2018 PRIZE BRIDGE AWARDS

AMERICA'S BEST STEEL BRIDGES have been honored in this year's Prize Bridge Awards competition. Conducted every two years by the National Steel Bridge Alliance (NSBA), the program honors outstanding and innovative steel bridges constructed in the U.S. The awards are presented in several categories: major span, long span, medium span, short span, movable bridge, reconstructed, technological advancement, integrated project delivery, special purpose, accelerated bridge construction and sustainability. This year's 16 winners, divided into Prize and Merit winners, include a first-of-its-kind tub girder solution in Ohio, a remote crossing in the frigid far north of Alaska and a modest double-counterweight design in a coastal Maine town. Winning bridge projects were selected based on innovation, aesthetics and design and engineering solutions by a jury of five bridge professionals.

This year's competition included a variety of bridge structure types and construction methods. All structures were required to have opened to traffic between May 1, 2015 and September 30, 2017.

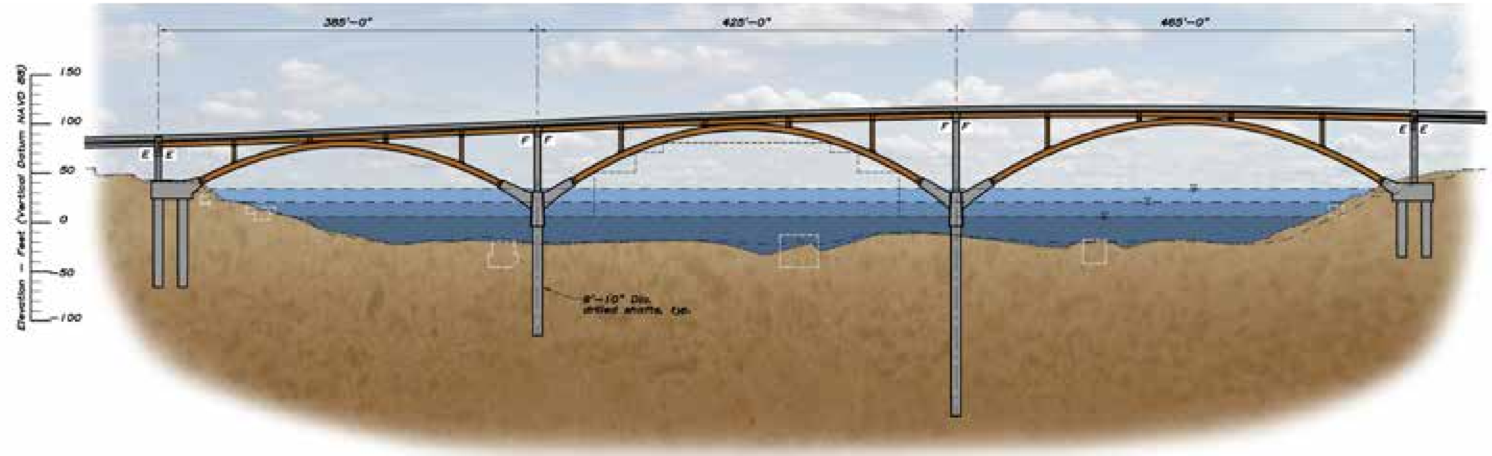
The competition originated in 1928, with the Sixth Street Bridge in Pittsburgh taking first place, and over the years more than 300 bridges have won in a variety of categories. Between 1928 and 1977, the Prize Bridge Competition was held annually, and since then has been held every other year, with the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

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

A look at the innovative, efficient and eye-catching winners of this year's Prize Bridge Awards competition.

Judges

Amber Blanchard, PE, Minnesota Department of Transportation
Michael Culmo, PE, CME Engineering
Tony Hunley, PE, PhD, Stantec
Frank Russo, PE, PhD, Michael Baker International
Dominique Shannon, PE, Kansas Department of Transportation



ELEVATION

MAJOR SPAN | NATIONAL AWARD

Sellwood Bridge, Portland, Ore.

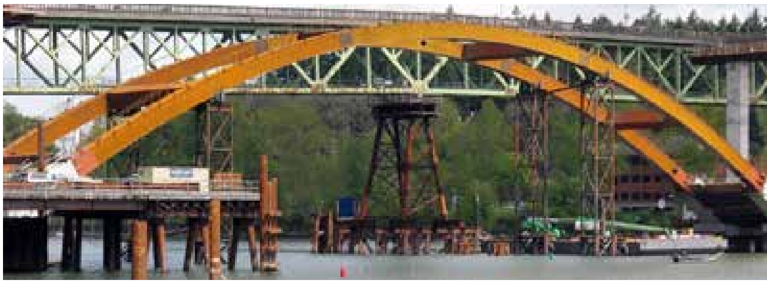
IN A CITY known for its bridges, Portland, Oregon's Sellwood Bridge over the Willamette River stands out amongst the rest for its elegant, flowing lines and low profile. It is also the city's first steel deck arch structure and currently the only structure crossing the Willamette River that meets modern seismic requirements.

The original Sellwood Bridge opened in 1925 and became the busiest two-lane bridge in the state. In 2005, it received a National Bridge Inventory sufficiency rating of 2 out of a possible 100. This low rating was attributed to critical issues such as deterioration of the approach structures and extensive cracking in the concrete girders, which was caused by a nearby hillside that was slowly sliding into the river, thus exerting pressure on the west end of the bridge.

Using 5,000 tons of structural steel, the new 1,976-ft-long replacement bridge—with 1,275 ft comprising the steel deck arch—features three arch spans that support the 63-ft-wide to 90-ft-wide deck of the main river spans. The bridge carries two 12-ft-wide vehicular lanes, two 6.5-ft-wide bike lanes/emergency shoulders and two 12-ft-wide shared-use sidewalks, and will also accommodate future streetcar service. The project included the replacement bridge, modernization of the Highway 43 interchange and stabilization of the hillside located west of the bridge and interchange.

As the profile for the new bridge ascended from west to east, the arch spans could not be in balance geometrically, which affected the differential thrust across the interior piers. The three arches have a rise-to-span ratio that varies from 1:7.7 (0.13) to 1:6.4 (0.16). The arch framing was scaled to trend with the profile, allowing the necessary balance at the piers. This same geometry for a deck arch resulted in rather shallow arches—shallower than structurally optimum for a deck arch. Bending moments from dead load for fixed arches would have dominated the arch size, creating a heavier arch profile. Through an innovative use of advanced ultra-high-molecular-weight (UHMW) plastic hinges, engineer T.Y. Lin designed the arch ribs to be pinned during construction, allowing rotation of the rib springing. Connections were designed to allow grouting and bolting of the springing at completion of the bridge for the desired continuity needed for live and seismic loadings.

Another challenge was how to replace a major transportation route with minimal traffic disruption. The original plan was to build the replacement bridge in two halves, using the existing



The bridge is a great blend of functionality and aesthetics. The three-span deck arch superstructure creates a signature structure for Portland while also working to provide cross-river access in the event of a natural disaster. —Tony Hunley

span for traffic while the southern half of the new bridge was built first. Once the southern half was completed, traffic would shift onto it, allowing demolition of the old bridge and construction to begin on the northern half of the new bridge. However, this plan had its drawbacks, including the need for extensive staging to keep traffic moving and increased construction time and costs. As such, an alternative solution was developed. Once temporary steel piers were erected north of the existing bridge piers, the entire 1,100-ft-long steel deck truss of the old bridge, comprising four continuous deck truss spans, was slid over on rails to a detour alignment using hydraulic jacks. The horizontal distance of the move was 66 ft at the west end and 33 ft at the east end. Temporary approach spans at both ends of the truss were also constructed. This solution enabled the replacement bridge to be built in one phase on the original bridge footprint. Benefits included eliminating the need for staged construction; reducing the number of arch ribs from four to two; freeing up the existing alignment for work crews; enhancing public safety by removing traffic from the construction zone; and reducing bridge closure time to only six days.

Multnomah County also saved up to a year in construction time and as much as $10 million in project costs with some help from steel fabricator, Thompson Metal Fab. The company proposed piece-by-piece stick erection for the steel deck arch, with arch ribs placed on shoring towers rather than the float-in system originally considered for arch erection. Each rib span contained two bolted field splices to match the optimum weights chosen by general contractor Sundt Construction for fabrication and erection. This resulted in three segments per span, with segment lengths of up to 148 ft and weights of up to 146 tons each. Steel was transported to the site on barges and placed with cranes operating from work bridges and these barges.

Owner
Multnomah County, Ore.

General Contractor
Sundt Construction, LLC

Structural Engineer
T.Y. Lin International

Steel Team

Fabricator
Thompson Metal Fab, Inc.

Detailer
Candraft

> The ability to preserve elements of the existing bridge and incorporate those touches into the new bridge is a nod to the past while providing a durable steel solution for the future.
> —Michael Culmo

LONG SPAN | NATIONAL AWARD

Greenfield Arch Bridge, Pittsburgh

THE GREENFIELD ARCH BRIDGE functions as a gateway arch to the greater Pittsburgh area for the more than 85,000 cars that pass under it each day. The structure takes numerous design cues from an existing structure and captures the historic nature of the area.

The existing reinforced concrete open-spandrel arch connected Greenfield to neighboring Schenley Park since 1921. Formally known as the Beechwood Boulevard Bridge and originally just spanning over a neighborhood street and stream, the structure eventually carried traffic over one of the busiest stretches of Interstate in Western Pennsylvania by the 1950s. Interstate 376, known locally as the "Parkway East," would grow under the bridge to become the main artery linking downtown Pittsburgh to all points east, and the bridge would become known as the city's gateway to the east.

In 2012, after years of study and consideration, it became apparent that it was time for a new structure and gateway. With an overarching goal to minimize impacts to the underlying Parkway, steel was selected for the new arch as it would simplify and expedite erection and minimize closure time of the important roadway.

The new bridge consists of a 287-ft open-spandrel arch span, with each rib of the arch consisting of just three field pieces of steel. Vierendeel bracing was used for the ribs to minimize members and connections. Additionally, the depths of the floor beams and stringers were matched to allow for simplified connections splicing the stringer flanges over the floor beam flanges. These design choices would allow the vast majority of the structural steel to be erected in just one weekend closure of the Parkway.

The piers were used to significantly reduce the effects of longitudinal loads such as braking and wind on the steel arch. Due to geometric and aesthetic requirements, the piers have significant strength and stiffness. By fixing the stringer/floor beam floor system to the piers and using expansion disc bearings at the shortest spandrel columns, the demands on the spandrel columns and associated connections were significantly reduced.

For a steel arch, the floor beams are traditionally defined as fracture-critical members (FCMs) requiring increased material testing and frequent in-depth inspections over the life of the structure. To eliminate the fracture-critical designation and eliminate the need for costly in-depth FCM inspections, the floor beams were detailed and designed as system-redundant members (SRMs); redundant members are those whose failure will not cause instability of the overall structure or loss of function.

The redundancy of the floor beams was achieved and verified through a combination of robust line girder analyses and detailed 3D finite element analyses (FEAs) accounting for the dynamic effects of a floor beam fracture. Line girder analyses were used to verify the ability of the stringers and their splices to effectively span two floor beam bays and also confirm the strength of the remaining floor beams to support the increased loads. The connections of the stringers to the floor beams were detailed to resist the high loads. In the event of a floor beam fracture, the stringer connection effectively becomes a splice at mid-span. The line girder analyses ignore the beneficial resistance of the remaining portions of the fractured floor beam and 3D load sharing of live load across the structure. In addition to the line girder analyses, 3D FEA simulations were used to capture the behavior of the structure during a complete fracture event.

