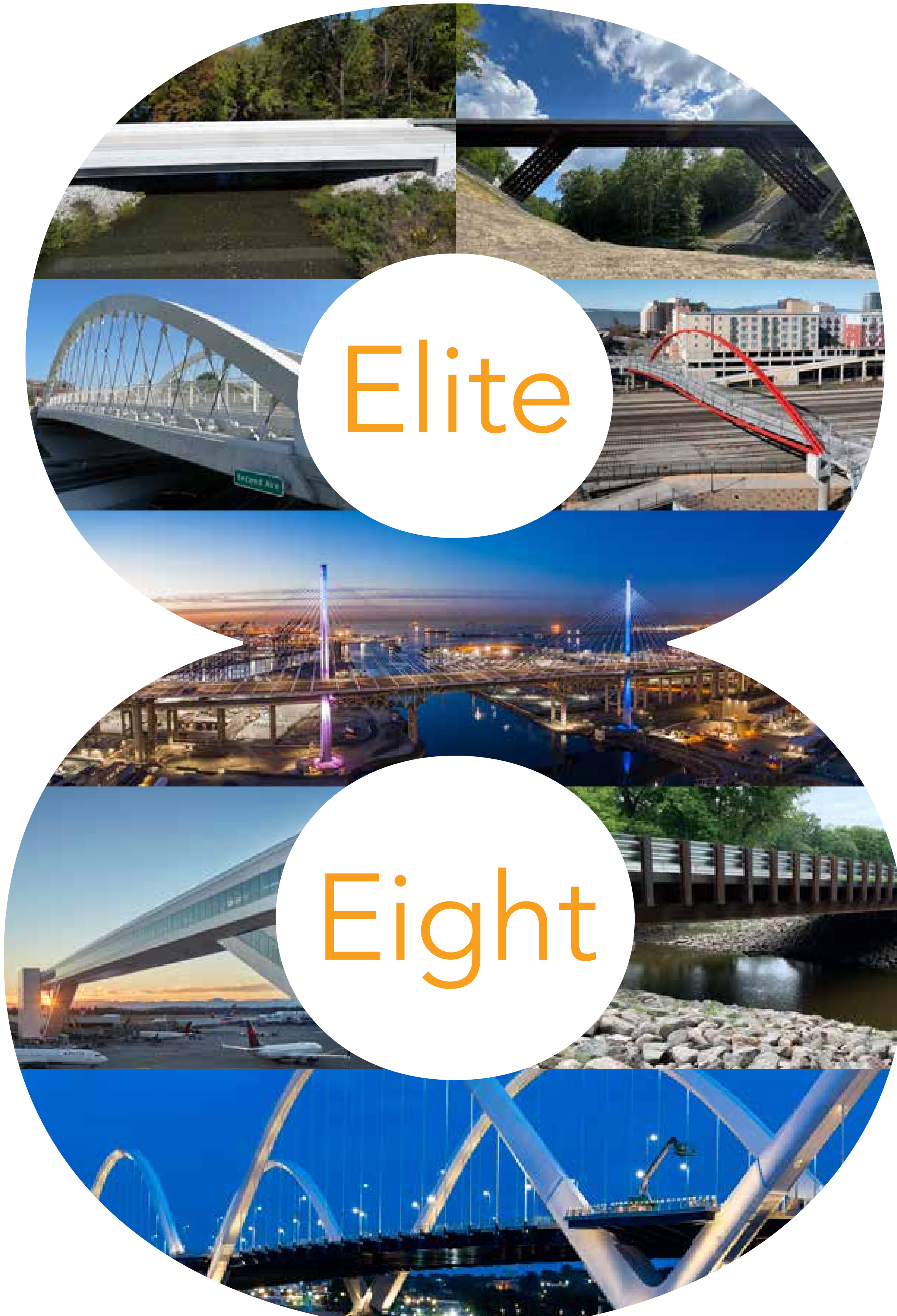
Elite Eight



An active taxiway crossing, a sparkling bridge connecting two growing neighborhoods in Washington, D.C., and several short-span projects are among the eight 2024 AISC/NSBA Prize Bridge Award winners.

INNOVATION ABOUNDS in the steel bridge industry, and eight recent bridges projects are especially captivating showcases of it.

AISC and the National Steel Bridge Alliance (NSBA) handed out the 2024 Prize Bridge Awards to eight recently completed structures, from short creek overpasses to major river crossings and even a taxiway bridge at an airport.

"Steel bridges have connected American communities for centuries," said NSBA Senior Director of Bridge Projects Jeff Carlson, PE. "This year's Prize Bridge Award winners continue that proud tradition and showcase the innovation—at all scales, from showcase bridges to local lifelines—that will keep Americans moving for centuries to come."

More than 600 bridges of all sizes from all four time zones have earned a Prize Bridge Award since 1928, when AISC gave the inaugural honor to Pittsburgh's Sixth Street Bridge. Some of those long-ago winners are still in service and have even outlasted the companies that built and designed them.

Prize Bridge Awards are handed out biennially. This year, two winners were in the long span category (one span of at least 300 ft), two were medium span (one span between 140 and 300 ft), two were short span (no span longer than 140 ft), and two were special purpose. The rehabilitation category did not have a 2024 winner.

A team of five acclaimed bridge experts served as the 2024 jury:

- Jim Nelson, PE, Bridge Engineer, Iowa Department of Transportation
- Deanna Nevling, PE, PhD, Senior Bridge Engineer, HDR
- Natalie McCombs, SE, PE, Associate Fellow, HNTB
- Tom Murphy, SE, PE, PhD, Senior Vice President, Modjeski and Masters
- Brian Witte, Vice President, Construction Engineering, Parsons Corporation

Judges weighed each project's use of structural steel from an architectural and structural engineering perspective, with an emphasis on creative solutions to the project's program requirements. They considered innovative design approaches in connections, gravity systems, lateral load resisting systems, and fire and blast protection. Other factors were aesthetic and visual impact of the project, innovative use of architecturally exposed structural steel (AESS), technical or architectural advances in the use of the steel, and creative design and construction methods.

The Prize Bridge Award program also recognizes the importance of teamwork, coordination, and collaboration in fostering successful projects. The 2024 awards also have a new feature, Owner of the Year, and the Texas Department of Transportation earned the inaugural honor.

"TxDOT isn't just implementing best practices for designing and building steel bridges—it is defining how an owner can maximize the potential of steel," Carlson said. "Recent projects like the remarkably economical Brazos River Bridge demonstrate how TxDOT's longstanding investment in steel bridge research is paying dividends for Texans today and tomorrow."

This year was the second selection of the Bridge of the Year, which went to the new Frederick Douglass Memorial Bridge in Washington, D.C. It earned the honor over the SeaTac IAF Pedestrian Walkway in Seattle and the Interstate 94 Second Avenue Bridge in Detroit.

Read on to learn more about and see stunning images of the eight winners.

Major Span

BRIDGE OF THE YEAR
NATIONAL AWARD
The new Frederick Douglass Memorial Bridge
Washington, D.C.
Submitted by AECOM

MERIT AWARD
Long Beach International Gateway Bridge
Port of Long Beach, Calif.
Submitted by Stinger Bridge & Iron

Medium Span

NATIONAL AWARD
Interstate 94 Second Avenue Bridge
Detroit
Submitted by HDR

MERIT AWARD
State Route 34B Bridge over Salmon Creek Replacement
Lansing, N.Y.
Submitted by New York State Department of Transportation

Short Span

NATIONAL AWARD
Grand Forks County Prefabricated Bridge
Northwood, N.D.
Submitted by KLJ

MERIT AWARD
State Route 32 Bridge over Stony Creek
Noblesville, Ind.
Submitted by Indiana Department of Transportation

Special Purpose

NATIONAL AWARD
SeaTac IAF Pedestrian Walkway
Seattle
Submitted by Thompson Metal Fab

MERIT AWARD
South Bayfront Pedestrian Bridge and Horton Landing Park
Emeryville, Calif.
Submitted by Stinger Bridge and Iron

2024 PRIZE BRIDGE AWARD

BRIDGE OF THE YEAR
NATIONAL AWARD | MAJOR SPAN

The New Frederick Douglass Memorial Bridge
Washington, D.C.

THE NEW FREDERICK DOUGLASS MEMORIAL BRIDGE is a replacement in designation only.

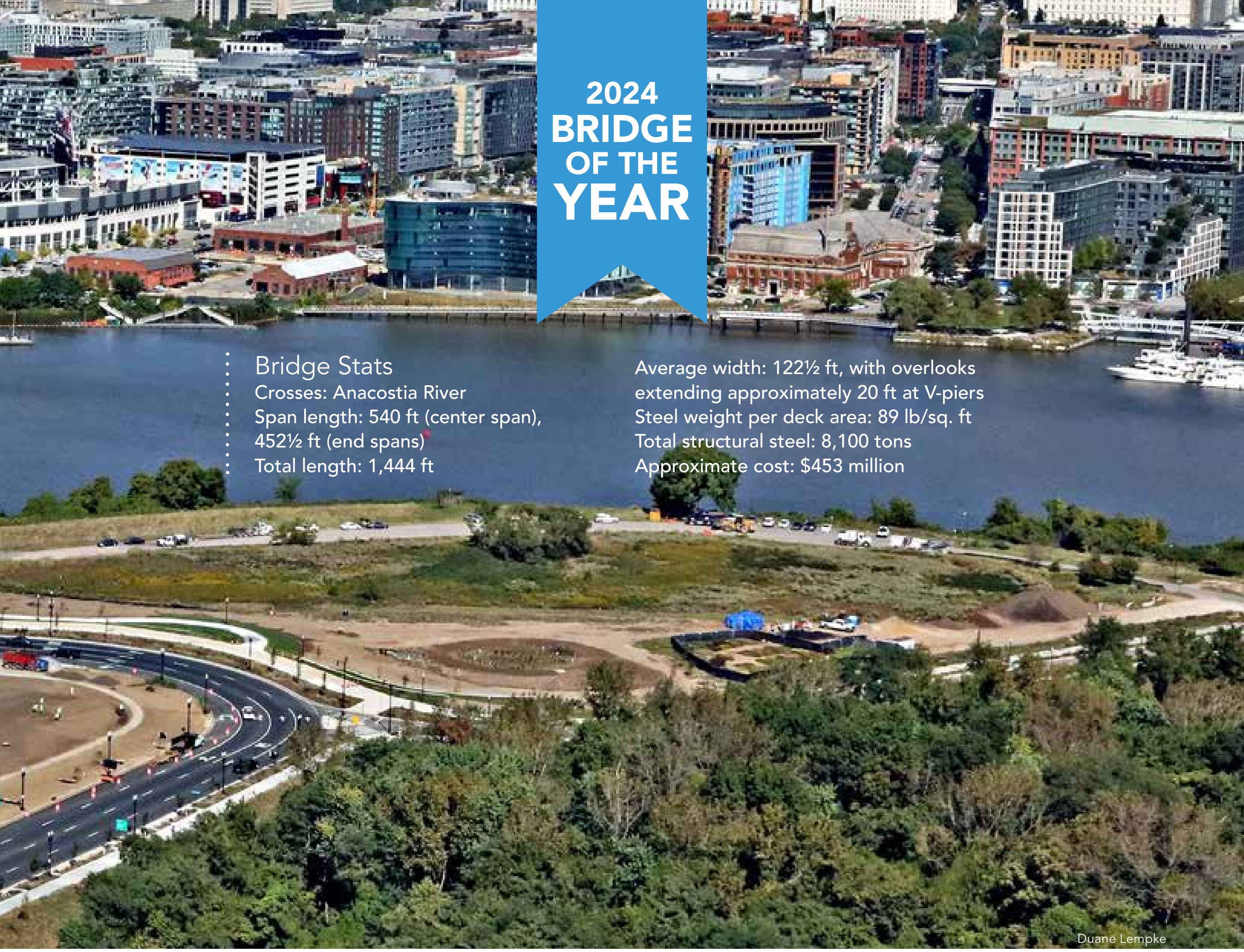
Yes, it technically took the place of an old structure bearing the same name crossing the Anacostia River in Washington, D.C. But it's much more than a link between two sides. The owner and design team envisioned a structure that would fit with Washington's timeless architecture—a bridge that is classic but not classical, dramatic but not theatrical.

