Modern Steel Construction

July 2024


S&S WELDING
ROBOTIC FABRICATION FAST TRACK
ROD RAMER
Plant Manager
SHARON PIECHOWIAK
VP and CFO
DALE PIECHOWIAK
President
MARK TRACEY
VP of Sales
"One morning when I came to work I found I had four fitters missing that day, and I had a lot of work to do. So I picked up the phone and called up Peddinghaus and ordered the PeddiAssembler."
-DALE PIECHOWIAK
THE PEDDIASSEMBLER
Peddinghaus
STRONGER THAN STEEL®
www.peddinghaus.com | info@peddinghaus.com | (815) 937-3800

Modern Steel Construction

July 2024

Dave Burk

features

columns

steelwise

field notes

business issues

ON THE COVER: The new Frederick Douglass Memorial Bridge is the 2024 AISC/NSBA Bridge of the Year, p. 22. (Photo: Robb Williamson)

MODERN STEEL CONSTRUCTION (Volume 64, Number 7) ISSN (print) 0026-8445: ISSN (online) 1945-0737. Published monthly by the American Institute of Steel Construction (AISC), 130 E Randolph Street, Suite 2000, Chicago, IL 60601. Single issues $8.00; 1 year, $60. Periodicals postage paid at Chicago, IL and at additional mailing offices. Postmaster: Please send address changes to MODERN STEEL CONSTRUCTION, 130 E Randolph Street, Suite 2000, Chicago, IL 60601.

Printed on paper made from a minimum of 10% recycled content.

editor's note

Strong, beautiful steel bridges are everywhere.

Some of them really stick with you. For example, if you regularly take the same route over the Mississippi River on your way from Chicago to visit family in the Hawkeye State, you tend to remember the massive U.S. 20 steel bridge that spans the river between East Dubuque, Ill., and Dubuque, Iowa. It becomes part of your journey and a marker of how much driving time is left on the way out and back.

Of course, while beauty is in the eye of the beholder, less is left to debate when it comes to strength.

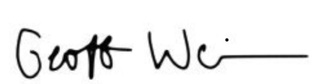
Walking under the steel bridge in the photo behind me, which was positioned over the River Walk in San Antonio, you could immediately tell that it wasn't brand-new and had clearly been in service for a while. But it appeared to be in good working order.

Of course, some steel bridges are in better shape than others. But as we know, some are better maintained or are more regularly and properly inspected than others—and that's true of all bridge types in the U.S., not just steel ones.

We routinely hear that a certain number or percentage of domestic bridges are not up to standard, need to be replaced or reinforced soon, or have earned a bad grade as if they're not doing so great in algebra. The numbers go up or down every year, but the overarching theme (was that a pun?) of these regular bridge report cards is that things need to get better. It's actually one of the few issues both major political parties can agree on (though how to address and fund it is a different story).

While the need for improvements and better maintenance for bridges—and our nation's infrastructure as a whole—isn't going away any time soon, it is refreshing to know that there are plenty of new steel bridges being built with longevity and durability in mind. In fact, you can read about eight of them starting on page 22. These elite eight are the winners of this year's AISC/NSBA Prize Bridge Awards, a biennial competition that recognizes the best steel bridges of all sizes. This year's winners range from a pedestrian walkway that crosses a live aircraft taxiway at Seattle-Tacoma International Airport to an innovative Interstate overpass in Detroit to a highway bridge replacement over a creek in New York State. Bridges like these will no doubt become memorable markers along countless travelers' journeys.

And when it comes to the next generation of steel bridges, fear not! North America's engineering students are on it. Nearly 50 teams from universities and colleges across the continent recently competed in the national finals of the Student Steel Bridge Competition (SSBC). Organized by AISC and the American Society of Civil Engineers (ASCE), the competition took place at Louisiana Tech University in Ruston, La., on May 31 and June 1, following 20 regional competitions held this past spring. You can get a brief look at one regional competition in Structurally Sound on page 66—and a full report of national finals in next month's issue.



Geoff Weisenberger
Editor and Publisher

Modern Steel Construction

Editorial Offices
130 E Randolph St, Ste 2000
Chicago, IL 60601
312.670.2400

Editorial Contacts
EDITOR AND PUBLISHER
Geoff Weisenberger
312.493.7694
weisenberger@aisc.org

ASSOCIATE EDITOR
Patrick Engel
312.550.9652
engel@aisc.org

SENIOR DIRECTOR OF PUBLICATIONS
Keith A. Grubb, SE, PE
312.804.0813
grubb@aisc.org

GRAPHIC DESIGN MANAGER
Kristin Hall
773.636.8543
hall@aisc.org

EDITORIAL DIRECTOR
Scott Melnick
312.804.1535
melnick@aisc.org

Advertising Sales
Geoff Weisenberger
312.493.7694
weisenberger@aisc.org

Address Changes and Subscription Concerns
312.670.2401
subscriptions@aisc.org

Reprints
Kristin Hall
hall@aisc.org

If you've ever asked yourself "Why?" about something related to structural steel design or construction, *Modern Steel*'s monthly Steel Interchange is for you! Send your questions or comments to **solutions@aisc.org**.

Hole Edge Distance from *k*

Does the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-22) specify a minimum hole edge distance from the *k* dimension of a wide flange section?

No. However, a minimum distance could be determined.

The *Specification* addresses minimum edge distances in Section J3.5. This section would provide a minimum distance from the center of a hole to an edge of a connected part. Also note that footnote [a] in Table J3.4 permits the use of smaller edge distances, although it is best to stick to the minimums provided in the table when possible.

Part 10 of the 16th Edition *Steel Construction Manual* provides a fillet encroachment (also known as "riding the fillet") on page 10-8. You could combine the recommended values from Part 10 and the minimum edge distances for Section J3.5 to come up with a minimum distance from the *k* for the placement of a hole.

It is more common to simply place bolt holes at certain established distances from the top flange of a member based on fabricator preferences (3 in., 4½ in., etc.). The 3rd Edition *Steel Detailing for Steel Construction Manual* states on page 7–32:

"In the interest of standardization and reduction of possible errors in matching connections, common practice is to place holes for connections on horizontal beam gage lines (rows) spaced 3 in. apart vertically, with the uppermost gage line set 3 in. below the top of the beam, when practicable, as shown in Figure 7-29.

"With a 3-in. dimension from the top of the beam to the first hole, the matching connection can usually be detailed with a 1¼-in. edge distance without encroaching on the fillet *k* distance of the supporting beam/girder to which it is bolted. If this is not possible, the 3-in. distance to the first hole must be increased to maintain the 1¼-in. edge distance. However, minor encroachment on the fillet is permissible, as shown in Figure 10-3 in the *Manual*, Part 10."

Carlo Lini, SE, PE

Identification of Lateral Force Resisting System on Structural Drawings

The *Specification* indicates in Section A4.1(g) that structural design documents and specifications shall give the "Identification of the lateral force-resisting system and connecting diaphragm elements that provide lateral strength and stability in the completed structure." Does this mean the lateral system (including bracing, moment frames, drag, and chord members) must be marked on the structural drawings?

No, there is no explicit requirement to do so. However, it is common to have bracings, moment frames, drag, and chord members marked on the structural drawings. While this is a new addition to the *Specification*, it is not a new requirement. The *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/AISC 303-22) provides examples of descriptions satisfying the intent.

The 1992 *Code* states, "To rationally provide temporary supports and/or bracing, the erector must be informed by the owner of the sequence of installation and the effect of loads imposed by such elements at various stages during the sequence until they become effective."

The 2000 *Code of Standard Practice* states, "The Owner's Designated Representative for Design shall identify the following in the Contract Documents… (a) The lateral-load-resisting system and connecting diaphragm elements that provide for lateral strength and stability in the completed structure."

The Commentary to the 2022 *Code* states, "The intent of Section 7.10.1 of the *Code* is to alert the ODRC and the erector of the means for lateral force resistance in the completed structure so that appropriate planning can occur for construction of the building. Examples of a description of the lateral force-resisting system as required in Section 7.10.1(a) are shown in the following.