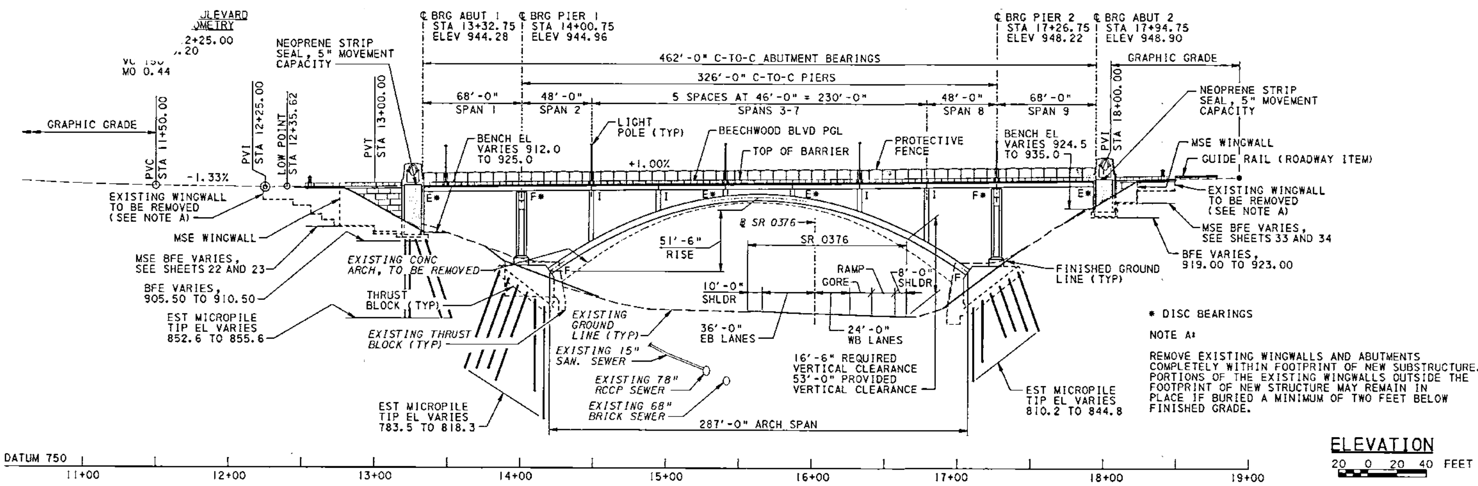
The analyses considered different levels of structural damping and fracture locations (floor beam mid-span and spandrel support). These parameters were varied to determine the appropriate increase in dead loads to account for dynamic effects. The parametric 3D FEA indicated that the simplified line girder analyses resulted in a design that provided more than adequate resistance during a fracture event.

Owner
City of Pittsburgh

General Contractor
Mosites Construction Company

Structural Engineer
HDR, Inc.

Steel Fabricator and Detailer
High Steel Structures, LLC AISC CERTIFIED FABRICATOR



MEDIUM SPAN | NATIONAL AWARD

Colville River Nigliq Bridge, Nuiqsut, Alaska

THE COLVILLE RIVER NIGLIQ BRIDGE is located almost as far north as you can go and still be in the United States, in an area where mammoth ice floes are no big thing.

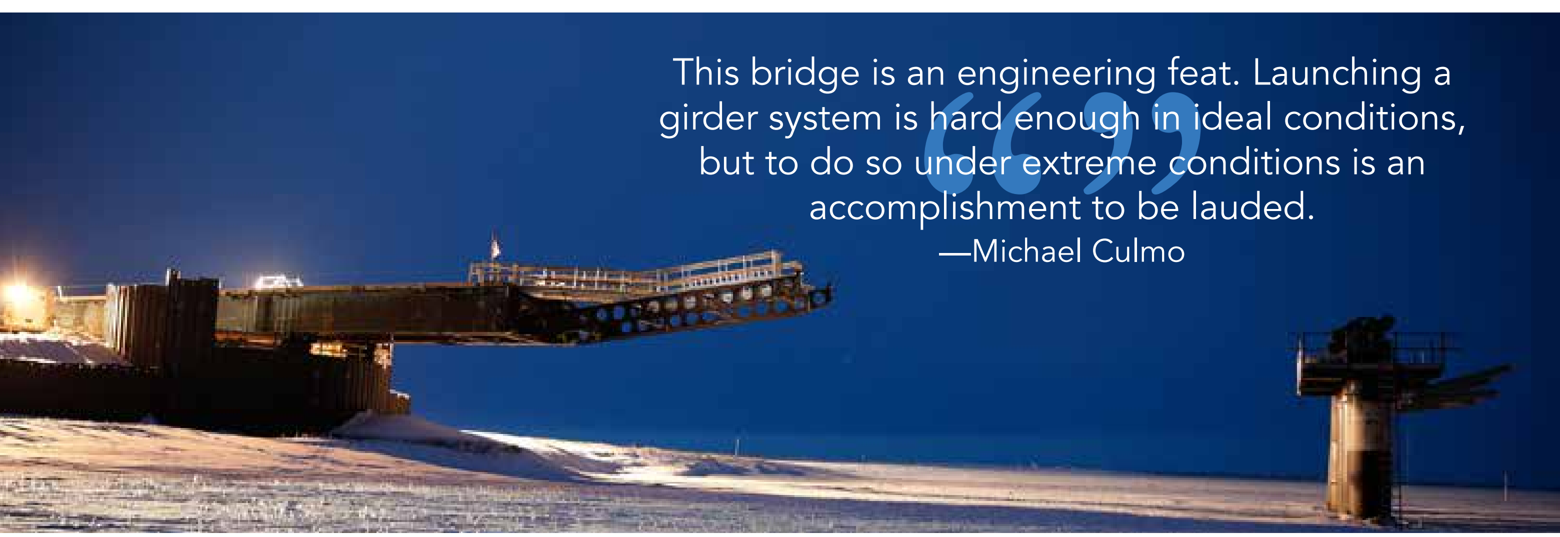
Located on Alaska's remote north slope, the bridge provides daily transportation access for trucks carrying thousands of barrels of oil, and crossing the Nigliq Channel of the Colville River was one of the project's greatest challenges. The resulting bridge consists of a 1,421-ft steel box girder and a total of eight spans varying between 162 ft to 200 ft, and provides access to oil field service vehicles weighing up to 175 tons. The design accommodated these vehicles by using a 115-ton gravel hauler as the AASHTO Strength I design vehicle loading configuration and a 175-ton drilling services vehicle as an AASHTO Strength II loading condition. Additionally, an 87.5-ton fatigue vehicle was considered in the analysis in recognition of the high frequency of heavy loads that can result in premature fatigue-related issues.

The span-depth ratio of the bridge girders (almost 28:1) was optimized to accommodate the navigation requirement on the Nigliq Channel while achieving an efficient section both in service and during the launching operation. The bridge was engineered with twin fully enclosed steel box girders to support a total of six pipelines along the entire length on the downstream side, in protection against 6-ft ice floes measuring over 200 ft wide.

The bridge substructure was designed with sloped ice breakers that reduced horizontal ice loads from 2,600 kips (crushing) to 370 kips (bending). This design approach passes the large ice floes more efficiently than vertical piles by breaking up the ice in bending and has the added benefit of providing an appealing look to the upstream side of the bridge. The substructure of the bridge consists of 48-in.-diameter steel pipe piles constructed over varying degrees of permafrost and fully thawed geotechnical conditions.

Fully enclosed steel box girders were ultimately selected for the span because they efficiently supported the bridge superstructure as well as the pipelines, which imposed a torsional load from the cantilever of up to 22 ft off the downstream side of the bridge. The box girders provided a stiff and stable system for the launching operation as well as redundancy for the two-girder system. While atwo-girder system is typically considered non-redundant and, thus, fracture-critical, the project's owner—ConocoPhillips Alaska—wanted the system to avoid operational issues associated with fracture-critical systems. Therefore, an in-depth analysis was performed to demonstrate system redundancy through the use of torsional capacity of the individual girders and the ability of the moment-connected diaphragms to transfer the loads under a "fracture" scenario. Using this analysis, the majority of the structure was demonstrated to have load path redundancy, with only a cou-

“This bridge is an engineering feat. Launching a girder system is hard enough in ideal conditions, but to do so under extreme conditions is an accomplishment to be lauded.”
—Michael Culmo



ple of locations at the girder ends and expansion joints requiring fracture-critical designations.

The bridge abutments used the Open Cell sheet pile system to contain the gravel approaches and protect the vertical abutment piles. The system is constructed of flat sheet piles in a circular shape that does not close on the back side, providing for much more efficient construction than traditional closed-cell systems. Similar to closed cellular structures, horizontal hoop stresses are developed from the lateral soil pressure, but these stresses are resisted solely by soil friction along the rear sheet piles buried beneath the roadway.

Construction on Alaska's North Slope is bounded by a short 90- to 110-day window—commonly called ice road season—during the depths of winter when ice roads offer access to remote locations across the frozen tundra. In order to support the subsequent launching operation, the various foundation systems for the bridge had to be installed within this three-month window in which ice roads were passable and river ice was thick enough for heavy equipment operations. As a consequence of working in the arctic environment in the depths of winter, numerous challenges and complications were faced. Among these were workforce limitations due to the remote site, billeting constraints at accessible camps, maintaining production under extremely low temperatures (-45 °F, with wind chills reaching -65 °F), blizzards, limited infrastructure, equipment limitations due to extreme climate, extended darkness and limited access due to ice road restrictions. As such, extreme planning and contingencies were incorporated into the project to ensure the successful completion within the allotted window.

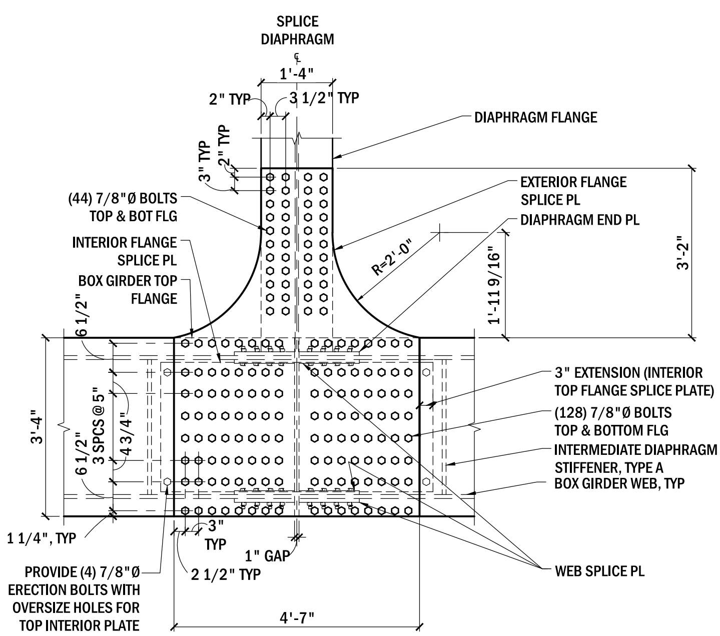
Due to the limited site access, the entire bridge superstructure was designed as prefabricated sectional steel spliced box girders for easy field assembly and launched to greatly reduce the project's environmental footprint and shorten the construction time frame. Bridge superstructure elements were brought onto the site during the first year ice road access season, during which the substructure elements were constructed. Most bridge segments were constructed in transportable units of less than 65 ft in length, with 14 segments fabricated in longer lengths and trucked using dollies. All other bridge components were transported on standard trailers. A "multi-season" insulated ice pad was then constructed to last through summer months as a storage site for these materials. The bridge girders and structural components were then assembled using bolted connections (a total of 10,000 bolts for the project) at the east abutment, incrementally launched on a custom hydraulic launch bed and lowered onto the bridge bearings.

Owner
ConocoPhillips Alaska, Inc.

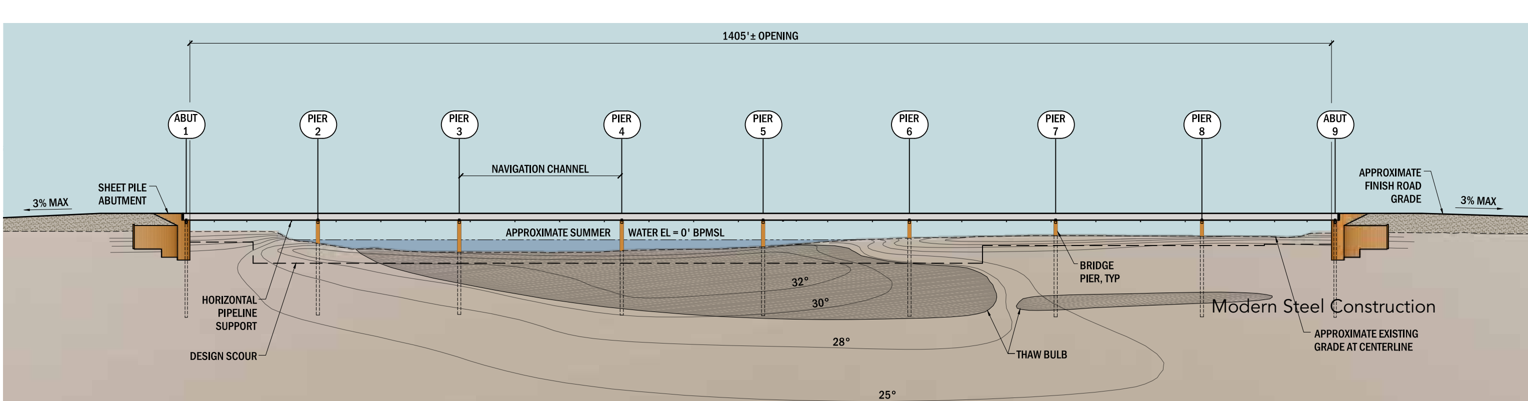
General Contractor
PCL Civil Constructors, Inc.