The result is the one-of-a-kind, above-deck arch design that opened in September 2021, replacing a bridge built in 1950. The new Frederick Douglass Memorial Bridge (FDMB) is 1,444 ft long with two 452-ft side spans and a 540-ft center span, significantly exceeding the minimum horizontal navigation channel width to open the waterway for all users.

Structural steel was the only solution for the bridge to achieve its signature arches, which have a variable hexagonal shape and a variable depth from the base to the crown. The three sets of lighted, parallel arches spring high above the water and nearby landmarks, visually marking the sky across the river between the increasingly dense western Buzzard Point neighborhood of Washington and the park-like neighborhoods of Poplar Point and Anacostia to the East.

The bridge provides a positive bank-to-bank connection, with the arch profile suggesting the path of a stone skipping across the water. Unlike other D.C. arch bridges, the desire was to extend the arches vertically above the deck to create a landmark structure.

The illuminated arches can produce any number of color schemes to celebrate occasions and holidays in D.C., including pink for the District's cherry blossom festival, rainbow colors for Pride month, and red, white, and blue for Independence and Veterans Day. In a city of arch bridges and national monuments, the FDMB stands out with its majestic above-deck arch design.



Duane Lempke

Bridge Stats

Crosses: Anacostia River
Span length: 540 ft (center span), 452½ ft (end spans)
Total length: 1,444 ft
Average width: 122½ ft, with overlooks extending approximately 20 ft at V-piers
Steel weight per deck area: 89 lb/sq. ft
Total structural steel: 8,100 tons
Approximate cost: $453 million

The bridge's namesake, Frederick Douglass, is celebrated throughout the structure. The bridge connects the D.C. neighborhoods where he worked and lived and is visible from the Frederick Douglass Historical Site in Anacostia. At each overlook, commemorative plaques share Douglass's legacy as an abolitionist, orator, writer, and statesman. Images of the FDMB are also featured on new D.C. driver's licenses.

The ovals at the approach of each entrance provide a unique application for traffic calming, smoothly moving 70,000 vehicles over the bridge per day. They also provide an urban oasis from city congestion by offering generous outdoor spaces with landscaped, park-like settings. The 2.7-acre ovals are each almost two football fields long and one football field wide. The ovals also offer the opportunity for future monuments on either side of the bridge.

Achieving the Arches

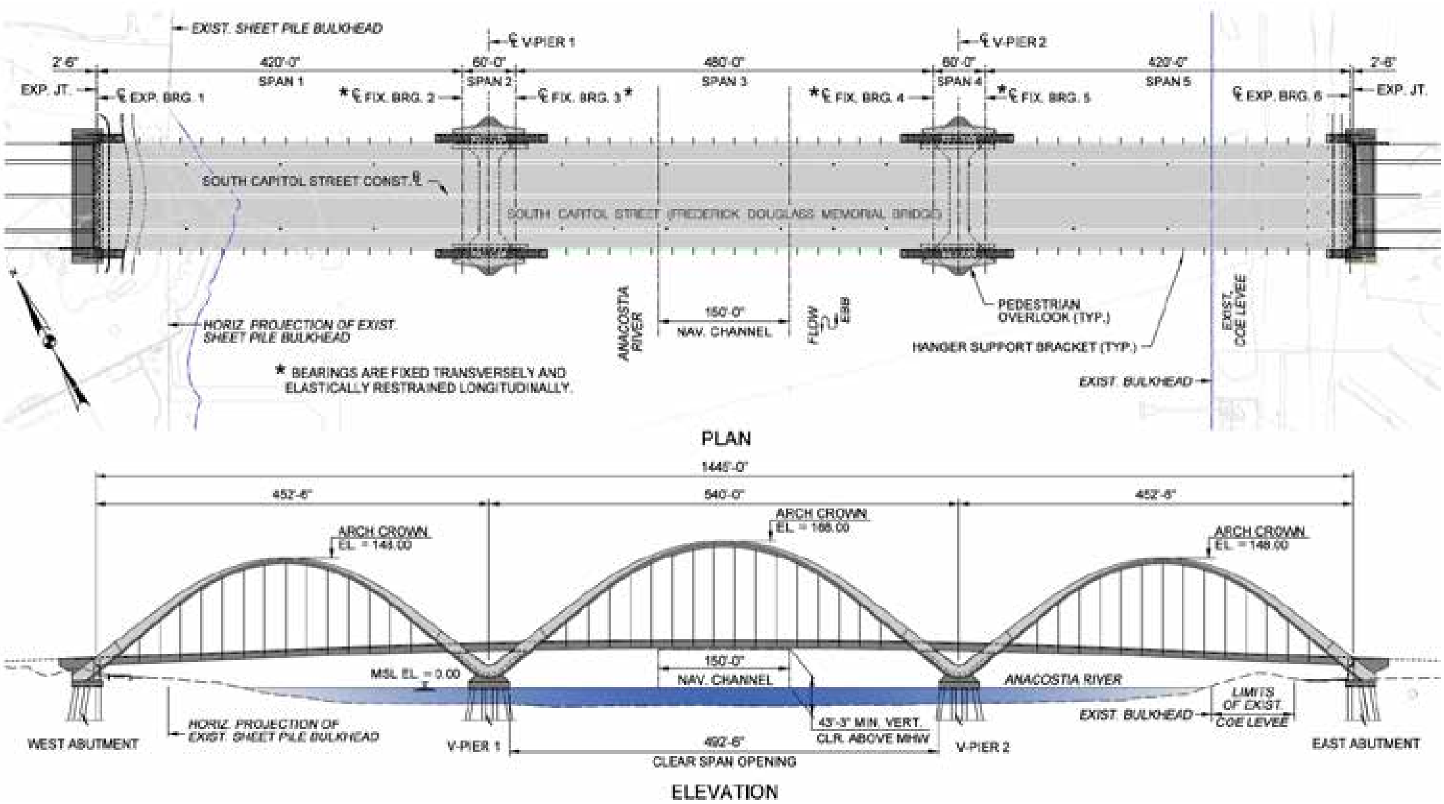
Once the concept was envisioned, the design team only considered steel for the arches due to their complex geometry. The team worked together on many of the fabrication design and detailing issues that arose throughout the design phase.

The arches' cross sections are hexagonally shaped to enhance the arches' visual appearance, which casts shadows that decrease their visual mass. Apart from each arch being symmetric about its centerline, the rib section constantly varies throughout the side and center arches from base to crown.

The arch is a constant 9½ ft wide at the web break, but the location of the web break travels up the section as the arch rises. The top web is angled at 15°, and the bottom web is angled at 30°, forming a kite shape from which the arch hexagon is extracted. The side arches vary in depth from 14½ ft at the abutment to 6 ft at the crown and back to 13½ ft at the V-pier. The center arches vary in depth from 13¾ ft at the V-piers to 7 ft at the crown.

The arches employ an unbraced design to provide an unobstructed view above the deck. The central arch is 20 ft higher than the side arches and has a 168 ft elevation above the water, a tremendous visual impact for travelers entering and exiting the nation's capital. The three-arch system was designed to allow the superstructure to move freely through the arches with expansion joints only at the ends of the structure. The arches are supported by concrete V-piers with the same cross-section as the steel arches, allowing for a seamless visual transition.

Steel gave the arches a seamless look from the outside, with all detailing occurring inside the arch section. The arches utilize butted splices that are entirely internal, providing improved aesthetics without external bolted splices. The arch base connection is also entirely internal, providing a seamless transition to the V-pier and protection for a critical connection. The six arches support 88 stay-cables with hangers in a vertical plane outside the deck edge, reducing the potential for falling ice on the roadway below.



The steel floor system provides a robust and economical system that carries three lanes of traffic in each direction, along with generous 18-ft-wide shared-use paths on each side of the bridge. All the sections are I-shaped plate girders with a composite precast panel deck. The edge girders are at a constant depth, with most of their length composed of Grade 50W steel. The sections at the V-piers are composed of Grade HPS 70W steel where the edge girders are not cable supported, but instead span between supports on the V-pier legs. Also at the V-piers, overlooks cantilever out past the arches to provide unobstructed views of the Anacostia River and the city, including the adjacent Navy Yard and Nationals Park.

One of the most challenging design aspects was the arch sections' butted splices. The arch splices that connect the segments had to be fabricated with high precision and tight tolerances to ensure an easy bolted fit-up in the field. Any misalignment of the arch segments could have resulted in the whole arch becoming out of tolerance. The arch splice ring plates were 3D scanned and match milled so an exact fit could be achieved. The result was a tight connection with a clean visual that uses fewer bolts than a typical splice connection.

