AISC AND THE NATIONAL STEEL BRIDGE ALLIANCE (NSBA) are proud to announce the winners of the 2020 Prize Bridge Awards.

The winners span everything from a rugged section of Lake Tahoe's shoreline to a tight Idaho Canyon to a wide stretch of railroad tracks along Chicago's lakefront to a high-profile expressway in Philadelphia's Center City to the Hudson River's massive Tappan Zee. All have made an enormous impact on the lives of the people they serve—some in particularly dramatic ways. For example, the Pfeiffer Canyon Bridge reconnected a California community after a landslide damaged a concrete bridge beyond repair (so much so that groceries and fuel had to be brought in by helicopter!).

"These projects are tributes to the creativity of the designers and the skills of the constructors who collaborated to make them reality," said AISC's president, Charlie Carter. "Steel shines and soars on their talents, and we celebrate the accomplishments these projects represent."

Since Pittsburgh's Sixth Street Bridge won the first competition in 1928, more than 600 bridges of all sizes from all across the United States have received a Prize Bridge Award. Some, 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 actually outlasted the companies that built them.

Read on to learn about all of the winners. They're also featured in a video at **aisc.org/nsba/prize-bridge-awards**.

Judges

AISC and NSBA would like to thank the 2020 Prize Bridge Award judges for their time and enthusiasm:

- Richard Marchione, deputy chief engineer (ret.), New York Department of Transportation
- Shane W.R. Kuhlman, state bridge engineer, New Mexico Department of Transportation Bridge Bureau
- Frank Russo, vice president and technical director, bridge engineering, Michael Baker International
- Rob Richardson, west region bridge leader, associate vice president, HDR
- Dennis Golabek, GEC-FDOT Structures Design office, WSP

These dedicated judges considered every entry's merits in terms of innovation, economics, aesthetics, design, and engineering solutions.

NATIONAL AWARD Short Span

Vine Street Expressway (I-676) Reconstruction Project—18th to 22nd Streets, Philadelphia

THE VINE STREET EXPRESSWAY is well-known to Philadelphia commuters.

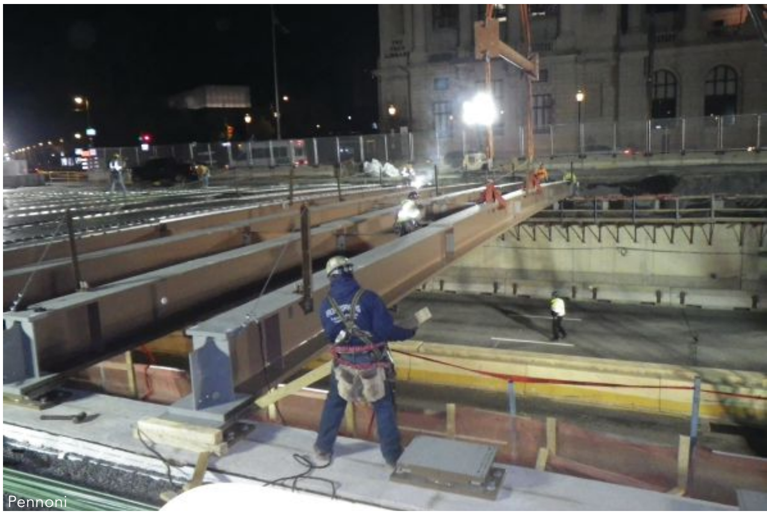
The nearly two-mile stretch of Interstate 676 in the City of Brotherly Love's downtown (aka Center City) is critical to the area's transportation network. But in recent years, six bridges carrying local roads over the expressway were aging and suffering from significant deterioration, and the Pennsylvania Department of Transportation (PennDOT) decided to replace these two-span prestressed concrete non-composite adjacent box-beam bridges with single-span welded-plate-girder steel bridges. Vertical clearance issues, reuse of existing bridge abutments, relocation of several utilities supported by the bridges, and high aesthetic standards were key project considerations. In addition, the new structures were also topped with extensive landscaped areas and streetscape finishes.

Each bridge had its own challenges and unique aspects. For example, the deck for the new Family Court pedestrian bridge, located between the 18th and 19th Street bridges, is now a park for the community. This new configuration required the bridge to carry a heavier load to support trees, additional sidewalks and seating areas, and a lawn. This new pedestrian bridge required thicker flanges to support the weight of the park, yet still be able to flex on the bearing pads on the existing abutment and expand and contract smoothly with temperature changes. Steel was pivotal for supporting the new loads that came with these features as well as maintaining the clearance needed below the bridge, providing the necessary strength in a shallow profile.

The 19th Street Bridge presented a different challenge. With four bays of utilities supported by the bridge, the team prepared a steel design and construction schedule that would allow the utilities to remain in service throughout construction. The utilities were moved to temporary supports while the bridge was removed around them, then the newly fabricated beams were set in place and the utilities were relocated to the new beams while the remainder of the new bridge was built. This reduced the need for outages to move critical utilities and kept them in working order throughout the construction.

Challenging geometry drove the design of the new bridge that would combine the existing 20th Street, Ben Franklin Parkway, and Free Library Bridges into one structure, the 20th/BFP/FL Bridge. Given the sharply skewed geometry (35°) of the Parkway across the bridge, the team investigated whether the design vehicular live loads could produce larger girder moments and shears running along the sharp skew as opposed to the typical live load configuration of vehicles traveling parallel to the girders. A 3D finite ele-


Pennoni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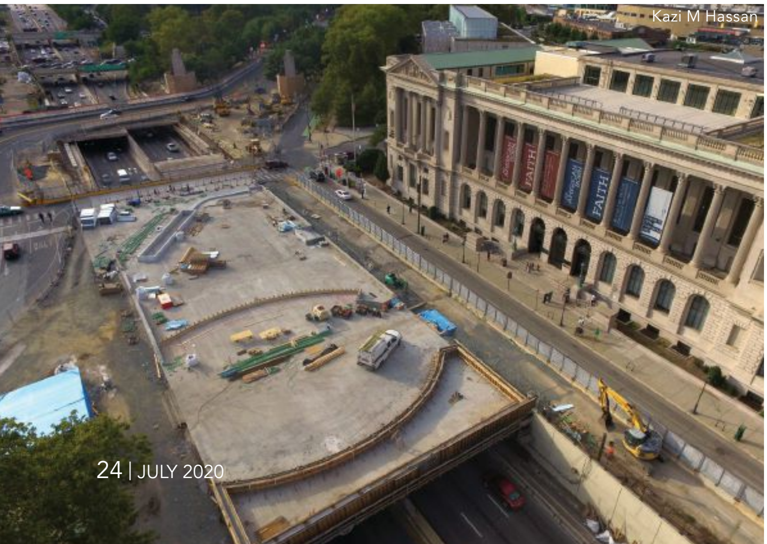
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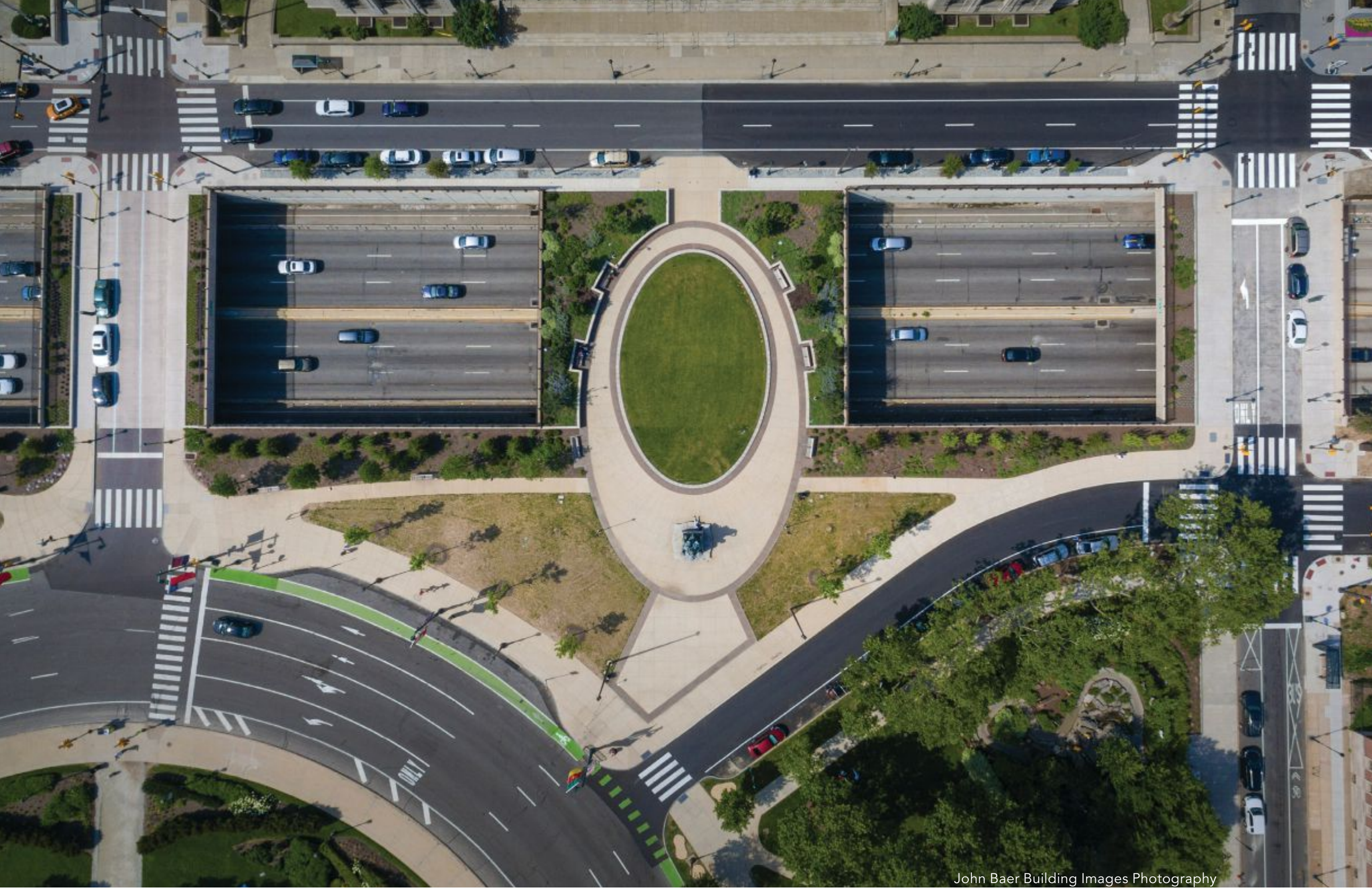
Pennoni


John Baer Building Images Photography

ment model was developed and used to confirm that the skewed live loading condition did not produce effects greater than the standard design vehicular loads running parallel to the girders. The resulting design yielded girders with 24-in.-deep webs and maximum 24-in.-wide by 3.5-in.-thick bottom flanges.

When it came to the 22nd Street Bridge, the clearance below the bridge was too low, there was a pump station behind one of the existing abutments that could not be removed, and there were numerous existing and proposed utilities to be set on the bridge. By implementing shallow steel beams, the center pier was eliminated and the profile was raised to the minimum 14 ft, 6 in. without exceeding the capacity of the existing abutments.

The existing, concrete 18th Street Bridge carried a heavy 22-in. steam pipe below the deck. The design team worked with the local utility to employ a lighter pipe using less insulation so that the new steel span would be able to not only carry it but also fit it between the bridge beams.

Finally, the 21st Street Bridge had the longest span of all the bridge replacements due to the presence of on/off ramps below the structure, meaning that the abutments had opposing skews of up to 10° from the girder span. As such, each steel girder on this span was unique, resulting in more extensive detailing.

Owner
Pennsylvania Department of Transportation, Harrisburg, Pa.

General Contractor
Buckley and Company, Inc., Philadelphia

Structural Engineer
Pennoni, Philadelphia

Steel Fabricator and Detailer
High Steel Structures LLC, Lancaster, Pa. AISC CERTIFIED FABRICATOR

Bridge Stats

Opened to traffic: November 1, 2018

Span lengths:
18th Street: 95 ft, 2 in.
Family Court: 95 ft, 5 in.
19th Street: 95 ft, 2 in.
20th Street/Benjamin Franklin Parkway/ Free Library: 95 ft, 8 in.
21st Street: 119 ft, 5½ to 133 ft, 10 in.
22nd Street:106 ft, 5 in.

Total lengths:
18th Street: 97 ft, 10 in.
Family Court: 98 ft.
19th Street: 97 ft, 10 in.
20th Street/Benjamin Franklin Parkway/ Free Library. 98 ft, 6 in.
21st Street: 120 ft, 3½ in. to 135 ft, 6⅞ in.
22nd Street: 108 ft, 11 in.

Average widths:
18th Street: 69 ft, 10½ in.
Family Court: 120 ft
19th Street: 64 ft, 11 in.
20th Street/Benjamin Franklin Parkway/ Free Library: 643 ft
21st Street: 67 ft
22nd Street: 83 ft, 6 in.

Total structural steel: 2,846 tons

Cost: $65.4 million for entire project

Coating/protection: Three-coat system consisting of an inorganic zinc primer, urethane intermediate coat, and aliphatic urethane finish coat

MERIT AWARD Short Span

Anchor Bay Drive, St. Clair County, Mich.

ANCHOR BAY DRIVE is a scenic road along Lake St. Clair in Clay, Mich., that carries fishing boats and yachts to the lake access and marina at the end of the road. It provides access to the hundreds of homes that take advantage of the spectacular views of the lake and lagoon via three bridges along the route.

A recent inspection by county engineers determined that these crossings—prestressed concrete box-beam superstructures with only a 30-year service life—had become either structurally deficient or functionally obsolete. They were replaced with galvanized steel press-brake-formed tub girder (PBFTG) bridges with a life expectancy two-and-a-half times as long. Combined with reinforced precast concrete deck panels, this steel solution provides a cost-effective replacement option at an accelerated construction schedule with a service life expectancy exceeding 75 years.

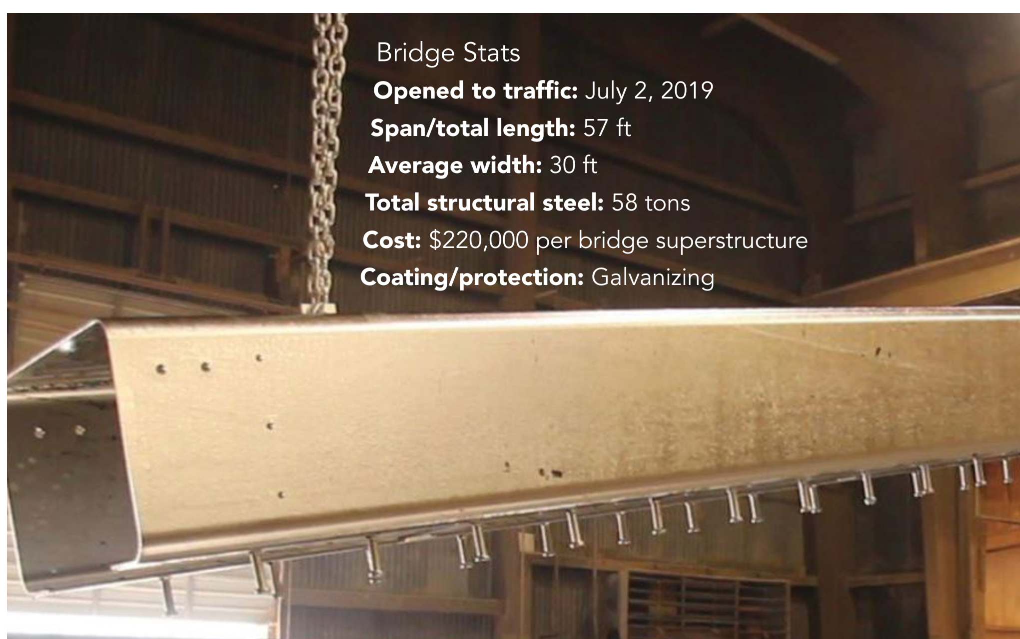
The St. Clair County Road Commission was able to bundle these three bridges into a collective, successful superstructure replacement project. During replacement, the bridges needed to remain passable as they provided the only point of access to the far reaches of Anchor Bay Drive, so a complete tear-down and rebuild was not possible. In addition, space around the bridges is extremely tight, with houses packed in close to the roadway and very little dry land to maneuver on.