Structural Engineer
PND Engineers, Inc.

Steel Fabricator and Detailer
Jesse Co. AISC CERTIFIED FABRICATOR



DIAPHRAGM & FLANGE SPLICE PLAN



SHORT SPAN | NATIONAL AWARD

US Route 340, Waynesboro, Va.

THE ROUTE 340 BRIDGE was the first highway bridge in the United States to be constructed completely out of stainless steel, including ASTM A1010 Grade 50 (A1010) steel for the girders and cross frames and stainless steel fastener assemblies for the bolted splices.

A1010, a martensitic/ferritic stainless steel, was selected based on two concerns. The first was that the bridge is located within sight of an industrial plant, which caused the surrounding soil to be contaminated with mercury and potentially created a highly corrosive environment. The second reason was that the bottom flange of the bridge is located only approximately 9 ft above the South River, which the bridge spans. Both the proximity of an industrial plant and the presence of a low-level water crossing are conditions in which the use of uncoated weathering steel is discouraged. Since A1010 has a considerably slower corrosion rate when compared to traditional bridge steels, the bridge is expected to be low-maintenance throughout its entire service life, which translates into significant maintenance savings.

Although other A1010 bridges have been constructed in the United States, some of the innovative features of the Route 340 Bridge were the first of their kind in the nation. Previous A1010 bridges have used either ASTM A709 Grade 50W or galvanized Grade 50 steel cross frames, and ASTM F3125 Grade A325 Type 3, galvanized Grade A325 or ASTM A193 stainless steel bolts and accompanying fastener assemblies. The Virginia Department of Transportation (VDOT), the owner and designer, elected to use stainless steel for the cross frames and fasteners so that the entire bridge would be uniformly low-maintenance. Since structural shapes are currently not available in A1010, VDOT offered fabricator High Steel the opportunity to select either welded, built-up shapes or bent plates mimicking rolled shapes.

High Steel elected to fabricate all of the angles and channels used for the cross frames with bent plate. Prior to the Route 340 Bridge, A1010 steel had been bent on one other highway bridge project (0.16-in.-thick plates were used on a

“A1010 will provide the owner with a superior corrosion protection system while reducing their long-term maintenance costs.”
—Dominique Shannon

bridge in Colusa County, Calif.). However, 0.5-in.-thick plates were required for the cross frames of the Route 340 Bridge. Since this was to be the thickest A1010 steel plate to be bent for a highway bridge project, the bends were examined using nondestructive testing (NDT) techniques, with successful results. As part of the haunched steel girder design, the bends on the flange plates were also tested and achieved passing NDT results.

The bridge is also the first to use stainless steel fasteners in a structural bolted splice application. To determine which types of stainless steel were most suitable for this bridge, a testing program was conducted on four types of stainless steel bolted fastener assemblies. Based on the test results, VDOT selected ASTM A193 Grade B8 bolts, ASTM A194 nuts and Grade 303 washers to be used for all bolted connections. The selection of the A193 bolts and accompanying fastener assemblies was finalized after a modified tightening procedure was developed to account for differences in mechanical behavior between these bolts and the Grade A325 bolts traditionally used on steel bridges.

In addition, a new type of welding consumable was also used on the Route 340 Bridge. Previous A1010 bridges had used 309L consumables, and VDOT planned to do the same. But due to an unforeseen business transition for the consumable supplier, VDOT ultimately identified and used a 309L-C consumable that complied with federal Buy America regulations. In order to approve the 309L-C consumables, additional NDT and weld procedure qualification record (PQR) tests were required, and passing results were obtained.

After the bridge was completed, ASTM A1010 was incorporated into the ASTM A709 specifications as Grade 50CR steel. VDOT is developing a special provision to provide guidance on using Grade 50CR steel for both new designs and repair strategies for steel bridges moving forward.

Owner
Virginia Department of Transportation

General Contractor
Fairfield-Echols, LLC

Structural Engineer
Virginia Department of Transportation–Staunton District

Steel Fabricator and Detailer
High Steel Structures, LLC

MOVABLE BRIDGE | NATIONAL AWARD

Gut Bridge, South Bristol, Maine

WORKING ON A PROJECT SITE about the size of two football fields was just one of the challenges for the team working on the Gut Bridge. Fitting within an approximately 300-ft-diameter circle, the project site was constrained by three buildings occupying the northwest, south west and southeast corners of the site. Thankfully, a double-counterweight design allowed the structure to fit within the site while blending seamlessly into the surrounding town.

The project replaced a failing 80-year old Bobtail Swing Bridge with a new cable-stayed bascule bridge across the Gut, a small channel that separates Rutherford Island from Bristol, Maine, and serves as a passage for boats hoping to avoid circumnavigating the island. The Bobtail Bridge had undergone multiple mechanical failures and the process of replacement had been underway for almost a decade. The bridge opens more than 8,000 times per year for the heavy boat traffic, so reliable operation is a necessity. The final bridge concept for a new crossing was developed with the local community's input and includes the bridge replacement (including foundations), construction of an operator's house, new traffic warning systems, approach work and a temporary runaround.

The Gut Bridge superstructure used a combination of innovative details that formed a new type of bascule span. The cable-stayed superstructure allowed the span to be efficiently counterweighted, resulting in a low bridge profile and reduced foundation costs, and using steel orthotropic deck minimized structure depth and weight (the roadway profile is low to the waterline, so a shallow superstructure was a necessity) thus reducing fabrication and operational costs.

It was challenging to develop a concept for the new bridge that provided dependable operation while also being aesthetically pleasing. The bascule configuration was selected to facilitate reliable operation, as it reduces demands on machinery. It functions as a simply span when seated for vehicular traffic and opens quickly for navigation traffic—important because again, it sees more than 8,000 openings per year. The cable-stayed configuration for the superstructure allowed the span to be efficiently counterweighted (balanced) and eliminated the need for an overhead cross counterweight, leaving an aesthetically pleasing appearance. The upper stays contain balance materials along with the back leg of the girder, and the rear portion of the bridge (stays and back legs) opens into slotted pits. The cables provide additional support to the forward leg of the girders, reducing the overall size of the superstructure, and pay homage to an early bridge at the site that was also cable-stayed. The height of the stays fits well to adjacent building structures, and drivers have a clear view between the stays because there is no overhead counterweight. And the slanted cables add a dynamic element to the bridge even when it is seated.

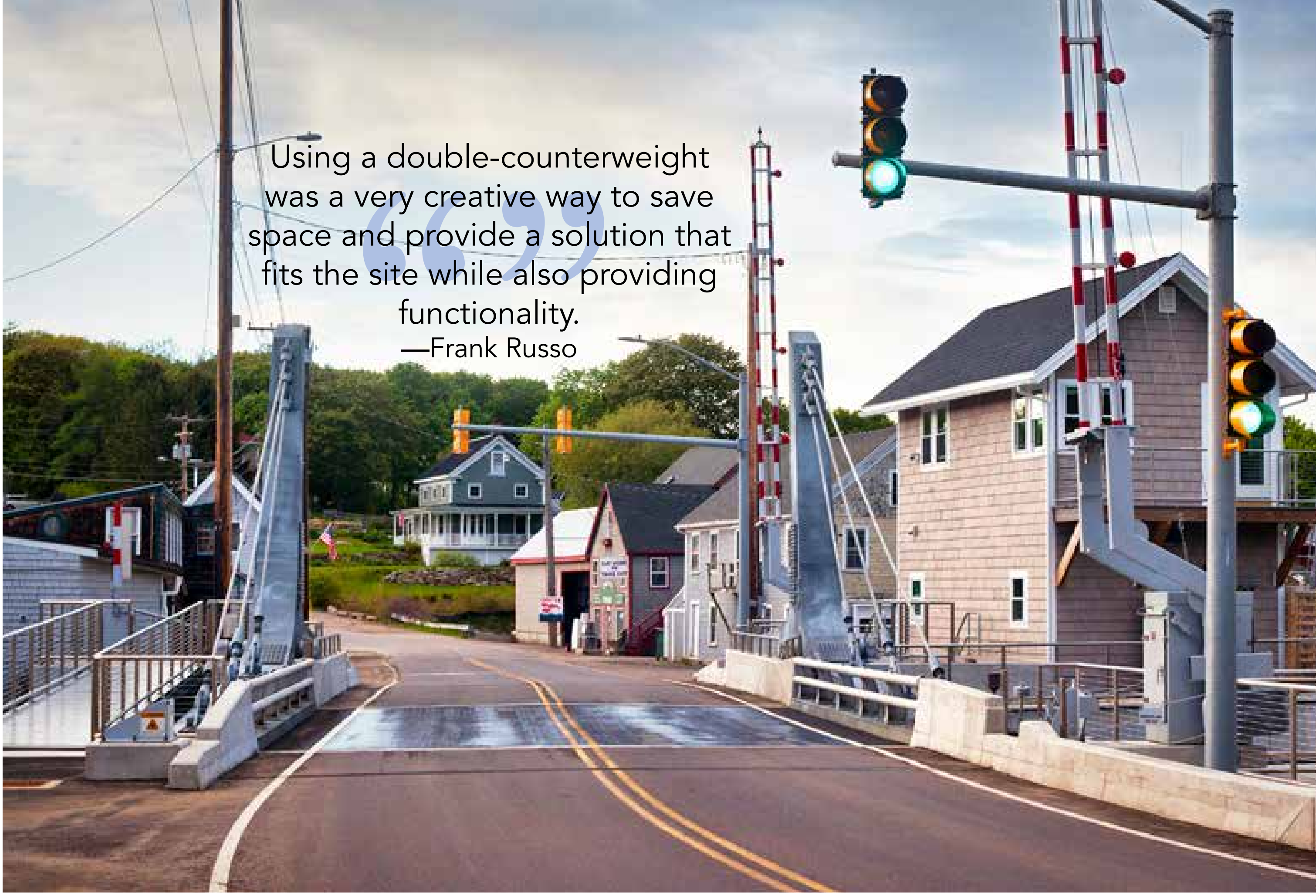
As South Bristol Harbor is busiest during the summer months, navigation through the Gut could not be restricted during this high season, and construction was primarily limited to two winters. Despite these restrictions, construction was completed on time.

Owner
Maine Department of Transportation

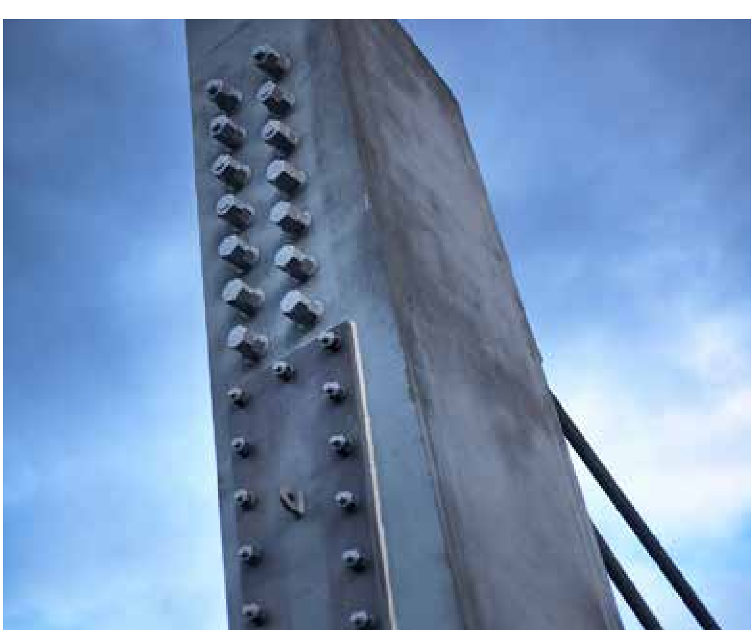
General Contractor
Cianbro Corporation

Structural Engineer
Hardesty & Hanover

Steel Fabricator and Detailer
Steward Machine Co., Inc.



Using a double-counterweight was a very creative way to save space and provide a solution that fits the site while also providing functionality.
—Frank Russo



RECONSTRUCTED BRIDGE | NATIONAL AWARD

RFK Bridge—Manhattan Approach Ramps, New York

WHEN BUILDING A NEW BRIDGE proved too costly, steel's ability to be retrofitted provided the economical solution for the RFK Bridge Manhattan approach ramps. Aside from localized deterioration, the steel superstructure of these approach ramps was in good structural condition but did not meet modern seismic requirements. Because of the bridge's importance as an evacuation route, the steel superstructure was retrofitted to include a seismic isolation system, thus extending the useful life of the bridge dramatically.

