete railing, old bricks, decorative rail posts and deck grating were used to embellish the site around the bridge.

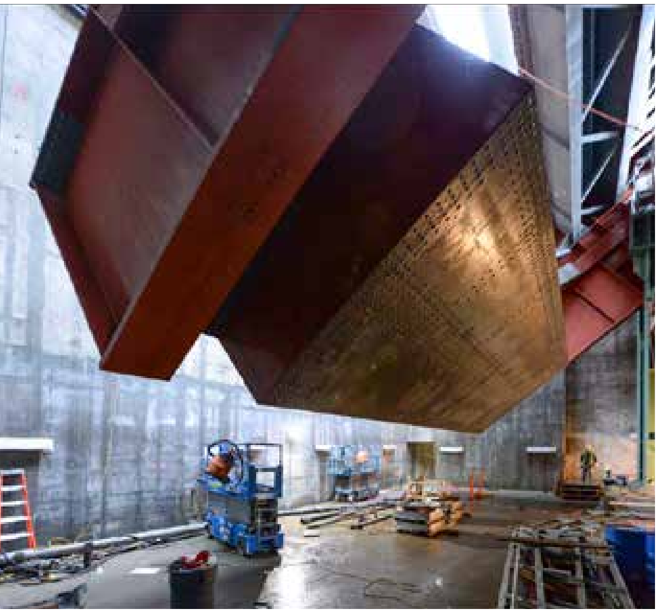
In addition, the design features a decorative rain garden that serves as landscape art while also collecting and naturally treating storm water runoff from the bridge prior to discharging it into the waterway, thus eliminating the need for a huge and expensive underground detention vault. The bridge was also engineered with an energy-efficient drive system that can operate each 1,500-ton draw span with approximately the same horsepower needed to drive a Toyota Prius.

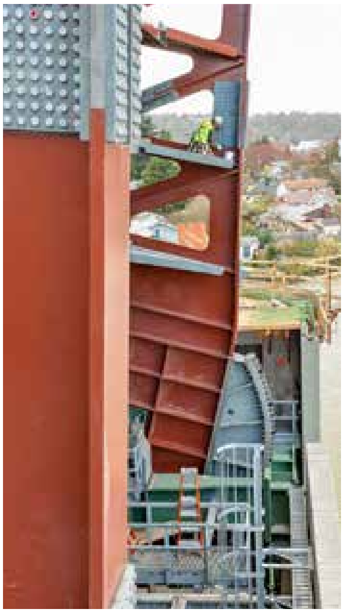
Owner
King County Department of Transportation, Seattle

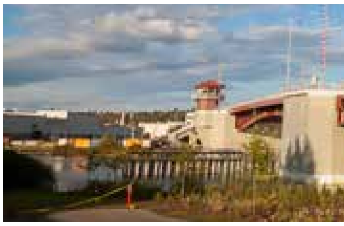
Designer
HNTB Corporation, Bellevue, Wash.

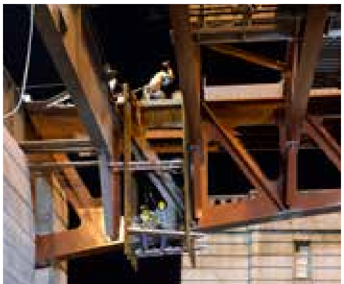
Contractor
Kiewit-Massman (JV), Federal Way, Wash.

Steel Fabricator and Detailer
Stinger Bridge and Iron, Coolidge, Ariz.









PRIZE BRIDGE: RECONSTRUCTION SPAN

Alexander Hamilton Bridge, New York

ALEXANDER HAMILTON IS NOT ONLY the star of Broadway's current smash hit, but also a star of the New York metro area's transportation infrastructure.

The $413 million Alexander Hamilton Bridge (AHB) Rehabilitation Project rejuvenates a major link in the area, leading to enhanced mobility throughout the region, improved safety and a structure that was designed to endure for generations. The project also restored existing recreational facilities and constructed new ones in the park land within the project to provide safe gathering areas for local communities.

The original AHB consisted of two separate superstructures with a longitudinal open joint along the centerline of bridge. The asymmetrical shifting of traffic lanes and cutting of the existing bridge cantilever brackets required extensive implementation of temporary and permanent bracing between the two superstructures to resist the unbalanced loadings during construction and in the final condition.

The weight of the new widened AHB and the modifications of existing bridge superstructure for the elimination of deck joints (transverse and longitudinal) required the strengthening of the existing four 505-ft-long deep steel-box arch-ribs that span between the Harlem river. Detailed step-by-step procedures were developed and provided in contract document for the pretensioning and installation of the new reinforcing top and bottom cover plates.