Luckily, the chosen PBFTG option, TEG Engineering's Con-Struct Bridge System, addressed these issues. The original bridge abutments were in good shape and would not require replacement, and the Con-Struct system can be installed on top of existing substructures. In addition, the system can be delivered two ways: with the precast concrete deck pre-attached to the tub girders or separate. For this project, the team did not want the girders and deck to be attached, due to the space limitations at the installation site.

The county demolished and installed the bridge one side at a time to


TEG Engineering


TEG Engineering



Valmont


TEG Engineering

TEG Engineering

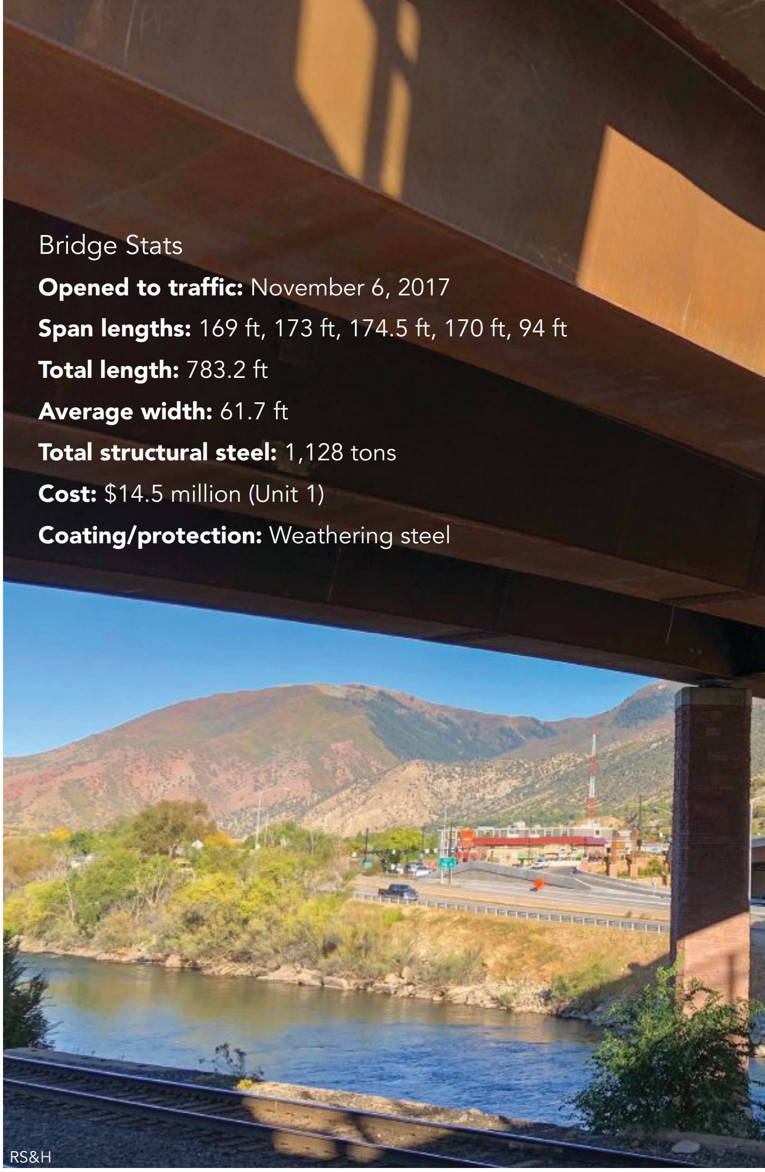
ensure that traffic flow could continue unhindered. The installation was much quicker than other available options due to the system's modular design, and both the galvanized steel tub girders and the decking take about half a day to set in place. The county's own crew and equipment easily managed installation without additional equipment rentals or labor, saving the county even more time and money.

Owner and General Contractor
St. Clair County Road Commission, St. Clair, Mich.

Structural Engineer
TEG Engineering, Wyoming, Mich.


RS&H


RS&H



Bridge Stats

Opened to traffic: November 6, 2017

Span lengths: 169 ft, 173 ft, 174.5 ft, 170 ft, 94 ft

Total length: 783.2 ft

Average width: 61.7 ft

Total structural steel: 1,128 tons

Cost: $14.5 million (Unit 1)

Coating/protection: Weathering steel

RS&H

NATIONAL AWARD Medium Span

Grand Avenue Bridge, Glenwood Springs, Colo.

GRAND AVENUE IN GLENWOOD SPRINGS, COLO., has a grand new thoroughfare.

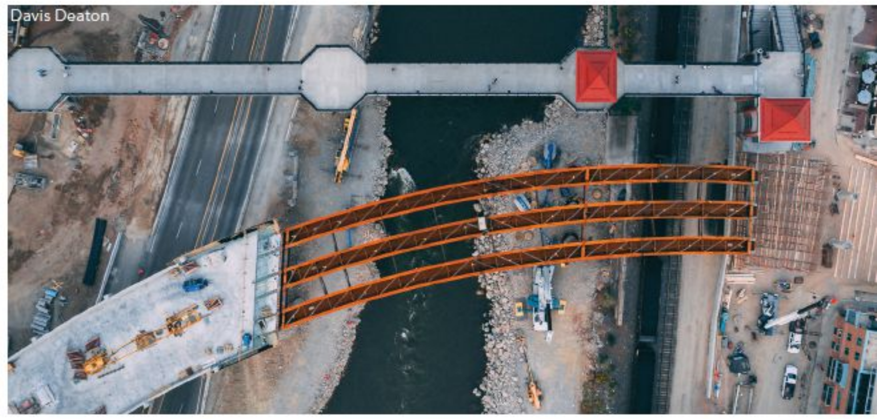
It was driven by the need to replace an aging and functionally obsolete bridge, a nine-span, 676-ft-long steel plate girder bridge constructed in 1953. The bridge carries SH82 over Interstate 70, the Colorado River, and Union Pacific Railroad (UPRR) lines before descending into the historic downtown business district of Glenwood Springs. It is one of only two crossings serving Glenwood Springs as well as other communities along the Roaring Fork River valley, including Aspen to the south.

The existing bridge had four roughly 9-ft-wide lanes that had effectively become a bottleneck to traffic flow. Widening the existing bridge was considered, but the structural capacity didn't meet current codes and there was limited service life remaining, thus making replacement the prudent choice. In addition, the Colorado Department of Transportation (CDOT) was unsuccessful in a previous attempt to replace the bridge due to opposition groups that were ultimately successful in shutting the project down. This time, CDOT made a concerted effort to improve the process by involving the designer, contractor, and public early in the design.

The project included changing the SH82 alignment over the bridge from straight to curved with a 625-ft radius. The new alignment and proposed intersections at the north end improved traffic flow at the SH82/I-70 interchange but made the new bridge geometrically challenging. The horizontal curvature resulted in the bridge crossing I-70, the river, and the railroad at varying degrees of skew. The north end of the bridge was tangent and required a flaring deck width to accommodate the changing lane requirements near the SH82/I-70 interchange. The profile also required a sharp vertical curve to get up and over the UPRR and then immediately begin the descent into downtown.

The new bridge had two distinct regions with significant variation in the required structure depths. A deeper structure of approximately 7 ft was required for the longer spans over the highway, river, and railroad. A shallower structure of approximately 3 ft was required for the shorter downtown spans to allow adequate headroom for a planned pedestrian plaza under the bridge.

For the deeper, steel portion of the bridge (Unit 1), which included the main spans over the Glenwood Hot Springs Pool parking lot, a Frontage Road, I-70, the Colorado River, and UPRR, a



five-span trapezoidal steel tub girder bridge using 6-ft deep girders was selected. A tub shape with sloped sides was the preferred aesthetic for its clean look, while also paying homage to the many steel and concrete tub/box girder structures supporting I-70 in nearby Glenwood Canyon. Tub girders also provided excellent torsional properties to efficiently handle the sharp curvature of the bridge. The tub girder section was optimized by using a narrower bottom flange (5 ft, 7 in. web to web) than had typically been used in Colorado. This, combined with recent enhancements in AASHTO regarding local flange buckling, helped achieve practical bottom flange thicknesses of 2 in. or less without requiring longitudinal bottom flange stiffeners. The increased web-to-web spacing between adjacent tub girders did affect the deck design, but this proved to be relatively inconsequential as compared to an even web spacing.

The number of tub girder lines was reduced from the four girders originally conceived down to three, resulting in fewer members to fabricate and erect and a maximum web-to-web spacing of 18.6 ft at the flared north end of the bridge. In addition, a refined deck analysis resulted in a reasonable deck thickness and reinforcement in this region. The contractor attached a temporary floor beam/stringer system from the tub girders to form the widest deck spans in the flared region. This proved more cost-effective than adding another girder line, which would have been required to accommodate standard deck forming systems in the flared region.

The reduction in girder lines also resulted in increased top flange lateral bracing demands, especially in the flared region. A study comparing Warren and Pratt truss layouts led to the selection of the Pratt truss as most optimal for this bridge. The Warren Truss design would have resulted in larger diagonal member forces in compression, which would have required larger diagonal members and the use of gusset plates at the flange connections. By comparison, the Pratt truss allowed strategic changes in diagonal member orientation to balance the member forces in either compression or tension while mitigating the magnitude of the diagonal member connection forces. The result was reasonable diagonal member sizes and direct connections to the top flange, and no gusset plates were needed.

Owner

Colorado Department of Transportation – Region 3, Grand Junction, Colo.

General Contractor

Granite/RLW Joint Venture, Glenwood Springs, Colo.

Structural Engineer

RS&H, Inc., Greenwood Village, Colo.

Steel Team

Fabricator

W&W/AFCO Steel, San Angelo, Texas AISC CERTIFIED FABRICATOR

Detailer

ABS Structural, Melbourne, Fla. AISC DETAILER

MERIT AWARD Medium Span

Williams Creek (Shoup) Bridge, Salmon, Idaho

THE TWO-LANE WILLIAMS CREEK (SHOUP) BRIDGE proves that two is sometimes better than one, as it replaced an existing single-lane river crossing in Salmon, Idaho, with an attractive two-lane bridge.

The original span was a flat compression-loaded bridge that sat on two concrete piers with sheet metal guard rails, and its replacement was architecturally finessed with arched beams for the main frame and tension-loaded with cross cables. The design team performed a fair amount of graphical design work to render the different bridge alternatives it was considering in order to facilitate engaged open houses and public meetings, and the team solicited local residents and business owners for their feedback on the various bridge types and looks. Modeling the different stages of steel erection, deck placement, deck curing, temporary support removals, and cable tensioning was a very involved and detail-oriented process, which allowed the team to accurately capture the cable tension and elastic lengthening and account for all of that elastic deformation in the design of the steel members—so that when everything was completed and all of the loads were on the bridge, the arch resulted in a nice, rounded shape and the roadway profile was at the proper elevation.

The team essentially had to start its analysis with the final product and work its way backwards to determine what shape the arch ribs and tie girders needed to be before they were erected and loaded. "The member lengths and shape of the arch in the final configuration are not the same as the lengths and shapes that get fabricated," noted one project engineer. "For me, that was the most complex part: the level of detail involved in the finite element model we built to determine all of the different loads and deflections anticipated for various support conditions throughout the entire fabrication to erection process."

During the construction phase, increased spring runoff flooded the Salmon River, and general contractor RSCI implemented progressively adaptive construction methods by shifting schedules for

Thompson Metal Fab


Thompson Metal Fab


Don Perkins

in-water work to meet the changing and unexpected water levels and fish spawning seasons. The allowable in-water work windows were tight and because of the historically high-water flows and ice dams, RSCI came up with alternate ways and times to set coffer dams, diversion barriers, and other elements, avoiding excusable schedule delays.

The team employed an Acrow temporary bridge structure for traffic during demolition and construction of the new bridge. The old bridge superstructure was demolished and the new single-span bridge was built using the existing bridge piers as temporary support structures; the piers were later demolished after traffic patterns were redirected onto the newly constructed bridge. This option was provided as a no-cost change order that eliminated the need to completely shut down traffic over the bridge for a period of 48 hours, providing continued use of the bridge during the contracted bridge slide. This method also minimized environmental impact to the river by eliminating the need to install and remove temporary piers required to support construction of the new bridge.

In similar fashion, RSCI implemented an alternate approach for structural steel erection that provided environmental and schedule benefits to the project. This involved designing, installing, and working from a platform that was built directly onto the permanent bridge girders and diaphragms. The work platform was constructed in modular units in the construction lay-down yard and erected along with the girders, allowing immediate use of the structurally supported working area once the substructure steel was installed. This working structure allowed for the use of aerial lifts, materials staging, and manpower to access parts of the bridge that would have otherwise required an additional work platform to be constructed adjacent to the bridge using a pile system, and thus disrupting more of the highly protected Salmon River.

Owners

U.S. Department of Transportation Federal Highway Administration, Vancouver, Wash.
Lemhi County, Salmon, Idaho

General Contractor

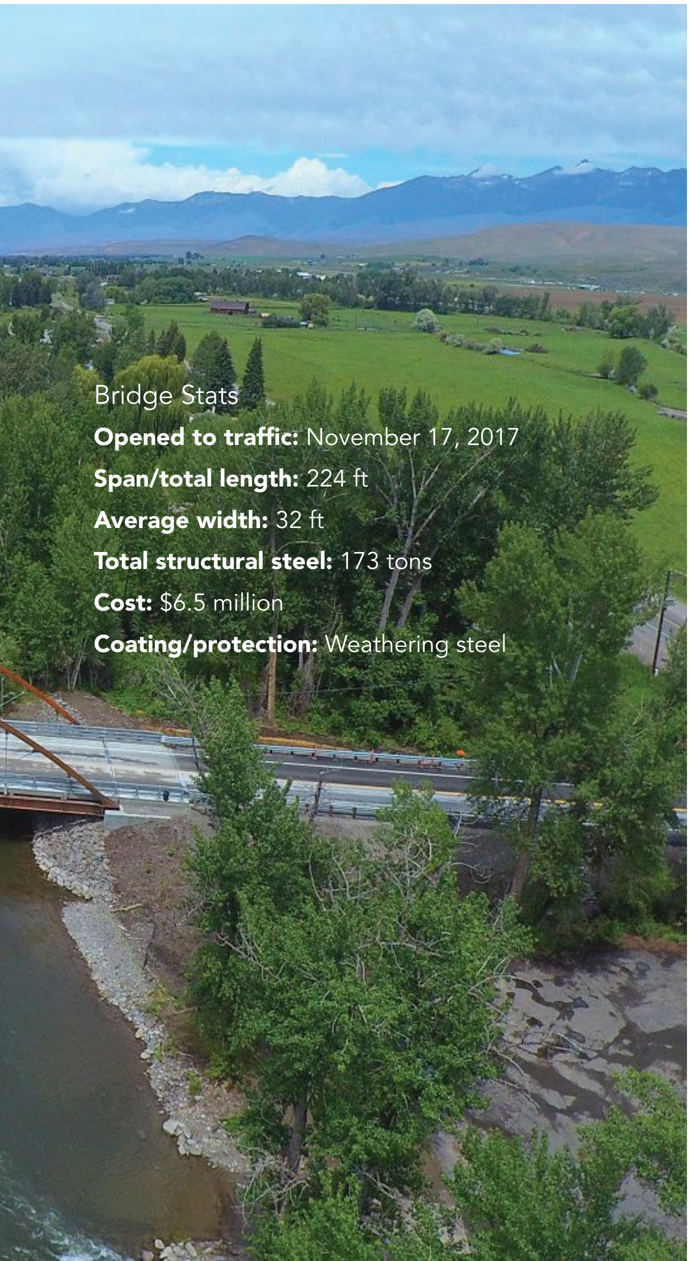
RSCI Group, Boise, Idaho

Structural Engineer

WSP|Parsons Brinckerhoff, Portland, Ore.

Steel Fabricator

Thompson Metal Fab, Inc., Vancouver, Wash. AISC CERTIFIED FABRICATOR



Bridge Stats

Opened to traffic: November 17, 2017

Span/total length: 224 ft

Average width: 32 ft

Total structural steel: 173 tons

Cost: $6.5 million

Coating/protection: Weathering steel

U.S. DOT Federal Highway Administration

Linda Ulery

Don Perkins

NATIONAL AWARD Long Span

Manning Crevice Bridge, Riggins, Idaho

THE MANNING CREVICE BRIDGE carries Salmon River Road across the Salmon River in a picturesque, V-shaped canyon 14 miles upstream from Riggins, Idaho.