Prior to this project, no major rehabilitation had been performed on the Manhattan approach ramps to the RFK Bridge (officially known as the Robert F. Kennedy Harlem River Lift Bridge) since its original construction in 1936. Due the effects of chronic deterioration, primarily at the locations of leaking expansion joints, a comprehensive rehabilitation effort of the steel portion of the structure was required. A number of unique and innovative methods were necessary to successfully complete this project within the congested urban environment—all while maintaining traffic on these critical ramps, which carry in excess of 85,000 vehicles per day.

The original structure consisted of concrete "cellular" spans near grade transitioning to steel rigid-frame spans for the elevated portions. While the concrete spans had significantly deteriorated and were in need of replacement, the steel spans were in relatively good condition (aside from localized deterioration near the expansion joints) making them a good candidate for rehabilitation. The steel structure consists of a non-redundant, two-girder system with typical span lengths of 60 ft framing directly into steel rigid-frame pier bents. The original structure does not use expansion joints; expansion and contraction is instead accommodated by flexure of the steel columns (which are oriented for weak-axis bending in the longitudinal direction of the bridge).

Due to this structure's importance as an emergency evacuation route, it is classified as a "critical" structure for purposes of seismic analysis and must be able to resist a 2,500-year return period event with minimal damage. "Extreme event" loads of this magnitude were not explicitly considered during the original design of the structure. As expected, the results of initial analyses indicated that numerous structural elements had inadequate capacity

Floating a new superstructure above the existing bridge was a solution that could only be provided by steel, and saved the owner hundreds of millions of dollars while creating a lifeline bridge that would function in the event of a natural disaster.
—Amber Blanchard

to resist these loads. These initial analyses showed that the existing steel rigid-frame pier columns benefited from the fact that they are rather flexible under lateral loading, resulting in relatively low seismic demands. However, there were certain vulnerable regions, specifically the column-to-girder and column-to-floor-beam connections, that were overstressed during the modeled seismic event. Due to details that are relatively common for structures of this era (built-up members with riveted construction, etc.), strengthening of these vulnerable locations was found to be problematic and cost-prohibitive (if not altogether unfeasible) due to tight access and the labor-intensive nature of the work. Since the existing concrete deck was slated to be replaced due to the advanced level of deterioration present, a "floating deck" isolation system was developed to reduce seismic demands by isolating the new deck and floor system from the existing steel rigid-frame substructure below. The isolation scheme that was developed resulted in a reduction in seismic demands such that only a handful of strengthening retrofits were required—all of which were located at regions that were relatively easy to access.

Unlike most isolation systems—which typically use conventional lead-core or elastomeric isolation bearings—for this very flexible structure it was necessary to develop a hybrid system using both sliding bearings (typical PTFE-stainless steel interfaces) and elastomeric bearings. In this design, the sliding bearings carry all vertical loads and dissipate energy through friction, while only a small number of isolation bearings are needed, solely to provide the required restoring force. At the service load level, the friction developed at the sliding bearings resists the lateral design forces of wind, live load braking and live load centrifugal force (where applicable on the curved section of the on ramp). The details of the floating deck seismic isolation system also resulted in the removal of the majority of the expansion joints, thereby reducing the major source of deterioration (namely chloride-laden water infiltrating the steel) and creating a more maintenance-free structure.

The original replacement cost was estimated by some to be as high as $200 million, and such a project would have been more disruptive to traffic and the local community in this highly congested area of Manhattan. But the rehabilitation solution developed by engineer Modjeski and Masters cost roughly $70 million, of which only a small percentage went to the cost of isolation bearings and installation of the additional seismic retrofits.

Owner
Triborough Bridge and Tunnel Authority

General Contractor
DeFoe Corporation

Structural Engineer
Modjeski and Masters, Inc.

SPECIAL PURPOSE | NATIONAL AWARD

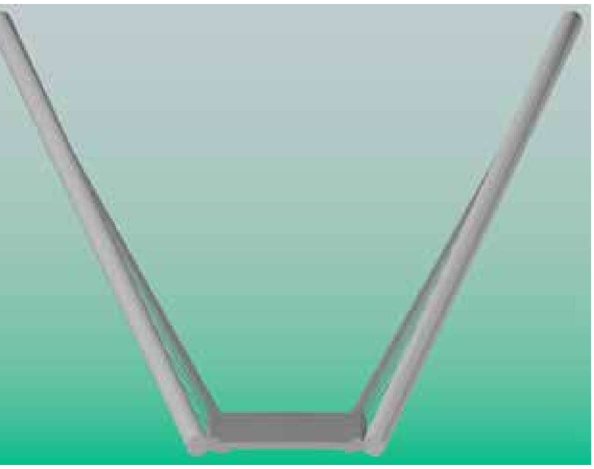
Peter Courtney Minto Island Bicycle and Pedestrian Bridge, Salem, Ore.

THE PETER COURTNEY MINTO ISLAND Pedestrian bridge is a 300-ft-long, tied-arch structure that links Riverfront Park with Minto Island in Salem, Ore. The structure blends seamlessly into the surrounding environment while providing trail access for outdoor enthusiasts.

The overall configuration is a five-span bridge with a main span steel tied arch of 304.5 ft at the spring-line chord and thin cast-in-place post-tensioned haunched slab approach spans, three at 50 ft on the island and one at 35 ft in Riverfront Park. The arches are a pair of 30-in.-diameter by 1-in.-wall round tube ribs, each bent to a hyperbola and tilted away from the deck at 25° from vertical and with no added lateral bracing.

The pair of tied arches supports a precast panel stress-ribbon deck. The precast panels are positioned on the arch ties, which are sequentially harped by the progressive panel placement sequence. Upon completion, the panels lie on a parabolic vertical curve profile. The precast panels also function as stay-in-place forms for a CIP post-tensioned topping slab. Full-length deck post-tensioning through the approach spans and the topping slab of the arch span provides capacity to the approaches and precludes live load tension at the arch span precast panel joints. Cast-in-place haunched panels connect the precast panels to the arch piers at the arch span ends. The arch-span deck is suspended from the arch ribs by 1.5-in.-diameter high-strength rods. These are arranged such that when projected onto the rib plane-of-curvature, they are radial to a point 490 ft above an arc passing through the ends of the arch spring-line chord. The completed arch-span deck, while very slender, is resistant to pedestrian-induced resonant vibrations and wind-induced aeroelastic flutter.

Meeting the combination of geometric, physical and administrative constraints necessitated an atypical design solution in a unique integration of multiple bridge engineering technologies. A pair of steel tied-arches on minimal size piers with a main span floor system depth of 15.4 in. from deck soffit to finish grade addressed the flood clearance, short approach length available to match grades in Riverfront Park, ADA maximum grades and the



The inclined arches are a unique solution to a long-span tied arch. The innovative approach to the arch ties provided a slender, aesthetically pleasing structure.
—Michael Culmo

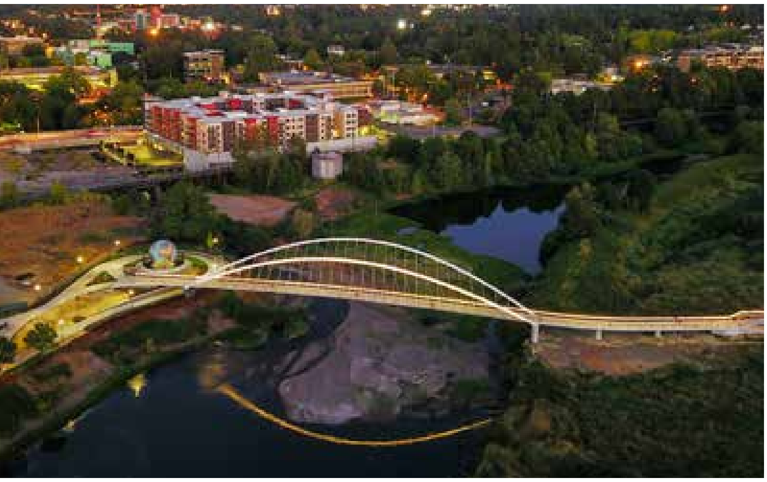
main span contribution to the FEMA "no rise" requirement. Each arch rib tilts outward from the bridge centerline 25° from plumb, with no cross bracing, to provide unlimited vertical clearance and an open feeling for bridge users. For the piers at the arch-span ends, the pier edges match the 25° tilt angle of the arches to form inverted delta piers that converge on the single shaft. The balance of forces between the self-weight of the rib plus the vertical component of suspender tension and the horizontal component of the suspenders lying slightly out-of-plane to the rib plane yields braced behavior that would not occur with the rib plane-of-curvature being oriented vertically.

The arches were fabricated off-site from A572 Gr. 50 1-in. plate formed and welded into tube with single-seam, double submerged arc welds in conformance to ASTM A252 Grade 3. The tubes were heat-bent to their specified hyperbolic shape, which follows the thrust line of the rib self-weight and the normal and tangential force components of the radial suspenders projected onto the rib plane-of-curvature. The radial suspenders impart a longitudinal force in the precast panels toward mid-span, which facilitated sequential placement of the panels outward from mid-span. For the center panel at mid-span, the suspender angles are mirrored on opposite ends of the panels for zero net horizontal force. Suspenders connect to the arch ribs via truncated angular plates, with the base against the rib fitting the skewed cross-sectional curvature. Because the rib is both curved and tilted, the suspender connection plates are attached at variable angles to the rib axis as tilt relative to the rib axis in the plane-of-curvature, rotation about the rib axis and twist relative to the rib plane. The fabricator created an independent 3D model for preparing shop drawings, with data for the connection plate fabrication and attachment angles in agreement with the design model. To verify that the plates were attached as intended and the rib segments matched the hyperbolic curvature for their positions along the arch, 3D laser scans were conducted in the fabrication shop. As part of the inspection and acceptance process, the scans were sent to the design engineer for comparison to the design model.

Owner
City of Salem, Ore.

General Contractor
Legacy Contracting, Inc.

Structural Engineer
OBEC Consulting Engineers



INTEGRATED PROJECT DELIVERY SPECIAL AWARD

Rouchleau Mine Bridge, Virginia, Minn.

IN PREPARING FOR the expiration of a land agreement between the state of Minnesota and a local mining company, set to expire in 2017, the Minnesota Department of Transportation (MnDOT) began plans for a new bridge. The new 1,100-ft weathering steel plate girder Rouchleau Mine Bridge sits 180 ft above the floor of the Rouchleau Mine pit and connects the mining towns of Virginia and Eveleth, Minn., on State Highway 53. Due to challenging site conditions, the three-span structure features a 480-ft main span and haunched girders with depths ranging from 7 ft, 9 in. at mid-span to 14 ft, 6 in. over the piers. Pier depth was limited to facilitate shipping to the rural area, and the girders were shipped horizontally. All steel was GR50 weathering steel.

To meet the project deadline, the bridge was designed and built under an accelerated schedule using the construction manager/general contractor (CMGC) delivery method. In addition to the fast-track schedule, the project was also challenged with near-vertical rock walls, mine waste rubble to depths of 120 ft below the pit floor, potential water elevation changes greater than 100 ft, the need to accommodate future mine blasting operations of the reactivated mine and construction over a lake that serves as the drinking water supply for the town of Virginia.

The design team worked collaboratively with MnDOT and the CMGC to validate the structure type and develop delivery strategies to directly address the project risks associated with schedule, the northern Minnesota weather and the unique terrain of the open pit mine. The project was delivered in two packages: an early steel package and a substructure/deck package. Structural engineer Parsons included detailer Tensor Engineering as a design team member to provide draft shop drawings as part of the bid package to minimize bid risks, facilitate mill orders and ultimately expedite fabrication. Within 52 days of Notice to Proceed, Parsons delivered the complete plans for the 5,200-ton superstructure. The remainder of the bridge package was delivered within the overall seven-month schedule, and the bridge opened this past summer.