"Example 1 is an all-steel building with a composite metal deck and concrete floor system. All lateral force resistance is provided by welded moment frames in each orthogonal building direction. One suitable description of this lateral force-resisting system is as follows:

> *"All lateral force resistance and stability of the building in the completed structure is provided by moment frames with welded beam-to-column connections framed in each orthogonal direction (see plan sheets for locations). The composite metal deck and concrete floors serve as horizontal diaphragms that distribute the lateral wind and seismic forces horizontally to the vertical moment frames. The vertical moment frames carry the applied lateral loads to the building foundation.*

"Example 2 is a steel-framed building with a composite metal deck and concrete floor system. All beam-to-column connections are simple connections and all lateral force resistance is provided

All mentioned AISC publications, unless noted otherwise, refer to the current version and are available at **aisc.org/publications**. *Modern Steel* articles can be found at **www.modernsteel.com**.

by reinforced concrete shear walls in the building core and in the stairwells. One suitable description of this lateral force-resisting system is as follows:

> *"All lateral force resistance and stability of the building in the completed structure is provided exclusively by cast-in-place reinforced concrete shear walls in the building core and stairwells (see plan sheets for locations). These walls provide all lateral force resistance in each orthogonal building direction. The composite metal deck and concrete floors serve as horizontal diaphragms that distribute the lateral wind and seismic forces horizontally to the concrete shear walls. The concrete shear walls carry the applied lateral loads to the building foundation. See also Commentary section 7.10.3."*

While this has been an explicit requirement for more than 30 years, and an implicit requirement for as long as the various aspects of design and construction have been parsed out to various parties, they were made explicit in the *Code* and the *Specification* in the interest of making sure these requirement were being satisfied.

If you have been satisfying this long-standing requirement, then this addition to the *Specification* should have no impact on your practice.

Larry Muir, PE

STEEL SOLUTIONS CENTER

Carlo Lini (**lini@aisc.org**) is the director of the AISC Steel Solution Center. **Larry Muir** is a consultant to AISC.

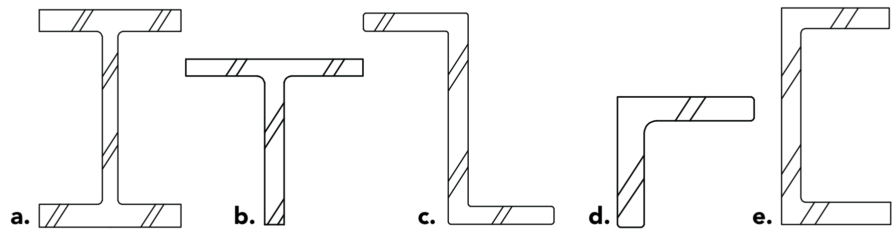
Steel Interchange is a forum to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Contact Steel Interchange with questions or responses via AISC's Steel Solutions Center: 866.ASK.AISC | **solutions@aisc.org**. The complete collection of Steel Interchange questions and answers is available online at **www.modernsteel.com**.

The opinions expressed in Steel Interchange do not necessarily represent an official position of the American Institute of Steel Construction and have not been reviewed. It is recognized that the design of structures is within the scope and expertise of a competent licensed structural engineer, architect or other licensed professional for the application of principles to a particular structure.

steel quiz

Twist and shout for this month's Steel Quiz; it's all about torsion! Learn more with AISC Design Guide 9: *Torsional Analysis of Structural Steel Members*. This guide includes an overview of the basic theory of torsional loading, analysis for torsion, and several design examples and design aids. Download your copy today at **aisc.org/dg**.

1 Which of the following shape(s) has a shear center that does *not* coincide with the centroid of the cross-section? Select all that apply.



2 **True or False:** When a torsionally fixed, cantilevered wide flange beam is subject to a torsional moment and no other combined loading, only pure torsional shear stresses are developed in the section.

3 **True or False:** The commonly used structural shapes with open cross-sections, such as wide flange members, offer relatively poor resistance to torsion.

4 The normal stress and shear stress due to warping may be taken as zero in which of the following cases:

a. Members for which warping is unrestrained
b. Structural tee members
c. Single-angle members
d. None of the above
e. All of the above

5 **Fill in the Blank:** For a member subject to a uniformly distributed torque and no other combined loading, the angle of rotation of the member about the member's longitudinal axis due to pure torsion and warping can be found by solving a ___-order differential equation.

6 **Fill in the Blank:** For an HSS member subject to combined torsion, shear, flexure, and/or axial force, the torsional effects may be neglected when the required torsional strength of the member is less than or equal to ___% of the available torsional strength.

TURN TO PAGE 12 FOR ANSWERS

NUCOR VULCRAFT

VERCO DECKING, INC. a NUCOR company

INSTANT RESULTS. ANYTIME,

ANYWHERE.

Instantly estimate and calculate at your fingertips. Whether it's for steel joists, deck or bar grating, Vulcraft and Verco's Online Design Tools can help you quickly run scenarios, allowing you to make the smartest choices for your projects no matter where you are – at home, the office, or on the job site.

Sign up for our Online Design Tools today.

Contact our team of experts for more information about how our suite of Design Tools can help you make fast, accurate estimates and calculations.

VULCRAFT

VERCO

steel quiz ⋮ ANSWERS

Everyone is welcome to submit questions and answers for the Steel Quiz. If you are interested in submitting one question or an entire quiz, contact AISC's Steel Solutions Center at 866.ASK.AISC or **solutions@aisc.org**.

Answers reference AISC Design Guide 9: *Torsional Analysis of Structural Steel Members*. Download your copy today at **aisc.org/dg**.

1 **b.**, **d.**, and **e.** The shear center is the point through which the applied loads must pass to produce bending without twisting. If a shape has a line of symmetry, the shear center will always lie on that line; for cross-sections with two lines of symmetry, the shear center is at the intersection of those lines (as in the centroid). Thus, the centroid and shear center coincide for doubly symmetric cross-sections such as W-, M-, S-, and HP-shapes, square, rectangular and round hollow structural sections (HSS), and steel pipe (P). Singly symmetric cross-sections such as channels (C and MC) and tees (WT, MT, and ST) have their shear centers on the axis of symmetry, but not necessarily at the centroid. The shear center location and centroid for all shapes shown in this question can be found in Figure 2.1 of Design Guide 9.

2 **False.** Shapes of open cross-section tend to warp under torsional loading. If this warping is unrestrained, only pure torsional stresses are present. However, when warping is restrained (in this case, at the torsionally fixed connection of the cantilevered beam), additional direct shear stresses as well as longitudinal stresses due to warping must also be considered. (See Chapter 4 to learn more).

3 **True.** The commonly used structural shapes with open cross-sections, such as wide flange members, offer relatively poor resistance to torsion. Hence, it is best to avoid torsion by detailing the loads and reactions to act through the shear center of the member. However, in some instances, this may not always be possible. When torsion must be resisted by the member directly, its effect may be reduced through consideration of intermediate torsional support provided by secondary framing (See Section 2.3).

4 **All of the above.** Pure torsional shear stresses are always present on the cross-section of a member subjected to a torsional moment. For sections which tend to warp, normal stresses and additional shear stresses develop when warping is restrained. When a member is allowed to warp freely, normal and shear stresses due to warping do not develop. While structural tees tend to warp, the warping stresses are generally small. For typical tee dimensions, the shear and normal stresses due to warping are shown to be negligible. Similarly with single angles, using typical angle dimensions, the two shear stresses due to warping are of approximately the same order of magnitude, but represent less than 20% of the pure torsional shear stress. Adding all shear stresses yields a maximum surface shear stress near mid-length of the angle leg. Since this is a local maximum that does not extend through the angle thickness, ignoring the shear stresses due to warping suffices. (See Chapter 4).

5 **Fourth.** The torsional resistance provided by a structural shape is the sum of that due to pure torsion and that due to restrained warping. The sum of the internal torsional moments is equilibrated by the applied external torque. The expression of this relationship in the angle of twist yields a fourth-order differential equation for a uniformly or linearly distributed applied torque (See Equations 3.2 and 3.3). See Appendix C for the derivation of these equations and solutions for several loading and boundary conditions.