Salmon River Road provides access to residences, resorts, commercial rafting ventures and is a main artery for recreational users of the river and forest lands. The existing bridge, built in 1938, had reached the end of its service life and required replacement. The location is remarkable not only due to its beauty but also its limited access and very limited space available to stage construction equipment and materials. The choice of steel for temporary and permanent works was key to developing a feasible erection scheme on this difficult site.

A single-tower, asymmetric suspension bridge was chosen after evaluating six different structure configurations. Competent bedrock at the site provided ample capacity for anchoring large horizontal forces, thus favoring arch and suspension bridge types over cable-stayed options. Given the limited access for construction equipment, a suspension option was judged to be more constructable than an arch because of the light weight and flexibility of steel cables. The bridge span length is 300 ft, and with a cable sag of 18.5 ft at mid-span, the resulting sag ratio (span/sag) of 16.2 is much flatter than the classical suspension bridge sag ratio of 10.

The site features a narrow shelf road with steep drop-offs in hard rock terrain. Standard construction techniques for such steep sites typically involve temporary benching, but the hard rock site and pristine canyon location made benching both cost-prohibitive and inappropriate. During design, a temporary crane platform was located on the north side of the river for erection of the tower and cable anchorages. Additional temporary platforms were also used for construction at the north anchorage and behind the tower base. The existing south-side roadway bench was wide enough to accommodate a crane for erection and still allow vehicles to pass. All construction materials were staged and delivered from Riggins to the north end of the bridge.

Project requirements for the bridge replacement included:

- A bridge deck clear width of 16 ft for a single lane
- A minimum vertical clearance of 18 ft
- A minimum load capacity of AASHTO HL-93 and a 45-ton logging vehicle
- Roadway curvature at the bridge ends must allow a logging truck to approach the bridge
- No permanent construction within the 100-year flood plain
- Traffic must be maintained on the existing bridge during construction
- The river must remain open to rafters during construction
- Construction equipment is not allowed in the river
- Reduce the visual contrast of the bridge within the context of the river canyon

Structural steel was integral to the success of the project, especially with regard to treading lightly on the site. The robustness of the erection equipment and temporary crane platform at the north abutment are directly proportional to the piece weights to be erected at mid-span over the river. The light weight of the structural steel sections, combined with the ease of connecting them using high-strength bolted splices, allowed for an erection scheme using only two fixed crane positions with reaches up to 160 ft.


FHWA-WFLHD


FHWA-WFLHD


Ken Saindon

Bridge Stats

Opened to traffic: January 22, 2018

Span/total length: 300 ft

Average width: 20.1 ft

Total structural steel: 188 tons

Cost: $7,912,900

Coating/protection: Weathering steel

Project representatives from the National Park Service were instrumental in identifying key aesthetic concerns, and the bridge deck overlay was designed as an ultra-thin bonded wearing course, with aggregate color that blends with the canyon setting. The bridge deck was cast-in-place concrete using integrally colored, internally cured concrete to enhance long-term durability and reduce visual contrast by providing a color that mimics dark appearance of the weathered granite rock outcrops adjacent to the bridge. The abutments and wind walls were given a surface stain to accomplish the same objective.

The completed structure should last more than 100 years, thanks to its protection scheme. Class C galvanizing was specified for the steel cables, and Grade 50 weathering steel was used for the towers and superstructure, both for corrosion resistance and the aesthetic considerations mentioned above.

The project has been overwhelmingly received by the community, both in terms of local residents and river user groups. The bridge officially opened June 5th, 2018 with a ribbon-cutting ceremony, and many attendees at the ceremony commented on how well the weathering steel finish complements the natural beauty of the canyon. The new single-tower bridge adds a touch of uniqueness to the canyon, with a force layout that reflects the constraints of the site.

For more on the Manning Crevice Bridge, see "Narrow Margin" in the October 2018 issue, available at www.modernsteel.com.

Owners

U.S. Department of Transportation Federal Highway Administration, Vancouver, Wash.

Idaho Transportation Department, Boise, Idaho

Idaho County, Grangeville, Idaho

General Contractors

RSCI Group, Boise, Idaho (also construction manager)

Inland Foundation Specialties, Boise, Idaho (ground anchors and micropiles)

Engineers

Atkins, Denver (structural design and project management)

Horrocks Engineers, Meridian, Idaho (CM/GC advisor and roadway design)

Shannon and Wilson, Denver (geotechnical design)

Steel Team

Fabricator

Rule Steel, Caldwell, Idaho

Detailer

ABS Structural, Melbourne, Fla.

all photos in this spread courtesy of Caltrans

MERIT AWARD Long Span

Pfeiffer Canyon Bridge, Big Sur, Calif.

RECORD RAINFALL IN THE WINTER of 2016/2017 in Monterey County, Calif., caused several landslides on the scenic coastal State Route 1, which closed the highway.

One of these landslides undermined a support for the Pfeiffer Canyon Bridge and caused severe damage that was beyond repair. The bridge was closed to traffic on February 15, 2017, and its loss devastated a portion of the Big Sur, which effectively became an island between the closed bridge on the north and a large landslide to the south. Groceries and fuel had to be helicoptered into the area. Children were no longer able to attend school located on the other side of the deep canyon. The community, whose main source of income was based on the tourist industry, now had lost its revenue source with State Route 1 closed on either side.

Caltrans immediately contracted with Golden State Bridge to demolish and construct a new bridge, designed by Caltrans, under an emergency force account (EFA). It was quickly determined that a temporary bridge was not feasible at this narrow mountainous site, since there was no room for both it and the permanent bridge as well as the required equipment and staging areas, making the design and construction of the new bridge even more urgent.

A single 310-ft-long composite welded-steel-plate-girder bridge was quickly determined to be the best solution for the replacement of the existing three-span concrete box-girder bridge. Plans for the steel plate girders were provided to the Golden State Bridge in just under two weeks after the damaged bridge was closed to traffic. The plans included two options for the girders: 1) hybrid girders consisting of Grade 50 steel for the top flanges and webs, and Grade 70 steel for the bottom flanges and 2) all Grade 50 steel girders. The latter option was chosen as it involved the quickest delivery when it came to all evaluated bid packages.

The girders were designed to have unstiffened webs to simplify and speed up their fabrication, and the webs were 1¼-in. thick to meet this criterion. The thicker unstiffened webs were also a benefit for launching since the shear resistance of the webs would be constant and not dependent on locations of the transverse stiffeners.

The new bridge width is 40 ft, incorporating three girder lines, and the total structure depth is 14 ft (the steel girders alone are just under 13 ft deep). Each girder line was fabricated in five segments for transport to the site and required four bolted field splices. The largest transported segment was 63 ft long and weighed 56.6 tons, and the girders were shipped to the site laying on their sides and required special Highway Patrol escort due to the width of the load on the narrow two-lane highway leading to the site.

Early on, Golden State Bridge decided it wanted to launch the girders across the canyon, since the girders could not be delivered to the south side of the canyon and erecting all girders from the north side would require a temporary trestle halfway across the deep canyon with an active landslide. Also, some of the temporary erection towers at the girder field splices would have to be located on the landslide.

The girder plans incorporated several details to accommodate the launching. To keep the bottom surface of the bottom flange level and flush for the rollers, the web plate height was varied depending on the flange plate thickness (instead of constant web plate height). Also, the lower field splice plates were redesigned to be three separate plates instead of a single plate so that the middle plate could be left off during launching to allow the rollers to pass though the splice. The existing bridge was on a horizontal curve, and the highway alignment for the new bridge was straightened to simplify the girder details to save design and fabrication time and allow for the girder launching.

To facilitate the launch, temporary pipe supports were constructed on each abutment extending from the seat to just above the back walls, and a central temporary tower was also constructed in the canyon at mid-span. This temporary tower consisted of multiple WACO shoring towers founded on a temporary concrete footing supported by cast-in-drilled hole piles. The approximately 75-ft-tall towers were also guyed at the top. A jacking frame was constructed on the south bank to pull the girders across the canyon using prestressing strands and two 235-kip hydraulic jacks.

All the girders were assembled on the north side of the canyon with a launching nose, and timber soffit formwork for the concrete deck and overhangs was added to the girders while they were being assembled on the launching bed; the catwalks were also installed while the girders were on the launching bed.

The launching plan involved a 14-stage process that included vertical alignment changes to raise the nose up and over the central tower and south abutment supports. The launch took three days following the very controlled and methodical launch plans. As each hydraulic strand jack piston cycled, the girder assembly was pulled in 12-in. to 18-in. increments. After each pull, measurements were taken to check for deflection and alignment to ensure the process was proceeding correctly. This process was repeated again and again until the assembled girders reached the south abutment—and marked the state's first bridge launch.

After the launch was completed, the top portion of the central temporary tower was removed along with the supporting rollers and guides. The girders were then lowered approximately 14 ft onto the abutment seats. The concrete deck was poured and then the see-through bridge railing was constructed. The new bridge opened to traffic on October 13, 2017, just eight months after the existing bridge was closed, reestablishing this vital link to Big Sur and the surrounding communities.

Owner

Caltrans District 5, San Luis Obispo, Calif.

General Contractor and Steel Erector

Golden State Bridge, Benicia, Calif. AISC ASSOCIATE

Structural Engineer

Caltrans Structure Design, Sacramento, Calif.

Bridge Stats

Opened to traffic: October 13, 2017

Span length: 310 ft

Total length: 315 ft

Average width: 40 ft

Total structural steel: 809 tons

Cost: $21.7 million

Coating/protection: Inorganic zinc primer undercoat with latex paint finish coat

NATIONAL AWARD Major Span

Governor Mario M. Cuomo Bridge, Westchester/Rockland Counties, N.Y.

THE NEW NY BRIDGE PROJECT produced a crossing of rather epic proportions.

The $3.98 billion undertaking replaced the old Tappan Zee Bridge with the new 3.1-mile-long twin-span Governor Mario M. Cuomo Bridge over the Hudson River, located approximately 20 miles north of New York City. One of the largest-ever transportation design-build contracts in the United States, it is designed for a 100-year service life and carries a new enhanced regional bus service in addition to typical road traffic, and the foundations are designed to carry future commuter/light rail tracks on structures erected between the two spans. The largest bridge project in New York history provides greater traffic capacity while improving operations and safety for motorists crossing one of the widest parts of the Hudson River.

The new bridge features parallel 3.1-mile-long structures, each with a 2,230-ft cable-stayed main span and ten 1,750-ft five-span continuous approach units comprised of 350-ft steel girder spans. It provides eight general traffic lanes, plus dedicated bus lanes and shoulders for emergency access. The design team selected structure types with proven service life and efficiency in order to maximize span lengths and minimize foundation demands while engaging local trade expertise. The approach structure design maximized span lengths using a long-span steel girder sub-stringer system with an average span length of 350 ft, resulting in fewer foundations needed. In the deep clay area, the highest-capacity friction piles (2,100 tons) ever used in these types of soils were implemented and have proven to be successful.

As the lead designer, HDR analyzed, designed, and detailed the approach structure steel girder sub-stringer system, which included composite steel girder design, sub-stringer design, and cross-frame design in accordance with AASHTO *LRFD Bridge Design Specifications*. 3D finite element models were created to analyze the steel system as a whole and to develop demands for design. Half of the units were located on a curved alignment, which required the design of continuous curved steel girders in which the effects of torsion were considered in both the temporary and permanent state.

Design of the approach spans was based primarily on five-span continuous units. The steel framing supporting each roadway deck included five main girders and four substringers to minimize foundation loads. Overall, 110,000 tons of fabricated structural steel went into the project.

Steel allowed much of the superstructure construction to be modularized. Large picks were made possible by the relatively light superstructure, saving time, minimizing the number of construction activities that needed to occur at elevation, and providing a safer construction process. The light steel superstructure also allowed the team to optimize the pier and foundation designs. Besides minimizing the gravity loads, the seismic demands were minimized by the reduced mass and increased flexibility of the superstructure when compared with other considered structure types. Most of the approach structures are founded on either 3-ft- or 4-ft-diameter steel pipe piles, and the towers, anchor piers, and approach piers adjacent to the anchor piers are founded on 6-ft-diameter steel pipe piles.

The flexibility of a steel superstructure was also highlighted in a portion of the site over Metro-North Railroad tracks where crane access was limited. HDR worked with the contractor to develop a steel girder system that could be launched from the Westchester abutment in multiple phases overnight during track outages. The designer worked hand-in-hand with the erection engineer up front to ensure that the design could accommodate variations in loading during launching activities, which minimized changes during the fabrication process.

Owner
New York State Thruway Authority, Albany, N.Y.

Design/Builder
Tappan Zee Constructors, LLC, a joint venture of:
Fluor, American Bridge Company,
Granite Construction Northeast, and Traylor Bros., Inc.

Structural Engineer
HDR, New York

Steel Team

Fabricators
High Steel Structures LLC, Lancaster, Pa. (approach unit superstructure, also detailer)
W&W/AFCO Steel, Greensboro, N.C. (approach unit superstructure, also detailer)
Canam-Bridges, Point of Rocks, Md. (main span superstructure)
L&M Fabrication and Machine, Inc., Bath, Pa. (main span superstructure)

Detailer
Tenca Steel Detailing, Inc., Quebec

Bridge Stats

Opened to traffic: September 1, 2018

Span lengths: Two parallel three-mile structures, each with:
- Unit 11 WB/EB: 2,230-ft cable-stayed unit comprised of a 1,200-ft main span and two 515-ft anchor spans
- Unit 1 WB/EB: 388-ft two-span simply supported approach unit comprised of 116-ft and 272-ft spans, respectively
- Unit 2 WB/EB: 1,000-ft three-span continuous approach unit comprised of spans varying between 309 ft and 350 ft
- Unit 3 WB/EB through Unit 8 WB/EB: Six 1,750-ft five-span continuous approach units comprised of 350-ft steel girder spans
- Unit 9 WB: 1,075-ft three-span continuous approach unit with spans varying between 345 ft and 365 ft
- Unit 9 EB: 1,666-ft five-span continuous approach unit with spans varying from 301 ft to 354 ft with a simple 224-ft jump span at the end
- Unit 10 WB: 745-ft three-span continuous approach unit with spans varying from 235 ft to 262 ft

Total length: 3.1 miles (16,368 ft) per bound

Average width: Westbound: 96 ft; Eastbound: 87 ft

Total structural steel: 110,000 tons (including steel pipe piles)

Cost: $3.98 billion

Coating: Painted weathering steel for the superstructure, galvanized rebar and specific coatings and overlay for the concrete deck

photos in this spread courtesy of New York State Thruway Authority

MERIT AWARD Major Span

Broadway Bridge Over the Arkansas River, Little Rock/North Little Rock, Ark.

THE ORIGINAL BROADWAY BRIDGE served the communities of Little Rock and North Little Rock, Ark., for over 90 years as both a vital crossing and a signature tribute to World War I veterans.

Built in 1922, it carried vehicular traffic into the downtown area with nearly 24,500 vehicles per day. However, with the continuing trend of residential redevelopment in the two cities' downtown areas, the increasing need for safe and efficient crossings of the river became more apparent. In 2010, the Arkansas Department of Transportation (ARDOT) made the decision to replace this functionally obsolete bridge due to it being structurally unsound as well as the lack of mobility it provided for the growing population in the area. The team of HNTB Corporation and Garver, LLC, was chosen to design the replacement bridge in 2011.

Garver developed a new layout to address the current traffic needs while increasing safety for the traveling public, and was responsible for improving sight distances, as well as separating motorists and pedestrians, through the addition of a 16-ft-wide shared-use path, two new pedestrian-only ramps connecting the trails directly to this path, and MSE walls to reduce right-of-way impacts and overall bridge length.

Pulaski County leaders wanted the bridge to serve as a unique and pleasing experience for pedestrians and cyclists by enhancing the aesthetics of the bridge, and contributed $20 million of the $98 million total project cost to be spent toward two signature spans over the river. These funds allowed the design to possess an enhanced aesthetic form constructed in an accelerated fashion and using a limited budget to satisfy the current and future needs of the community.