The hexagonal cross-section of the arches seamlessly transitions into the V-pier substructure to obtain the skipped-stone path of the structure. Unlike most steel-to-concrete connections, which typically have a base plate external to the section, all parts of the anchorage are internal to the arch section. That layout created several challenges that needed to be considered and overcome, including arch bearing stiffener/anchor rod layout, edge spalling effects of the concrete V-pier, baseplate details and fabrication, and coordination with V-pier post-tensioning detailing.

The design and analysis of such a unique arch shape brought about many challenges in detailing and fabrication. The design team utilized global and localized 3D models to analyze the behavior of the arches. Because of the unique shape, the steel arch rib required stiffening in various locations on the top flange, bottom flange, top web, and bottom web, which were not consistent throughout the arch.

The decision to use internal splices came early in the project. A ring plate is at the start and end of each arch segment and at each anchorage. Managing all the stiffeners ring plates and constantly changing geometry required close coordination with the detailers so the section could be fabricated efficiently. Even though the arch is primarily a compression member, its shape and unbraced nature mean tension stresses occur in the section. The team worked to eliminate any poor fatigue details within the section, often requiring complete joint penetration welds or stiffeners that terminated with a ground radial transition.

Several iterations of stiffener and anchor bolt layouts were evaluated for use at the arch base. The team used hand calculations for the initial design. For the final design, it developed a local finite element model composed of shell elements for the steel plates, tension-only members for the anchor rods, and springs to model the combined stiffness of the underlying concrete and grout. The arch base connection utilizes large 2½-in. diameter anchor rods to transfer the large bi-axial forces that arise with the unbraced arch design.

The team worked closely with the fabricator and installers to ensure that all tightening equipment would fit between the stiffeners for the large anchor bolts. An anchor plate that matches the geometry of the base plate is embedded deep into the concrete V-Pier to transfer any tension forces that arise in the anchor bolts.

The original FDMB had a swing bridge span adjacent to the new bridge and a central pier that was in the middle of the navigation span, which resulted in the need for a temporary navigation channel to be offset to one side of the center arch during construction. The temporary channel prevented any temporary support from being placed in that location.

The two side arches were initially erected using two temporary supports per arch. Since only one support could be placed for the center arch, the east side of the center arch was erected using temporary cables attached to the side arch until the keystone arch

AJ Cardini

Duane Lempke


Robb Williamson


Robb Williamson


DC Magazine, Norman E Jones

piece could be placed. Because the temporary navigation channel was offset, the floor system construction proceeded asymmetrically over the bridge length, which required arches to support the asymmetric dead loading.

Several efforts economized the steel fabrication and minimized the long-term maintenance. The bridge has four-way symmetry, giving it economy of repetition even with the arches' complex detailing. The floor system and railings were detailed with as much repetition as possible. Where additional strength was needed for the edge girders over the V-piers, grades of steel were varied instead of varying the cross section, keeping detailing consistent throughout the structure.

The 18-ft shared-use path on each side allows for under-bridge inspection vehicles or aerial lifts to be driven to the edge of the structure for easier inspection. The arches are placed outside of the roadway width, allowing for minimal roadway closures and easier inspection. The bridge was also designed for a 100-year service life using several high-performance materials and coatings, reducing long-term maintenance needs.

Community Staple

The bridge creates extraordinary value for Washington in many ways other than cost. Community members, commuters, and visitors enjoy the bridge's signature profile and vastly improved transit and mobility opportunities. They also directly benefit from a wide array of project-related public investment programs designed to better the region on both sides of the river.

The FDMB's sustainable urban design, bridge innovation, and dramatic presence have spurred equitable societal and economic growth within southeast Washington along both riverbanks. It augmented multimodal connections for pedestrian, bicycle, and transit and created a waterfront esplanade for Buzzard Point, a once bare and neglected community.

On the other bank, Poplar Point's visionary plan integrates FDMB's urban design features and helped facilitate a new, mixed-use neighborhood surrounded by generous parks and natural open spaces. The areas feature enhanced recreational and cultural amenities and extend the Anacostia community to the river, enlivening the water's edge.

Robb Williamson

The project's large-scale public programs expanded participants' vision of societal connection and helped attendees obtain education to better their job possibilities. The most notable is the District DOT's local hiring initiative, a first-of-its-kind federally funded on-the-job training program to hire and train women and minority candidates named "Strive – Build the Bridge to Your Future." The program mentored next-generation civil engineers, and a construction on-the-job mentoring program delivered design, construction, and construction management training.

"The new Frederick Douglass Memorial Bridge is a fitting tribute to an iconic Washingtonian and a forefather of Black excellence who we continue to emulate and who helped build Washington, D.C., into the city we are today," Washington Mayor Muriel Bowser said during the bridge's ribbon cutting ceremony. "This project was never just about getting people from Point A to Point B; it was about building a more connected D.C. by connecting Ward 8 and Ward 6, connecting residents to jobs and prosperity, and connecting our entire community to the future of multimodal transportation."

Owner
District of Columbia Department of Transportation

General Contractor/Erector
South Capitol Bridgebuilders (SCB), joint venture of Archer Western, Granite Construction, and Walsh Construction

Structural Engineer
AECOM, Glen Allen, Va.

Erection and Construction Engineer
McNary, Bergeron & Johannesen, Hartford, Conn.

Lead Bridge Architect
BEAM Architects, Bridgport, U.K.

General Engineering Consultant
HNTB, Arlington, Va.

Steel Team

Fabricator
Veritas Steel, LLC AISC CERTIFIED FABRICATOR, Eau Claire, Wis., and Palatka, Fla.

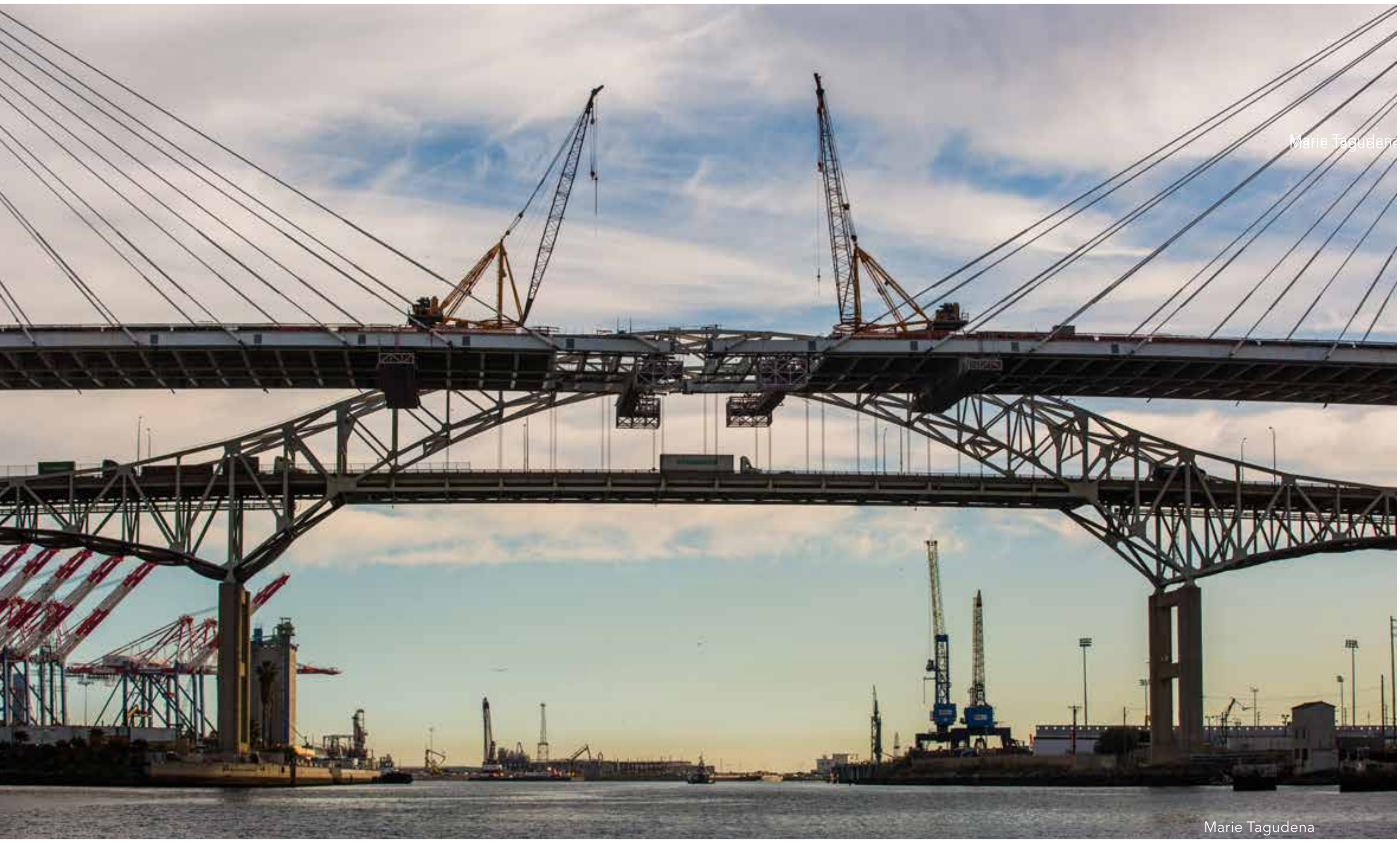
Detailer
Tensor Engineering AISC DETAILER, Indian Harbour Beach, Fla.

Marie Tagudena

Bridge Stats

Crosses: Long Beach's back channel
Span length: 1,000-ft clear span
Total length: 2,000 ft
Average width: 150 ft
Approximate cost: $1.5 billion

Marie Tagudena



Marie Tagudena

Marie Tagudena


Nancy Henderson

2024 PRIZE BRIDGE AWARD

MERIT AWARD | MAJOR SPAN

Long Beach International Gateway Bridge, Long Beach, Calif.

THE GATEWAY to an American economic centerpiece is as architecturally striking as it is crucial to daily commerce in Southern California.

About 15% of all North American maritime container traffic crosses the Long Beach International Gateway Bridge, and freighters pass under it when entering the Port of Long Beach's back piers. It's a critical infrastructure link and a vital component of the regional and national economy.

The new bridge is also a landmark of a city best known for its port—and a first-of-its-kind bridge in the state.