Owner
Minnesota Department of Transportation

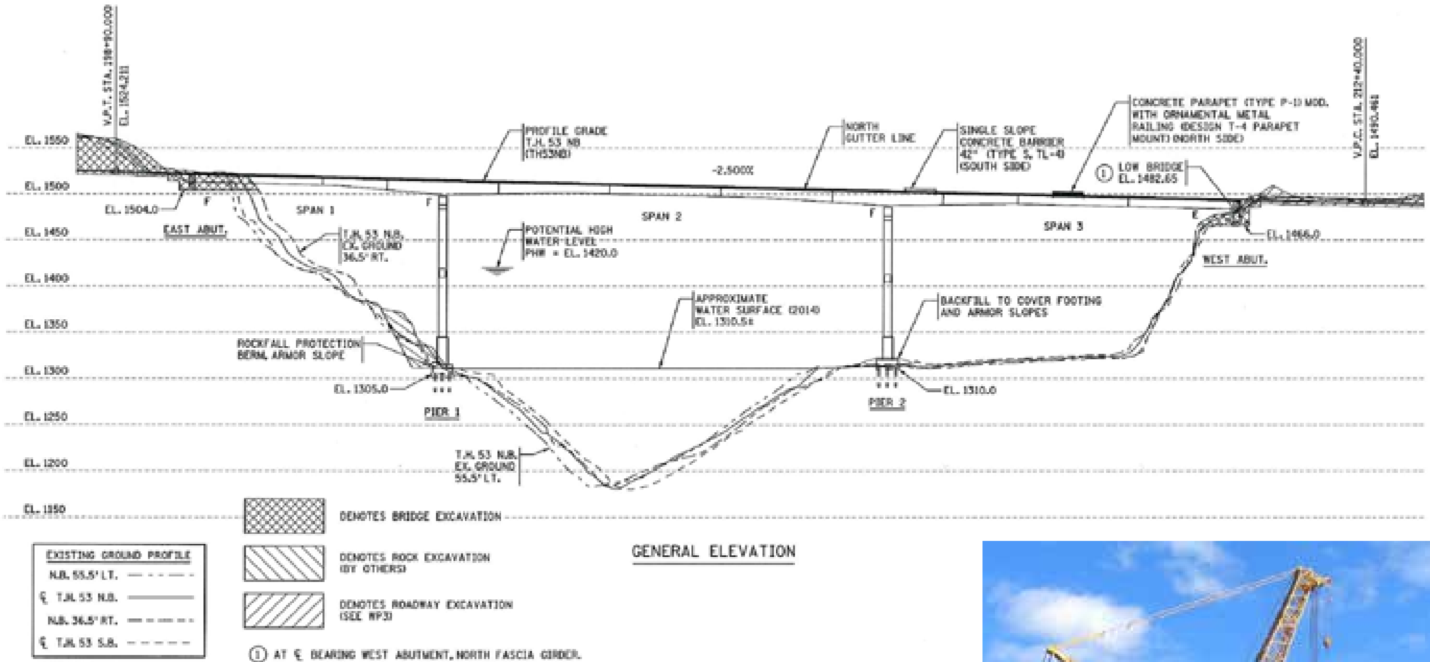
General Contractor
Kiewit Construction

Structural Engineer
Parsons Corporation

Steel Team

Fabricator
Veritas Steel (AISC Certified Fabricator)

Detailer
Tensor Engineering (AISC Detailer)



When it comes to the CMGC project delivery process, steel is a real winner because of its ability to be delivered quickly and reliably.

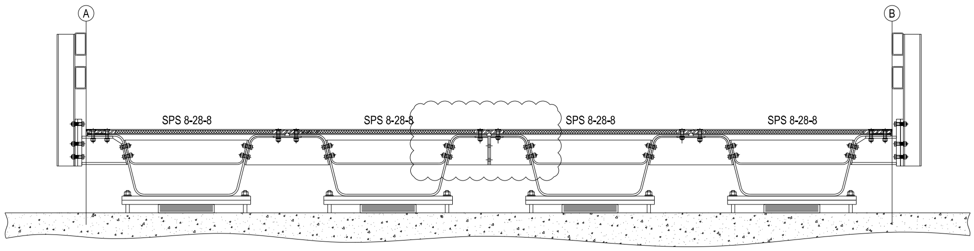
—Tony Hunley

> Using innovative construction practices to beat out conventional construction methods goes to show that engineers shouldn't accept the status quo.
> —Frank Russo

TECHNOLOGICAL ADVANCEMENT | SPECIAL AWARD

Folded Steel Plate Girder Bridge, Muskingum County, Ohio

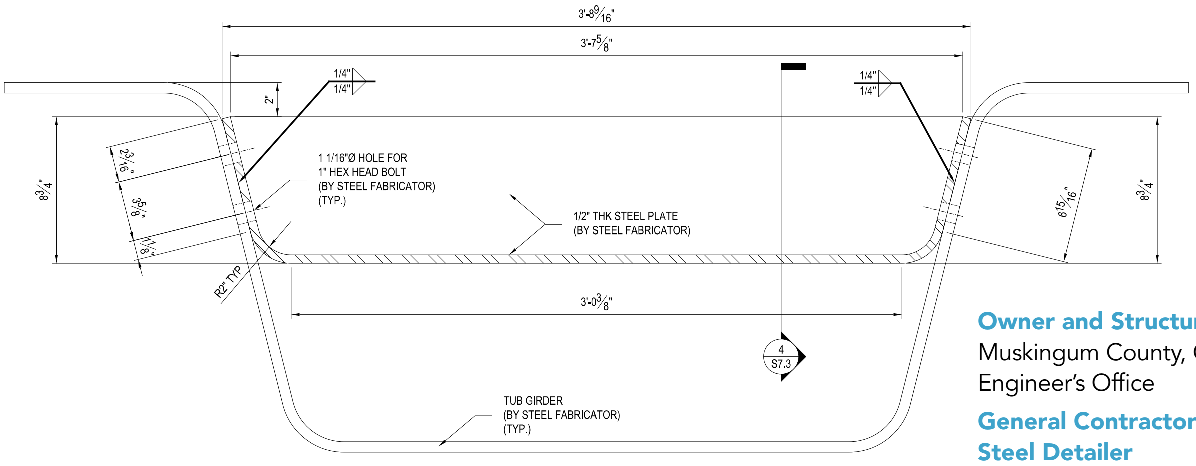
MUSKINGUM COUNTY, OHIO, broke new ground in the short-span bridge market with the first press-brake steel tub girder structure to use a steel Sandwich Plate System (SPS) deck. The system uses two steel plates that are bonded to a compact polyurethane elastomer core. The elastomer, as a two-part liquid, is injected into closed cavities formed by the steel face plates and perimeter bars. This approach effectively lowers dead loads and eliminates the time required to cure a concrete deck. The all-steel solution saved the community from a lengthy closure, while the shallow superstructure and lack of a horizontal surface is a big benefit to the owner because of the structure's location over a stream that is prone to flooding.



3 S8.1 ASSEMBLY ARRANGEMENT - COMPLETE BRIDGE
SCALE: 1/4" = 1'-0"

As the bridge superstructure is one-of-a-kind, there were no traditional shop drawings or specifications to refer to. Hand drawings were used and CAD drawings were ironed out to make these new details available to future designers. The bridge was preassembled in two halves and set and bolted in place in one day; the whole project was completed in 26 days. This included removal of the existing structure and a H-pile foundation with spread footings and concrete cast-in-place abutment walls. Once the substructure was completed, the superstructure was set in place in just 20 minutes.

The short duration of the project eliminated the need for traffic to endure an eight-mile detour around the road closure. In addition, the design of the tub girder, using a smooth bottom, prevents stream debris from getting caught on the superstructure during frequent storms that cause local flooding in the area.



1 S7.3 TYPICAL INTERNAL TUB GIRDER STIFFENER
SCALE: 1 1/2" = 1'-0"

Owner and Structural Engineer
Muskingum County, Ohio, Engineer's Office

General Contractor and Steel Detailer
US Bridge (AISC DETAILER)

MAJOR SPAN | MERIT AWARD

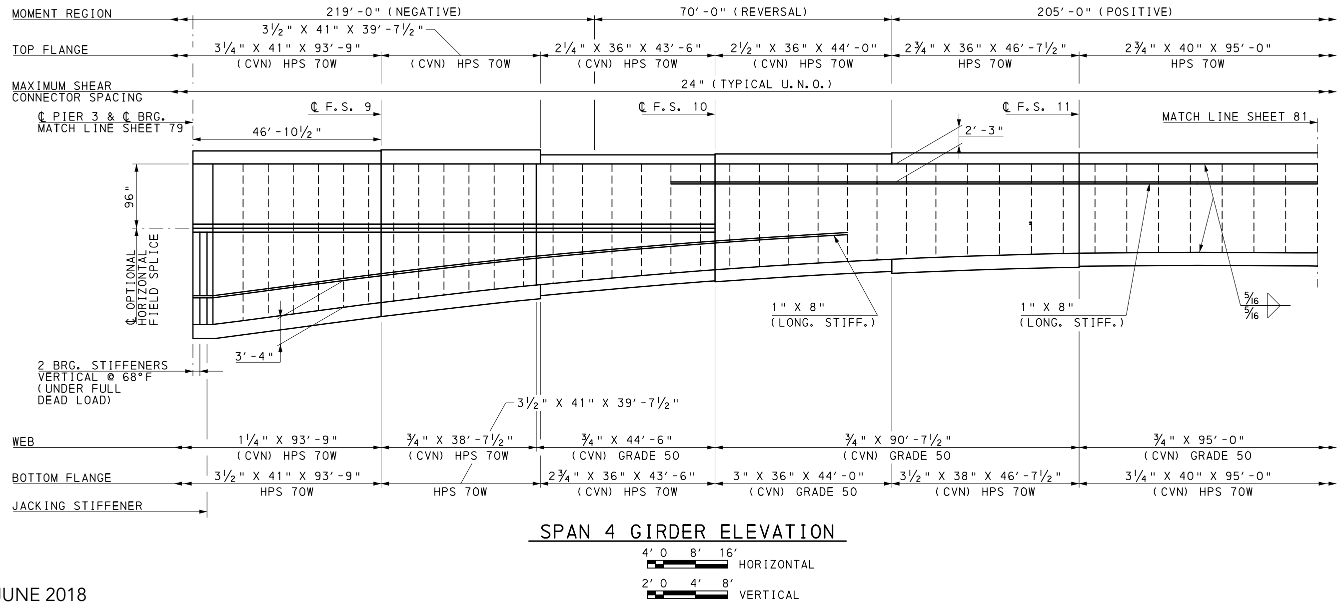
Hulton Bridge, Pittsburgh

A WESTERN PENNSYLVANIA LANDMARK located 13 miles east of Pittsburgh, the Hulton Bridge provides a vital regional connection to the Pennsylvania Turnpike and State Route 28/910 interchange. With a main span of over 450 ft, the Hulton Bridge is proving that steel plate girders can be the economical choice for major-span bridges.

With average daily traffic counts increasing yearly, the condition and functionality of the original Hulton Bridge, a Parker Pratt Through Truss built in 1908, did not meet growing community traffic demands and was structurally deficient. To enhance the traffic level of service and meet regional mobility goals, PennDOT contracted Gannett Fleming and Brayman Construction Corporation to design and construct a new $65 million bridge. A signature achievement built to last well into the 22nd century, the enhanced 1,633-ft-long, multi-span, steel haunched girder structure improves safety, traffic flow and functionality.

The new bridge consists of a 100-ft single span over the Norfolk Southern Railroad and a four-span continuous section over the Allegheny River with span lengths of 274 ft, 479 ft, 500 ft and 275 ft. The railroad span was supported on a splayed substructure configuration to accommodate both the alignment of the railroad and skew of the river. This geometry required varying beam lengths for the eight constant-depth steel girders. The four-span superstructure was comprised of five haunched steel girder lines with varying web depths from 9 ft at the end supports to a maximum of 20 ft over the piers. The five girder lines spaced nearly 15 ft apart allow for four traffic lanes on the new structure compared to the existing two-lane bridge. The girders used a hybrid configuration by incorporating both 50-ksi steel and high-performance 70-ksi steel to optimize the design. Due to girder depths in excess of 14 ft, horizontal splices were designed and detailed to facilitate fabrication, delivery and erection. Additionally, longitudinal stiffeners were used to minimize web plate thickness for material efficiency. Top chord lateral bracing was provided between fascia and first interior girders to accommodate wind loading during construction.

Preliminary studies considered five potential crossing locations covering a 3.5-mile stretch of the Allegheny River from Blawnox, Pa., to the State Route 910 interchange with State Route 28. The best solution to maintain the existing roadway network and connectivity across the Allegheny River was a new structure just upstream of the existing bridge on a skewed alignment from the original structure. The skewed configuration allowed the entire bridge superstructure to be constructed in one phase, which optimized the construction duration and minimized impacts to right-of-way and utilities.



> The bridge is proportioned so well it masks the fact that the main span is 500 ft long. Coupled with an innovative strand jacking method of main-span construction, steel bridges again show their flexibility to adapt to any site.
> —Frank Russo

The project team conducted studies to evaluate traffic capacity issues, pedestrian access, bicycle movements, accident data and master planning. As a result, the new upstream structure design features four 11-ft lanes, two 6-ft shoulders, a 4-ft median, a 5-ft sidewalk, an eastbound turn lane onto Allegheny Avenue and westbound right and left turn lanes onto Freeport Road that create more efficient traffic movements. The improvement in multimodal transportation mobility is a dramatic safety upgrade. While roadway safety features now meet current industry standards, future maintenance measures were also incorporated into the bridge design. For example, the bridge width and five girder lines allowed traffic to be maintained in both directions during re-decking. Construction crews also had enough room to safely perform maintenance as the bridge remained open to traffic. The new structure includes steel underdeck inspection walkways within the interior superstructure bays, as well as direct access to gas, electric and communication utilities supported by the superstructure.