The HNTB-designed main spans of the Broadway Bridge are composed of two 448-ft network tied-arch spans with steel plate girder approaches. The lengths of the five approach spans vary from 126 ft to 227 ft. The final design consists of inclined basket-handle arches with a framed-in floor system, resulting in a cost savings for the bridge. The tied arches allowed a signature structure to be constructed on the existing alignment ahead of the anticipated 180-day closure by using an accelerated bridge construction (ABC) technique to float the arches into place.

Throughout design and construction, great care was taken to observe the U.S. Federal Highway Administration's strict guidelines for fracture-critical members. The bridge was made with ASTM A709 Grade 50 steel, which includes the Charpy V-notch Zone 3 requirements for increased toughness. This was important for the tie girder, floor beams, and hanger plates as they are all considered fracture-critical members. For the tie girder, the cross section con-


Trey Cambern, courtesy of HNTB

Bridge Stats

Opened to traffic: March 1, 2017

Span lengths (approach and main spans): 126 ft, 137 ft, 180 ft, 448 ft, 448 ft, 199 ft, 227 ft

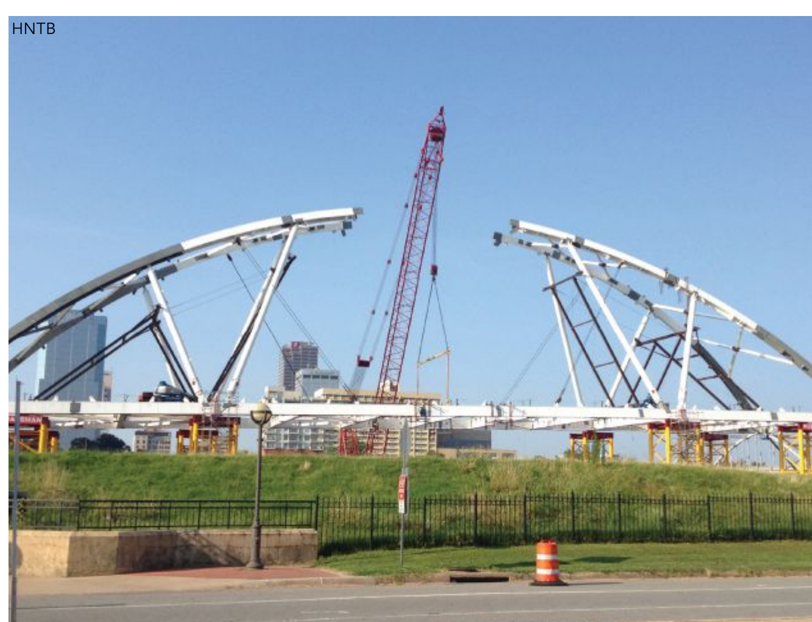
Total length: 1,765 ft

Average width: 73 ft out-to-out

Total structural steel: 4,097 tons (arch spans)

Cost: $98.4 million

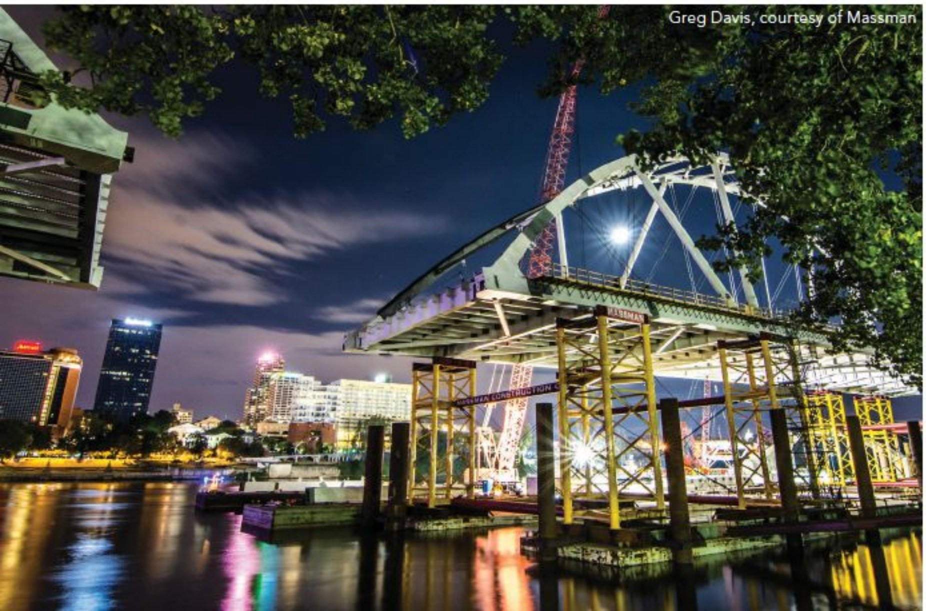
HNTB



HNTB

HNTB

Greg Davis, courtesy of Massman



Greg Davis, courtesy of Massman

sists of a closed parallelogram box girder made up of two inclined webs and two horizontal flanges. The web plates are welded to tab plates with a double-fillet weld and are then bolted to the flanges. This bolted connection isolates a potential fracture of one plate without allowing the fracture to propagate throughout the cross section. The resulting three-sided tie girder section was designed to carry the structural demands at an extreme event limit state, and this internal redundancy eliminates the potential of a catastrophic structural failure.

The construction of the arches took place on falsework floating in the river moored to the north bank of the Arkansas River. This technique provided extra space for the contractor to work since the construction footprint was limited for such a large urban project. To minimize the closure period during construction, the bridge's new foundations were strategically placed to provide clearance from the existing foundations. This allowed the contractor to use specialized equipment to construct the new drilled shafts and waterline footings beneath the existing bridge while the bridge remained open to traffic. The new tied-arch structure was floated into place once the primary structural steel framing was erected. This ABC provess required only two 24-hour river closures.

Using these techniques, the team was able to open the $98 million structure to vehicular traffic on March 1, 2017, removing 28 days from the anticipated 180-day closure period and following 2.5 years of construction.

For more on the Broadway Bridge, see "Making a Signature Connection" in the July 2017 issue, available at ***www.modernsteel.com***.

Owner

Arkansas Department of Transportation, Little Rock, Ark.

Prime Contractor

Massman Construction Co., Overland Park, Kan.

Structural Engineers

HNTB, Kansas City, Mo.
Garver, North Little Rock, Ark.

Steel Team

Fabricators

Veritas Steel, Palatka, Fla. AISC CERTIFIED FABRICATOR
W&W/AFCO Steel, Little Rock, Ark. AISC CERTIFIED FABRICATOR
Delong's, Inc., Jefferson City, Mo. (also detailer, south approach) AISC CERTIFIED FABRICATOR

Detailers

Tensor Engineering, Indian Harbour Beach, Fla. (arch spans) AISC DETAILER
ABS Structural, Melbourne, Fla. (north approach) AISC DETAILER

Bridge Stats

Opened to traffic: December 11, 2017

Span length: 483 ft

Total length: 963 ft

Average width: 22 ft

Total structural steel: 4,300 tons

Cost: $68 million

Coating/protection: Paint

all photos and graphics in this spread courtesy of Modjeski and Masters

MERIT AWARD Major Span

Portageville Bridge Replacement, Portageville, N.Y.

THE NEW PORTAGEVILLE BRIDGE had big shoes to fill, so to speak.

The original bridge crossed the scenic Genesee River Gorge, known as the "Grand Canyon of the East," in Letchworth State Park in Portageville, N.Y., which hosts more than a million visitors a year thanks to its stunning scenery, including three large waterfalls along the Genesee River (the new bridge, adjacent to where its predecessor once stood, is located directly above the Upper Falls).

The old viaduct bridge, built in 1875, was considered iconic within the Park and it was expected that a new bridge would need to be as well. After nearly a decade of public meetings, stakeholder input, environmental study, and engineering analysis it was determined that the new bridge would be a spandrel-braced arch. Through the State Environmental Quality Review Act, nine different alternatives were evaluated, based on the project objectives and the site's unique characteristics. Ultimately, the best alternative was to build a new bridge on a parallel alignment and remove the existing bridge.

Modjeski and Masters (M&M) led the structural design of the new 483-ft-long arch. The arch is flanked on both sides by three 80-ft-long welded girder spans, and the track is supported across the bridge with a 20-ft-wide concrete ballast deck. The welded girder spans are supported on reinforced concrete piers and abutments that are founded on micropiles. The selected design was the first true arch bridge built for the rail industry since the late 1940s.

The bridge required project-specific design criteria as its span was beyond the guidance provided by the *American Railroad Engineering and Maintenance of Way Association (AREMA) Manual*, which is primarily used on simple-span bridges less than 400 ft in length. The arch was erected in two halves, from the east and west skewback foundations, using the cantilever method. An east and west "arch tieback system" was designed to support each arch half during cantilever erection up until arch closure. Each tieback system tied into the gusset plate at the end of top chord of the arch, and then anchored into a guy tower and backstay system with 12 cables. The guy towers transferred cable demands to a series of back stay members and directed the vertical components into the permanent approach span abutment. The backstays were connected to a grillage system that was anchored by 140-ft -ong pretensioned rock anchors.

Each individual cable was connected to a tensioning device equipped with a jacking rod and center-hole jack, which was used to adjust the cable lengths and thus the arch geometry during erection and arch closure. The deflection of the arch and the tension in the tieback system cables were monitored throughout cantilever erection stages. Field-recorded values were compared to theoretical values obtained from a staged construction analytical model to ensure the arch closure geometry was eventually achieved. At the arch closure stage, the geometry for each half was fine-tuned using the tieback system until the bolt holes in the lower center panel point were aligned.

The gorge walls had an irregular shape and were not easily accessible. The difficult terrain would have made conventional surveying methods difficult, so lidar scanning was used to make a preconstruction survey of the gorge walls. The preconstruction survey was used for placement of cranes and the determination of lifting radius, and an additional lidar scan was made after the gorge pockets were completed to verify excavated quantities.

The AREMA guideline for spacing trusses at 1/15 of span length was not followed, due to the unnecessary width that would be added due to the long span. The structure was proportioned such that no load combination produced uplift, except for a few combinations during construction staging. Plate thicknesses of box members were sized to preclude the need for longitudinal stiffeners. The main members were designed including in-plane and out-of-plane bending moments. As many of the applied loads can be multi-directional and thus cause moments to change direction, a conservative assumption was made to combine them in an additive manner and match the polarity of the axial loading under investigation.

A memorandum of agreement between the Federal Highway Administration; Norfolk Southern; New York State Department of Transportation; the New York State Office of Parks, Recreation, and Historical Preservation; the National Park Service; and various Indian Nations was created to produce a mutually agreed plan to avoid, minimize, or mitigate the impacts on various historic and cultural resources. The agreement stipulated that portions of the existing bridge would be salvaged and displayed to mitigate the removal of the bridge. Impacts on other historical resources were avoided through a construction protection plan. In addition, plans were developed to protect endangered species, including northern long-eared bats, timber rattlesnakes, and bald eagles during construction.

Owner

Norfolk Southern Corporation, Atlanta

General Contractor and Steel Erector

American Bridge Company, Coraopolis, Pa. AISC ASSOCIATE AISC CERTIFIED ERECTOR

Structural Engineer

Modjeski and Masters, Mechanicsburg, Pa.

Steel Team

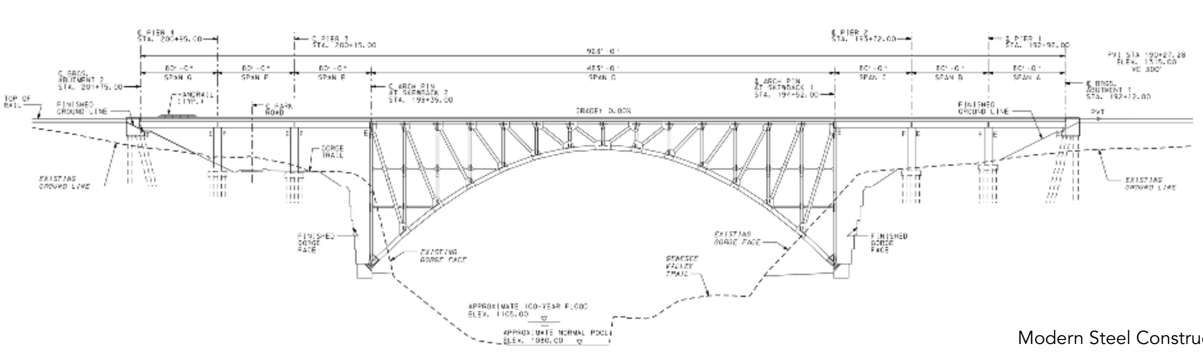
Fabricators

Canam-Bridges, Point of Rocks, Md. (arch bridge)

Veritas Steel, LLC (approach deck girder steel spans)

Detailer

DBM Vircon Services, Port Coquitlam, B.C., Canada AISC DETAILER



NATIONAL AWARD Moveable Span

Sarah Mildred Long Bridge, Kittery, Maine/Portsmouth, N.H.

THE NEW SARAH MILDRED LONG BRIDGE across the Piscataqua River between Portsmouth, N.H., and Kittery, Maine, replaces an existing span built in 1940.

Where the original bridge involved a bi-level lift span and approach bridge format, the new incarnation is a single-level lift span with bi-level approach spans. Both new and existing structures were designed to carry vehicular traffic (on the upper level) and rail traffic (on the lower level), with the new single-level lift span lowering for rail traffic and raising for maritime vessels.

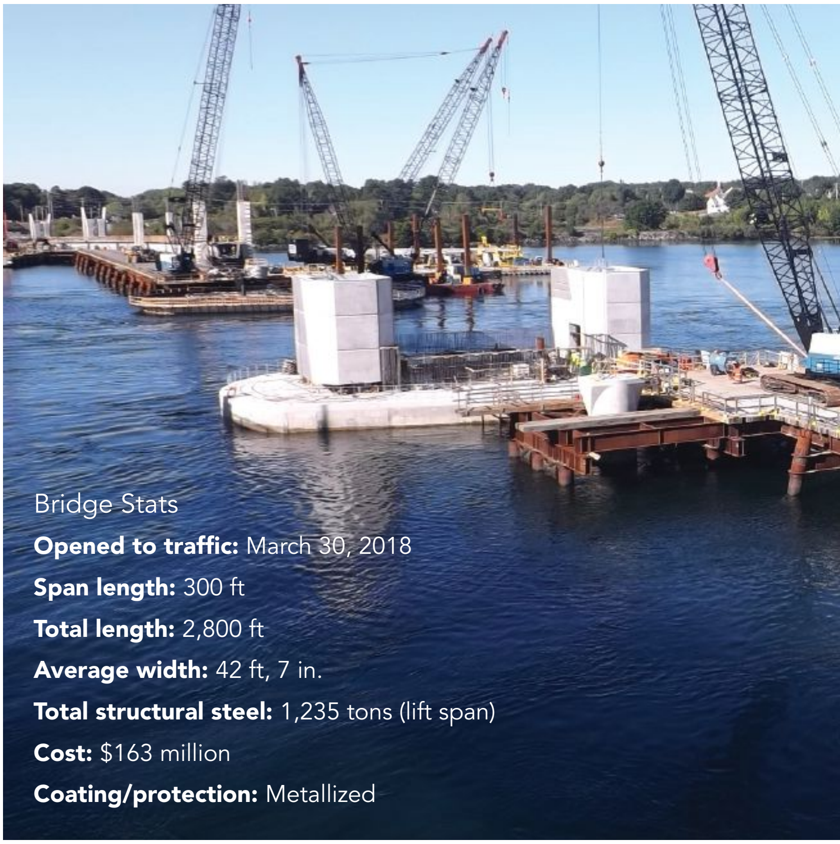
The project included a complete bridge replacement including foundations, an operator's room, new traffic warning systems, a new 300-ft-long steel box girder lift span, and precast post-tensioned towers and vehicular and railroad approach segments. Key challenges included minimizing construction costs and construction time, a swift tidal channel with a current of approximately 5 knots and a tidal change of 8 ft, and a design vessel collision force of 6,000 tons.

On the lift span itself, where originally positioned on separate levels, the rail and roadway are on the same level, with the tracks are embedded in the median, and dual seating positions (vehicular and rail) allow the single-level lift span to match the bi-level approaches. Since the new bridge has a 56-ft vertical clearance when in its "resting" position (an increase in vertical clearance from the original configuration) there will be 68% fewer bridge openings than with the old bridge, significantly reducing the number of traffic delays. The lift span is simply lowered down to match up with the railroad bridge approaches on the relatively rare occasion when trains are traveling across the river.