The superstructure of the new bridge is composed of a girder-floor beam-stringer system. For the strengthening of existing floor beams and the introduction of new retrofit girders between the existing girders under live loads, detailed analyses were performed and complex details were developed for the safe cutting and temporary support of the existing floor beams. For the new widening, the existing cantilever brackets along the fascia of AHB were replaced with longer (57-ft) cantilever brackets, almost twice the original length. To strengthen and replace corroded sections, temporary support and bracing details were developed and provided in contract documents for the partial disassembled of long and slender composite box-sections under heavy loads.

For more on a different award-winning portion of the Alexander Hamilton Bridge project, see the "Ramp TE Over I-95" write-up in the 2014 Prize Bridge Awards feature in the June 2014 issue, available at www.modernsteel.com.

Owner
New York State Department of Transportation, Long Island City

Designer
Jacobs Engineering, New York

Contractor
Halmar International, Nanuet, N.Y.

Steel Fabricator and Detailer
Canam-Bridges, Claremont, N.H.

"This project is as complicated as it gets. Where it was possible, the superstructure was salvaged, resulting in a revitalized link that will carry over 200,000 cars per day for the next 100 years."
—Michael Culmo

PRIZE BRIDGE: SPECIAL PURPOSE
The 606 - Milwaukee Avenue Bridge, Chicago

CHICAGO'S LATEST HIGH-PROFILE PARK rises above it all.

The 606, named for the first three digits of the city's zip codes (and also known as the Bloomingdale Trail), is a 2.7-mile-long former elevated train line that was converted into a new park and pedestrian trail on the city's north side.

Often seen as the centerpiece of the project, one of the park's bridges—over Milwaukee Avenue—was transformed from a four-span, low-clearance structure with three piers that obstructed traffic below, to a single-span tied-arch structure that allowed street traffic to flow unobstructed and with improved sight lines and vertical clearances.

In order to reuse as much of the structure as possible, the team proposed transforming the existing superstructure into a tied-arch bridge while reusing the existing plate girders as the tie girder and installing new curved rectangular HSS arches that provide support to the new single 98-ft, 2-in. span. LUSAS and CSiBridge modeling software were used to analyze the structure, including modal and dynamic analysis. The existing girders were spliced together at the piers for continuity and retrofit steel was added to the existing plate girders where needed due to the deterioration that had taken place over the past 100 years. Lateral earth loads were reduced by the use of geo-foam, allowing the existing abutments to be completely reused.

The skew of the bridge provides for unique perspectives of the structure from different vantage points. Motorists below see three staggered arches that appear tall and steep, while train riders above, from a view perpendicular to the arches, see them as long and shallow. Pedestrians passing through the arches see the unique angles and elevation changes of the bracing and arch members provided by the 45° skew. With limited space due to nearby Chicago Transit Authority (CTA) Blue Line elevated train structural support columns, creating access at the west side of Milwaukee Avenue forced the designers to think outside the box. The solution was to have the access ramp cut through the existing retaining wall, starting outside the elevated portion of

"Retrofitting the existing plate girders as the tie girder for a new arch structure was innovate and could provide a method for retrofitting many of our shorter-span structures where the substructure has deteriorated but the superstructure has retained its load-carrying capacity."
—Carmen Swanwick

the trail at Milwaukee Avenue and moving inward and upward until access to the trail was gained. Tied-back steel sheet pile wall was incorporated to accomplish this feat.

Owner
Chicago Department of Transportation, Chicago

Designer
Collins Engineers, Chicago

Contractor
Walsh Construction Company, Chicago

Steel Fabricator
Prospect Steel Company, Little Rock, Ark.

Steel Detailer
Weaver Bridge Corporation, Granville, Ohio

Bender-Roller
Chicago Metal Rolled Products Co., Chicago

MERIT AWARD: MAJOR SPAN

Stan Musial Veterans Memorial Bridge, St. Louis/St. Clair County, Ill.

TOO MANY INTERSTATES ON ONE BRIDGE were causing quite the traffic nightmare over the Mississippi River near downtown St. Louis.

The Poplar Street Bridge, which carries Interstates 55, 64 and 70 as well as U.S. 40, was overburdened with traffic, so the decision was made to build a new crossing for I-70, the Stan Musial Veterans Memorial Bridge. The bridge features two 400-ft towers above the third-longest cable-stayed bridge in the United States.

Currently carrying four lanes, the design allows for the addition of two lanes through re-striping and can accommodate a future adjacent four-lane bridge. Traffic is now able to flow at posted speeds adjacent to downtown St. Louis between Missouri and Illinois, which reduces congestion, enhances air quality and aids in interstate commerce. Designer HNTB co-located with owner and FHWA representatives to solve problems in real time, thus delivering a buildable, economical design in one year—half the typical time for similar bridges.