The $1.5 billion, 9,996-ton bridge opened in 2020, replacing the 51-year-old Gerald Desmond Bridge that carried six lanes of Interstate 710 over the port's back channel. The replacement project didn't just create a bridge designed to last 100 years and secure long-term port access. It birthed California's first major cable-stayed bridge and an aesthetically pleasing addition to Long Beach's waterfront cityscape. It also pushed the envelope of seismic design for bridges.

In 2011, the Gerald Desmond Bridge had been open for 43 years, was seismically deficient, and exceeded its useful life. The Port of Long Beach—in partnership with the California Department of Transportation (Caltrans), the Federal Highway Administration, and Los Angeles Metro—invited several teams to provide design-build bids for a replacement project, which included replacing the main span bridge, overhauling the bridge's elevated approach structures, and rebuilding the major freeway interchanges that feed them.

Caltrans and the port expected the replacement bridge would be a two-tower, six-lane cable-stayed bridge with a 100-year service life, providing seismic resilience and adequate vertical and horizontal clearance to accommodate the newest generation of cargo ships—all within an affordability limit. Steel provided a lightweight superstructure for an economical and innovative approach to seismic design.

The final product is a 2,000-ft-long by 150-ft-wide bridge fabricated from A709 HPS-50W plate. It has fracture critical elements, trapezoidal box edge girders, I-beam floor beams, complex box end girders, pier skin plates, and cable stayed anchor boxes. A 2,000-ft bike and pedestrian structure cantilevers off the south end.

Trusted Towers

The owner mandated a tapered mono-pole tower after an architectural study of form and proportion involving a world-renowned bridge architect. The design-build team


Nancy Henderson


Nancy Henderson

responded to the architectural vision by designing a unique tower form that tapers from an octagon to a diamond. The tower design emerged from aesthetic, constructability, and seismic performance considerations.

The 515-ft-tall mono-pole towers support the 1,000-ft main span. The non-redundant towers must remain undamaged in the 1,000-year seismic design event, with a peak spectral acceleration of 1.4g. Those requirements are met by an array of seismic dampers that isolate the superstructure from the substructure, allowing 32 in. of movement in any direction.

The towers are designed to be extremely flexible, allowing the top to displace more than 8 ft in the design event, with peak strains remaining well below essentially elastic limits. Layers of beyond-design-basis performance were provided, including ductile detailing, capacity protection, provision of structural stops to protect dampers, capacity protection, and explicit analysis of 125% of design ground motions.

The octagonal tower geometry successfully merges two occasionally competing objectives: construction efficiency and aesthetic distinction. To facilitate an efficient jumping formwork system for the towers, only four of the eight sides were tapered, meaning half of the vertical formwork components remained unchanged with each jump. The tapered faces are orthogonal to the bridge's primary axis.

Keeping the diagonal faces constant resulted in a diamond geometry, simultaneously resolving the geometric conflict between cable stays and the section corners and creating a unique and instantly recognizable tower form. The octagon-to-diamond solution uses light and shadow to identify the structure's unique design while facilitating optimized construction methods and structural performance. Seismic detailing drew upon prior research into seismic design of concrete chimneys to understand behavior of tall hollow reinforced concrete cantilevers in high seismic zones.

The faceted shape combines elegance with economy, and the light and shadow interplay creates definition. Box girder approaches provide for clean lines, and the tall, slender columns respond to the shape of the tower with architectural column flares to articulate the connection between the substructure and the superstructure. A dramatic aesthetic lighting scheme brings the bridge to life at night.

An innovative moveable scaffold system (MSS) allows long spans at high elevation while avoiding utility constraints. The double Texas U-turn on land eliminated two flyover ramps, cutting costs and returning valuable real estate to the port. Foundation savings were also found through an innovative manchette tube tip grouting system.

A Seismic Superstar

To achieve the extreme seismic requirements of the site with a cable-stayed structure, the bridge towers and end bents feature a unique design to remain essentially elastic during seismic events. The bridge deck is isolated from the towers and end bents by 34 structurally fused viscous hydraulic dampers, which activate only during major seismic events. After the fuse is released, the viscous dampers dissipate the energy of the quake.

The unique seismic design reduces maintenance requirements for the port, ensuring uncompromised performance during the design-basis seismic event and improved life cycle resilience. Fuses and dampers were designed with the port's resilience concerns at the forefront, featuring integrated pressure gauges, observation windows, and transducers to facilitate routine maintenance. The dampers were further optimized to make their size manageable for installation or replacement by the contractor. Towers and end

Marie Tagudena

Nancy Henderson

bents were also simplified to contain fewer items to inspect and maintain, improving constructability and cost efficiency.

Taylor Devices International (TDI) in Buffalo, N.Y., supplied and manufactured the dampers, which have a force capacity of up to 884,000 lb and a mid-stroke length of up to 20½ ft. The dampers underwent a rigorous prototype and production testing program at TDI's facility and at the University of California San Diego.

Post-seismic inspection and resetting were critical to the design. Comprehensive access facilities have been included with the bridge and were designed to accommodate the full range of seismic movements so maintenance personnel can easily access any damper after an earthquake.

Tell-tales on the dampers will indicate whether the fuse has activated, and jacking positions are provided in the bridge to facilitate recentering and replacement of fuses. The bridge allows for full traffic even after fuses have been activated, with no disruption during post-seismic inspection and fuse replacement.

A comprehensive and strong motion monitoring system with accelerometers on the bridge and ground facilitates evaluation of earthquake events for bridge operation and research purposes.

Community Impacts

The innovations introduced to the project directly translate into material savings, which reduced the carbon footprint. The double Texas U-turn alone saved approximately 5,000,000 $kgCO_2e$ and avoided environmental risks associated with installing deep foundations through a known hydrocarbon contaminant plume near the proposed flyover structure.

The U-turn was part of the traffic engineering plan that reduced physical infrastructure while still achieving the required functionality, significantly reducing local environmental impacts and embodied carbon. Environmental impact reduction also came from the long spans of the approach bridges and the selection of the MSS construction method, which minimized the disturbance to the ground.

The bridge is not exclusively for cars. The 1.5-mile-long Mark Bixby Memorial Bicycle Pedestrian Path along the south side offers spectacular views of the San Pedro Bay, the port, and much of the city's coastline. The path is named after one of Long Beach's leading bicycle advocates, Mark Bixby, who helped create the city's Bicycle Master Plan and founded the Long Beach Bicycle Festival. He also spearheaded the successful grassroots effort to include a bike path in the design of the new bridge.

Active public engagement throughout construction led to substantial community involvement and awareness, including a highly active social media campaign and regular public tours of the site. The community has welcomed the bridge and gave it a new name, the Long Beach International Gateway Bridge, by public vote.

Owner

California Department of Transportation

Owner's Representative

Port of Long Beach

General Contractor/Erector

SFI (Shimmick/FCC/Impregilo) JV, Irvine, Calif.

Structural Engineer

Arup, New York

Steel Team

Fabricator

Stinger Bridge & Iron AISC CERTIFIED FABRICATOR & ERECTOR, Coolidge, Ariz.

Detailer

SSP Engineering AISC DETAILER, Queen Creek, Ariz.

2024 PRIZE BRIDGE AWARD

NATIONAL AWARD | MEDIUM SPAN BRIDGE OF THE YEAR FINALIST

Interstate 94 Second Avenue Bridge
Detroit

HDR – Matt Longfield

A CORE PIECE of Detroit's $2 billion Interstate 94 corridor reconstruction and downtown revitalization made history with its daring engineering.

The new 245-ft bridge carrying Second Avenue over I-94 is the first skewed and unbraced network tied arch bridge in the United States. It was also erected offsite and moved into place.

A historic building adjacent to the bridge location required an 18° skew, which offset the bridge's arches longitudinally by nearly 30 ft. Structural steel's strength, low weight, and flexibility were essential to reduce the bridge skeleton's dead load and facilitate the self-propelled modular transporter (SPMT) move and installation. During the design, one of the controlling load cases was the buckling capacity of the unbraced arch ribs, and the torsional stiffness of structural steel was up to the challenge.

All told, 800 tons of AASHTO M270 Grade 50 steel makes up the trapezoidal arch ribs, floor beams, and lateral bracing in the floor system. The unbraced arch ribs consist of trapezoidal box sections with PL 1¾ in. by 4¾ ft for the top flange and PL 1¾ in. by 2½ ft for the bottom flange. Web plates also consist of 1¾-in. material on a 1:3.74 inclination.

The elegant and sophisticated design uses four planes of steel hanger cables crossing from the top of the arch rib to the tie girder. These inclined cables dramatically increase structural stiffness, reduce dead and live load deflections to approximately 10% compared to a vertical hanger system, and increase structural redundancy.

The Michigan Department of Transportation (MDOT) wanted a durable, redundant structure to resist over-height vehicle strikes. The network hanger arrangement provides much greater redundancy than a conventional tied arch with vertical hangers. The structural system also reduces member forces in the rib and tie girders, which allows for more efficient use of materials and a slender, attractive appearance.

The design team also evaluated a conventional steel girder bridge as part of the preliminary design. However, MDOT's plans to widen and shift I-94's alignment in the future would require building a pier in the current median and then constructing a future median pier to accommodate the shifted alignment. Steel was also the preferred material for the later configuration due to the ability to design multiple support locations during the bridge's life.

The tied arch span allowed the bridge to be constructed without the need for future demolition and reconstruction of a median pier that would have been required with a conventional steel girder bridge at that location. The tied arch spans completely over the

Bridge Stats

Crosses: Interstate 94
Span length: 245 ft
Total length: 255 ft
Average width: 96½ ft
Steel weight per deck area: 73.4 lb/sq. ft
Total structural steel: 893 tons
Approximate cost: $26 million

HDR – Mike LaViolette

current freeway alignment and was designed to be long enough so that the future shifted freeway will fit comfortably between the abutments, providing complete construction access for the current and future alignments.

Limited vertical clearance over I-94 demanded a strong, thin floor system for the network tied arch span. The design team chose welded steel I-girder floor beams for the 89½-ft span between tie girders. The floor beams required a bat wing profile to accommodate the roadway and SUP cross slopes. Each floor beam was slightly different than the others due to the skew and asymmetric vertical curve on the bridge, and these geometric differences were carefully documented in the shop drawing and fabrication process.

The steel design allowed for vertical warping of the floor system up to 3 in., and the contractor's SPMT system used hydraulic jacks to make continual adjustments to ensure that the bridge remained safely within the tolerance.