A traditional twin steel tub girder design with a continuous top plate was employed for the lift span superstructure to facilitate shipping to the site by truck from inland fabricators. This allowed the final configuration of the lift span to be fabricated at local inland facilities then assembled on-site, reducing the construction schedule and planned existing bridge closures.

The lift span girder is a multi-box steel structure with a composite concrete deck. Based on the length-to-width ratio of the structure, the entire cross section is effective in resisting global forces. The primary longitudinal load carrying members include two main boxes with separate bottom flanges, two fascia box beams, and a composite concrete deck. In addition to contributing to the overall cross section, the composite deck is designed to transmit local loads transversely to the main longitudinal elements. Longitudinal elements are braced at discrete points along the length of the span at 12-ft increments. Transverse elements include cantilever brackets between fascia boxes and main boxes, internal box bracing, and intermediate diaphragms along the centerline of the span between main boxes, and the lift span girder is supported at each end by transverse lifting girders.

all photos in this spread courtesy of Maine DOT



Bridge Stats

Opened to traffic: March 30, 2018

Span length: 300 ft

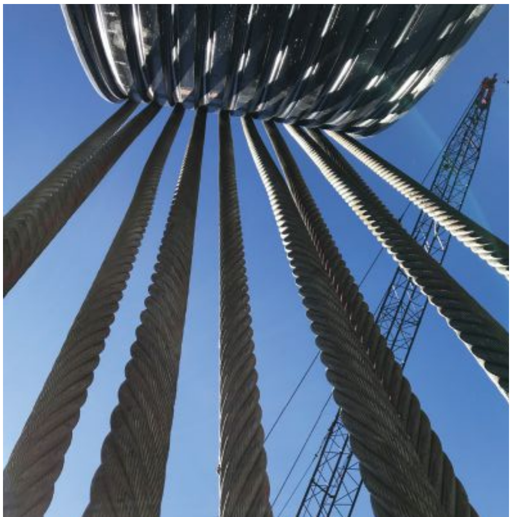
Total length: 2,800 ft

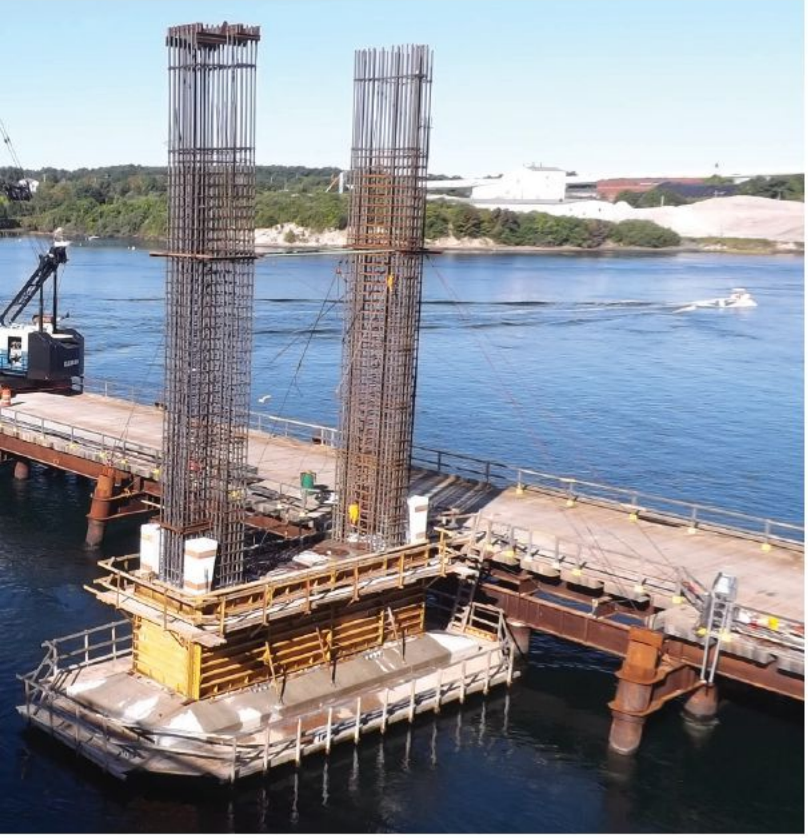
Average width: 42 ft, 7 in.

Total structural steel: 1,235 tons (lift span)

Cost: $163 million

Coating/protection: Metallized





The main boxes are aligned such that the interior webs are located directly below each rail track. The track is embedded within the concrete deck, with minimal cover to the top of the steel, and the design team implemented a direct load path into the box section. In addition to providing a predictable load path, this alignment eliminated the need for supplemental track support structures and ultimately reduced the span weight.

An innovative retractable support system was developed to support the lift span at the mid-level roadway position and move out of the way to allow the lift span to lower to the rail position. Tapered steel columns founded on spherical bearings at the rail level and cylindrical bearings at the electrical room under the roadway level rotate to allow for the dual seating of the lift span.

The fatigue critical areas of the structure are primarily located along the top flange plate when subjected to transverse loading. Fatigue analysis of the deck plate required an increased plate size along the centerline of the span, below the track and extending beyond the interior web plates. Deck plate details in the longitudinal direction are not a fatigue concern, as the flange always remains in compression.

Placing the operating machinery at the base of the tower is an innovation that is relatively recent to the movable bridge industry—and one that was implemented on the new Sarah Mildred Long Bridge. By locating the lifting machinery, mechanical systems, and electrical systems lower in the tower, all this equipment was installed before completing tower erection and lift span float-in. This provided for quicker construction, reducing initial costs and providing easier access for future maintenance.

The lift span box girders and other lift span steel components were fabricated at Casco Bay Steel Structures in South Portland, Maine, sent by rail to a waterfront facility, and then barged to the bridge site. Float-in was a complex operation that required a fixed guide barge, an adjacent push barge with two tugs, and a lift span overhanging barge. Several important steps followed the float-in, including deck placement, joint installation, finger joints, mitre rail, span guides, access, and rope connection.

The bridge was designed with long open spans, using 11 fewer piers than the old bridge. This span layout not only enhanced vistas for residents and motorists, but it also enabled the new bridge to cross Market Street without a pier in the median and serve as a gateway entrance into historic downtown Portsmouth.

Owners

Maine Department of Transportation, Augusta, Maine
New Hampshire Department of Transportation, Concord, N.H.

General Contractor and Steel Erector

Cianbro, Pittsfield, Maine

Structural Engineer

Hardesty & Hanover, LLC, New York

Steel Team

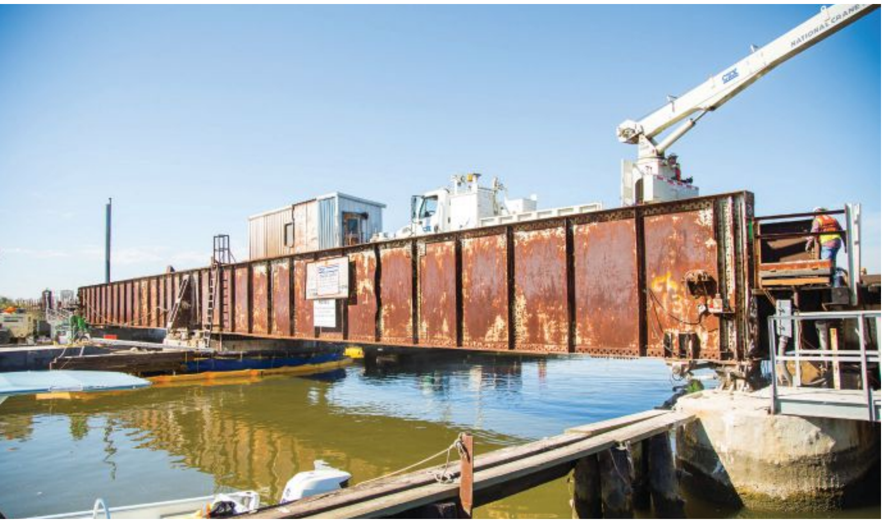
Fabricator

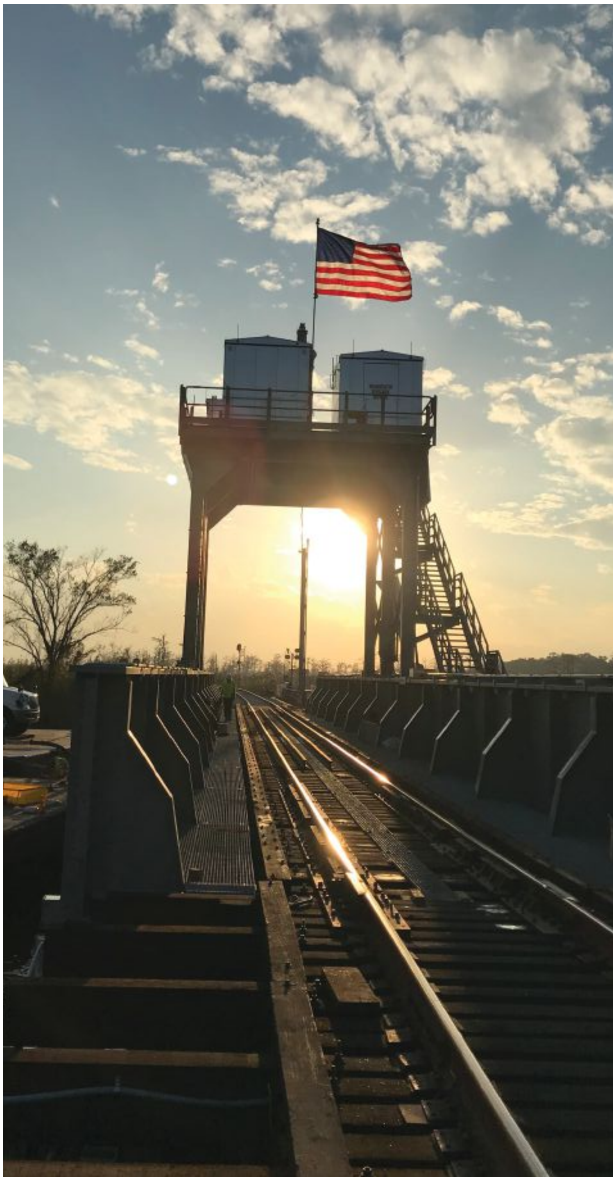
Casco Bay Steel Structures, Inc., South Portland, Maine

Detailer

Tensor Engineering, Indian Harbour Beach, Fla.

all photos in this spread courtesy of HDR





MERIT AWARD Moveable Span

Bayou Sara Swing Bridge, Mobile County, Ala.

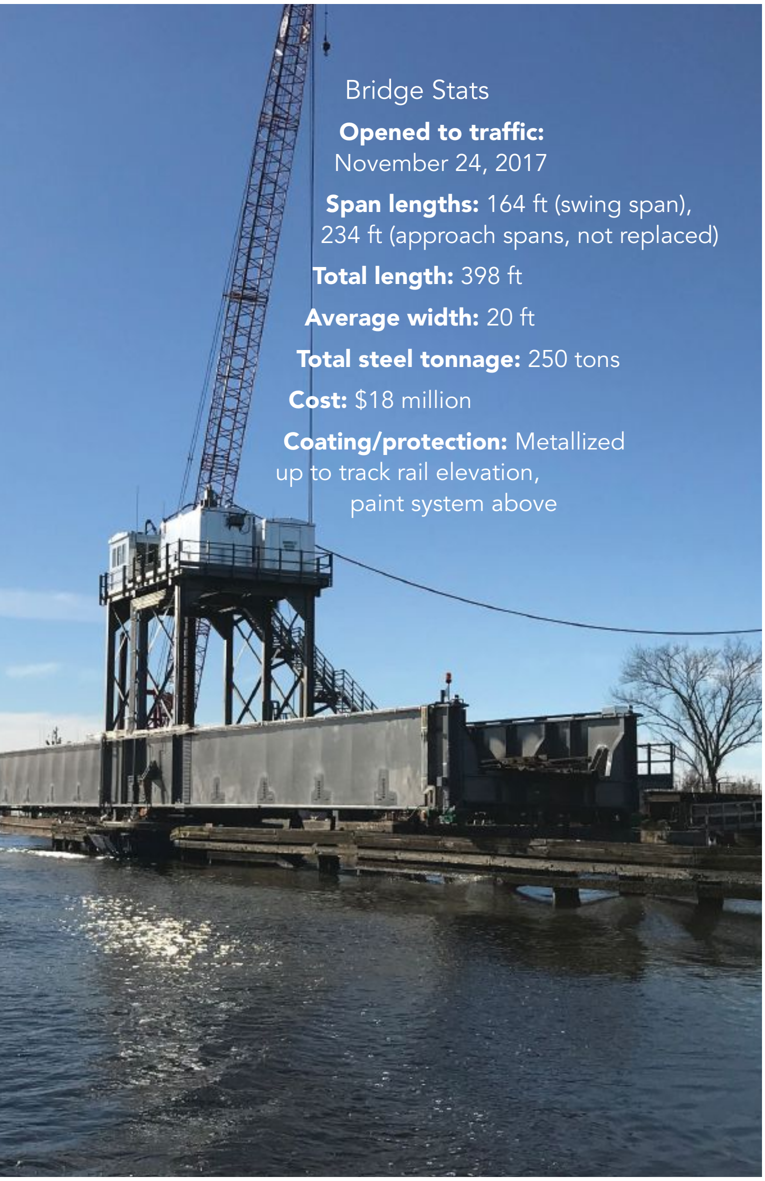
CSX'S SINGLE-TRACK, 163-FT-LONG Bayou Sara Swing Bridge is one of the rail transportation company's 47 movable bridges.

While the approach spans had been recently replaced, the swing span was over 90 years old and was scheduled to be replaced as part of a program to upgrade all of CSX's movable bridges. To replace this critical link on the company's Mobile Bay line, they turned to HDR to design a durable replacement to include remote operation, minimized maintenance, and limited rail service interruption during construction. By opting for an in-kind replacement, the team reused the substructure, simplified construction, sped up the schedule, and reduced permitting requirements and track outages.

The mass of a swing span must be balanced for proper operation. Many swing spans, including the old Bayou Sara Bridge, have the control house mounted to a platform along the span edge, near the pivot. This requires a counterweight on the opposite girder to transversely balance the span. In the replacement bridge, the new electrical components, hydraulic equipment, and control systems are positioned on a platform above the track. This platform required ample height to allow trains to pass beneath, elevating the bridge's equipment. This brought several advantages, including security, environmental resiliency, and balance as the counterweight steel was reduced by 20 tons. An outboard access walkway and stairway provide access to the platform, away from the track.

Using a steel "grillage" to be embedded in the pier cap concrete, the bridge machinery and bearings were aligned and locked in their final position on this assembly suspended from beneath the span prior to float-in. The grillage took the place of the top portion of the pivot pier, which was removed during construction. It provided support for all dead and live loads applied to the pivot pier, permitting rail traffic to pass almost immediately after the span float-in. The outage for marine navigation was longer than for the track, and this allowed for casting the surrounding concrete in place after the float-in phase and prior to operating the swing span.

During hurricanes or lunar high tide, it was common for the water to rise above the bottom flange of the girders, inundating the bridge machinery with brackish coastal water. Since the bridge



approaches could only be raised minimally, the replacement bridge incorporated features that mitigated the effects of high water inundating the lower part of the bridge. The team placed the operational machinery on a gantry 28 ft above the track to remain above the water even during the worst of storms.

Given the challenges, collaboration was critical to project success. The decision to proceed with the grillage concept was ultimately made in September 2017, approximately two months prior to the target float-in date. This limited the schedule for detailed design, procurement, fabrication, and assembly. When the grillage concept was first discussed, general contractor Brasfield and Gorrie immediately contacted the steel fabricator, Steward Machine, to discuss constructability and material availability, and Steward provided feedback on available structural shapes, which were approved. This collaborative effort expedited shop drawing development and engineering review, which was crucial to procuring the grillage in time for installation prior to the float-in.

From the beginning of the project, the rail outage allowed by CSX's freight rail operations team was to be 48 hours, which is a challenging window for removing a movable bridge span and installing a new one. During the construction phase, a plan was developed to swap out the spans within this time frame, using a precast concrete pier cap to simplify construction and replace the deteriorated concrete cap.