To optimize materials, the team chose steel floor beams and edge girders composite with precast concrete panels for the superstructure, which made it easier to erect. The design eliminated the tedious job of constructing concrete corbels for the upper cable anchors and incorporated steel anchor boxes to reduce the amount of post-tensioning around pylons. The decision to fabricate the boxes in the shop made them safer and more precise while eliminating significant amounts of work 300 ft or more above the river. The steel anchor boxes incorporated a bolted connection between the anchor beam and anchor box, which allowed the fabricator to precisely locate the anchorage before bolting it permanently into position. The lower cable anchorages were steel weldments bolted to the side of the edge girders. By locating the these anchorages alongside the edge girders as opposed to on top of them, the length needed between the strand anchor and top end of the guide pipe could be obtained such that smaller more compact friction cable dampers could be used. In addition, HPS70W steel was used in the edge girders to reduce the overall weight of the superstructure.

The superstructure was designed to be redundant and able to withstand the loss of any cable without significant damage to the bridge. The cable spacing was optimized to assist with the load transfer in the superstructure under the cable-loss scenario. Various details were incorporated into the design of the bridge to address security measures important in today's world.

Because of the bridge's location in a high-seismic zone, the magnitude of the span and the soft soils and potential for liquefaction during a seismic event, HNTB tapped researchers at the University of Illinois and University of California-Berkeley. They analyzed the design using a conditional mean spectrum (CMS) approach, which had never before been used for bridge design. The approach considers the most expected response spectrum of a structure under different ground motions rather than aggregating multiple ground movements from various potential seismic events. The analysis revealed realistic demands on the bridge and eliminated potential for lateral spreading and the need for any associated ground improvements. To further test its effectiveness, HNTB performed dual-level seismic checks to ensure the bridge would be in service after a 1,000-year event and suffer only minimal damage at the 2,500-year maximum credible event. The process confirmed that the CMS approach reduces costs, and its successful implementation points to future value for the engineering profession.

For more on this project, see "Thinking Inside the Box" in the November 2013 issue, available at ***www.modernsteel.com****.*

Owner
Missouri Department of Transportation, Jefferson City

Designer
HNTB Corporation, Kansas City

Contractor
MTA (JV), Kansas City

Steel Fabricator
W&W | AFCO, Little Rock, Ark.

MERIT AWARD: LONG SPAN

(I-270 over) Chain of Rocks Road Canal Bridge, Granite City, Ill./Bellefontaine Neighbors, Mo.

STRUCTURALLY DEFICIENT AND FUNCTIONALLY OBSOLETE (technical terminology for "way past its prime") is the best way to describe the twin truss bridges that carried I-270 over the Chain of Rocks Canal near Granite City, Ill.

Built in 1963, the bridges had served as a major Interstate and St. Louis Area commuter link between Illinois and Missouri, crossing the canal that acts as a Mississippi River Bypass for all barge traffic traveling through St. Louis. Heavy existing traffic—nearly 55,000 vehicles per day—coupled with the regularly required bridge repairs caused significant congestion and delay for users and was a major source of concern and countless complaints, and the decision was made to replace the bridges.

Designer HDR's analysis showed the I-270 trusses were deficient; the structures needed serious help. Determining a remedy for the larger issue of how to design and construct a replacement bridge while keeping I-270 open to traffic quickly moved the project up on the priority list. In addition to managing preliminary engineering and final design services for the bridge replacement, HDR also inspected the bridges annually to ensure that the structural integrity of the existing bridges was sufficient during the design and construction phases. Due to the recent I-35W bridge failure, the inspections and follow-up specifically included gusset plate inspections and ratings to determine and monitor the strength of the connections in the trusses. After assessing the existing condition of the nearly 50-year old bridges, HDR identified rehabilitation requirements to keep the structures serviceable in the near term. Since construction funding was not secured at the time, HDR developed a plan to construct the bridge in phases as funding became available.

The project's Traffic Management Plan (TMP) staged construction to maintain two lanes of traffic in each direction and provided motorists with advanced warning/information of the lane closures and alternative route options, thus minimizing traffic backup lengths and using the most efficient method of construction staging to maximize safety and quality.

Due to the navigable canal and adjacent levee, the question was whether the USACE and the United States Coast Guard would issue permits in and around a levee in the "post-Katrina" environment. HDR's mutually acceptable solution involved placing suitable compacted fill to widen the levee and stabilize the area enough so that the pier location could be allowed. The bridge design could then proceed at speed.