6 **20.** For an HSS member subject to combined torsion, shear, flexure, and/or axial force, the torsional effects may be neglected when the member's required torsional strength is less than or equal to 20% of the available torsional strength. When the required strength is greater than 20% of the available strength, the interaction of torsion, shear, flexure, and/or axial force is checked using Equation H3-6 in the 2022 AISC *Specification for Structural Steel Buildings*. (See *Specification* Section H3.2 and Commentary).

Pondering Ponding

BY MARK D. DENAVIT, PE, PhD, AND JAMES M. FISHER, PE, PhD

Design Guide 40 provides design professionals with critical information and examples for designing roof framing systems for rain loads and avoiding ponding instability.

RAINY WEATHER WON'T RUIN YOUR DAY—especially if you've planned for it by considering ponding issues in your roof designs. AISC Design Guide 40: *Rain Loads and Ponding*, released earlier this year, consolidates information design professionals need to know to design roofs framed with structural steel or open web steel joists.

Ponding provisions are found in several places, including the 2022 versions of the AISC *Specification for Structural Steel Buildings* (download it at **aisc.org/standards**) and *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI 7). Both include significant changes relevant to design for ponding: the appendix in previous editions of the *Specification* that described methods of ponding analysis has been removed, and the definition of rain load in ASCE/SEI 7 has been revised to be based on the deflected shape of the roof. The new provisions require a more realistic evaluation of the effects of ponding that is consistent with other aspects of structural design, but one that may be unfamiliar to design professionals.

Design Guide 40, a joint effort by the Steel Joist Institute (SJI) and AISC, should increase familiarity with new provisions. In addition to the design guide, SJI has developed an interactive Microsoft Excel spreadsheet-based design tool to assist in the design of roof systems, including evaluation of ponding stability.

The new design guide is organized into six chapters.

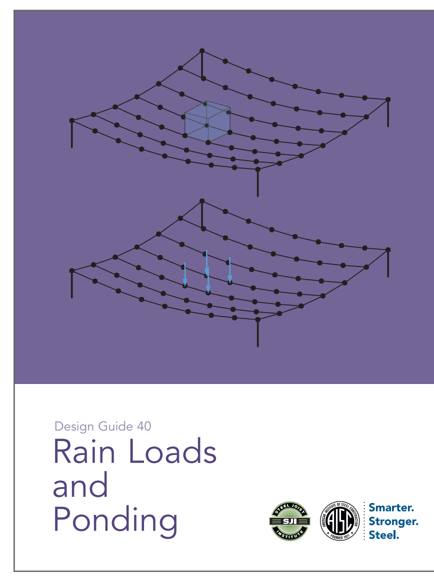
Chapter 1 describes the behavior of roofs subject to rain loads and highlights important design provisions relevant to rain loads and ponding. Ponding is a process where water, gravitating to low points in the deflected surface of a roof system, causes progressively increasing deflection and load. When sufficient strength and stiffness are provided, the result of ponding is equilibrium, albeit with loads greater and in a different distribution than expected based on the undeformed roof.

Given the multi-disciplinary nature of roof drainage, rain loads, and ponding, many standards include provisions relevant to the design and assessment of roof systems. Provisions in the 2022 edition of ASCE/SEI 7 are particularly relevant for structural engineers and are discussed. The provisions of the *International Building Code*, the *International Plumbing Code*, provisions from FM Global, and material-specific standards are also examined, as are the commonly used but now obsolete methods for design of ponding defined in Appendix 2 of the 2016 *Specification*.

Chapter 2 introduces the recommended method of design for ponding. Noting the limitations of the traditional methods of design for ponding, a more general method of design for ponding compliant with current standards is presented. For bays that accumulate water, the rain load and a special case of snow load are computed considering the deformed shape of the roof system.

Once computed, the rain and snow loads are used in standard strength load combinations to determine required strengths, which are then compared to available strengths per AISC *Specification* Section B3 or SJI *Specification* Section 4.2.1 or 4.2.2. If the available strength of each structural component equals or exceeds the required strength, no further ponding checks are required.

Chapter 3 discusses four methods of analysis for ponding: closed-form solutions, amplified first-order analysis, negative spring stiffness, and iterative analysis. Each method captures the nonlinear effect



arising from the applied loads dependent on the roof's deflected shape. The design guide describes how the methods vary applicability and ease of use, and how the engineer may select the method of analysis most appropriate for the situation.

Iterative analysis is the most general method of analysis for ponding. This method involves a series of analyses with rain loads updated in each iteration based on the deflections from the previous iteration. The change in rain load from one iteration to the next will either increase or decrease as successive iterations are performed. With increasing increments of rain load, the deflections and internal forces will diverge to infinity, indicating instability. With decreasing increments of rain load, the deflections and internal forces will converge to equilibrium.

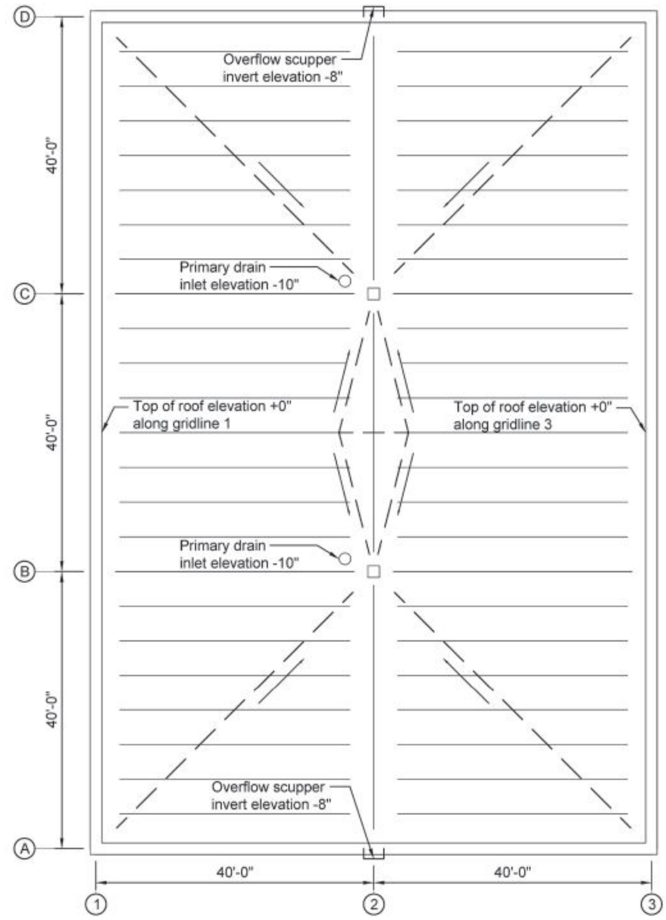
Chapter 4 illustrates the use of the SJI Roof Bay Analysis Tool, available at **www.steeljoist.org**. The tool is implemented in a Microsoft Excel spreadsheet and can be used as a design aid for estimating purposes or for the optimum selection of roof framing. It also can perform the recommended method of design for ponding described in Chapter 2 using the iterative method of ponding analysis. The tool applies only to rectangular bays with equally spaced secondary members, but it explicitly accounts for roof slope, camber, and rigid perimeter supports.

Chapter 5 contains five design examples. The first revisits an example presented in the 1966 *Engineering Journal* paper "Ponding of Two-Way Roof Systems" by Frank Marino that formed the basis of the traditional methods of design for ponding. The example is completed with hand calculations and highlights differences between the traditional and proposed methods.

The second and third examples illustrate the use of the SJI Roof Bay Analysis Tool. The framing for Example 2 is shown in Figure 1 and consists of open web joist framing. Example 3 uses the same framing plan but with structural steel framing. Calculations for the hydraulic head are also presented, and the SJI Roof Bay Analysis Tool input and output values are explained in detail. The fourth and fifth examples illustrate the evaluation of bays with low slope. Example 4 has secondary members perpendicular to a free-draining edge. Example 5 has secondary members parallel to a free edge.