However, as the planned outage drew near, CSX asked if the outage could be reduced so as to avoid delaying trains, several options were considered, including temporary piles, which would have added significant costs to the project. In the end, the collaborative efforts between the owner, contractor, and engineering teams concluded that the most cost-effective solution was a structural steel support frame (grillage) suspended from the new swing span with pre-mounted rack, wedges, and pivot bearings. This additional pre-work allowed for an accelerated swap-out of the swing spans, reducing the required track outage to only 14 hours.

Owner
CSX Corporation, Jacksonville, Fla.

General Contractor
Brasfield and Gorrie, Birmingham, Ala.

Structural Engineer
HDR, Newark, N.J.

Steel Fabricator and Detailer
Steward Machine Co., Inc., Birmingham, Ala.

NATIONAL AWARD Special Purpose

Frances Appleton Pedestrian Bridge, Boston

THE FRANCES APPLETON PEDESTRIAN BRIDGE project achieves visual transparency and lightness through a carefully selected structural steel system as it connects Boston's Beacon Hill neighborhood to the Charles River Esplanade.

The slenderness of the bridge was balanced against creating a structure that would potentially have issues with pedestrian-induced vibrations. During the design process, multiple iterations of the structural system were performed to achieve the "maximum" comfort range for pedestrians while eliminating the need for future supplemental measures, such as installing tuned mass dampers. The final design includes the creative use of a lightweight concrete deck with foam-filled stay-in-place forms and appropriate foundation details.

The 750-ft-long multiuse walkway, adjacent to the historic landmark Longfellow Bridge, consists of a contemporary tubular steel arch with a span of approximately 226 ft over a parkway. The steel superstructure, approximately 550 ft in length, is continuous without any joints and its shape in plan follows a curvilinear alignment in two directions. The arch and approach spans follow a distinct architectural theme of slender steel piers and struts for visual consistency and aesthetic appeal.

The new crossing replaced an existing bridge that was too narrow and had inadequate access stairs, and conflicts between pedestrians and bicyclists were common. The placement and overall geometry of the new bridge were carefully selected to comply with the ADA maximum slope requirements and avoid impacting large trees in the parkland as much as possible—and its width of 14 ft doubles that of the original bridge. Integrated into the bridge are several entry points and connections to the existing network of walkways along the Esplanade.

The elegant steel superstructure consists of steel girders branching into two curved staircases and a scenic overlook plaza near the river. The bridge's steel fit-up required careful planning during the final design phase as construction over a busy arterial road necessitated a detailed erection plan and sequencing, and stresses were evaluated in all structural members during both fabrication and erection. The major challenge of this unique bridge was the fabrication of the steel structure and its overall constructability, and its design included complex curves and welded connections.

The main steel arch has a unique shape, being wider at the crown and narrower at the abutments, which helped minimize the

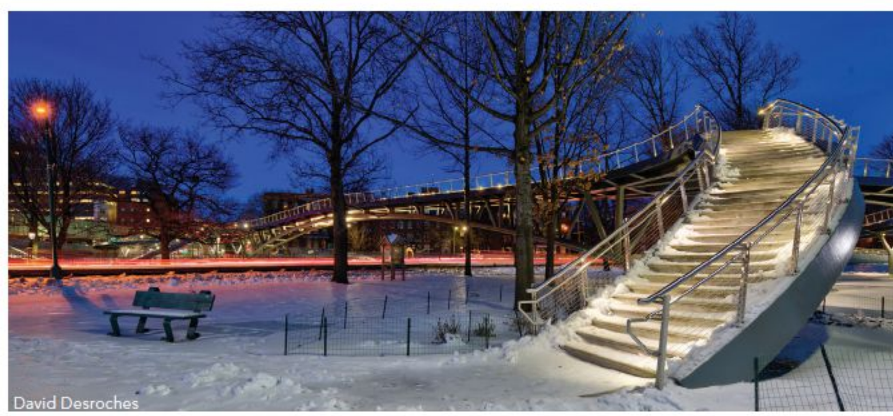
Juan Navarro

Christopher McIntosh

Newport Industrial Fabrication


David Desroches

Carlos Arazaga


David Desroches

size of the anchoring abutments at the park level. The arch also includes a series of inclined struts, creating a unique aesthetic truss effect, and is the longest bridge span over Storrow Drive connecting the city to the riverfront. The crossing is also higher than any other existing bridge along the highway corridor, opening views and incorporating appropriate vertical clearances.

The arch was brought to the site in pieces and assembled during overnight hours to reduced traffic impacts, and it was welded in place in order to avoid using visible bolted connections. The bridge approaches include Y-shaped piers, which visually match the main architectural theme creating a visually unified structural system. Aesthetic lighting is also included to increase the sense of safety and appeal at night, and the sinuous crossing is perfectly integrated into the landscape thanks to its transparency and lightness.

The new signature pedestrian bridge has quickly become a source of pride for the community due to its technical ingenuity, elegant detailing, and context-sensitive design, which perfectly integrates into Boston's landscape and historic riverfront.

For more on the Frances Appleton Pedestrian Bridge, see "Take Me to the River" in the April 2019 issue, available at www.modernsteel.com.

Owner
Massachusetts Department of Conservation and Recreation, Boston

General Contractor
White/Skanska/Consigli, JV, Framingham, Mass.

Designer
Rosales + Partners, Boston

Structural Engineer
STV, Boston

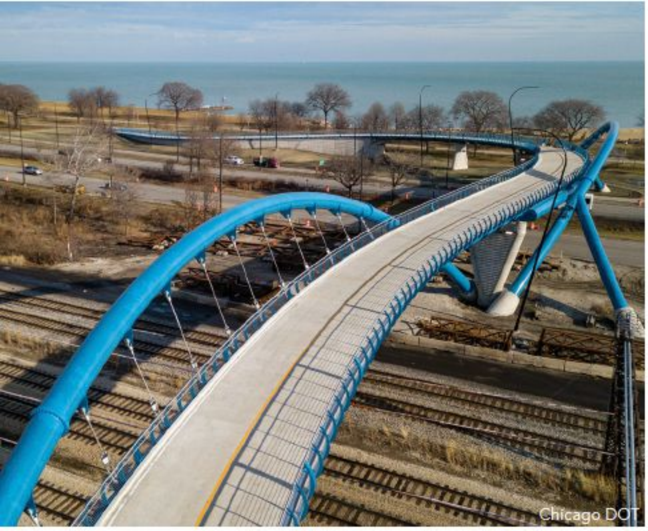
Steel Team

Fabricator and Detailer
Newport Industrial Fabrication, Newport, Maine

Erector
Saugus Construction Corp., Georgetown, Mass.

Bender-Roller
Kottler Metal Products, Willoughby, Ohio

Castings
Cast Connex Corporation, Toronto


Chicago DOT

Bridge Stats

Opened to traffic: December 20, 2018

Span length: 750 ft

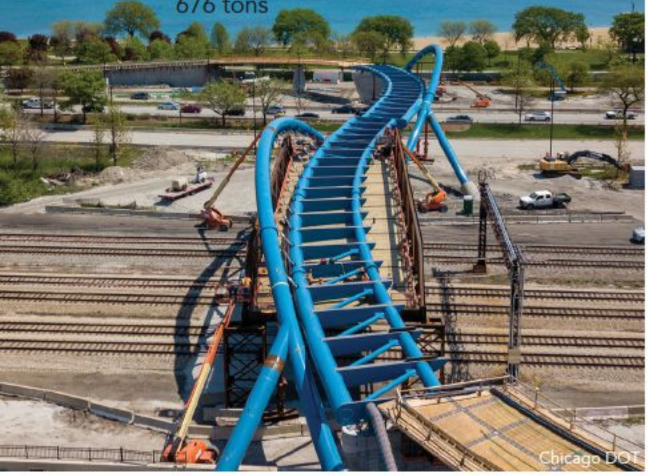
Total length: 1,500 ft

Average width: 24 ft

Total structural steel: 676 tons

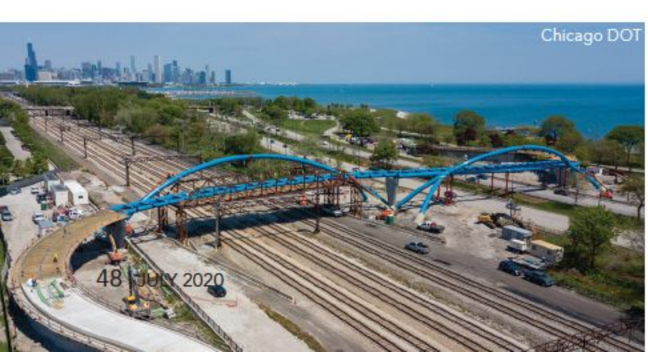
Cost: $29 million

Coating/protection: PPG 68HS primer, Amercoat 399 intermediate coat, Amercoat 450H final coat (Blue Oasis)


Chicago DOT


Kenny Flowers

Illinois DOT


Chicago DOT

MERIT AWARD Special Purpose

41st Street Pedestrian Bridge, Chicago

CHICAGO'S 41ST STREET PEDESTRIAN BRIDGE design was an award winner right from the get-go.

The design team's curving, arch-supported steel concept won an international design competition to create the bridge, and the resulting span connects the city's Bronzeville neighborhood with the trail system that runs along Lake Michigan. The bridge provides pedestrians with safe passage over Lakeshore Drive as well as the Metra Electric/CN Railroads, both of which had to stay in operation during construction. The railway sees approximately 263 trains per day while Lakeshore Drive carries approximately 100,000 vehicles per day.

The main span of this pedestrian bridge is made up of two main component round sections (36-in. and 48-in. OD induction bent pipe) tied together with built-up box girders. The pipe and bridge have both sweep and camber, so the pipe had to be carefully bent in order to induce both elements simultaneously. The process of induction bending the pipe was particularly challenging given that the actual diameter, ovality, and pipe shrinkage had to be taken into consideration prior to fabrication to ensure all of the subcomponents that tie into the pipe fit correctly. The bridge was progressively preassembled in the shop in order to ensure proper geometry and fit-up, which was especially challenging due to the large sweeping and curving geometry that required much preplanning and lots of shop floor space.

Another challenge that was met head-on was the logistics of shipping the large sections of the bridge from two fabrication shops to the project site. The bridge components were shop-welded to their fullest extent, resulting in extremely long, wide, and heavy permit loads that required significant preplanning and coordination. The largest structural piece was 62 ft long, 24 ft, 4 in. wide, and 38.3 tons, with the heaviest structural piece being just over tons. The bridge was shipped to the job site in 14 built-up sections, including six approach single-pipe spine assemblies and eight main span double-pipe assemblies; the main span assemblies were over 24 ft wide. The arches use bolted splices as well as field welds for aesthetic purposes, and the design team chose to use the end-plate bolted connection option to save time and cost during erection. Prior to delivery to the site, the structural steel was blasted and painted with a three-coat paint system in the shop. The project came in under budget and opened six months ahead of the original contract completion date.

Owner
Chicago Department of Transportation, Chicago

General Contractor
F.H. Paschen, S.N. Nielsen and Associates LLC, Chicago

Construction Manager
TranSystems, Chicago

Designer/Structural Engineer
AECOM, Chicago

Steel Team

Fabricators
Hillsdale Fabricators, St. Louis
Metal Pros, LLC, Wichita, Kan. (handrails)

Erector
S&J Construction Co., Inc., Oak Forest, Ill.

Detailer
Esskay Structures, Inc., Vienna, Va.

Bender-Roller
BendTec Inc., Duluth, Minn. (also additional fabrication)

MERIT AWARD Special Purpose

East Shore Bridge, Lake Tahoe, Nev.

THE THREE-MILE STRETCH BETWEEN Incline Village and Sand Harbor State Park on the east shore of Lake Tahoe in Nevada is, in a word, stunning. And a series of new steel-framed bridges is now part of this scenic multiuse path.

The owner, the Nevada Department of Transportation (NDOT), used the construction-manager-at-risk (CMAR) delivery method for this $40 million trail project, which was defined by an accelerated delivery schedule, challenging subsurface conditions and terrain, high seismicity, limited construction access, and an environmentally sensitive project location.

The three miles of new multiuse path was installed on a steep side slope between the existing State Route 28 and Lake Tahoe. A total of five steel bridges, totaling 809 ft, are included along the path. To create a structural system that could be installed with minimal disruption to traffic on the heavily used SR-28 adjacent to the trail alignment, prefabricated bridge spans were designed that were comprised of weathering steel girders that supported lightweight fiber-reinforced polymer (FRP) deck units. The 50-ft-long prefabricated deck units were manufactured by Composite Advantage with steel supplied by fabricator Cox Brothers Machining. The deck units were shipped to the site and placed by contractor Granite Construction during short-term road closures.

Aesthetics was of primary concern due to various regulatory agencies that have jurisdiction over the project area. The project is highly visible from the lake and minimizing visual impacts to the terrain was very important. Weathering steel was used for the steel girders and hand railings to minimize long-term maintenance costs associated with painted steel and to provide a surface finish that blends in with the natural terrain. The steel pipe sections used for the columns at the piers were galvanized and then coated with Natina to provide a finish that matches the weathering steel stringers.

Owner
Nevada Department of Transportation, Carson City, Nev.

General Contractor
Granite Construction Inc., Sparks, Nev.

Structural Engineer
Jacobs, Sacramento, Calif.

Steel Fabricators
Stinger Bridge and Iron, Coolidge, Ariz. AISC CERTIFIED FABRICATOR (substructure elements)
Cox Brothers Machining, Inc., Jackson, Mich. AISC CERTIFIED FABRICATOR (steel stringers and diaphragms)

Mike Okimoto

Mike Okimoto

Bridge Stats

Opened to traffic: June 21, 2019

Span length: 50 ft

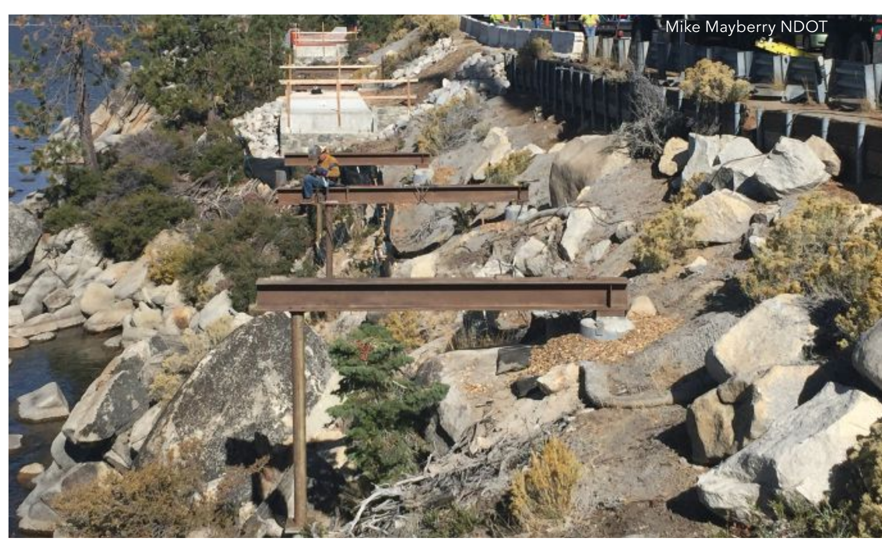
Total length: 809 ft

Average width: 11 ft

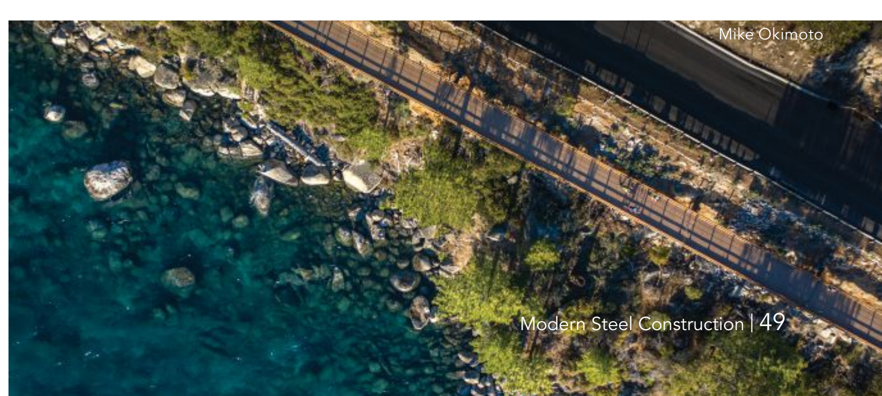
Total structural steel: 76.6 tons

Cost: $1.9 Million

Coating/protection: Weathering steel (girders and railings), galvanizing and Natina (pipe columns)



Mike Mayberry NDOT



Mike Okimoto

Bridge Stats

Opened to traffic: November 17, 2017

Span lengths: 72.80 ft, 221.36 ft, 442.08 ft, 221.36 ft, 41.95 ft, 61.45 ft

Total length: 1,061 ft

Average width: 66 ft out-to-out

Cost: $25,425,000

Coating/protection: Three-coat organic zinc-epoxy-urethane (Aztec Gold)

David Briskey

Aaron Colorito

Aaron Colorito

NATIONAL AWARD Rehab

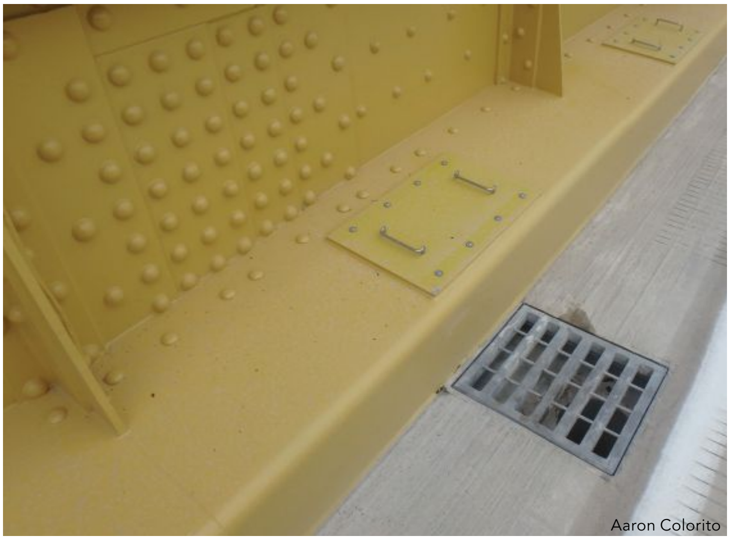
Andy Warhol (Seventh Street) Bridge, Pittsburgh

THE ANDY WARHOL (SEVENTH STREET) BRIDGE, an eyebar-chain, self-anchored suspension bridge, carries Seventh Street over the Allegheny River, the Tenth Street Bypass, and the Three Rivers Heritage Trail in downtown Pittsburgh.