The designers felt that a skewed arch with lateral bracing between the ribs would appear warped from the driver's perspective and decided early on an unbraced arch solution would be the most appropriate. The ribs were erected with temporary lateral bracing in place that remained until after the bridge skeleton move finished and the deck casting was complete.

Lateral bracing in the floor system consists of WT9×48.5 members in an X-configuration. The design dictated a specific tightening sequence for the lateral bracing members, and the contractor completed that work without any significant problems.

The combination of skew and curvature meant no connections would be square, and each fabricated steel floor beam would be unique. Shop drawings were carefully prepared and reviewed to ensure the skewed connections fit properly in the field.

MDOT did not want I-94 closed for an elongated period, making offsite erection and fast installation an appealing solution. The bridge was erected on temporary supports at each corner that matched the elevations of the permanent bearings on the abutments. Normally, these geometric details are not difficult to accommodate on a conventional bridge. However, with a network tied arch transported using SPMTs skidded over the top of the abutment to another set of SPMTs, differing elevations must be considered at every step of the lift and move.

The only feasible assembly area for the bridge was a parking lot approximately 500 ft from the final location, meaning an SPMT move would be required to install the bridge. The SPMT portion, though, had to navigate a 20 ft elevation difference between the staging area and I-94.

The design team considered the final condition for the bridge with unbraced ribs and a complete concrete deck and the load case where the bridge skeleton without deck would be transported using SPMTs. LARSA models were used to evaluate stress, deflection, and the potential for arch rib buckling at each load case.

Working directly with MDOT and the Federal Highway Administration, the design team solicited feedback from several heavy-lift contractors regarding the most feasible means of moving the bridge skeleton into place. Confidential one-on-one meetings helped gather ideas to incorporate into the assumed construction sequence without giving an unfair advantage to any contractor. MDOT brought on an independent peer review engineer about 80% of the way though the design stage.

The construction process used three separate accelerated bridge construction (ABC) operations in a single project:

- SPMTs moved the bridge skeleton from the staging area to the rear of the south abutment.
- A skidrail system launched the bridge skeleton over the south abutment.
- SPMTs and steel towers were again used to transport the bridge skeleton across the depressed freeway.

The bridge skeleton (consisting of arch ribs, tie girders, floor beams, and end diaphragms) weighs just over 2,500 tons. It was jacked, transferred to SPMTs, and driven over 500 ft to the I-94 crossing location as the first step in the installation process.

The team used four clusters of SPMTs—one at each bridge skeleton corner—supported by and driven by a single operator via a digital control panel. After assembling the structure, they jacked the skeleton nearly 8 ft, transferred the load to timber cribbage, and removed the temporary falsework used during assembly. They then drove the SPMTs beneath the bridge, removed the towers, and shifted the loads to the SPMTs.

SPMTs took several hours to move the bridge skeleton from the staging area to a location behind the south abutment, which included a 90° turn. When lined up with the permanent alignment, the skeleton's leading end was transferred to a skidding system on the abutment, while the trailing end remained on the SPMTs.

At this point, MDOT closed the interstate and rerouted traffic to nearby freeways.


HDR – Mike LaViolette

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HDR

HDR – Matt Longfield

The contractor delivered and compacted nearly 4,000 tons of crushed stone over the freeway to provide the SPMTs with a level driving surface. To manage a 20-ft elevation difference between the staging area and the freeway, the team relocated SPMTs onto the freeway and added a 34-ft-tall temporary tower to accept the bridge's leading end from the transporters above.

The team transferred the structure via hydraulic jacks from skid tracks on the abutment to the SPMTs—the final step before driving the skeleton across I-94 and reversing the process to lower the bridge onto the permanent bearings.

Before reopening I-94, MDOT and the project team inspected the bridge skeleton to confirm the site was safe for the public. Moving the bridge skeleton from the staging area to its permanent location took less than a week, but years of planning, design, fabrication, and construction.

Once in place, MDOT saw the bridge as a community connector structure linking the Wayne State University campus to residential and commercial areas on the opposite side of I-94. The bridge has wide shared-use paths with continuous planter boxes as a separator between traffic and pedestrians and aesthetic lighting, creating a safe and inviting park-like environment for students and other users. The unbraced arch ribs provide an unobstructed view of the sky.

The tied arch span, now accented with energy-efficient LED lighting, is an aesthetic gem representing significant progress toward future freeway improvements.

Owner
Michigan Department of Transportation

General Contractor
Z Contractors, Shelby Township, Mich.

Structural Engineer
HDR, Ann Arbor, Mich.

Erection Engineer
Janssen & Spaans Engineering, Indianapolis

Independent Peer Review
Parsons, Chicago

Steel Team

Fabricator
Veritas Steel, LLC (AISC Certified Fabricator), Eau Claire, Wis.

Detailer
Tensor Engineering (AISC Detailer), Indian Harbour Beach, Fla.

2024 PRIZE BRIDGE AWARD

MERIT AWARD | MEDIUM SPAN

State Route 34B over
Salmon Creek Replacement
Lansing, N.Y.

A TWO-LANE highway bridge replacement project in Central New York became a banner structure for the state.

The new State Route 34B bridge over Salmon Creek in Lansing, N.Y., keeps its predecessor's aesthetics but is the longest and tallest slant-leg rigid frame structure in New York State. The 500-ft bridge is made of modern 50-ksi weathering steel, giving it a 100-year expected service life.

The old bridge was a three-barrel arch structure with a rustic appearance, and weathering steel was the perfect option for the replacement to mimic its look and feel as defined by the State Historic Preservation Office (SHPO). Steel provided the flexibility to design and construct a unique bridge that gives the community something worthy of replacing a register of historic places-eligible structure. It also lent itself to a rapid erecting process that limited closures and detours for a central roadway in and out of the Ithaca, N.Y., region and to Cayuga Lake attractions.

By selecting a slant-leg rigid frame structure, the SHPO invited several unique design challenges. The knuckle region has a large, unbraced height and a large axial and flexural demand. The supporting legs of the structure are slanted and spring from thrust blocks embedded in the bedrock below. These legs have high axial, shear, and flexural forces, uncommon in typical steel structures. The intersection of the leg members with the roadway girders contained the highest axial and flexural forces within the structure and an extremely high web height.

Bridge Stats

Crosses: Salmon Creek
Span length: 200-ft center span, 150-ft end spans
Total length: 500 ft
Average width: 43¼ ft out-to-out,
girders spaced at 9 ft, 4½ in.
Steel weight per deck area: 98.93 lb/sq. ft
Total structural steel: 1,070 tons
Approximate cost: $16.5 million

All photos courtesy of John Banewicz

Because of the axial and flexural forces within the main span and legs, the splice location could not be optimized at the points of dead load contraflexure and was analyzed for these axial and flexural forces. Erection was done with both knuckles attached to the main span and lifted as one piece, fitting on the previously installed legs. The legs were supported during construction with a concrete pad and counterweights on the approach above. Post-construction, they're supported on pinned shoe bearings containing seven steel-finger plates.

The depth of the gorge the bridge crosses suited the slant-leg frame, because bedrock was relatively high and offered a sound foundation for the legs. The visual appeal when looking up from the gorge is striking.

Owner and Structural Engineer
New York State Department of Transportation

General Contractor/Erector
Tioga Construction Company, Herkimer, N.Y.

Steel Team

Fabricator
Canam-Bridges (AISC Certified Fabricator), Claremont, N.H.

Detailer
DBM Vircon (AISC Detailer), Phoenix

All photos courtesy of Wade Thompson

Bridge Stats

Crosses: Goose River
Span length: 80 ft
Total length: 81 ft
Average width: 32 ft
Steel weight per deck area: 64.15 lb/sq. ft
Total structural steel: 154 tons
Approximate cost: $750,000

2024 PRIZE BRIDGE AWARD

NATIONAL AWARD | SHORT SPAN

Grand Forks County Prefabricated Bridge, Northwood, N.D.

ANY NEW BRIDGE spanning the Goose River near Northwood, N.D., must remain sturdy in a flood hotspot with limited vertical clearance from the water and withstand long winters. Ideally, it's also constructable during one of those winters.

A prefabricated steel frame ensured the refreshed 36th Street NE bridge over the river did all three. Weathering steel beams offered durability and minimal maintenance. Steel also created flexibility in the depth of the superstructure in an area prone to flooding, the ability to clear the channel with one span, and the possibility of fabricating the superstructure offsite and delivering it in minimal pieces to install quicker and easier. The substructure used steel to help facilitate cold-weather installation and expedite the construction timeline.

The design team also considered concrete, but limited availability and high cost of heating during the preferred cold weather construction window made concrete less favorable than steel or timber. A timber prefabricated superstructure option was carried out through design and included in the bid package for contractors. The structural steel prefabricated bridge was the lowest bid option at the construction bid opening.




The prefabricated bridge lent itself to completion within the sensitive construction window and the limited allowance for increasing the roadway height. Using the same size H-piles for the wingwalls and pile caps provided an economy of scale for materials.

The ability to span across the entire channel became even more crucial during construction when a near-record flood event hit toward the end of installation. The substructures were clear of the main channel area and not affected by flooded cofferdams, impact from debris, or flood cleanup once the water receded. Cleaning off steel rather than an uncured concrete pier potentially being compromised became a significant advantage when the flood hit.

The local economy is mostly agriculture-related commerce that peaks in spring and summer, and the ability to construct in the winter minimized the installation's economic inconveniences. The bridge opened to traffic before the spring planting season.

The entire bridge substructure is also comprised of steel. HP14×73 beams provide the capacity to withstand the loadings required, and sheet piling holds the soil behind the abutment to keep the roadway in place.

The superstructure was fabricated at TrueNorth Steel's Fargo, N.D., plant and delivered to the site in four pieces consisting of steel beams and corrugated decking. Those were placed and secured onsite to create a 32-ft-wide roadway on the bridge. All told, removing the old bridge and erecting the new one took just two months.

The project site had limited vertical clearance to carry a stream with high flow volumes during spring runoff. Steel beams allowed a slimmer superstructure depth to provide freeboard on the design flood event.

A nearby roadway with an out-of-service bridge over the river had created a higher traffic volume on 36th Street NE, making a

quick replacement and shorter closure duration more significant factors in the chosen replacement alternative.