Chapter 6 contains concluding notes on the important points presented in the design guide. Key provisions related to rain loads and ponding are summarized. Avoidance and mitigation, the two general strategies for addressing ponding in design, are emphasized. Avoidance is achieved by providing sufficient slope to a free-draining edge, and mitigation is achieved by sufficient strength and stiffness to support the ponding load. However, if the roof is inadequate, its design can be revised by:

- Stiffening the roof system to reduce the additional load caused by ponding.
- Strengthening the roof system to support the additional load caused by ponding.
- Adjusting the shape of the roof surface to reduce the additional loads caused by ponding, such as roof slope, camber, tapered insulation, and sloping fill.



- Increasing drainage capacity (for example, adding drains near columns).
- A combination of the above.

Chapter 6 concludes by saying structural steel and open-web steel joists are economical and efficient for roof systems. Still, their use requires that design professionals give close attention to the potential for ponding. Aspects of design not typically associated with strength, such as deflections, roof slopes, camber, and the locations and sizes of roof drains, can strongly influence the safety and reliability of the roof system with ponding. Nonetheless, design teams can effectively address ponding with proper attention and coordination. ■

You can download Design Guide 40 from the AISC and SJI websites: ***aisc.org/dg*** *and* ***www.steeljoist.org/publications****, respectively. Other AISC Design Guides and SJI Technical Digests can be downloaded from their respective websites. You can also download SJI's Roof Bay Analysis with Ponding Tool spreadsheet at* ***www.steeljoist.com/design-tools****.*

Mark Denavit is an associate professor in the Department of Civil and Environmental Engineering at the University of Tennessee, Knoxville. **James Fisher** is emeritus vice president of CSD Structural Engineers. Both serve as consulting engineers to the Steel Joist Institute.

Prolifically Published

INTERVIEW BY GEOFF WEISENBERGER

Mike Grubb's exhaustive writing on steel bridge design led to him earning one of the profession's highest honors.

ONE OF THE MOST prestigious groups in the steel industry added a member this year.

Mike Grubb, a bridge design expert and the executive director at M. A. Grubb and Associates, became the 13th person to receive AISC's J. Lloyd Kimbrough Award since its inception in 1941. Previous recipients include David Steinman (1957), Ludwig Mies van der Rohe (1961), Fazlur Khan (1973), and Leslie Robertson (2001). The most recent recipient is David Ruby, who earned it in 2022.

The award, named for AISC's first president, recognizes the preeminent steel designers of their era who have made outstanding contributions to the industry. Candidates are nominated every year. But they are rarely chosen.

"I'm really flabbergasted by the whole thing," Grubb said.

Past Kimbrough recipients are street namesakes, company founders, and engineers and architects who designed some of the country's most recognizable structures. In that regard, Grubb is a unique Kimbrough Award club member because he doesn't have a portfolio of iconic structures he helped design.

His work has trained many people who do, though.

Grubb has authored more than 40 publications on all areas of steel bridge design that would likely satisfy tenure requirements at most universities. In fact, his work has been incorporated in class curricula at engineering schools across the country. He has written and co-written technical work that eclipses 1,000 pages. He runs a one-man company, though its name implies other members.

Grubb spoke with *Modern Steel Construction* about his career and work.

Let's start at the beginning. Where did you grow up and how did you get into the industry?

I was born in Philadelphia. My father, an engineer himself, was transferred to Orono, Maine, when I was eight. So I grew up in Maine, which was very cool. But I went to school in Upstate New York—did my undergrad at Clarkson University and my master's at Cornell. That's sort of how I ended up in the steel bridge industry. I wanted to go to Cornell, and the school had a scholarship offer through the U.S. Steel Research and Technology Center outside of Pittsburgh. It would pay for two semesters of graduate tuition, but you had to work at the lab there for two summers.

I interviewed for it and competed with guys from Cornell. The late Jerry Haaijer was the interviewer. I answered one question on torsion that they didn't, and the rest is history. I got the scholarship and went to work at the U.S. Steel lab in Monroeville, Pa. Phil Carskaddan took me under his wing there; he was the original author of the Simon Program, a bridge design program now widely used in the industry. He taught me a lot about steel bridges, and that's where I got interested in them.

When I returned to Cornell, he would send me letters and articles. He kept me interested, and I decided to stay at the lab after finishing my master's degree. That's how I ended up in Pittsburgh, and I've been there ever since.

I worked for Jerry at the lab, and later, he went to AISC. I was also going to work for AISC, but I was getting married, and my wife didn't want to move to Chicago. I ended up having to back out of AISC and stay in Pittsburgh. Instead, I went to work for HDR, a large bridge consultant.

What made you decide to go into engineering in the first place?

My father was a drainage engineer. My brother was an engineer and designed hydro turbines, so it was in the family. I followed my father's footsteps and went into civil engineering. I had to take classes in different disciplines, and I was attracted to the structural part. I grew to like bridges more than buildings after I learned more and more.

It seems like most bridge-oriented engineers start with buildings and find their way to bridges.

I've always found bridges a little more interesting because they have moving loads, composite design, and unsymmetrical sections. You're not taught a lot of that in college. I learned a lot through the old U.S. Steel Highway Structures Design Handbook, which was the only thing available when I finished school to learn about bridges. It's a well-done handbook and still exists today under NSBA. It taught me a lot, I found it interesting, and I stuck with it.

Can you point to a really memorable bridge project from your career?

My career has been unique because I have never designed a large structure. I did design and help with an overpass bridge, but that's about it. I've contributed in other ways by developing the steel specifications for bridge design, editing them, and keeping them up to date. I've been doing that for close to 40 years. I'm really the guy people come to for it. I've developed a lot of design courses and design examples.

Field Notes is *Modern Steel Construction's* **podcast series**, where we interview people from all corners of the structural steel industry with interesting stories to tell. Listen in at **modernsteel.com/podcasts**.

I like to teach people how to do the design. If I can't understand the specifications, nobody else will, because I'm just a regular guy. I like to write them so people can hopefully understand the background and what they're saying. I hope I've been successful at that.

Has there ever a part of you that wanted to go into teaching?

I thought about it, but I didn't want to get a PhD, which is basically a requirement for teaching. But I teach mainly with the Federal Highway Administration. We teach a lot of courses on bridges.

I've given a lot of talks over the years on many different subjects. I've always enjoyed it. It's always been interesting to do talks, especially at NASCC: The Steel Conference, and see the reaction and the interest.

Do you have any advice for people who want to get into designing bridges?

You need to do a lot of work on your own. You need to study. A lot of material is available now that wasn't around when I started. As I mentioned, only the U.S. Steel handbook was available for me. Now, the National Steel Bridge Alliance (NSBA) has done a great job, and there are lots of examples and publications. You really need to do some bedtime reading, I always say.

Go through the examples yourself by hand to really understand what you're doing—understand the basis, the formulas, and how to apply them properly. I think that's very important.

Of your 40-plus publications, do you have one you'd consider a masterpiece?

I worked for a guy named Dann Hall, who had a company called BSDI that did a lot of 3D analyses of bridges in the early 1980s. They were 25 years ahead of their time. I worked for him and his partner for 14 years and learned a lot from them. They were great teachers and big players in the industry that often don't get the credit they deserve. Dann and I wrote a 1,000-page reference manual on curved and skewed bridges, and that won some awards. I'd say I'm the proudest of that thing. But over the years, I've written two or three manuals that topped 1,000 pages over the years. It takes time, but you just have to grind through it.

Mike Grubb (center) with AISC President Charles J. Carter (left) and AISC Board of Directors chair Hugh McCaffrey.

Recently, I've been working with fellow bridge expert Frank Russo on a college course for NSBA. That was a fun project, and we spent two years on it. That will eventually be given away to faculty and made available to the industry. We put together the curriculum, and professors and consultants can do whatever they want with it. They can use it as a basis for a class or tweak it to develop their own, but it will have all the information they need. The need-to-know stuff is in there.

I'm really excited about that. I think that's going to be a great product. It's coming out this year.

You've been in Pittsburgh for a while. What are some of your favorite things about it?