Named for the famed artist who hailed from Steel City, it is one of the "Three Sisters" bridges constructed from 1924 to 1928 that comprise the only trio of identical, side-by-side bridges in the world, and is the first self-anchored suspension span constructed in the United States.

Due to accelerating age-related deterioration, the bridge required rehabilitation. The project involved replacing the bridge deck, totally repainting the superstructure, performing structural steel substructure repairs, and applying scour protection. Michael Baker International was chosen by the Allegheny County Department of Public Works to perform analysis and design of the rehabilitation, and the design team combined recognition of historical significance with modern engineering practices to complete a structurally superior, sustainable rehabilitation that was also aesthetically relevant and pleasing.

The bridge was analyzed for the first time using a fully 3D finite element model to examine the effects of unbalanced loading and modern vehicles on the structure. Numerous materials not normally used in new bridge construction were required to complete the rehabilitation. These included post-tensioned tie-down anchorages, forged steel bridge pins and nuts, permanently lubricated bronze bushings and washers, and bronze dedication plaques cast to replace missing plaques. Additionally, thousands of rivets were replaced with ASTM F3125 Grade F1852 high-strength bolts with button heads to mimic the look of rivets, thus improving structural capacity while being sensitive to appearance. These bolts were installed using electric shear wrenches capable of both providing uniform tension values and expediting bolt installation.


Aaron Colorito


Aaron Colorito


Aaron Colorito

New bridge lighting was provided on sidewalks and pylon rooms in a style replicating the original lighting fixtures. Additionally, new roadway curb boxes replaced the original flat curbs to prevent salt and debris from sitting on and corroding the stiffening girders. The curbs were designed to be as unobtrusive as possible while providing the benefit of draining water.

The complex rehabilitation was performed as a conventional design-bid-build construction project and concurrent with road work on I-279/HOV lanes/North Shore Expressway. This necessitated well-organized traffic control for nearby PNC Park and Heinz Field (homes to the Pittsburgh Pirates and Steelers, respectively) events, maintenance of pedestrian crossings at the adjacent streets, and sustained access to riverside trails and adjacent businesses.

The bridge also had to act as its own lay-down yard, resulting in tight site conditions. Temporary underdeck shielding was used to allow safe river access, which required coordination with the U.S. Coast Guard and local river users for minimum vertical clearances. Notice was broadcast daily to mariners, and a monitored phone number and radio channels were established for large vessels. Additionally, temporary Duquesne Light (electrical) conduit was provided to enable work on sidewalk brackets and replacement of electric conduits and supports. Temporary conduit in plastic corrugated pipe was placed on the sidewalk to maintain safe working conditions around energized lines, as well as to maintain a major power supply for downtown Pittsburgh.

A variety of other construction innovations were implemented, including vibro-screed (air screed) and pump trucks to place the concrete deck, over-pouring the deck by ¼ in., subsequent grinding to provide correct cross slopes and longitudinal smoothness, and employing a temporary hold-down system using permanent post-tensioning rods. The new reinforced concrete deck is fully structural, using channel-type shear connectors to make the deck composite. The existing buckle plates, once the structural part of the deck, now remain as stay-in-place forms.

Owner
Allegheny County Department of Public Works, Pittsburgh

General Contractor
Brayman Construction, Saxonburg, Pa.

Structural Engineer
Michael Baker International, Moon Township, Pa.

MERIT AWARD Rehab

Winona Bridge, Winona, Minn.

THE FRACTURE-CRITICAL WINONA BRIDGE spanning the Mississippi River stands as a beloved landmark and vital thoroughfare for motorists traveling between Wisconsin and Minnesota. Built in 1942, it is the only pre-1946 cantilever through-truss bridge in the latter state and played a central role in sustaining the economy of Winona and facilitating the flow of defense materials during World War II.

That history was threatened in 2007 with the collapse of Minneapolis's I-35W bridge. Following the collapse, the Minnesota legislature provided funding and required MnDOT to develop an ambitious 10-year bridge replacement program, with a focus on fracture-critical bridges. MnDOT's inspection team discovered corrosion and section loss on multiple truss members, resulting in a load-posting that restricted heavier commercial vehicles and closed the bridge for more than a week. Immediate repairs provided a short-term solution, but they highlighted the structure's continued importance: Wisconsinites who depended on Winona's first-call ambulance services found their link to the town severed and local businesses took a hit during the shutdown. Nearly 12,000 motorists were forced to make detours of 60 miles roundtrip every day to other crossings over the Mississippi.

In 2014, MnDOT engaged Michael Baker as prime consultant and Ames Construction as prime contractor—the department's first use of the construction manager/general contractor (CM/GC) approach—to work together to ensure the long-term reliability of the structure. Tearing down the bridge had already been ruled out; it was eligible for listing on the National Register of Historic Places and had become an iconic asset for the region, even appearing on a postage stamp celebrating the state's sesquicentennial. So the team aimed for an ambitious goal: completely rehabilitating the bridge to resist modern permit loads, reconstructing the approach spans, rebuilding the deck, and adding internal redundancy to comply with the intent of the state statutes, all while avoiding any adverse effects determined by the State Historic Preservation Office. By modernizing the structure, the team would establish the first through-truss bridge in the Midwest to have internal redundancy added to all its fracture-critical elements.

Accomplishing all this required creative problem-solving and complex coordination. Completing a historic bridge rehabilitation is an intricate undertaking wherever the work occurs, but doing it on budget in Minnesota's harsh climate is a whole other matter. Long winters and road salting had fueled deterioration, making it possible the contractor would uncover even more corrosion in the field. Lead paint had to be removed, section-loss measurements taken, and the entire structure repainted. High-strength bolts and new steel plates had to be installed over tens of thousands of rivets, which had not always been installed according to the original plans. The team also had to replace the aging bridge deck and patch spalled piers to blend with the bridge's concrete color. After analyzing

Bridge Stats

Opened to traffic: July 1, 2019

Span lengths: 47 ft, 119 ft, 123 ft, 134 ft, 134 ft, 130 ft, 130 ft, 242 ft, 450 ft, 242 ft, 130 ft, 130 ft, 130 ft, 130 ft

Total length: 2,291 ft

Average width: 33 ft

Total structural steel: 710 tons

Coating/protection: Inorganic zinc-rich three-coat paint system

Kent Zinn

Keith Molnau

Nicholas Sovell

Kent Zinn

the structure's timber piles, it encountered another dilemma: The piles would not stand up to the impact of a modern barge collision and would have to be strengthened as well.

Every step of the way, Michael Baker's team worked with the project historian and MnDOT's Bridge Office and Cultural Resources Unit (CRU) to evaluate each engineering improvement for compliance with the National Historic Preservation Act of 1966 and Minnesota's State Historic Preservation Office. This called for extensive, detail-oriented work and intense coordination.

The CM/GC team began work on the Winona Bridge in 2014. It first generated complex 3D finite element models to analyze the fracture-critical components of the structure and formulate plans for strength and internal redundancy retrofits. These designs relied on steel plates and post-tensioning bars that strengthened the bridge and extended its service life by 50 years.

Owing to the age of the structure and the parameters for historic designation, the team faced numerous obstacles during the rehabilitation. It solved the issues posed by the bridge's timber piles by implementing a scour-protection system, which consisted of geobags and rip rap. Additionally, an innovative, underwater strut system was designed, essentially linking the original structure to the new parallel bridge. In doing this, the team ensured that both structures would share the impact of any barge collision, distributing the force and bolstering the older bridge's timber-pile foundations.

To rebuild the approach spans, the team installed six new, steel deck truss spans and constructed 15 prestressed concrete girder spans. For the main through-truss spans, 148 truss members were reinforced with steel plates and 76 with high-strength rods. From the original design, the team replaced nine concrete piers by using longer, prestressed girder approach spans, which were less expensive to fabricate and construct.

Ultimately, the CM/GC approach proved to be a massive success, providing expert oversight, comprehensive coordination, and state-of-the-art solutions. What's more, it delivered these innovative designs with great cost certainty prior to construction and no construction cost growth, opening the bridge to traffic six months ahead of schedule.

Owner
Minnesota Department of Transportation, Rochester, Minn.

General Contractor
Ames Construction, Burnsville, Minn.

Structural Engineer
Michael Baker International, Chicago

Steel Team

Fabricator
LeJeune Steel Company, Minneapolis

Erector
Danny's Construction Company, Shakopee, Minn.

Detailer
DBM Vircon Services, Port Coquitlam, B.C., Canada

Jeff Jobe

NATIONAL AWARD Reconstruction

BNSF Wind River Bridge, Skamania County, Wash.

WITH AN EXPECTED LIFESPAN OF A CENTURY, the new, reconstructed BNSF Wind River Bridge serves as a critical connector on BNSF's Fallbridge Subdivision, enabling the safe and reliable crossing of both freight and passenger traffic over the mouth of the Wind River in the Columbia River Gorge in Washington State.

HNTB provided design, permitting, and construction management services for the steel bridge's reconstruction. The new bridge consists of a 260-ft-long single-track truss span with precast double cell box beam approaches supported on concrete pier caps with drilled shaft and driven pile foundations. The project site is in a national scenic area between State Highway 14 and the Columbia River, which resulted in limited available site access for the contractor and the need for strict environmental compliance during construction.

Because the bridge carries a large amount of freight and passenger traffic, minimizing track closures remained a priority throughout the project. An accelerated bridge construction (ABC) technique, float-in/out, provided two distinct advantages to the project. First, it reduced the need for temporary work bridge piles, which were required to be installed and removed within a dedicated in-water work window. Secondly, it minimized impacts to railroad operations by limiting the time required to remove the existing span and install the new truss span on the existing bridge alignment.

Addressing the challenges associated with the float-in/out operation was one of the greatest challenges faced during the project, due to the number of associated variables. Because the truss span was erected in Portland, Ore., roughly 60 miles west of the project site, it was critical that the contractor's plan to float the erected truss span down the Columbia River be fully vetted. To this end, BNSF and HNTB worked with the contractor to review their proposed maritime procedure and engineering and developed a plan to coordinate water levels with the Bonneville Dam to control the pool elevations during the bridge change-out.

Because the bridge is located in the Columbia River Gorge National Scenic Area, it was critical that the aesthetics of the new structure not disturb the existing view for the public. To address this concern, BNSF and HNTB worked with the applicable regulatory agencies to review proposed span types and bridge colors. The new main span used a Warren-type truss with weathered steel to closely match the feel of the existing Pratt-style truss and its weathered patina. Concrete pier caps and approach spans were also stained with a charcoal color to better blend in with the existing landscape. Materials were carefully selected to fulfill the project's specific aesthetic requirements while also ensuring the integrity of the new bridge's 100-year lifespan.

In addition to meeting a variety of requirements, the bridge design also needed to be adaptable. The bridge can accommodate the heavy live loads of current freight and passenger trains, and it is also robust enough to meet demands imposed by enhanced future railroad loading.

Owner

BNSF Railway, Kansas City, Kan.

General Contractor

Hamilton Construction Company, Portland, Ore.

Structural Engineer

HNTB, St. Louis

Steel Team

Fabricator

Fought and Company, Inc., Tigard, Ore. AISC CERTIFIED FABRICATOR

Detailer

Graphics for Steel Structures, Hicksville, N.Y. AISC DETAILER


Kyle Izatt


Jeff Jobe

Bridge Stats

Opened to traffic: August 6, 2019

Span length: 260 ft (main span truss)

Total length: 363 ft, 4 in.

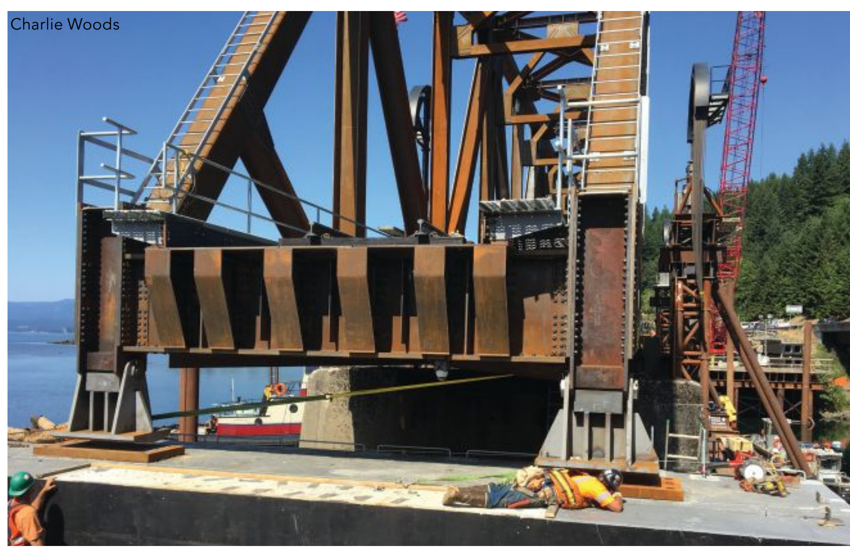
Average width: 23 ft

Total structural steel: 850 tons

Coating/protection: Weathering steel


Jeff Jobe

Jeff Jobe


Charlie Woods


Kyle Izatt

Kiewit Infrastructure South Co.

MERIT AWARD Reconstruction

I-240 MemFix4, Memphis, Tenn.

WHEN THE TENNESEE DEPARTMENT OF TRANSPORTATION (TDOT) was faced with the urgent need to replace or repair four deficient structures over I-240 in Memphis, subjecting roadway users to another long-term construction project simply wasn't an option. With traffic levels of approximately 180,000 vehicles per day, TDOT wanted this critical project completed quickly, with minimal impact to travelers.

The four bridges in the project, dubbed MemFix4, are two new Poplar Interchange bridges; a new Norfolk Southern Railroad (NSR) bridge; and rehabilitation of the concrete Park Avenue bridge. This $54 million project was delivered under the CM/GC delivery method—the second-ever CM/GC transportation project in the state of Tennessee. Throughout the process, TDOT, Benesch (designer), and Kiewit (general contractor) worked together in the design phase to develop innovative ideas that addressed the numerous site challenges and all project needs while maintaining the ability to meet the project's aggressive schedule.