Opened to traffic in 2014, the new I-270 bridge represents the largest steel plate I-girder bridge in Illinois. The five-span crossing, with a total length, of 1,970 ft, includes spans of 350 ft, 440 ft, 490 ft, 440 ft and 250 ft. The span arrangement was dictated by the need to span the canal and adjacent east flood protection levee and in doing so, the bridge was configured with 10 variable-depth steel plate I-girders. Given the amount of steel required, the design strived to achieve economy with regard to material, fabrication and construction. Flange plate thicknesses are repeated throughout the structure as much as possible in an effort to reduce the number of plate sizes required to be procured by the fabricator, Stupp Bridge. For the 18 girder field pieces along each girder line, only six different Grade 50W flange plate thicknesses are used, and only four different HPS70W flange plate thicknesses are used.

*For more on this project, see "Increasing Spans and Possibilities" in the March 2014 issue, available at **www.modernsteel.com**.*

Owner
Illinois Department of Transportation, Collinsville, Ill.

Designer
HDR, Inc., Chicago

Contractor
Walsh Construction, Chicago

Steel Fabricator and Detailer
Stupp Bridge Company, St. Louis

MERIT AWARD: MEDIUM SPAN
Falls Flyover Ramp, Wichita, Kan.

FOR MORE THAN TWO DECADES, the City of Wichita, Kan., sought to relieve traffic congestion at the I-235 interchange with Zoo Boulevard, which provides access across the Wichita-Valley Center Floodway, known locally as the "Big Ditch."

The solution is manifested in the form of two structural steel plate girder bridges—2,273 ft long and 1,690 ft long, respectively—which are part of a new partial interchange with 13th Street and I-235.

Establishing the flyover bridges' span arrangement to fit the project site was challenging due to multiple constraints. The design team had to carefully locate the bridges over 1,000 ft of floodway and around its levees, as well as around I-235, other roadways, a lakeside residential development and a county park. Bridge piers were located a minimum of 20 ft from the toe of the east and west levees in order to avoid impacts to the integrity of the levee system. The U.S. Army Corps of Engineers (USACE) required a geotechnical seepage analysis be completed for bridge piers adjacent to the dry side of the levees to demonstrate they would have no substantive impact upon seepage potential through or beneath the levees.

Structural steel plate girders were chosen as the preferred structure type early in the preliminary design process due to the bridges' horizontal curvature and span lengths up to 225 ft, and weathering steel was selected to minimize future maintenance requirements. In all, the bridges use 2,875 tons of structural steel.

Both bridges are 32 ft, 6 in. wide, with four plate girders spaced at 8 ft, 8 in. apart, and the girder webs are 84 in. deep. The 45-mile-per-hour design speed was a major factor in setting the bridge's geometric features, such as longitudinal grades, super-elevation rates and curve radii. Vertical bridge profiles were set to provide for an access road on top of the levee at three crossings and an access road adjacent to the dry side of the levee at the fourth crossing.

For more on this project, see "Flying over the Floodway" in the March 2015 issue, available at www.modernsteel.com.

Owner
Kansas Department of Transportation, Wichita, Kan.

Designer
HNTB Corporation, Overland Park, Kan.

Contractor
Dondlinger and Sons Construction Company, Wichita

MERIT AWARD: SHORT SPAN
SUSTAINABILITY COMMENDATION
Mill Creek Bridge, Astoria, Ore.

EVER-INCREASING REHABILITATION needs for corroded steel bridges are one of the Oregon Department of Transportation's (ODOT) biggest ongoing concerns.

While high-performance steel (HPS) is an important step in increasing toughness and corrosion resistance when compared to weathering steel, it is still vulnerable in corrosive and high-humidity environments inherent to the state's coastal areas. The conventional way to accommodate bridge steel corrosion is to apply protective paint coatings and to periodically recoat the bridge during its service life. However, the lifecycle cost of this design choice can be much higher than the initial cost of the bridge. An alternative to weathering steel or HPS and painted steel girders is corrosion-resistant ASTM A1010 Grade 50 steel that needs no corrosion protection coating.

A sample steel plate girder bridge employing A1010 is the 123-ft-long, 42-ft, 8-in.-wide Mill Creek Bridge along Lower Columbia River Hwy. No 2W (U.S. 30), only the second A1010 plate girder bridge for public use in the world. The pre-purchasing contract adopted for the project divided it into two segments: contracting steel fabrication as soon as the steel design and specification was completed followed by the remainder of construction. This type contract gives the fabricator extra time for ordering steel plate, testing plate samples for compliances to the contract requirements and replacing plate that does not meet them, and helps prevent time loss from unforeseen issues that could cause delays.

For the other bridge project using A1010 Grade 50 steel, see the Dodge Creek Bridge item in the 2014 Prize Bridge Awards section (it won the same award and commendation as the Mill Creek Bridge) at www.modernsteel.com.

Owner and Designer
Oregon Department of Transportation, Salem

Contractor
Oregon State Bridge Construction, Inc., Aumsville, Ore.