The soft soils of the Red River Valley in eastern North Dakota require deep foundations to support the superstructure. The design used 130 ft of HP14×73 to provide adequate support and galvanized sheet piling to complete the backwall of each abutment.

The bridge superstructure sections were built inside a manufacturing shop, where the weather would not impact timelines. Shop construction permitted extensive oversight as the prefabricated sections were being built, helping ensure a more uniform fit once the pieces were delivered to the site and installed. The bridge sections were placed with the same equipment that installed the substructure, meaning less mobilization of varying equipment and specialized equipment such as a concrete pump truck.

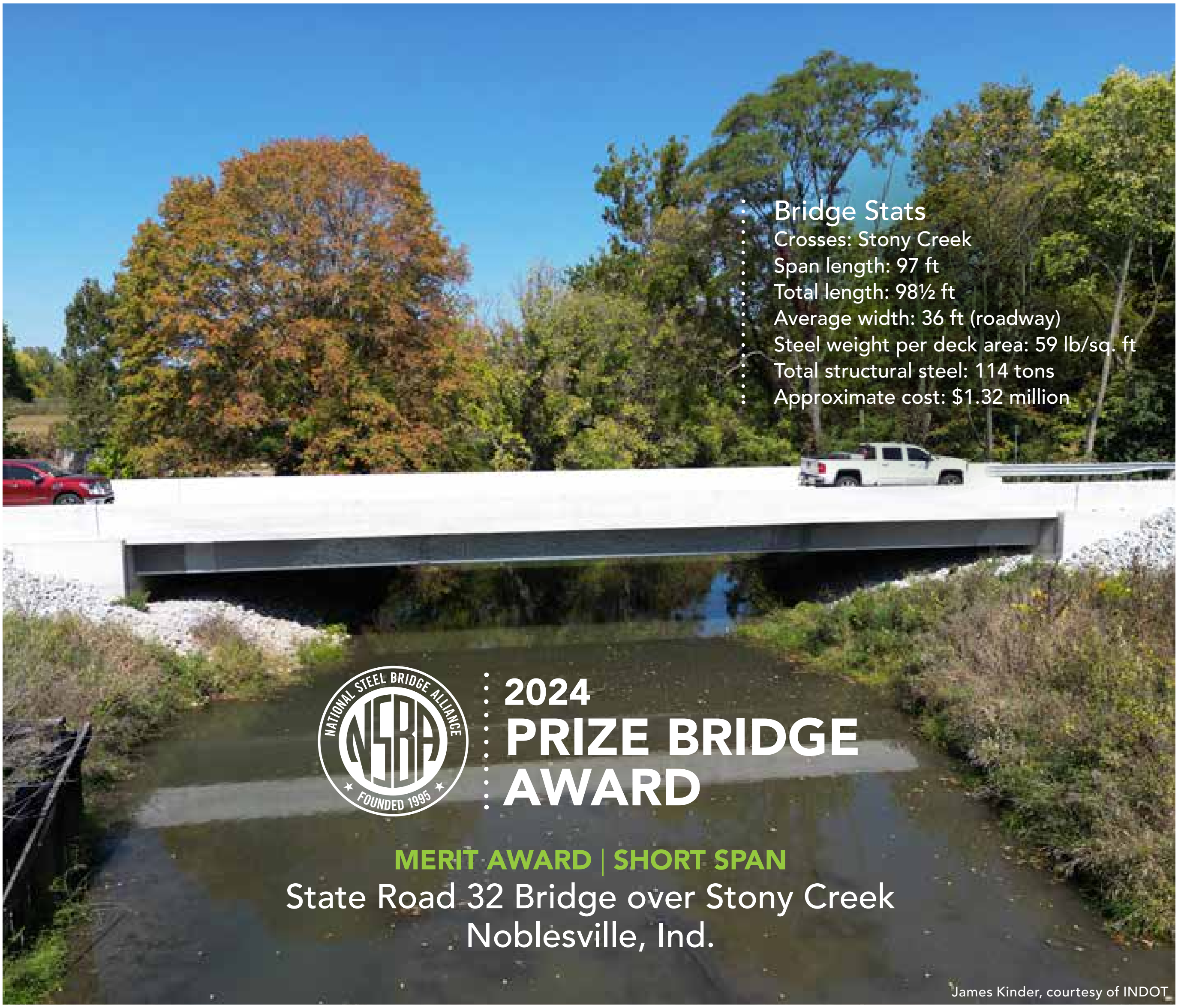
All these pieces reduced the construction timeline, thereby avoiding significant impacts on the local economy and providing a construction timeline when contractors are not typically busy, allowing them to keep staff working during the winter.

Owner's Representative
Grand Forks County, Grand Forks, N.D.

General Contractor
Industrial Builders Inc., West Fargo, N.D.

Structural Engineer
KLJ Engineering, Grafton, N.D.

Steel Fabricator/Detailer/Erector
TrueNorth Steel (AISC Certified Fabricator), Fargo, N.D.



James Kinder, courtesy of INDOT

A NEW BRIDGE installed in suburban Indianapolis is part infrastructure project, part research collaboration. And its use of steel traces directly back to a February 2018 NSBA brainstorming workshop aimed at making steel bridges more competitive in the short-span marketplace.

The workshop introduced a bolted-up tub girder concept as a strategy that capitalized on the steel industry's ability to fabricate components on demand with steel that is already in stock. It more closely mirrors the workflow used by the precast concrete industry, which dominates the short-span bridge market. Indiana Department of Transportation (INDOT) representatives were in attendance and intrigued by the concept.

In January 2019, the University of Notre Dame, in collaboration with HNTB Corporation, pitched the same concept to INDOT. It was funded in the next fiscal year, with a start of January 2020.

Innovation is a core INDOT value and aligns with INDOT's mission to focus on new, practical ideas and technology to continuously serve customers better and more efficiently. Using built-up press-brake-formed tub girders (PBFTGs) to replace the State Road 32 bridge over Stony Creek in Noblesville offered just the opportunity to take the plunge. It represented a typical bridge in Indiana traditionally delivered using precast prestressed concrete girders. Fostering innovation in short-span steel bridges can enhance competition in that span range and help DOTs reduce project costs and delivery schedules.

Using steel was critical, but readily available steel was the essential component of condensing the project timeline and lowering costs. Leveraging the workflows and equipment that form an integral part of the fabrication of transmission poles (a nearly $3 billion North American market) was a primary goal. The project created a path for new fabricators to enter the bridge market, especially given the unprecedented funding for infrastructure in the Infrastructure Investment and Jobs Act.

The State Road 32 replacement project included a unique and collaborative delivery team of engineers, researchers, steel fabricators, and suppliers: INDOT, the University of Notre Dame, HNTB, Delta Steel, and Nucor Corporation. The team's rare level of depth and comprehensiveness was critical to implementing a novel design concept in less than three years. Nucor and Delta Steel donated their steel and fabrication time for this project, representing a remarkable commitment from the steel industry to develop new and innovative solutions.


Angela Pearl, courtesy of HNTB


Ashley Thrall, courtesy of University of Notre Dame


Josh Osterloh, courtesy of Kard Bridge

The SR 32 bridge project fits the PBFTG approach in several ways. First and foremost, it extended the span range of applicability. It allowed the team to answer the key implementation questions that go with any new technology. Its more rural setting and water crossing helped the research team gain significant access to the bridge to validate performance before erection, following deck slab completion and under live load.

The project had five key objectives:

1. Develop and implement a new design methodology (HNTB) consistent with AASHTO, but also build on recent research on internal redundancy and folded press-brake tub girders.

2. Conduct research (Notre Dame) to ensure design workflows are appropriate for design and load rating of this new bridge typology, measure the behavior of the built structure as experimental evidence of performance, and ultimately develop a kit-of-parts approach for wider industry adoption (ongoing).

3. Work together with the PBFTG manufacturer (Delta Steel) to develop an implementation strategy that uses their workflows (press brake and bend radius tooling, CNC drilling, and plasma cutting capability).

4. Ensure the steel used for the press-brake bent webs meets or exceeds AASHTO requirements (Nucor).

5. Incorporate PBFTG bridges into INDOT's established workflows, including shop inspection, shop drawing reviews, and bridge load ratings.

The team's unwavering collaboration allowed this project to go from a sketch at a workshop to a completed project open to traffic in less than three years, despite the inherent challenges of implementing innovation into practice.

While PBFTG bridges are becoming increasingly common and are an alternative to replacing prestressed concrete vehicular bridges, they are typically limited to spans of less than 90 ft and are not designed as continuous. The approach developed for the State Road 32 bridge used a bolted-up section with press-brake-formed webs bolted to flat bottom and top flange plates. Because this bridge design allows for changing plate sizes in top and bottom flanges and much deeper tubs, spans up to 300 ft are possible.

Additionally, bolted built-up fabrication allows for the internal redundancy design methodology, further optimizing the bridge for efficient and reliable service with tailored inspection protocols intrinsically linked to the damage tolerance and resilience for which this design approach is known.

All five steps brought challenges and hurdles. How are shop drawings translated into fabrication drawings for CNC cutting and hole drilling? Could holes be drilled before bending? Would they be sufficiently accurate and reproduceable to allow for web-to-flange assembly? The tubs are fabricated in roughly 30- to 45-ft segments and must be piecewise straight between splices—could these be accurately cambered? Would heat straightening be necessary? Could they be hot-dipped in galvanizing tanks without significant distortion?

Those questions and more had to be answered for successful project delivery. The team's collaborative nature and additional effort—particularly on the part of INDOT—introduced a shop assembly process before and subsequent to hot-dip galvanizing that was instrumental to ensuring project success. Cross-discipline learning and collaboration in a short time frame is the best way to measure value for this project.

The State Road 32 bridge builds on the PBFTG system and could extend its applicability for much longer spans. Further, it introduces internal redundancy as a strategy for enhanced safety and resilience. By eliminating the need for welding, the State Road 32 approach reduces the fabricator's need for highly skilled labor, minimizes shop setup and handling, and prioritizes automation.


Ashley Thrall, courtesy of University of Notre Dame


Spencer McKenney, courtesy of INDOT


Spencer McKenney, courtesy of INDOT

Most importantly, it promises to deliver fabricated steel bridges in weeks instead of months.

Tub girders were half the weight of the traditionally used precast prestressed concrete girders. Moving them required a much smaller crane, and multiple girders could be shipped on a single truck. The movability was particularly useful for the State Road 32 bridge, a river crossing, where the lighter pick sizes simplified the complex crane operations from behind the stub abutments.