The WB and EB Poplar Avenue bridge replacements required use of multiple innovative prefabricated bridge elements. The constructed Poplar Ave. bridges consist of a 263-ft, two-span bridge for WB Poplar and a 222-ft, two-span bridge for EB Poplar. For the replacement of these structures, extensive modeling and structural analysis was required to address high seismic conditions. Several custom elements were developed to facilitate efficient installation and serve as a sustainable solution for years to come. These included custom steel bearings and framing, over 13,000 linear ft of micropiles, new substructures constructed under traffic, and modular bridge superstructures—which addressed site challenges while completing the project in just 18 months.

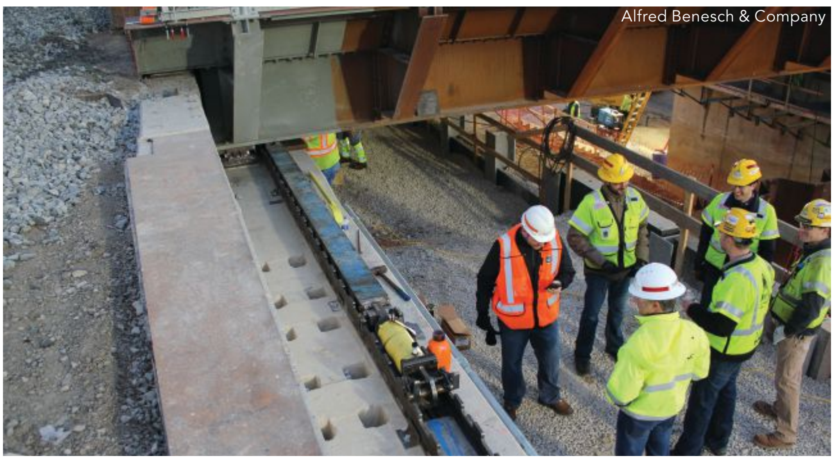
The project team called upon accelerated bridge construction (ABC) methods to address site constraints and the necessity for minimal impacts to traffic. This led to the Poplar Avenue bridges being built off-site at a "bridge farm," rolled to the site using self-propelled modular transporters (SMPTs), and then lifted into place using large crawler cranes. Once the bridges were constructed, Kiewit was able to complete the planned widening of I-240 to alleviate the lane drop that was required due to entrance ramps.

For the Norfolk Southern (NS) Rail Bridge, since the existing piers were founded on spread footings, it was not cost-efficient to upgrade the existing bridge's substructures to meet current seismic design standards. TDOT realized that the next project needed to replace the structures while minimizing impacts to the thousands of vehicular travelers through this interchange and the nearly 20 trains per day on the NS/I-240 overpass.

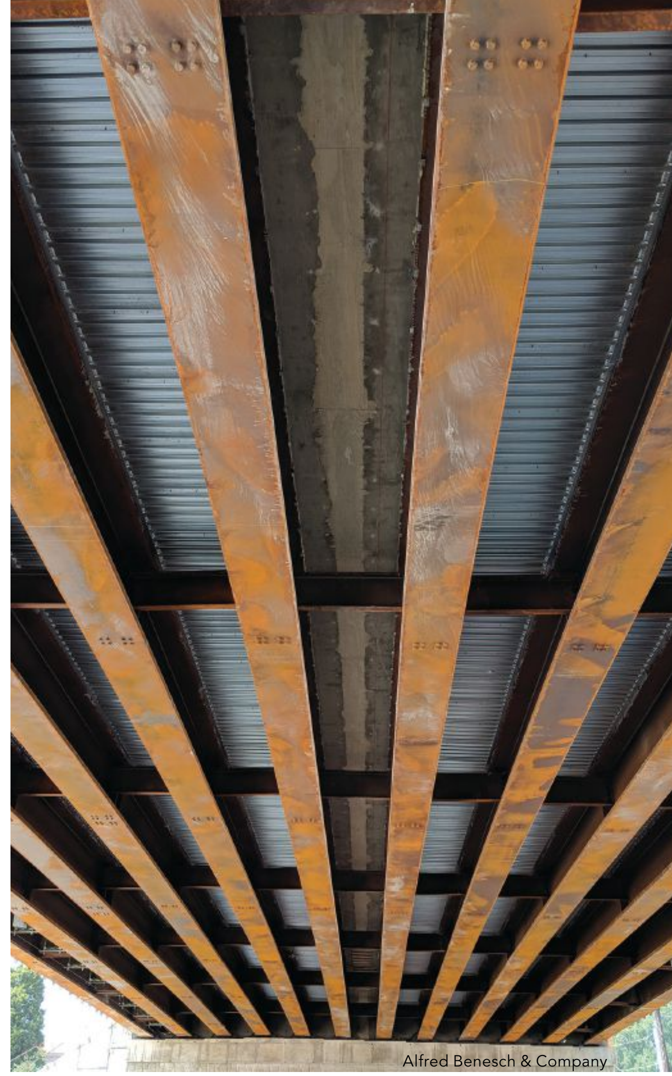
To replace this bridge, a temporary shoofly structure was constructed adjacent, just inches away from the existing bridge. It was comprised of temporary concrete piers supported by a foundation of over 6,000 linear ft of micropiles. Leaving train traffic largely uninterrupted during construction, the permanent steel superstruc-

Alfred Benesch & Company

Kiewit Infrastructure South Co.



Alfred Benesch & Company



Alfred Benesch & Company

ture supporting a ballasted track was erected on the shoofly alignment and trains were switched onto this alignment. With trains traveling on the shoofly structure, the old bridge was demolished and the new substructures were built. The two new 1,100-ton superstructure sections were then laterally slid 35 ft into place, one track at a time, during two weekend Interstate closures.

The Memphis area resides in the influence zone of the New Madrid Fault, which in 1811 and 1812 produced four of the most powerful earthquakes east of the Rocky Mountains in recorded history. Significant effort was spent during the design phase to ensure that solutions could be constructable while still meeting the seismic demands. Designers focused on the impacts of time during the construction phase, especially when it came to key elements that would be built during weekend closures. Benesch used finite element modeling to precisely design elements such as the bearing anchors to minimize the materials and labor required while still meeting the design requirements.

For more on the I-240 MemFix4 project, see "A Bridge Replacement in Four Parts" in the October 2019 issue, available at ***www.modernsteel.com***.

Owner
Tennessee Department of Transportation, Nashville, Tenn.

General Contractor
Kiewit Infrastructure Co., Brentwood, Tenn.

Structural Engineer
Benesch, Nashville, Tenn.

Steel Fabricator and Detailer
W&W/AFCO Steel, Little Rock, Ark. AISC CERTIFIED FABRICATOR

Bridge Stats

Opened to traffic: June 30, 2019

Span lengths: WB Poplar Ave.: 150.5 ft, 113.08 ft; EB Poplar Ave.: 88.17 ft, 134.17 ft; Norfolk Southern Railroad Bridge: 50.83 ft, 73.5 ft, 73.5 ft, 87.5 ft, 50.83 ft

Total lengths: WB Poplar Ave.: 222 ft; EB Poplar Ave.: 263 ft; Norfolk Southern Railroad Bridge: 338 ft

Average width: WB Poplar Ave.: 65 ft; EB Poplar Ave.: 72 ft; Norfolk Southern Railroad Bridge: 36 ft

Total structural steel: WB Poplar Ave.: 614 tons; EB Poplar Ave.: 287 tons; Norfolk Southern Railroad Bridge: 948 tons; All bridges: 1,849 tons

Cost: $28.4 million (combined structures cost)

Coating/protection: Weathering steel (WB and EB Poplar Ave.), weathering and painted steel (Norfolk Southern Railroad Bridge)

SPECIAL AWARD FOR RESILIENCE
Liberty Bridge, Pittsburgh

THE LIBERTY BRIDGE has been a landmark structure and Pittsburgh icon since it opened in 1928.

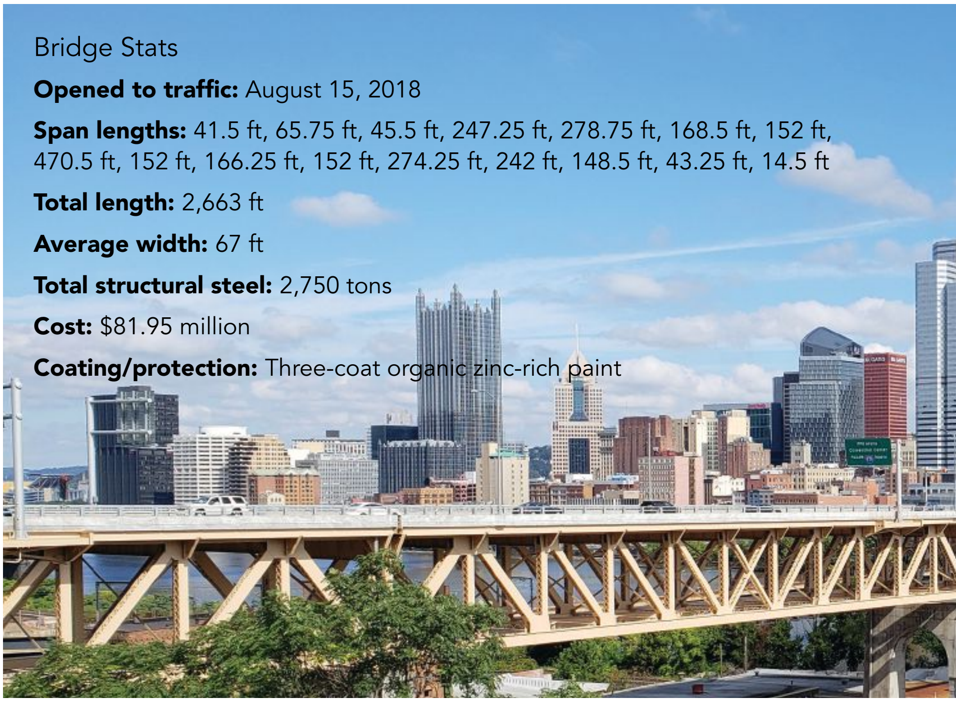
It created the modern suburbs, quadrupled property values south of Pittsburgh, and opened with a parade five miles long. However, by 2014 the bridge, which carried 55,000 vehicles per day, was in poor condition. It could no longer carry trucks and had become a poster-child for America's infrastructure crisis. *60 Minutes*, profiling America's neglected infrastructure, highlighted the bridge. Referring to Liberty Bridge and others like it, Ray LaHood, United States Secretary of Transportation, stated plainly: "Our infrastructure is on life support right now."

PennDOT and HDR responded with a rehabilitation project that preserved the structure while meeting current engineering and accessibility standards. The main goals for PennDOT in this rehabilitation were to remove the load posting on the bridge, ensure the bridge was accessible and safe per current codes, and secure 40 more years of use from this historic truss.

By using the first steel Exodermic grid deck in Pennsylvania, impacts to the bridge's thousands of daily users were reduced while a deck the size of three football fields was replaced. Sections of this deck were prefabricated in panels that could be installed over weekend closures and connected together with high-strength concrete. A custom rapid-set concrete mix was created for this project, which allowed traffic to use new deck sections just a few hours after the concrete was placed. The new deck combines the strength of steel T-beams with reinforced concrete on top, making it strong, light, and easy to overlay in the future.

Innovations for the deck were planned, but the greatest innovations are often unplanned. When an accidental construction fire warped and buckled a main truss compression chord, forcing an immediate bridge closure, the team raced to develop a solution to fix the bridge and reopen this critical urban link. The bridge was in a perilous state; it was not known how badly the structure might be overstressed or if collapse was imminent. To assess and fix the bridge, teams of engineers worked many days and nights until the bridge reopened.


Nicholas Burdette, PE



Bridge Stats

Opened to traffic: August 15, 2018

Span lengths: 41.5 ft, 65.75 ft, 45.5 ft, 247.25 ft, 278.75 ft, 168.5 ft, 152 ft, 470.5 ft, 152 ft, 166.25 ft, 152 ft, 274.25 ft, 242 ft, 148.5 ft, 43.25 ft, 14.5 ft

Total length: 2,663 ft

Average width: 67 ft

Total structural steel: 2,750 tons

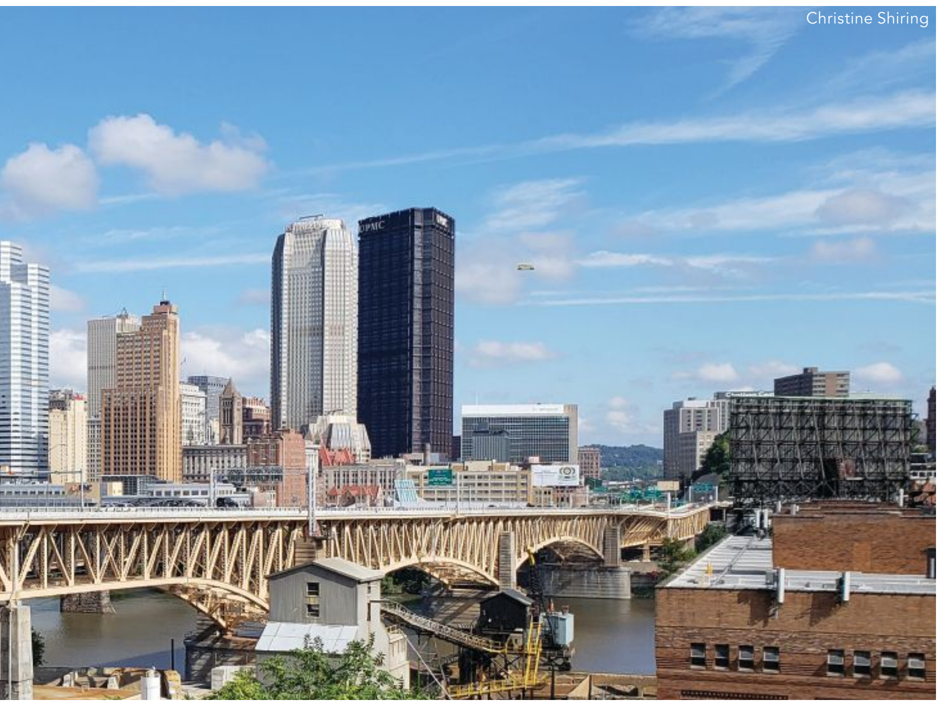
Cost: $81.95 million

Coating/protection: Three-coat organic zinc-rich paint


Nicholas Burdette, PE


LB Foster

Christine Shiring



Christine Shiring

Christine Shiring

A 3D analysis model was built to assess the crippled structure, including both trusses, every bracing member, and the partially removed deck. Using hand-drafted documents from the 1920s, hundreds of unique truss and bracing members were modeled. The day following the closure, the new model showed that most of the 1,000 tons carried by the damaged chord shed into the undamaged sister truss through wind bracing. The 3D steel truss and bracing system proved redundant. No member was overstressed from the bridge dead load. This finding gave authorities confidence in opening the river below the structure to commercial traffic, preventing further economic impact to river commerce.

Without a historical precedent to go by, engineers also developed a steel jacking frame concept that same day to fix the buckled member. This frame would attach to the member and 2,000 tons of force could be applied with huge jacks to straighten the buckled steel. This concept was adopted by the contractor and further developed by their design team. Twenty-four days later, the member was repaired through a combination of jacking and heat straightening, and traffic was restored on the bridge—a momentous day for Pittsburgh commuters.

By performing hundreds of unique steel repairs on beams, truss members, and connection plates, and by replacing the bridge deck and supporting stringers, trucks can now use the structure. Replacing the bridge deck was crucial in order to preserve the bridge and allow it to function safely for another 40 years. The new deck, with modern bridge joints and drainage, provides a robust and waterproof "roof" to keep the steel below dry and corrosion-free. In addition, replacing the old stringers along with the deck eliminated many poor details that are prone to cracking over time. Holes, cuts, and welds in these beams did not meet current fatigue requirements. As years of exposure to traffic mounted, these details were a long-term liability requiring detailed documentation for each inspection. By replacing all stringers with new, properly fabricated beams, this liability was eliminated. ■

Owner
PennDOT, Engineering District 11, Bridgeville, Pa.

General Contractor
Fay, an i+iconUSA Company, Pittsburgh

Structural Engineer
HDR, Pittsburgh

Steel Fabricators
Hall Industries, Inc., Ellwood City, Pa.
L.B. Foster Company, Pittsburgh