It's a great city. I think people would be surprised if they went there. It has a relatively low cost of living, a lot to do, and it's beautiful with the three rivers. The neatest thing is when you drive through the Fort Pitt Tunnel and come into the city and, boom, there's the cityscape. That's part of what attracted me to it at first. It's amazing how many people mention that as the reason they visit and end up living there.

I've made a lot of friends there over the years. The only bad thing is it's cloudy a lot. That's the only downside.

Your company is M.A. Grubb and Associates. Who are the associates?

There are no associates [laughs]. When we formed the company, the lawyer suggested that name. I said, "What do you mean? There's nobody else." She said it sounds good and rolls off the tongue. It's been somewhat of a running joke ever since. At The Steel Conference, many people joked with me the associates must have been thrilled about the award. ■

*This interview was excerpted from my conversation with Mike. To hear more from him, listen to the July Field Notes podcast at **modernsteel.com/podcasts**, Apple Podcasts, or Spotify.*

Geoff Weisenberger (**weisenberger@aisc.org**) is the editor and publisher of *Modern Steel Construction*.

Tracking Trade Talent

BY MAX CLEMENT

Attracting talent—especially in the trades—requires a multifaceted and tailored approach to job seekers' lives and trends.

SKILLED TRADE WORK IS A UNIQUE career path with many benefits. Job security remains steady as long as the industry continues growing and expanding, career growth opportunities are plentiful, and workers have a tangible impact on the world around them that many find rewarding. Yet finding talent to fill an increasing number of open positions is a challenge keeping many business owners up at night.

High demand in all facets of the steel and overall trade industry is creating pressure on craft availability for manufacturing facilities and on-site field labor. Most notably, a large share of the existing workforce is hitting retirement age. Between 2003 and 2020, the percentage of construction workers over age 55 nearly doubled, jumping from 11.5% to 22.7%, according to the Bureau of Labor Statistics.

Meanwhile, young people are pursuing trades jobs at a lower rate due to widespread incentivizing to attend four-year colleges. Demand for highly skilled labor is also on the rise, and finding people with the right training and qualifications can feel like searching for a needle in a haystack, especially amid a dwindling talent pool and high turnover rates.

Building interest in skilled trades jobs and drawing more long-term workers to the industry requires a multifaceted recruitment approach.

Tailor your process to the field. The skilled trade workforce has a different job-hunting experience than professionals in other industries. They don't work traditional 9-to-5 schedules, and construction safety protocols don't allow them to access their phones for most of the day. Recruiters should be flexible with interview availability and send an email or text message in addition to leaving a voicemail to allow candidates to respond when they have time.

Equally important is to make scheduling an interview easy on the candidate. Enabling applicants with tight schedules to self-serve and book interview times using a scheduling tool integrated in your recruiting calendar can help them feel like they have more control during the hiring process.

Make applications easy. Being mindful about the time to complete an application is critical, especially when filling niche or high-volume roles. Steel craftworkers have physical jobs. Scanning the internet for job openings—much less completing an application—can be a high-effort task right after a shift on an inherently demanding job. Additionally, candidates may have years of skilled trade work experience and a variety of skills. It can be taxing for them to list every role they've worked on in an application, especially if they're applying to multiple opportunities.

For best results, application questions should be strategic and straightforward, avoiding busy work with little to no benefit for either side. For example, is a cover letter truly necessary? Include must-have requirements and qualifications on the application and ask detailed questions during the job interview. Job descriptions should also use inclusive, neutral, and easy-to-understand language.

Applications should prompt candidates to highlight their skills and experience, such as welding certifications, fit-up experience, and shop document reading experience. Those types of applications need a different format than those for an office job.

Eliminate endless feedback loops. We live in a world where people have come to expect immediate delivery and communication—and the job market is no different. It's important to make the hiring process concise and efficiently move qualified candidates through the hiring pipeline, or you'll risk losing them to a competitor with a more efficient process.

Diversify sourcing channels. Traditional job boards like Indeed, LinkedIn and Glassdoor are good starting points, but to reach a larger candidate pool, hiring companies should put significant effort into industry-specific channels.

If the candidate pool in your industry is active on some traditional platforms more than others, focus attention on those. Find where the job seekers in your field most frequently search for open positions and meet them there. A LinkedIn-heavy approach to marketing job openings, for example, will work for some industries and be fruitless in others. Tap into professional associations like AISC and leverage their outreach resources.

Optimize your applicant tracking system. Applicant tracking systems (ATS) can streamline many recruitment tasks to give companies the best chances of finding and securing great talent. The tool can automatically post to multiple job boards and scan talent pools based on specific criteria to help narrow down qualified candidates. Possible candidates who aren't hired can also be stored and automatically notified when a new position opens that matches their specific skill sets.

To maximize outreach and keep qualified applicants from slipping through the cracks, ensure your talent pool is properly labeled and categorized in the ATS. While a candidate may not have met the job requirements for one position, that person could be suited for a different role within the organization.

Dedicate time to community outreach. Connecting face-to-face is a great opportunity to introduce candidates to a company and its employee benefits. Work with the local chamber of commerce and association chapters to plan in-person events within the community.

Career and technical education programs in high schools are ripe grounds to nurture a future talent pipeline. School fairs and events are excellent occasions to educate students and parents about the expansive career opportunities in the steel industry and dispel any misconceptions they may harbor about working in skilled trades. The most effective outreach programs have consistent face-to-face engagement and make efforts to build steady relationships with students.

Establishing apprenticeship programs with local schools and community colleges, such as welding courses, can also support recruitment efforts. Students who decide to pursue trades careers after their experience in a hands-on learning program will already be trained in some of the skills needed to make them successful in available trades roles.

Strengthen your employee benefits program. The right employee benefits program can be a candidate's deciding factor between two companies. These are some avenues companies can explore to improve their benefits packages:

- **Insurance:** Lower medical plan deductibles, co-insurance, and increased employer contributions can help cover healthcare costs and bring employees peace of mind. In addition, consider offering insurance options that allow employees to meet their families' ongoing needs, such as dental, vision, life, and disability.
- **PTO and flexible schedules:** Holidays, sick leave, bereavement leave and flex time are highly valued benefits, especially for work-life balance-conscious Millennials and Gen Zers. When possible, offering flexible work hours can be a great incentive to accept a job offer. Flexibility can be tricky to accomplish in craftwork, but not impossible. It could include allowing employees to choose their arrival and departure times, allowing shift exchanges, or giving employees the flexibility to take a break during the day and finish up at night.
- **Wellness support:** Consider supplementing primary health coverage by offering wellness support like mental health and substance abuse counseling, gym memberships, health screenings and stress management education.

All told, one job's strong benefits program does not trump another's notably higher wages and total take-home pay. But it can sweeten the deal for two openings with comparable wages.

Establish an employee referral program. Studies show that employee referrals are effective tools for candidate sourcing, resulting in high conversion rates, shorter hiring cycles and better retention rates.

An employee referral program (ERP) encourages employees to recommend and recruit qualified potential candidates from their personal and professional networks. Successful programs offer incentives like cash, PTO, gift cards and other compensation for every successful referral that ends up as a new hire. Even a $50 bonus can go a long way, especially when considering the nearly $4,700 average cost of hiring a new employee, according to the Society for Human Resource Management.

Highlight professional development opportunities. Educational opportunities help build and retain a more skilled workforce, benefitting the individual and the company long-term. Demonstrating a culture of training and development shows potential hires they will have opportunities to advance in their craft and career—and that their employer supports them along the way. AISC's Fabricator Education Training can be used to show new hires a transparent career path and where an entry-level position can lead.

Invest in technology at all business levels. Millennials and Gen Zers have high expectations for technology in the workplace, and it's not only the tech used in the field. Integrating human resources technology to enhance workforce management efficiency can make an employer more attractive. From improving first impressions to enabling accessible career development, these are three key HR technologies to consider investing in, depending on company size:

- **Applicant tracking systems:** Facilitate online job applications and automatically update candidates on their application status or new openings that match their qualifications.
- **Learning management systems:** These systems house everything from company policy and culture training to OSHA safety certifications. Use a learning management system to establish centralized learning portals for employees to access required safety training and track upcoming expirations dates, as well as enroll for additional coursework to learn new skills. The AISC Fabricator Education Training is one example of a learning management system.