Further, the bridge confirmed the original research premise that press-brake bent webs could be fabricated using steel transmission pole manufacturing workflows with in-stock steel, and pre-drilled holes to sufficient accuracy can be readily assembled into tub girders. The potential for these webs to be fabricated on demand as a "kit-of-parts" solution in 6-in. member depth increments (36 in. to 96 in.) over a range of two or three plate sizes (½-in., ⅝-in., and ¾-in) using in-stock steel gives designers, fabricators, contractors, and bridge owners a new solution to meet the schedule needs for rapid bridge replacement projects.

The bridge opened to traffic in July 2023 and has already generated significant interest in the industry at a level typically seen only several years after the launch of a new approach.

Of all the project's noteworthy aspects, the time from concept to completion stands out. Implementation of a new bridge typology is typically only undertaken after research and laboratory testing. Even with the team taking advantage of 10 years of work completed on PBFTGs, the new built-up press-brake-formed tubs introduced many new design, fabrication, and construction challenges. Most of those challenges involved implementation, not design, making implementation an important project goal.

The project confirmed several aspects of the fabrication. The webs could be reliably and accurately bent without unusual fit-up issues at the splices. Bolt holes could be pre-drilled prior to bending. Flanges and webs could be drilled using CNC equipment with limited hole rework as part of assembly. Webs can be nested for cost-efficient trucking. Hot-dip galvanizing did not introduce significant distortion and did not impact fit-up. Chorded connections achieved accurate camber. Full flange and web splices, bolted diaphragms, and access openings were all incorporated into the workflows with no welding other than shear studs for composite action.

The State Road 32 bridge extends the range and applicability of PBFTG bridges. It introduces the potential for unconventional steel bridge fabrication workflows and capabilities to provide additional fabrication capability to the industry. Using bolted connections provides for internal redundancy, making the PBFTG structural system even more robust and tolerant to damage with tailored risk management throughout the structure's life.

Owner

Indiana Department of Transportation

General Contractor

HIS Constructors, Inc., Indianapolis

Structural Engineer

HNTB Corporation, Kansas City, Mo.

Consultants

University of Notre Dame, South Bend, Ind.
Nucor, Boise, Idaho

Steel Team

Fabricators

Infra-Metals/Delta Steel AISC CERTIFIED FABRICATOR, Houston
Kard Bridge Products AISC CERTIFIED FABRICATOR, Minster, Ohio

Detailer

V&S Galvanizing AISC DETAILER, Columbus, Ohio

2024 PRIZE BRIDGE AWARD

NATIONAL AWARD | SPECIAL PURPOSE BRIDGE OF THE YEAR FINALIST

SeaTac IAF Pedestrian Walkway
Seattle

SEATTLE-TACOMA INTERNATIONAL AIRPORT (SeaTac) dove into a rarely used method for passenger cross-taxiway transit and set the standard for it.

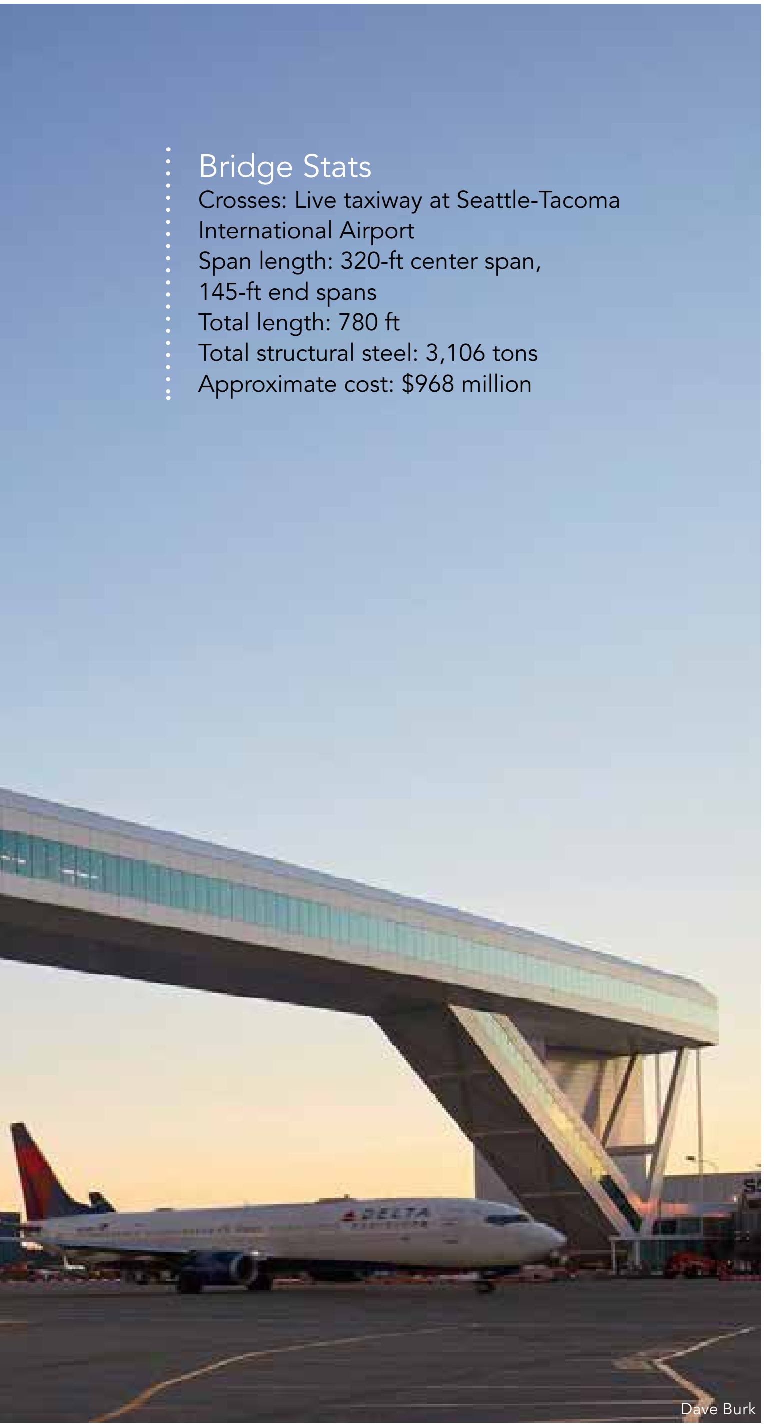
Most airports move passengers from terminal to terminal with an underground walkway, a subway tram, or an elevated tram that hugs the terminal buildings. Port of Seattle, which owns and operates the airport, chose the most direct but difficult concept: an overhead bridge crossing an active taxiway.

Only two other airports in the world have previously built a bridge over a tarmac. Seattle's new bridge outdid both. Its 780-ft walkway is the world's largest structure over an active taxiway. Its 610-ft span also represents the longest clear-span structure at an airport. If stood vertically, it would be the second highest structure in Seattle, 150 ft taller than the Space Needle. It's a direct and efficient route for international passengers to reach the International Arrivals Facility, which houses customs. Stunning views of the Pacific Northwest and Mt. Rainier greet travelers as they ascend its escalators and walk across it.

The bridge took eight years to plan, design, and construct. Steel was the material of choice due to the clear span length, seismic criteria, and need for innovative design and construction methods. The walkway contains 3,000 tons of steel, while the cores use another 160. It has 800 tons of rebar and a 2,200-ft cable length. Its 191-ft escalators are among the 10 longest in the United States.

Bridge Stats

Crosses: Live taxiway at Seattle-Tacoma International Airport
Span length: 320-ft center span, 145-ft end spans
Total length: 780 ft
Total structural steel: 3,106 tons
Approximate cost: $968 million



Dave Burk


Dave Burk


Port of Seattle

Steel V-Piers support the pedestrian bridge at either side and allow the bridge to have an 85-ft clearance from the bottom deck to the tarmac, enough room to fit a Boeing 747.

The aerial walkway was designed as a cable-stayed bridge and built with the Accelerated Bridge Construction (ABC) method. Unique design and geometry created complex, heavy weld joints.

Erecting a 780-ft walkway and a 320-ft, 1,565-ton center span on site would have meant an untenable closure length for a portion of a taxiway and several gates. Instead, the walkway was built in one of the airport's cargo areas in 17 major prefabricated components, including the center span. The ABC method minimized the project's impact on airport operations and allowed for simultaneous construction of various walkway components. The V-Piers were erected and welded on site while the taxiway remained open.

Once completed, the center span moved three miles on four remote-controlled self-propelled modular transporters (SPMTs). The SPMTs operated at walking speed down a closed center runway in the early morning hours when airplane traffic is at its lowest. The three-and-a-half-hour move took months of planning between general contractor Clark Construction, airport operations, and the Federal Aviation Administration.

Upon arrival, the center span was lifted into place and connected to the pre-erected structural V-piers. That connection clicked without issue after several hours of site checks to ensure the

Michael Moore

Port of Seattle

Port of Seattle

Clark Construction

Dave Burk

pieces lined up. Structural engineer KPFF adjusted the side spans to account for the center span's weight and projected a 7¾-in. deflection upon final placement. A fast and efficient installation and welding of the center section closed the taxiway for only a week.

Owner
Port of Seattle

General Contractor
Clark Construction, Seattle

Structural Engineer
KPFF, Seattle

Designer
Skidmore Owings & Merrill

Steel Fabricators
Thompson Metal Fab (AISC Certified Fabricator), Vancouver, Wash.
Jesse Engineering (AISC Certified Fabricator), Tacoma, Wash.
Transco Industries (AISC Certified Fabricator), Portland, Ore.
Greenberry Fabrication (AISC Certified Fabricator), Vancouver, Wash.

2024 PRIZE BRIDGE AWARD

MERIT AWARD | SPECIAL PURPOSE

South Bayfront Pedestrian Bridge and Horton Landing Park
Emeryville, Calif.

All photos courtesy of Tom Loomis

A RAIL YARD essentially sliced Emeryville, Calif., into two pieces for pedestrians and cyclists along Horton Street in the city's southern half.

The area has bridges over the sprawling Union Pacific Railroad (UPRR) right-of-way at Powell Street and 40th Street. The vehicle bridge at 40th Street has a painted bike lane but doesn't qualify as usable by people of all ages and abilities. The Powell Street bridge does not allow bikes at all.