Because of commercial traffic on the Allegheny River, the U.S. Coast Guard prohibited using temporary towers in the navigational channel and limited the channel closure to a maximum of 72 hours. The restrictions required an innovative approach to erect the 1,200 ton, 280-ft-long, 60-ft-wide closure section of the steel superstructure over the channel in less than three days. To meet this challenge, engineer Gannett Fleming proposed a strand jacking erection technique that had never before been used by the Pennsylvania Department of Transportation (PennDOT) on a steel girder bridge. (Strand jacks are hydraulic devices that use multiple steel cables, or strands, to lift large loads.) Lifting the navigational channel span into place required four 600-ton capacity strand jacks. The five-girder system was preassembled on barges and floated into place the night before the lift. At 10:00 a.m. the following day, the strand jacks, each using 36 ¾-in.-diameter strands, began lifting the span into place inches at a time. The segment was raised approximately 50 ft to its final elevation at 6:00 p.m. Once in final position, girders were secured so that the strand jacks could be removed and the channel reopened.

To safely open the navigational channel, 25% of the girders' 10,000 field splice bolts needed to be in place and fully torqued, and 50% were required to release and remove the strand jacks. All five girders were erected simultaneously, with only a 48-hour channel closure.

Owner
Pennsylvania Department of Transportation

General Contractor
Brayman Construction Corporation

Structural Engineer
Gannett Fleming

Steel Fabricator
High Steel Structures, LLC AISC CERTIFIED FABRICATOR

MEDIUM SPAN | MERIT AWARD

Sewalls Falls Bridge, Concord, N.H.

CROSSING THE MERRIMACK RIVER, the Sewalls Falls Bridge in Concord, N.H., is a vital link to the local four-season recreational area. Designed for the next 100 years, the bridge pays homage to the 100-year-old truss bridge that it replaced by repurposing a number of bridge truss sections into the new Heritage Park.

Due to increased traffic volume and heavier truck weights, it was determined that the existing bridge had reached the end of its functional service life and needed to be replaced. The design team worked with the owner and many other project stakeholders to develop a replacement design that honored the history of the existing bridge while also contributing to the natural landscape and park-like setting.

Integrating a bridge into its environment is a big challenge. The project team accepted that challenge and pulled it off really well.
—Amber Blanchard

The design team worked closely with local historians and the Department of Historic Resources to preserve the historical integrity of the existing bridge, which was designed by John W. Storrs. A notable bridge engineer who retired in 1933, Storrs was credited with having carried out or overseen the design and construction of more bridges in New Hampshire than any other individual. Following retirement from professional practice, Storrs later served as a two-term mayor of Concord. When complete replacement of the bridge was selected as the preferred alternative, the design team was determined to develop a project that honored the local history of the original bridge ad well as its preeminent designer. A small park was designed and built next to the bridge along one of the existing recreational trails. Portions of the historic metal truss bridge were repurposed and used as a trellis within this newly created Heritage Park, which included the original commemorative bridge plaque as well as new interpretive sign panels explaining the history of the original bridge. In addition, the granite stone masonry blocks from the original bridge piers were repurposed on-site to serve as retaining walls and benches within the park.

The new bridge is a modern three-span structure using steel plate girders with variable-depth (haunched) girder profiles at each pier. Structural steel girders were selected based on economic and aesthetic considerations, and they also pay tribute to the century of service life provided by the original steel truss bridge at the same location. The two-column piers each consist of two 6-ft-diameter drilled shafts socketed into bedrock, while the abutments are founded on steel H-piles driven into bedrock. The new bridge accommodates a 32-ft-wide roadway for vehicles and bicyclists, along with a 5-ft sidewalk on one side of the bridge for pedestrians. A powder-coated steel rail system was selected for its openness, and deck overlooks were provided along the bridge allowing pedestrians to enjoy the scenic landscape. Five continuous steel plate girders support the roadway, which are designed as composite with a reinforced concrete deck slab. Partial-depth (3½ in.) precast concrete deck panels were used as stay-in-place elements for the slab.

The structural steel is ASTM A709 Grade 50 weathering steel, which was used to reduce future maintenance and eliminate the need for painting. The girders feature ⅝-in.-thick web plates with web depths varying from 48 in. to 80 in. in order to create the haunched girder profile while also providing a slender and visually appealing beam system. Maximum flange plate sizes over the piers are 20 in. by 1¾ in. Bolted field splices are located near points of dead load contraflexure for design efficiency and to balance girder section weights for improved constructability. Maximum shipping lengths were less than 90 ft, and the maximum steel weight for each girder section was less than 15 tons.

Owner
City of Concord, N.H.

General Contractor
E.D. Swett, Inc.

Structural Engineer
McFarland Johnson

Steel Team

Fabricator
Casco Bay Steel Structures, Inc. AISC CERTIFIED FABRICATOR

Detailer
Tensor Engineering AISC DETAILER

SHORT SPAN | MERIT AWARD

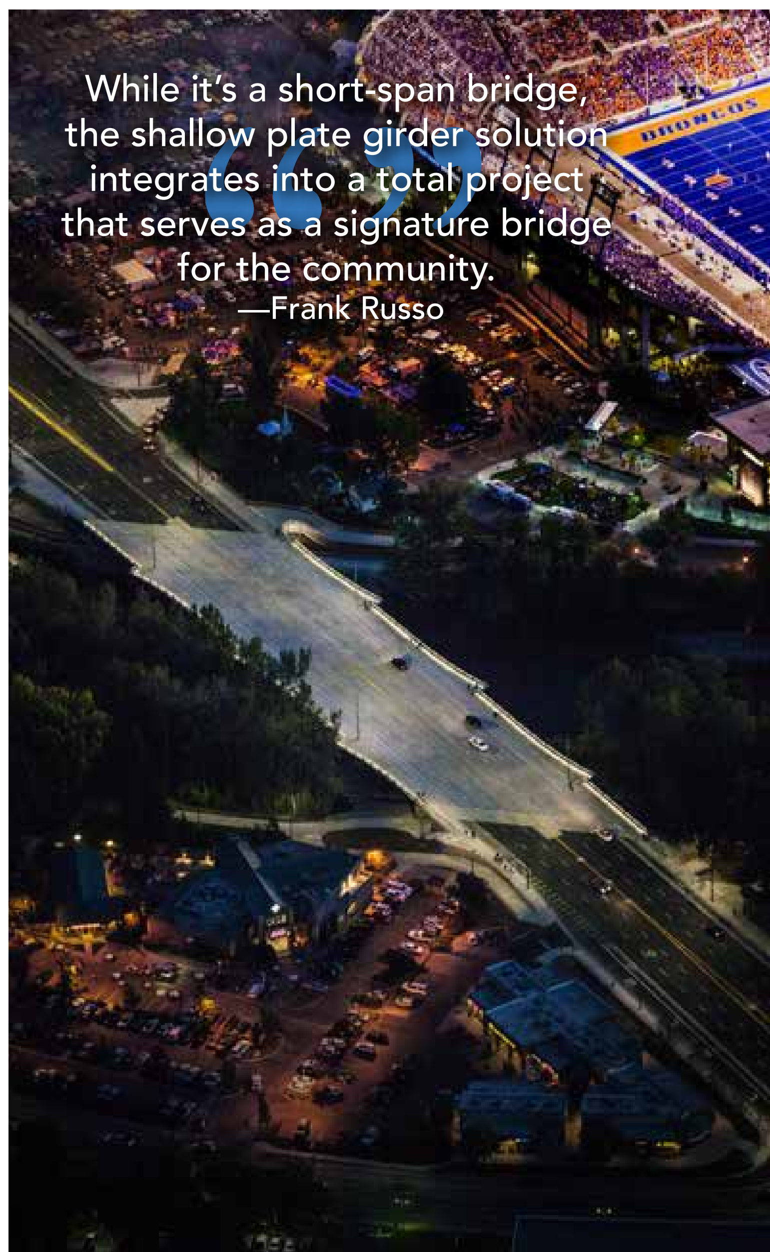
Broadway Avenue Bridge, Boise, Idaho

THE BROADWAY AVENUE BRIDGE connects the communities of Boise, Idaho, by spanning the Boise River with a single-span, parabolic haunched plate girder system. The bridge is the focal point of the greenbelt paths that run along the river through downtown Boise.

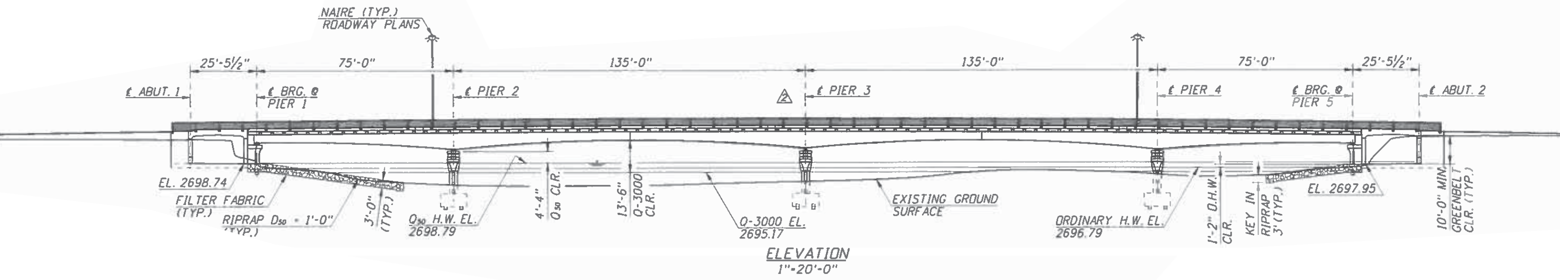
The new bridge includes beautiful tunnels under both ends, 10-ft-wide sidewalks with flared belvederes on both sides of the bridge complementing the steel girder curvature, design for future streetcar/light rail transportation, dedicated bike paths on both sides and six travel lanes (three in each direction). The bridge also incorporates design for future thermal utility water lines for potential expansion of the current system used by the city and university for heating needs. City planners and architectural designers assisted with aesthetically pleasing design features such as lighted steel pedestrian railings, pier and tunnel wall patterns/finishes and sidewalk saw-cut patterns and coloring.

The four-span, continuous steel girders include a parabolic haunched design for pleasing visual effects and higher clearances for rescue personnel during high flows. The bridge deck included modillions under the overhangs for supporting the larger loads due to the flared belvederes. The steel railing on the sidewalks, paths, tunnels and stairs adds some flare to the steel bridge, and the wave design of the steel railing and belvederes reflects the waves of the Boise River.

Collaboration with steel detailers allowed for efficient stiffener details and diaphragm details as well as efficient flange and web sizing. Initially, the design team considered using half-pipe attached to the web with the stiffener, believing this would handle the 45° skew for the cross frames at the piers and abutments. The assumed degree of difficulty for welding these stiffeners proved false, allowing the team to detail normal stiffeners at a 45° angle. Additionally, the efficient use of bent plates was encouraged for some of the diaphragms. Confirming the availability of $\frac{11}{16}$-in. web plate sizes gave the team comfort in steel availability going into final design. To accommodate emergency rescue personnel, given the high recreational use of the Boise River, the parabolic



While it's a short-span bridge, the shallow plate girder solution integrates into a total project that serves as a signature bridge for the community.
—Frank Russo



haunched girders allow for additional clearance in excess of the 2-ft requirement over Q50 river flow.

One of the biggest challenges for this project was minimizing impact on the traveling public as much as possible. The team decided that a full closure of less than one year provided the least amount of impact. This allowed a short window for all work in or near the water to be accomplished. Additionally, the city restricted work activities at night. The work schedule required several crews working on different foundations and piers at the same time. Some girders were placed on completed piers while other piers were still being constructed. To improve success with the accelerated schedule and ensure that the project could be out of the water in early spring, the team put out a separate contract to the steel industry to have the girders built prior to the bridge project being bid. Another challenge was ensuring that the greenbelt recreational path elevations were above the high water mark and allowed clearances for maintenance vehicles. This required the use of jump spans (tunnels) to meet the required elevations.