Steel Fabricator
Thompson Metal Fab, Inc., Vancouver, Wash.

Steel Detailer
Candraft Detailing, Inc., New Westminster, B.C., Canada

MERIT AWARD: MOVABLE SPAN
Henry G. Gilmerton Bridge, Chesapeake, Va.

THE HENRY G. GILMERTON BRIDGE, one of five critical bridges connecting the Hampton Roads region in southeastern Virginia, is in one of the world's largest natural harbors, so it's not surprising that the bridge carries approximately one million travelers every month.

But nearly 70 years after the original bascule bridge was constructed, the Virginia Department of Transportation (VDOT) determined that it would need to replace the aging span and thus embarked on a $134 million project. The replacement, which was substantially completed in 2013, was built with the goals of reducing automobile congestion at the bridge and alternate routes, increasing clearance to accommodate marine and motorist traffic with fewer openings and increasing lane width to improve traffic flow and accommodate future widening of Military Highway—all without impacting vehicular or marine traffic, changing the existing alignment of military highway or modifying the navigational channel geometry.

In addition, the close proximity of the Norfolk Southern Railroad line to the bridge posed a significant challenge. Installation of the bridge's eight new 12-ft-diameter drilled-shaft foundations, erection of the superstructure and demolition of the original bridge all needed to be done in such a way that did not disrupt the railroad bridge or its foundations. Complicating the need for increased width is the nearby railroad bridge's right-of-way. A hard bend in the river south of the bridge eliminated the possibility of expanding in that direction, so Norfolk Southern's willingness to yield some of its right-of-way was the only way the wider bridge could be constructed; the 89-ft-wide bridge is one of the widest lift spans ever to be built.

During installation of the new drilled shafts, the team used vibration-monitoring equipment to identify potential settlement impacts to the railroad bridge foundations. Installing the foundations also presented a challenge for the construction and design teams. The Gilmerton Bridge is located in the Great Dismal Swamp, a marshy area on the coastal plains region in southeast Virginia with less than desirable soil conditions. The drilled-shaft foundations were designed to reach 120 ft below ground level, which required special equipment and a team of industry experts. The team employed a massive oscillator to drill the foundations, and the project incorporates some of the largest drilled shafts ever constructed using the oscillating method.

Because rock was too deep to rest the drilled shaft foundations on, the foundations were predicted to experience some settlement with time. Settlement can be an issue for any bridge, but is of particular concern for movable bridges because of the precise tolerances required to ensure operation without binding. Jacking brackets were designed into the towers to allow them to be jacked under full, dead load to compensate for the settlement.

The lift bridge tower legs were positioned outside and behind the existing bascule bridge piers. This allowed the new towers to be built over the existing bridge without impacting the bascule span's ability to open for marine traffic. This required the lower portion of the tower to be designed as an unbraced portal frame. The new steel towers provide the required 135 ft of vertical clearance for the 250-ft lift span. Due to the exceptional bridge width, four 15-ft-diameter sheaves, each carrying twelve 2¼-in.-diameter wire ropes, were required on each tower to support the load of the lift span and counterweights—twice as many as typically necessary.

Using accelerated construction for the lift span required that the span be floated in on barges following construction of the towers. A specially retrofitted barge was needed to carry the nearly 2,500-lb lift span. Removing the old span and floating in the new span not only required continuous collaboration of design and construction teams, but it also required very specific timing around weather patterns and the tide.

Perhaps one of the bridge's most striking features is its turquoise paint. This color was chosen by the City of Chesapeake as part of an ongoing bridge unification initiative, which calls for matching paint coatings for all of their iconic structures. Another, more functional, coating treatment can be found in the machinery room. For safety purposes, movable bridge components are coordinated using bright colors to distinguish between movable, stationary and other bridge parts. Additionally, the silhouette and form of the new Gilmerton Bridge complement the nearby railroad bridge, even when both movable structures are in the open position.

Ultimately, the bridge was built to hold six travel lanes, addressing the original goal of accommodating future growth of Military Highway. Initially, however, both outside lanes will be striped, allowing them to operate as shoulders before the necessary expansion. The new bridge's 35-ft clearance allows smaller craft to traverse under the bridge without impacting vehicular traffic and reduces openings by 40%, as well as wear on bridge mechanical components. The reduction in congestion allows a growing community easier travel, while ensuring the uninterrupted flow of commercial goods by vehicle, rail and boat.

*For more on this project, see "Widening the Gap" in the January 2013 issue, available at **www.modernsteel.com**.*

Owner
Virginia Department of Transportation, Richmond

Designer
Modjeski and Masters, Inc., Mechanicsburg, Pa.

Contractor
PCL Civil Constructions, Inc., Tampa, Fla.

Steel Fabricator and Detailer
Banker Steel Company, Lynchburg, Va.