Labor shortages undercut a business's ability to perform effectively and take on new business, but finding qualified candidates is an increasingly difficult endeavor. If skilled labor is harder to come by, then the hiring strategies we employ must also change. Painting the right picture that your culture is the right fit and your business approach is innovative is just as important as leveraging all available networks to meet new talent.

A strong retention rate yields the best return on investment in hiring and recruiting. If a trade work employee has a satisfactory work-life balance, a positive working relationship with a boss, works in a convenient location, has comprehensive benefits, and enjoys the job's tasks, the chances of keeping that person increase. A sound hiring and recruiting process should address those areas. ■

Max Clement
(**Max.Clement@arcoro.com**) is a sourcing specialist at Arcoro.

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

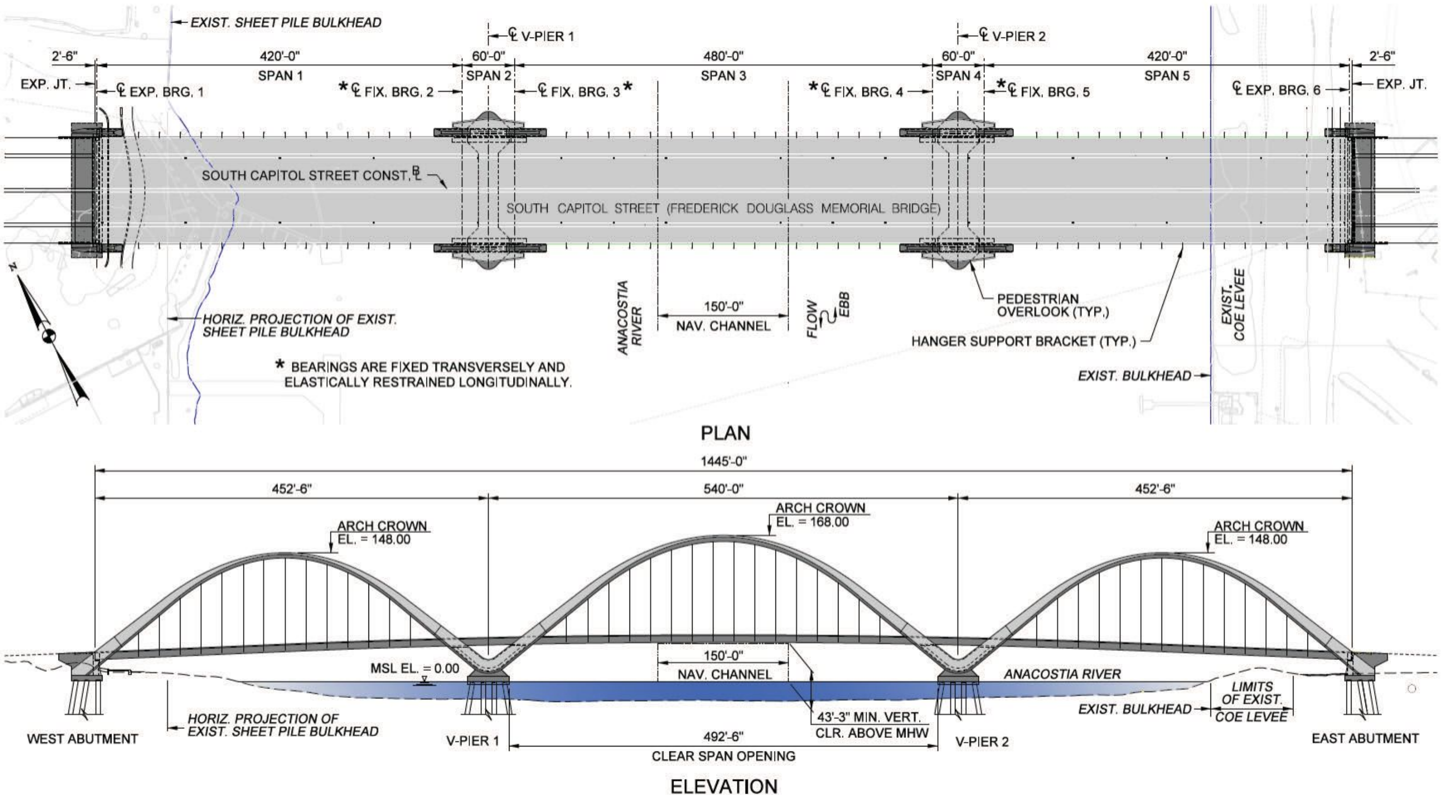
Once the concept was envisioned, the design team only considered steel for the arches due to their complex geometry. The team worked together on many of the fabrication design and detailing issues that arose throughout the design phase.

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.

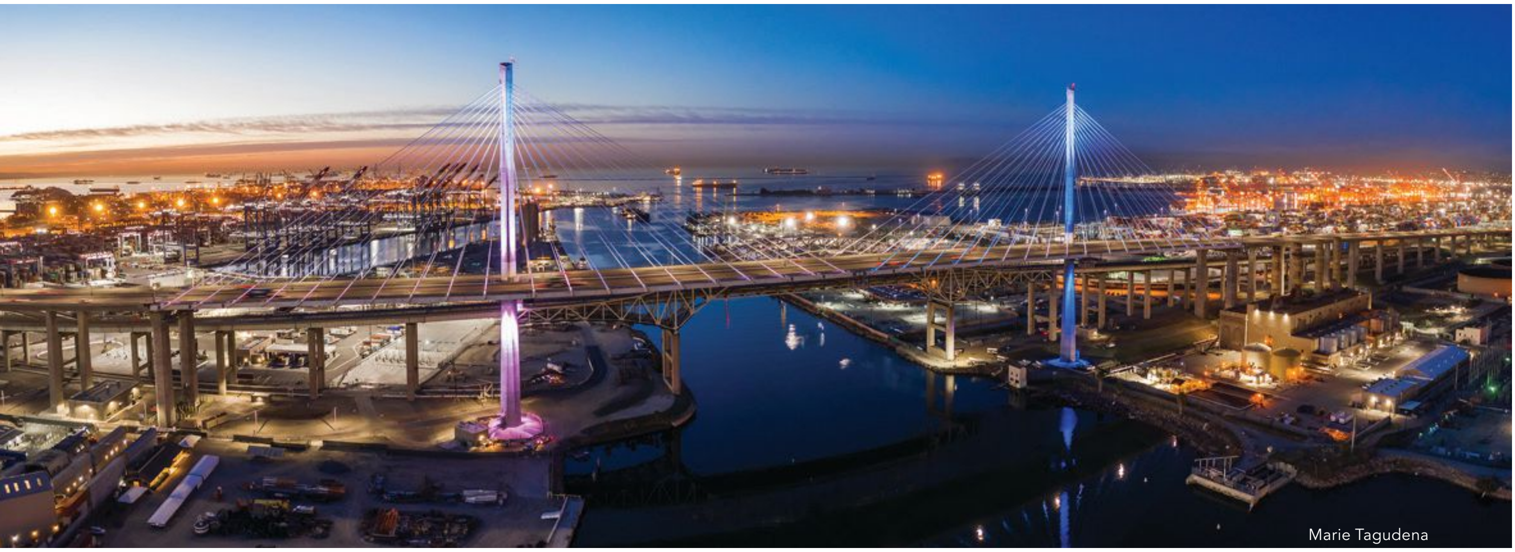
Lead Bridge Architect
BEAM Architects, Bridgport, U.K.

General Engineering Consultant
HNTB, Arlington, Va.