Due to the large skew, length and 108-ft width of the bridge, the design team worked closely with the contractor to make sure the girders were plumb after placing the deck and directing the use of two staggered screeds during deck placement. This involved explaining why the girders were detailed out-of-plumb prior to placement, due to the 45° skew, and giving guidance during fit-up of the girders on-site. It also required guidance on the importance of the pour sequence, allowing for rotations of the girders to take place and eliminating some permanent stress in the girders.

Another innovation enabled by using steel girders was the type of forming used to support the large overhangs from the sidewalk belvederes. An elaborate steel formwork was designed and attached to several girder flanges to support the overhangs and facilitate successful construction of the modillions and flared belvederes.

Owner and Structural Engineer
Idaho Transportation Department

General Contractor
Knife River Corporation Northwest

Steel Fabricator and Detailer
Utah Pacific Bridge & Steel AISC CERTIFIED FABRICATOR

MOVABLE BRIDGE | MERIT AWARD

Fort Street Bridge, Detroit

A RECORD-SETTING, single-leaf bascule bridge proves innovation can also be economical. The 176-ft bascule span Fort Street Bridge in Detroit is the heaviest bascule leaf in the world and second-largest by deck area. It is also one of the most efficient to open due to the rolling-lift design.

The original Fort Street Bridge had been an important connection over the Rouge River since the 1920s. The bridge was built in 1922 as a result of the dredging and enlargement of the Rouge River (to twice its width and depth) for the Ford River Rouge Plant. By the early years of the 21st century, the existing bascule bridge was nearing the end of its useful life and required replacement. The Michigan Department of Transportation (MDOT) engaged engineer Hardesty & Hanover to study alternatives and then take the most feasible option through final design. There were several critical goals for the new bridge. It had to increase the navigation channel from 118 ft to 135 ft, accommodate five 12-ft traffic lanes and two pedestrian/bikeways, minimize right-of-way impacts, avoid two utility tunnels and existing sub-piers and provide a striking visual enhancement to the community.

The new bridge is the heaviest bascule leaf in the world at 4,100 tons and the second-largest by deck area at over 15,000 sq. ft. Due to the efficient rolling-lift design, it requires minimal power to operate the bascule span under normal conditions. However, the two 150-HP motors move the bascule span during high wind and heavy ice conditions. Stringers, floor beams and two 13-ft-deep pony trusses support the steel grid-reinforced lightweight concrete deck.

The two segmental girders support the entire dead load of the bascule leaf in all positions. Each segmental girder is a heavily stiffened three-plate weldment. The web is 3 in. thick by 96 in. deep. The curved top flange is 32 in. wide by 3 in. thick, and the curved bottom flange is 32 in. wide by 3½ in. thick, after finishing. The steel for these girders is Grade HPS70W.

An enhanced design was developed for the segmental treads and tracks. These elements are high-strength steel castings, ASTM A148, Grade 130-115, with very robust cross sections to support the 2,050 ton loads on them. They are I-shaped with 10-in.-thick webs and 30-in.-wide flanges. Both edges of the tread bottom flanges have protrusions (lugs or teeth) that extend down into corresponding pockets in the tracks. These are spaced longitudinally at 25-in. centers. Locating the protrusions on the treads instead of the tracks, as is historically done, prevents debris from being trapped against the vertical surfaces of the protrusions.

> The project sets a record for a single-leaf bascule bridge while the counterweight structure creates a unique and visually striking bridge for the community.
> —Dominique Shannon

The counterweight structure is a six-panel trapezoidal box truss, 25 ft, 10 in. deep by 18 ft, 6 in. wide at the top and around 9 ft, 6 in. wide at the bottom. The bottom of the front truss is supported by the upper ends of the segmental girders, and there are cross frames at each panel point. The back truss is sloped so that it is parallel to the roadway when the bascule is fully open. Sloping the back truss provided the most efficient counterweight, which is sheathed in stainless steel panels to provide an enhanced aesthetic appearance and reduce future maintenance needs. The stainless sheathing on the roof of the counterweight and machinery room is underlain with a heating system to limit the amount of snow and ice that can accumulate and potentially fall onto the roadway.

Due to the very poor soil conditions in the immediate area of the bridge, an extensive geotechnical investigation was conducted. It was determined that concrete slabs borne on steel piles would provide an efficient structure to support fill, road and live loads and adequately address the soil instability concerns. These pile-supported slabs are located behind each abutment and each is supported by 43 steel HP12×74 piles. The bascule pier is located over two utility tunnels and the four 12-sq.-ft sub-piers of the existing bridge. The new foundation had to avoid these obstructions while supporting the 9,000-ton weight of the pier and bascule structure as well as the plus/minus 162,000 ft-kip overturning moment. Bedrock is located about 80 ft below the footing. Various foundation systems were investigated, and the ideal solution was to use the new heavy steel piles, HP18×204, which provide very high capacity with a relatively small individual footprint. A total of 12,745 ft of these sections was used, and this is the first MDOT project to employ these new steel sections.

Owner
Michigan Department of Transportation

General Contractor
Toebe Construction, LLC

Structural Engineer
Hardesty & Hanover

Steel Team

Fabricator
Steward Machine Co., Inc.

Detailer
Tenca Steel Detailing, Inc.

RECONSTRUCTED | MERIT AWARD

BNSF Railway Company, Bridge 482.1, West Memphis, Ark.

BNSF'S RAIL BRIDGE 482.1 proves accelerated bridge construction (ABC) isn't always about building new structures. Simultaneously sliding in a new superstructure while removing an existing 339-ft truss span was one of many challenges overcome by using ABC techniques.

HNTB Corporation provided design, permitting and construction engineering and inspection services for replacement of the 125-year-old bridge's west approach. The single-track bridge, which lies between West Memphis, Ark., and Memphis, Tenn., carries 90 million gross tons of intermodal and coal traffic over the Mississippi River annually and is essential to the BNSF Kansas City-to-Birmingham corridor. Reconstruction of the approach was split into four phases, with the final spans of the bridge replaced in August 2017.

As part of BNSF's $6 billion capital expenditure plan, the 2,712-ft-long existing west approach—consisting of fracture-critical, open-deck approach spans supported on steel towers—was replaced with new ballasted deck plate-girder spans supported on hybrid drilled shaft-micropile foundations. All structural steel used on the project was unpainted weathering steel, which will greatly reduce BNSF's future maintenance costs.

To keep the existing bridge in service during construction, HNTB designed a phased construction schedule with minimal track closure windows. Intermediate jump spans were designed to transition the existing open deck bridge to the new ballast deck bridge. The ABC approach allowed 2,712 ft of bridge to be changed out during four track-closure windows over a 10-month period, with the final spans replaced and traffic resuming in August 2017. The four track-closure windows ranged in duration from 36 hours to 52 hours, and the new approach consists of 27 ballasted deck plate-girder spans ranging in length from 72.5 ft to 191 ft.

The Phase I change-out replaced the first seven spans on November 10-11, 2016. This change-out was complex due to the approach requiring two 176.5-ft spans to cross over the

Big River Crossing pedestrian bridge and a county road. With the weight of these spans greater than the capacity of the on-site cranes, both spans were erected on extended pier caps and rolled into place during the change-out. Close coordination between the project team and the Memphis engineering firm in charge of the Big River Crossing trail was important throughout the design and construction phases. The opening of the Big River Crossing trail was scheduled three weeks before the Phase I change-out in 2016, and timing to install a canopy below the BNSF bridge was critical due to interference between the canopy and the bottom of the new deck plate-girder span prior to the final roll-in. The canopy was successfully installed two days after completion of the Phase I change-out.

Next, 708 ft of the approach was replaced during both the Phase II change-out on February 20-21, 2017, and the Phase III change-out on April 3-4. All spans in these two phases were 88.2 ft long and were shipped to the site in two shop-assembled units, which greatly reduced field assembly time. During the Phase II and III change-outs, each span was erected in place with one on-site crane after the existing structure was removed.

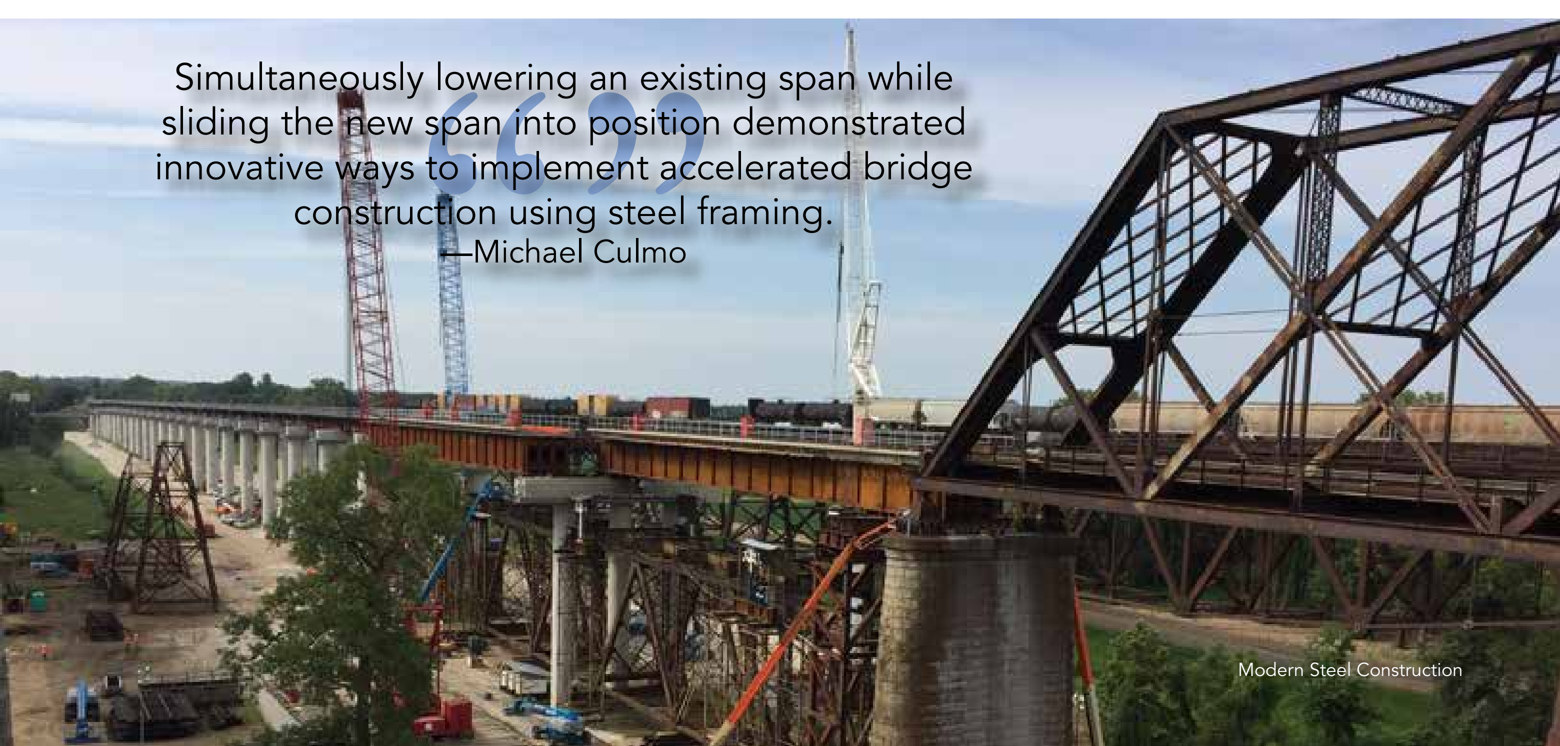
The Phase IV change-out, on August 28-30, replaced the final 548 ft of approach. Construction activities leading up to this change-out included constructing a pier cap and column through the existing 339-ft deck truss and erecting extensive falsework and shoring towers to aid with removal of the deck truss. Managing this fourth and most complex phase involved lowering a 339-ft deck truss using strand jacks, rolling a 191-ft span transversely into place and rolling a 178-ft span both transversely and longitudinally. Prior to lowering the deck truss, the north and south ends of the truss were removed to clear the existing piers, and portions of the truss surrounding the center pier were removed to permit the truss to be lowered around the pier.

Owner
BNSF Railway Company

General Contractor
Kraemer North America

Structural Engineer
HNTB Corporation

Steel Fabricator and Detailer
Delong's, Inc. AISC CERTIFIED FABRICATOR



> Simultaneously lowering an existing span while sliding the new span into position demonstrated innovative ways to implement accelerated bridge construction using steel framing.
> —Michael Culmo

SPECIAL PURPOSE | MERIT AWARD

Moose Run Golf Course Bridge, Anchorage, Alaska

A NEW STRIKINGLY beautiful bridge serves as a signature crossing for golfers on the Moose Run Golf Course. The Moose Run Golf Course Bridge suspension bridge used a unique approach that saved construction costs while mitigating environmental impacts to the surrounding area. To support the bridge deck, a system of horizontal and vertical cables spans between two vertical towers.