MERIT AWARD: MOVABLE SPAN
World War I Memorial Bridge, Portsmouth, N.H./Kittery, Maine

SINCE 1923, THE WORLD WAR I MEMORIAL BRIDGE linked Portsmouth, N.H., and Kittery, Maine, providing a multimodal transportation system that enhanced commerce, tourism, community life and the historic and aesthetic character of both communities.

But in recent years, structural deficiencies led to its closing, prompting the need for a replacement crossing. The new bridge is 900 ft long and comprises three spans: two approach spans of 298.75 ft each and a lift span of 302.5 ft, with a width of 49.5 ft to 54.6 ft.

In the designing the truss, contractor Archer Western and designer HNTB hoped to explore new fabrication capabilities to avoid one of the most challenging aspects of truss design: gusset-plate connections. The demise of the existing bridge was due to corrosion and deterioration of gusseted truss connections, which are difficult to inspect, collect debris, corrode and are impossible to remove and replace without underpinning the structure. In addition to avoiding gusset plates, the team elected to fabricate the top and bottom chords much in the same way plate girders are fabricated and to use rolled wide-flange sections for the diagonals to further simplify fabrication.

For the continuous flanges, the team designed the bottom flange of the bottom chord and the top flange of the top chord to be continuous. To add the necessary area, designers made the bottom flange of the bottom chord bigger than the top flange of the bottom chord and vice versa. The result is a monosymmetric I section, where the bottom flange is wider than the top flange. This has several advantages, including: 1) the truss acts as a deeper truss; 2) it forces some of the load to transfer around the web instead of going back into the web; and 3) the bottom chord/bottom flange and the top chord/top flange are wider and heavier. While there are more than 20,000 truss bridges in service across the U.S., the design team knows of no other bridge that has used this strategy to eliminate gusset plates. It is likely that this modified truss design, using plate-girder fabrication technology, is the first of its kind in North America.

For more information on this project, see "A New Way to Connect" in the April 2014 issue, available at www.modernsteel.com.

Owner
New Hampshire Department of Transportation, Concord
Maine Department of Transportation, Augusta

Designer
HNTB Corporation, Westbrook, Maine

Contractor
Archer Western Contractors, Canton, Maine

Steel Fabricator and Detailer
Canam-Bridges, Claremont, N.H.

MERIT AWARD: RECONSTRUCTION

Donald R. Lobaugh Bridge, Freeport, Pa.

SPANNING THE ALLEGHENY RIVER approximately 25 miles northeast of Pittsburgh, the Freeport Bridge, also known as the Donald R. Lobaugh Bridge, carries State Route 0356 and a multiuse path. Built in 1965, the bridge is vital for commerce and serves as a route for tourists and outdoor enthusiasts using the extensive nearby rails-to-trails network, including the Kiskiminetas-Conemaugh water trails.

However, recent inspections by the Pennsylvania Department of Transportation (PennDOT) indicated that emergency attention was necessary to extend the bridge's useful service life and ensure the safety of the traveling public. Several existing conditions contributed to bridge deterioration, including steady chloride-laden runoff passing through a 1-in. open median joint, leaking stringer relief joints and free-fall roadway drainage from slots at the base of the barriers. This deterioration became a prime concern for PennDOT and prompted the need for emergency repairs.

In late 2006, designer Modjeski and Masters provided PennDOT with designs and details for significant emergency repairs to temporarily prevent the bridge from being weight restricted. Had these emergency repairs not been performed, all heavy live loads, including school buses and emergency vehicles, would have been prohibited from crossing the bridge resulting in a 20-mile detour. Steel plate reinforcement of deficient portions of the truss span's floor system was complete; however, to preserve a safe crossing more extensive repairs would be required in the future.

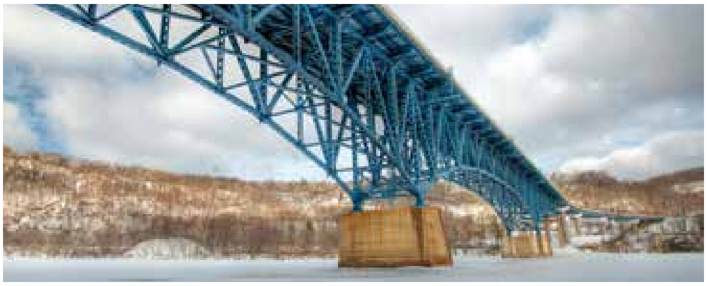
Beyond the need for immediate structural repairs, improvement of the roadway geometry and safety features was also required. Substandard features included inadequate curb-to-curb width, outdated bridge rails, insufficient sidewalk width and lack of pedestrian protection. Design for the modernized bridge needed to address the steel corrosion and section loss issues and bring the bridge's geometric features up to current standards.