Steel Team

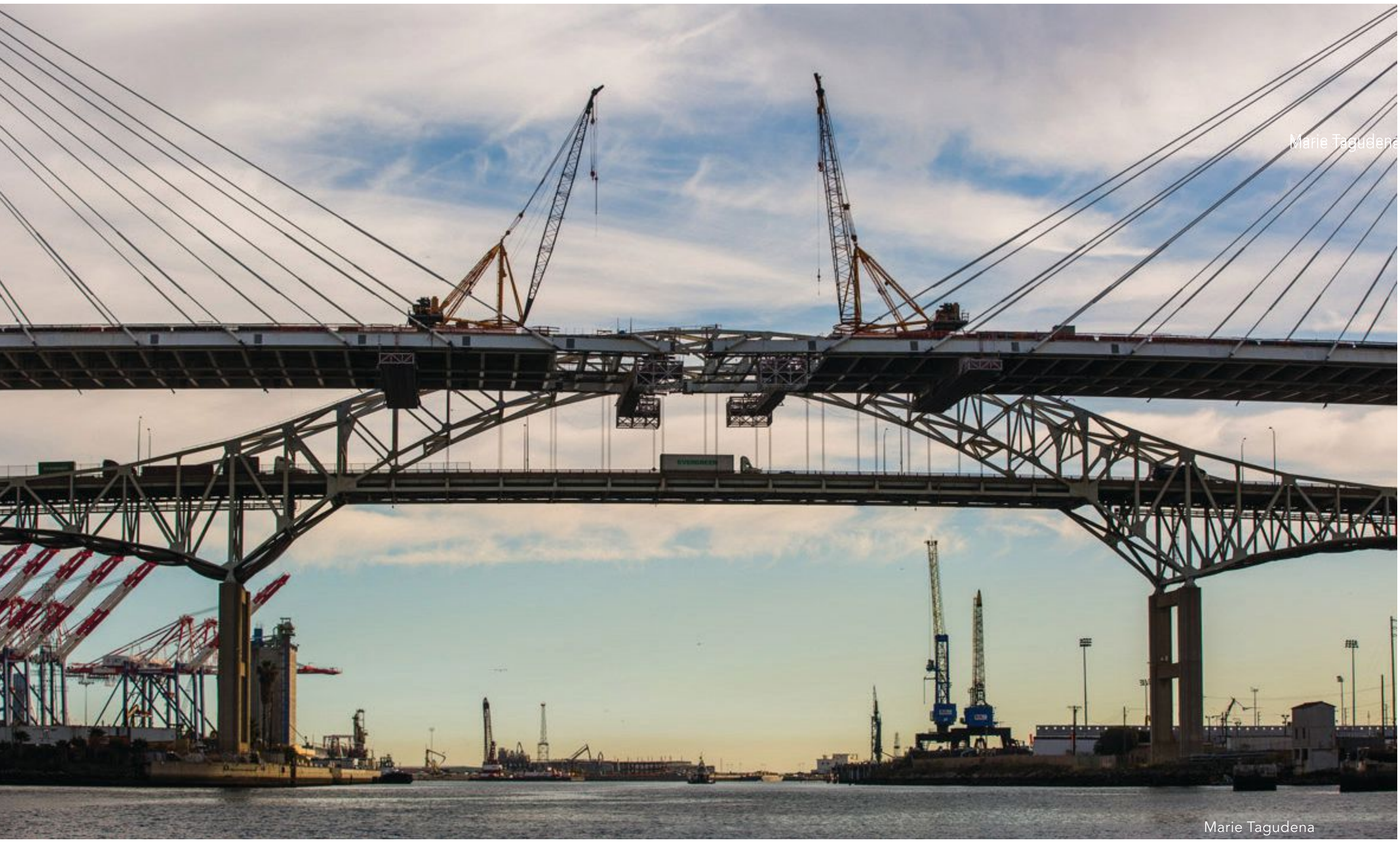
Fabricator
Veritas Steel, LLC (AISC Certified Fabricator), Eau Claire, Wis., and Palatka, Fla.

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



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



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.

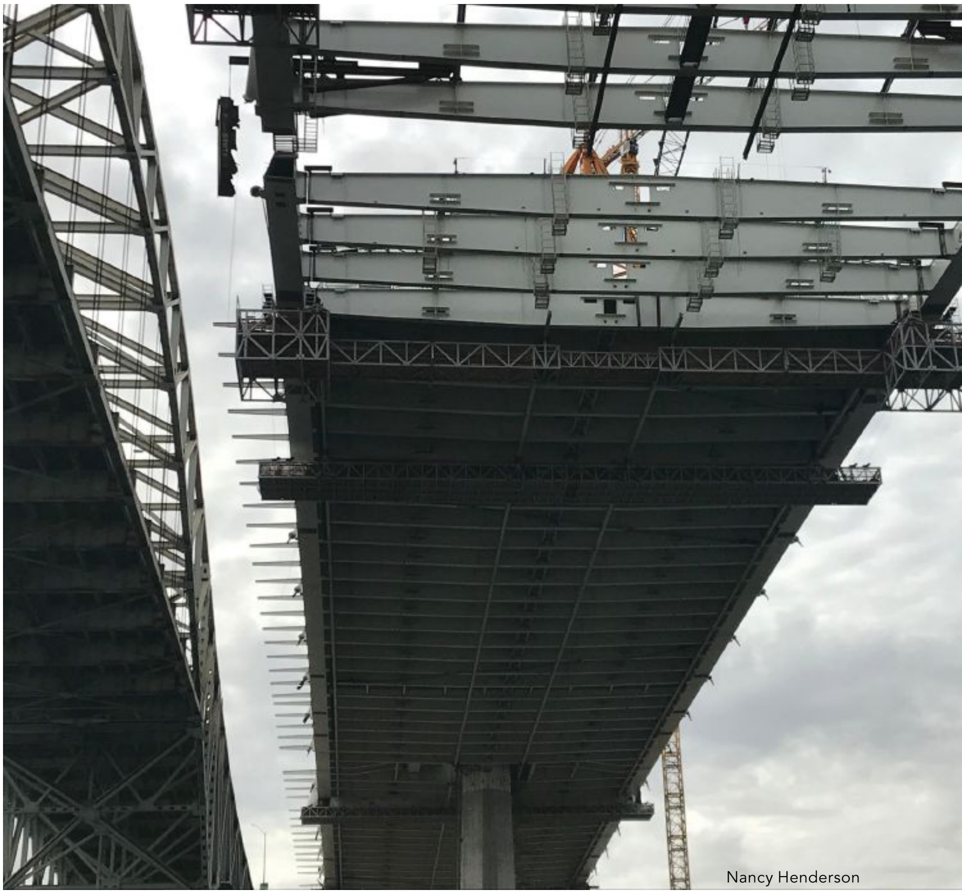
An innovative moveable scaffold system (MSS) allows long spans at high elevation while avoiding utility constraints. The double Texas U-turn on land eliminated two flyover ramps, cutting costs and returning valuable real estate to the port. Foundation savings were also found through an innovative manchette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

HDR – Matt Longfield

2024 PRIZE BRIDGE AWARD

NATIONAL AWARD | MEDIUM SPAN BRIDGE OF THE YEAR FINALIST

Interstate 94 Second Avenue Bridge
Detroit

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


Stimulate Your Infrastructure
With Steel Curved by
Chicago Metal Rolled Products
17-92 Pedestrian Bridge (Longwood, FL)
It doesn't matter how complex the curve is. For this project Chicago Metal Rolled Products curved 66 tons of 14" square tubing up to 70' long with both sweep and camber.
Highland Bridge (Denver, CO)
This award-winning bridge is both dramatic and economical. Chicago Metal Rolled Products' Kansas City facility was able to curve 153 tons of 18" outside diameter tubing up to 100' long, which reduced splicing costs.
Tempe Town Bridge (Tempe, AZ)
Winner of multiple prestigious awards, each of the four 228' long arching sections consists of 16" diameter HSS pipe curved up to 46' in good arc....a pedestrian bridge providing both function and aesthetics.
Our nation needs infrastructure improvements. Let Chicago Metal Rolled Products help you build bridges, tanks, tunnel supports, cofferdams, culverts, man ways, guard rails, viaducts, reinforcing columns and other structures.
Call us at 866-940-5739
When you need high-quality, high-value curving of steel.
CHICAGO METAL
ROLLED PRODUCTS COMPANY
CHICAGO • KANSAS CITY
cmrp.com
AISC
ASSOCIATE
NOMMA
SMA