Suspension bridges, while materially efficient, are often some of the most difficult to build because they require unusual and complex means of construction and may require extensive temporary aerial catwalks and gantries. The most typical superstructure for a 200-ft-long clear-span pedestrian bridge such as the Moose Run Bridge would be a heavy through-truss or heavy girder design. Construction of this type of bridge would generally require mobilizing a large crane or multiple cranes to set the superstructure, adding considerable cost to the project and significant impact to the environment.

Alternatively, PND Engineers designed the bridge as a Strand Bridge, a type of suspension system that uses vertically harped and horizontal strands to form the bridge support, provide for bridge erection and form the final hand rails. This bridge type, codeveloped by PND and contractor Swalling Construction Company, is launched instead of using conventional construction methods, permitting the use of smaller construction equipment and requiring no significant temporary structures, further reducing costs over classic suspension bridges.

After construction of the foundations and towers, horizontal strands are placed and intermediate U-frames and minimal decking are launched from one side of the bridge. These horizontal strands also function as hand railing for the completed bridge. Once the U-frames are in place, harped suspension strands are installed and tensioned to provide a flat bridge camber, after which the bull rail and the remainder of superstructure elements are installed. The bridge is then cambered to its final position and load tested.

Using the Strand Bridge method, the Moose Run Bridge's superstructure was launched from one side of the bridge, rather than being craned into place. The design used high-strength, low-relaxation, galvanized pre-stressing strands. Ultimately, the bridge is sturdy enough to support use by pedestrians, golf carts and groundskeeping equipment (load tested with an 8-ton H-configuration truck) and to accommodate a 90-psf uniform load in accordance with AASHTO. The uniform load easily accommodates the local design snow load of 57 psf.

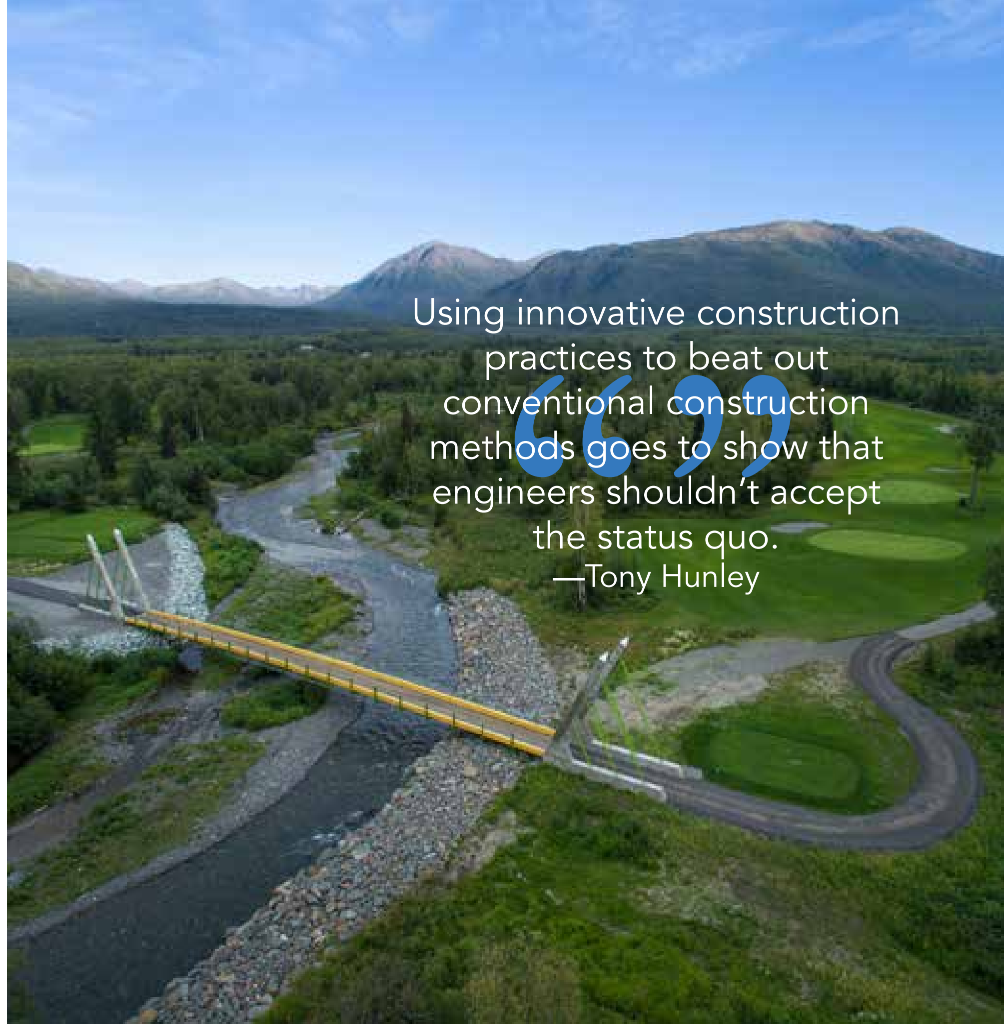
In function, the post-tensioning strands provide vertical global support for the 200-ft span, and the rectangular steel HSS box beams efficiently provide local vertical and torsional stiffness as well as function as a vehicle guard rail. Because these types of light bridges are prone to vibrational amplitudes and frequencies that pedestrians are often sensitive to, and because these characteristics are sometimes difficult to accurately predict, this bridge was designed with several important considerations. It was detailed to readily accept mass-dampers if the bridge dynamics were shown to be a problem. The HSS beams were designed to provide vertical, lateral and torsional stiffness to the system, which in turn mobilizes more mass from the structure, thereby helping to mitigate the localized pedestrian dynamic loads. Post-construction, the bridge was monitored with velocity transducers to determine its vibration amplitude and frequency characteristics. Although the bridge is relatively light, its amplitudes have not been considered objectionable.

Owner
Moose Run Golf Course at Joint Base Elmendorf-Richardson

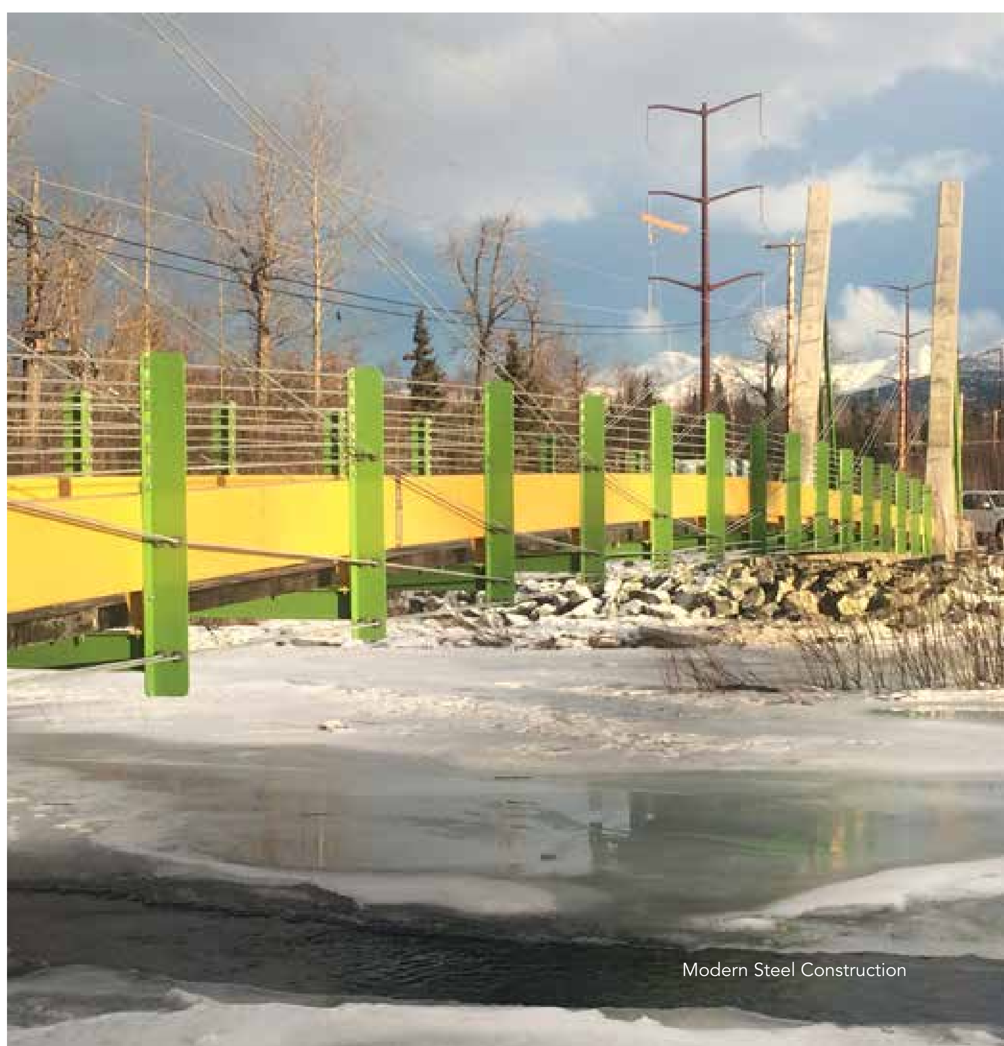
General Contractor
Swalling Construction Company

Structural Engineer
PND Engineers, Inc.

Steel Fabricator
Jesse Co. AISC CERTIFIED FABRICATOR



Using innovative construction practices to beat out conventional construction methods goes to show that engineers shouldn't accept the status quo.
—Tony Hunley




CAT

SUSTAINABILITY COMMENDATION

Neponset River Greenway, Milton, Mass.

THE NEPONSET BRIDGE in Milton, Mass., blends seamlessly into the canopy of the surrounding trees. Designed and fabricated to limit material waste and using a durable coating system will limit the life-cycle costs associated with the bridge. When it comes to designing for sustainability, this project checks all of NSBA's boxes.

This structure is a single-span steel arch bridge that spans the Neponset River. The preassembled weight was approximately 62.5 tons and originally required a 660-ton crane for the pick. Directly under the laydown area for the crane was a 48-in. sewer line that had to be protected. A crane of this size would have created a large impact on the site and involved the removal of numerous trees in the wetland area as well as posed a risk to the sewer line. General contractor S&R opted to erect the structure by using a tandem pick with two cranes: a Liebherr LR-1200 crawler crane on the north side of the river and a Liebherr LTM-1400 hydraulic crane on the south side. This method also involved creating a 65-ft-long temporary crane "runway" bridge, allowing the LR-1200 to crawl into position while completely avoiding the sewer main. This method of erection ultimately resulted in a time and cost savings as well as protected the extremely sensitive environmental areas adjacent to the project.

All structural steel was prefabricated and preassembled to the fullest extent possible off-site, resulting in minimal cutting and assembly in the field. Concrete forms also were fabricated off-site, resulting in minimal waste. All Ipe wood decking was cut to length before being delivered, and all custom millwork of Ipe handrails was done at a sawmill before being delivered to the job site. This technique of prefabricating material allowed S&R Corporation to have minimal waste, while most projects of this magnitude would generate a much larger amount of waste and leave a much larger impact on the local landfills.

The project was heavily focused on aesthetics and involved many unique and creative applications. The railing system on all of the structures involved steel posts coated with Tnemec paint, square tube steel railing frames, DecorCable stainless steel mesh infill panels and custom-milled Ipe wood. This was a complex application due to the intricacies for the 100+ different shapes of steel frames and DecorCable infill panels, with tolerances as low as $^3\!/_{16}$ in.

In addition, the bridge structure is fitted with a unique and impressive lighting system. There are 10 lighting fixtures located within the structural steel arch (using the steel framing as conduit) shining down onto the Ipe deck and illuminating the walking surface. In addition, 30 lighting fixtures were recessed into the deck to shine upwards, illuminating the steel arch.

To complete this uniquely aesthetically pleasing project, the bridge is fitted with steel tree silhouettes and acrylic leaves set in a specific, detailed pattern to assume the appearance of seasonal trees with decorative foliage. S&R used full-size renderings of the designed pattern to ensure that more than 2,700 acrylic leaves were placed specifically to capture the beautiful outcome envisioned by the designers. ■

Owner
Massachusetts Department of Conservation and Recreation

General Contractor
S&R Corporation

Structural Engineer
AECOM

Prime Design Consultant
Crosby Schlessinger Smallridge, LLC

Fabricators
M C IronWorks, Inc. AISC CERTIFIED FABRICATOR
STS Steel, Inc. AISC CERTIFIED FABRICATOR