The project focus became the rehabilitation and strengthening of the three-span deck truss spans and complete replacement of the north and south approach structures, an ambitious project with an overall length of 2,443 ft from abutment to abutment when completed (a reduction of 671 ft). The deck cross section accommodates four lanes of traffic and one variable-width barrier protected multi-use path.

The first challenge related to meeting PennDOT's requirement to maintain two-way traffic during all construction phases. Due to the existing bridge deck geometry, the deck needed to be temporarily widened for the first phase of construction. This temporary widening included the removal of the existing sidewalk and barrier. The widening required several modifications to maintain structural stability and ensure safety of the construction crews and traveling public.

Due to strength issues, construction staging and PennDOT's desire for a joint-less deck, the two-span stringer units and stress relief joints on the truss spans were replaced with continuous full-length stringers. The new joint-less reinforced concrete deck will extend the service life of the bridge and minimize future maintenance requirements for PennDOT.

Two of the six expansion rocker bearings on the truss-spans were observed to behave abnormally—they were in their expanded position on a cold day—and PennDOT opted to replace rather than to attempt to reset them. Because of the very large vertical loads and the need to move due to thermal expansion and contraction, pot-type high-load multi-rotational bearings were selected. Since the rocker bearings do not introduce eccentricity in the end post and the end post was not designed for



such a loading, the replacement bearing configuration needed to replicate this condition. In a normal pot bearing application, the nonmoving component (the pot) is connected to the substructure. In this case, the nonmoving component needed to be connected to the end post and the sliding surface on the substructure, which could resist the additional loading due to the eccentricity. This meant that the bearings needed to be installed upside-down and protected with sheet metal covers. At six other expansion bearing locations on the truss spans, seismic retrofits were installed to improve the connection of the superstructure to the substructure in the event of an earthquake.

Owner

Pennsylvania Department of Transportation, Uniontown

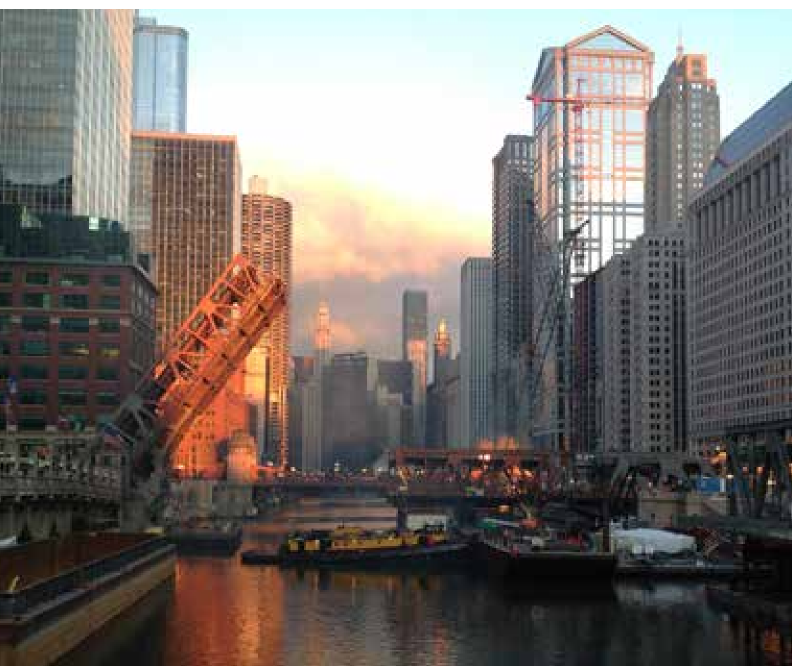
Designer

Modjeski and Masters, Inc., Mechanicsburg, Pa.

Contractor

Brayman Construction Corporation, Saxonburg, Pa.

MERIT AWARD: RECONSTRUCTION
Wells Street Bridge, Chicago



THE WELLS STREET BRIDGE is the longest double-deck, double-leaf, bascule bridge built over the Chicago River, and only one of two remaining bascule bridges in the city of Chicago that carries both automobile and transit (Chicago Transit Authority elevated trains) on two levels.

Recent in-depth inspection and analysis of the 1922-built bridge revealed that substantial structural rehabilitation was required. As the bridge carries an average daily traffic of approximately 12,000 vehicles and serves nearly 4,500 pedestrians a day on the lower level and a two major transit lines carrying 70,000 riders per day on the upper level, the crucial crossing had to be rehabilitated with minimal impact to its users.

In the initial design plan, CTA would only allow weekend shutdowns, which only provided for partial replacement of select members. To accomplish this partial replacement the rail operations would have needed to be suspended for 15 long weekends throughout the year, a situation that was deemed unacceptable. Instead, it was determined that the replacement of the truss "river arm" structure and framing would take place during two nine-day shutdowns of upper-level train traffic (two weekends and one work week).