It begged for a pedestrian and bike-only bridge somewhere in the middle, especially with the rapidly growing Bay Street Center mixed-used development on the east side of the tracks. The city's Horton Landing Park project near Bay Street Center and the Emeryville Greenway—completed shortly after the bridge—provided the necessary final push. A transformative project like it couldn't meet its goals with poor pedestrian access.

Now, a 230-ft single-span bridge across the tracks provides that long-overdue link and boosts Emeryville's walkability. Its combination of an S-curved deck and asymmetrical single tied-arch creates a striking image while resolving complex site conditions.

The South Bayfront Bridge's design and construction highlight why steel is a strong choice for single-span structures that exceed 200 ft in length. The single straight bowstring truss/arch that extends diagonally across the deck consists of a pair of steel tubes, from which cables connect to the deck framing and create an aesthetically appealing structure.

The City of Emeryville showed the value of patience, partnership, and persistence during the process. The bridge is the start of crossing brownfield sites to build a more sustainable and united community. It spans a mainline rail corridor and rail yard and links major employment and commercial centers. It's a crucial connection between the city's Park Avenue District and the Bay Street retail and residential development. Most importantly, it has prioritized active transportation, providing safe access for multi-modal transportation across the railroad tracks.

Construction of the South Bayfront Bridge included the main bridge structure, access ramps, stairs, landscaping, community outreach, stakeholder coordination, and permitting for all elements of the project. The bridge and ramps accommodate bicycles and pedestrians and are Americans with Disabilities Act compliant. It's a tied single-arch structure designed for construction over nine UPRR tracks within a rigid and limited track closure window.

The main span consists of the S-curved single span, supported at its ends by concrete bents. It's supported by a straight bowstring truss/arch extending diagonally across the deck. The top chord/arch rib is a pair of steel tubes, the bottom chord/tension tie is within the deck framing, and the cable diagonals/suspenders support the deck edges. A concrete slab travel way, with fencing and lighting, is carried by the steel deck framing.

The bridge design was also developed in close coordination with the adjacent property owners and UPRR.

The bridge approaches combine for more than 1,000 ft of ramps. The west ramp is a switch-back ramp that connects to the Bay Street shopping center. The west ramp is adjacent to the mall's parking structure within a 30-ft setback from the UPRR property line. The east ramp connects to Horton Landing Park. Both ramp structures are cast-in-place concrete structures. The project also included access stair structures on each side of the railroad corridor for pedestrian access to the main bridge.

A detailed construction management plan was necessary to oversee the project's complex construction on a site near and over an active railway corridor for numerous daily freight, Amtrak, and Capitol Corridor trains, plus the UPRR train yard. Additionally, the project required UPRR-specific agreements, permits, and flagging responsibilities that were tracked and followed carefully.

The design and construction team worked closely with stakeholders to plan and schedule the bridge assembly outside of the UPRR right-of-way in the future Horton Landing Park. Deck and arch components were welded and bolted together, and temporary towers ensured the appropriate geometries conformed to the design. Full assembly took place at the temporary Horton Landing Park staging area, and the completed bridge was lifted into place over the tracks under the tightly restricted timeline.

Months of extensive planning and preparation preceded the bridge lift and placement. The key components were:

- Review and approvals of submittals by UPRR, which took approximately seven months
- Utilities realignment and site preparation
- Excavations adjacent to the UPRR tracks required shoring designs that met UPRR requirements and review and approval by UPRR prior to start of construction
- Bridge abutment construction on the east and west sides, including installation of driven piles to support the structure
- Crane mats and steel plates placement to support the cranes and provide an even traveling surface for the cranes to move the bridge
- Crane erection and bridge load balancing

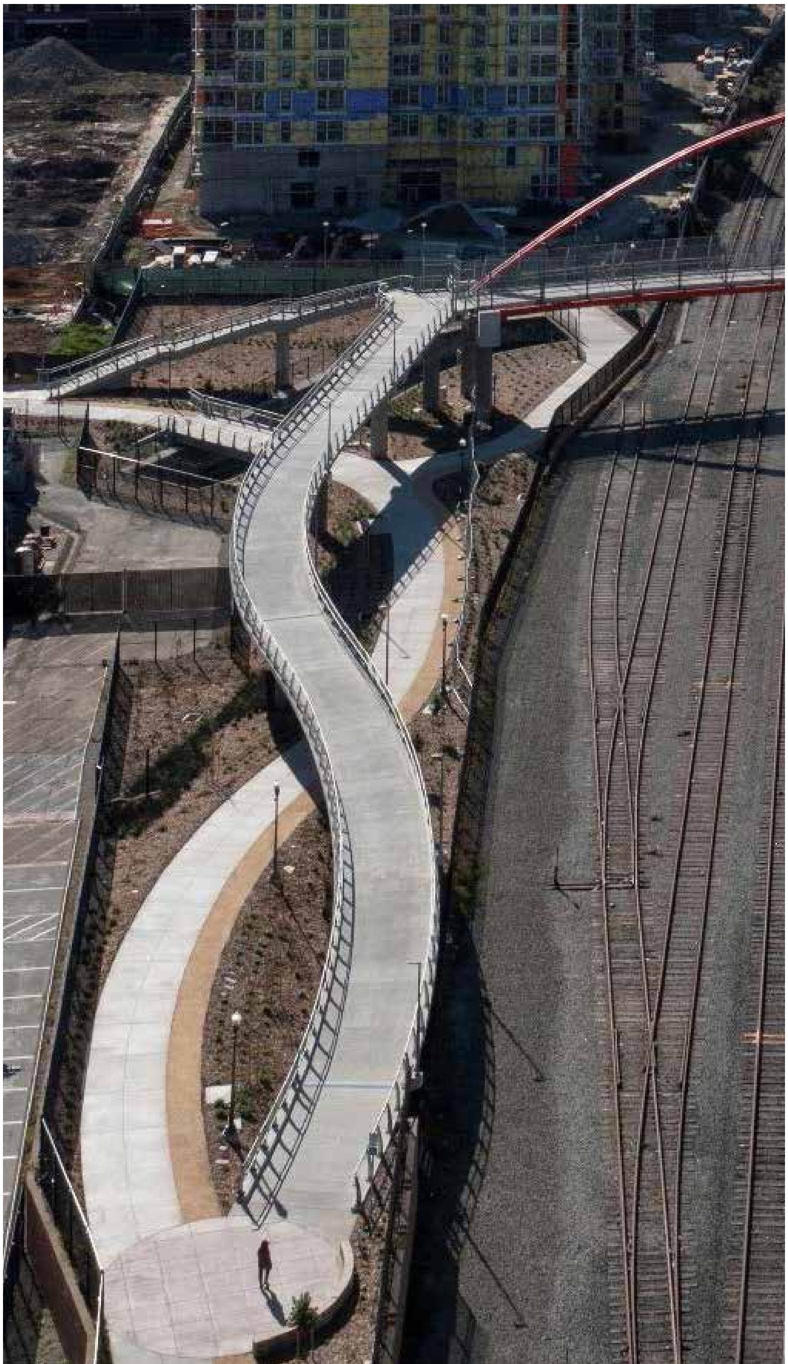
The bridge lift operation was completed within a three-day continuous effort window, possible only with collaboration and intense planning and preparation. The team worked 24 hours each day to ensure a safe and efficient operation with minimal impact on train operations.

Elsewhere, a variety of water and electrical connections were removed from the project to reduce maintenance costs and prevent vandalism. The construction management team used a cloud-based system to administer the project. Team members could pull up project documents anytime through their computer, tablet, or smartphone.

Extensive surveying was performed during the entire construction process to ensure the main bridge would fit during the final installation, including high-level surveys while installing the tie-down bolts for the bridge on both abutments piers to ensure they were consistent with the designed bridge length. That survey was repeated during the fabrication and installation processes.

Bridge Stats

Crosses:
Union Pacific Railroad tracks
Span length: 227¼ ft
Total length: 229¾ ft
Average width:
14 ft walkway width, 22 ft bridge bottom chords width
Steel weight per deck area:
84.5 lb/sq. ft
Total structural steel:
134.21 tons
Approximate cost:
$21.4 million



Stinger Bridge & Iron performed fabrication at its Arizona facility and completed initial assembly in October 2020. The bridge deck and arch components were shipped by truck to Horton Landing Park in early November 2020.

Stinger fabricated the bridge and provided design assistance to the engineer before fabrication. Design assist measures included 3D scanning of the foundations, 3D modeling of the new structure, engineering analysis of site conditions, re-design to incorporate required changes, engineering design to change field-welded connections to bolted connections to expedite field erection, and full shop preassembly to ensure bridge geometry and expedite field erection.

Stinger's prefabrication efforts and design assist measures ensured that the fabricated structure fit perfectly on the constructed foundations. Prior planning and field verification of dimensions simplified the erection, making everything fit as designed.

Three special design features provide critical structural functions while giving Emeryville an iconic signature bridge.

The cable layout was developed to enhance the buckling stability of the arch. The Nielsen cable arrangement significantly increased the arch's buckling strength while minimizing the number of cables required in a network cable arrangement. The cable arrangement satisfied structural efficiency and aesthetic appeal.

The single-arch member design in a high-seismic location like the San Francisco Bay Area was a considerable challenge. The design goal was to avoid inelastic behavior in the arch during the design seismic loading. To maintain elastic behavior, a reduced-beam-section (RBS) comprises the end member at the arch's base. The RBS is similar to an RBS used in building design. It absorbs the high seismic energy and maintains an elastic response in the single arch.

The deck truss serves two critical structural functions: the tension-tie that resists the thrust and compression delivered by the arch, and the lateral diaphragm that delivers the seismic loading from the deck to the support columns. ■

Owner
City of Emeryville, Calif.

General Contractor
Ghilotti Construction, Inc., Santa Rosa, Calif.

Structural Engineer
Biggs Cardosa Associates, Inc., San Francisco

Steel Team

Fabricator/Detailer
Stinger Bridge & Iron AISC CERTIFIED FABRICATOR & ERECTOR, Coolidge, Ariz.

Erectors
Stinger Bridge & Iron AISC CERTIFIED FABRICATOR & ERECTOR, Coolidge, Ariz.
Adams & Smith AISC ASSOCIATE AISC CERTIFIED ERECTOR, Lindon, Utah

Detailer
SSP Engineering AISC DETAILER, Queen Creek, Ariz.

Bender-roller
Albina Co., Inc. AISC ASSOCIATE, Tualatin, Ore.