The main span of the bridge is 345 ft long and 72 ft wide. Dual open-web trusses, as main load carrying members, support both levels of framing. Both levels of framing were entirely replaced along with major rehabilitation to the mechanical and electrical components of the bridge. Bridge houses and bridge pits, including counterweight boxes, received select repairs. Due to the bridge's historic status, most elements such as the railings, bridge houses and major structural components were replaced in-kind to preserve the historic look.

The bridge was rehabilitated one leaf at a time, providing temporary shoring under the counterweight box for the leaf under construction so train traffic could be maintained. Vehicle and pedestrian traffic was safely detoured to other local streets and bridges over the river, and working on only one leaf at a time allowed one leaf to remain operable to accommodate river traffic.

The first shutdown took place in March 2013 and another in April 2013. During each line cut, transit service over the structure was halted on a Friday evening and resumed again by rush hour on the second Monday. As CTA was planning to perform loop track repairs around the same timeframe as the Wells bridge rehabilitation—and these repairs would have required additional weekend shutdowns—the two projects were combined and resulted in minimal impact to users as well as a $500,000 savings for the city.

Construction staging was perhaps the most complex part of the work and the key to the success of the project. In addition to the limited closures for CTA trains, the Coast Guard required that one leaf be operational at all times between March and October. Because the bridge was located over a river in the heart of the city, nearby streets were not available for the staging of the material, and the project relied heavily on marine equipment for staging. Before the project was bid, an early procurement contract was awarded for the river arm structural steel fabrication. The fabricator stored the trusses and assisted the contractor in assembly of the truss/floor beam river arm that was eventually barged to the site.

Achieving bridge balance was another challenge. In order to proceed with work on the north leaf, the south leaf first needed to be operational, which required the latter to be balanced in the interim condition. To balance the bridge for operation, concrete jersey barriers were lashed to the deck toward the nose of the span. The north leaf counterweight was then shored and the construction sequence was repeated for the north leaf.

The Wells Street Bridge project demonstrates that in-situ rehabilitation of moveable structures nearing their useful life can be a viable alternative to replacement. Full-scale replacement of moveable bridges can be a long process often requiring realignment, property acquisition and displacement of people and businesses. The rehabilitation of the Wells Street structure was performed with minimal disruption to local businesses in a congested urban site.

Owner
Chicago Department of Transportation, Chicago

Designer
AECOM, Chicago

Contractor
Walsh Construction and II in One (JV), Chicago

Steel Fabricator
Munster Steel Company, Inc., Hammond, Ind.

Steel Detailer
Candraft Detailing, Inc., New Westminster, B.C., Canada

ACCELERATED BRIDGE CONSTRUCTION COMMENDATION

Milton-Madison Bridge, Milton, Ky./Madison, Ind.

SINCE ITS COMPLETION IN 1929, when America was on the brink of the Great Depression, the original US-421/Milton-Madison Bridge served as a vital link over the Ohio River between Milton, Ky., and Madison, Ind.

A structure that was designed for the occasional Model-A Ford had seen its burden grow to more than 10,000 modern vehicles per day, including semitrailer trucks loaded at full capacity. Although it was historically significant, the aging bridge had become functionally obsolete. A TIGER discretionary grant from the U.S. government became the catalyst to one of the most innovative bridge replacement project endeavors in the nation.

Using the accelerated bridge construction (ABC) method, the project began with the construction of temporary approach ramps, allowing traffic to be rerouted off of the existing approach spans to begin their unobstructed demolition and replacement. While these phasing activities were occurring, sections of the 7,200-ton truss superstructure were being preassembled on barges for the eventual float-in and strand lifting onto temporary piers, which were constructed adjacent to each existing pier stem. The temporary piers were designed to support live traffic on the completed bridge in its temporary alignment, freeing the existing structure for explosive demolition and pier cap widening. The temporary pier caps featured a key design element—the "sliding girders"—which would serve as the pathway for the record-breaking truss slide. The nearly ½-mile long completed bridge, weighing more than 16,000 tons at the time of the slide, was moved 55 ft laterally into place atop the refurbished and widened pier stems of the existing bridge.

*For more on this project, see "Move that Bridge!" in the February 2012 issue and the item "Biggest-Ever Bridge Slide" in the News section of the August 2014 issue, both available at **www.modernsteel.com**.*

Owner
Indiana Department of Transportation, Indianapolis
Kentucky Transportation Cabinet, Louisville

Designer
Buckland and Taylor, Ltd., North Vancouver, B.C., Canada

Contractor
Walsh Construction, Chicago

Steel Fabricator
High Industries, Lancaster, Pa.