Standard Mill Shapes - Rolled To Your Specifications

Call 866-940-5739

No.	Shape	Dimension	We bend ALL sizes up to:
1	Angle Leg Out	INSIDE DIA.	10" x 10" x 1" Angle
2	Angle Leg In	OUTSIDE DIA.	10" x 10" x 1" Angle
3	Flat Bar The Hard Way	INSIDE DIA.	24" x 12" Flat
4	Flat Bar The Easy Way	INSIDE DIA.	36" x 12" Flat
5	Square Bar	INSIDE DIA.	18" Square
6	Beam The Easy Way (Y-Y Axis)	MEAN DIA.	44" x 335#, 36" x 925#
7	Beam The Hard Way (X-X Axis)	INSIDE DIA.	44" x 285#
8	Channel Flanges In	OUTSIDE DIA.	All Sizes
9	Channel Flanges Out	INSIDE DIA.	All Sizes
10	Channel The Hard Way (X-X Axis)	INSIDE DIA.	All Sizes
11	Tee Stem In	OUTSIDE DIA.	22" x 142 1/2# Tee
12	Tee Stem Out	INSIDE DIA.	22" x 142 1/2# Tee
13	Tee Stem Up	MEAN DIA.	22" x 142 1/2# Tee
14	Angle Heel In	INSIDE DIA.	8" x 8" x 1" Angle
15	Angle Heel Out	OUTSIDE DIA.	8" x 8" x 1" Angle
16	Angle Heel Up	MEAN DIA.	8" x 8"x1" Angle
17	Square Tube	INSIDE DIA.	24" x 1/2" Tube
18	Rectangular Tube The Easy Way (Y-Y Axis)	INSIDE DIA.	20" x 12" x 5/8" Tube
19	Rectangular Tube The Hard Way (X-X Axis)	INSIDE DIA.	20" x 12" x 5/8" Tube
20	Square Tube Diagonally	MEAN DIA.	12" x 5/8" Square Tube
21	Round Tube & Pipe	MEAN DIA.	24" Sched. 80 Pipe
22	Round Bar	MEAN DIA.	All Mill Produced Sizes

We also roll stair stringers, helical hand rails, off-axis bends, formed shapes and extrusions.

Visit cmrp.com for more information.

CHICAGO METAL ROLLED PRODUCTS COMPANY

CHICAGO • KANSAS CITY

AISC ASSOCIATE · NOMMA · SMA MEMBER

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

HDR – Mike LaViolette


HDR – Mike LaViolette


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, Claremont, N.H.

Detailer
DBM Vircon, Phoenix

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

All photos courtesy of Wade Thompson

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, 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.

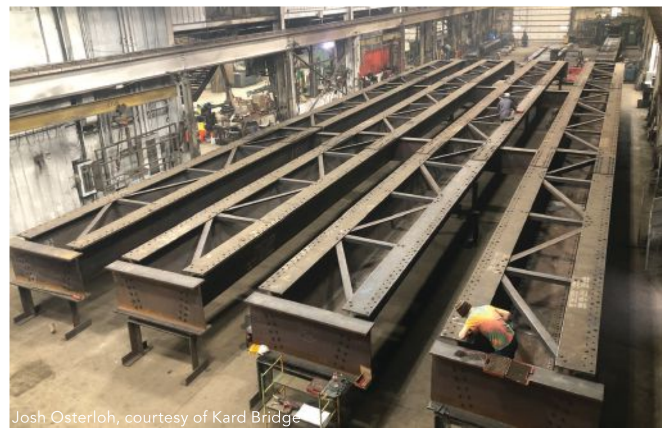
Innovation is a core INDOT value and aligns with INDOT's mission to focus on new, practical ideas and technology to continuously serve customers better and more efficiently. Using built-up press-brake-formed tub girders (PBFTGs) to replace the State Road 32 bridge over Stony Creek in Noblesville offered 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. Most importantly, it promises to deliver fabricated steel bridges in weeks instead of months.


Ashley Thrall, courtesy of University of Notre Dame


Spencer McKenney, courtesy of INDOT


Spencer McKenney, courtesy of INDOT

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, Houston
Kard Bridge Products, Minster, Ohio

Detailer

Weaver Bridge Corporation, Granville, Ohio

Galvanizer

V&S Galvanizing, 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.

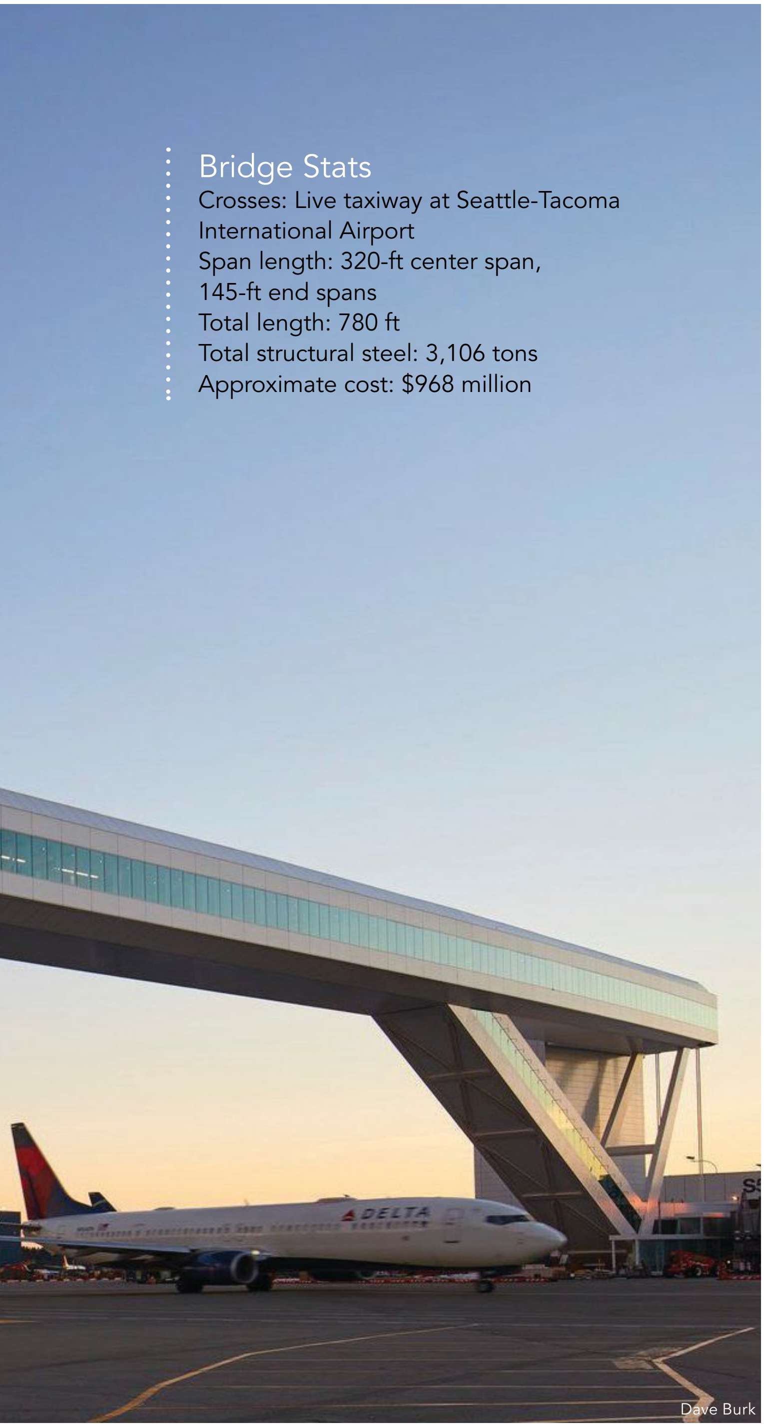
Most airports move passengers from terminal to terminal with an underground walkway, a subway tram, or an elevated tram that hugs the terminal buildings. Port of Seattle, which owns and operates the airport, chose the most direct but difficult concept: an overhead bridge crossing an active taxiway.

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.

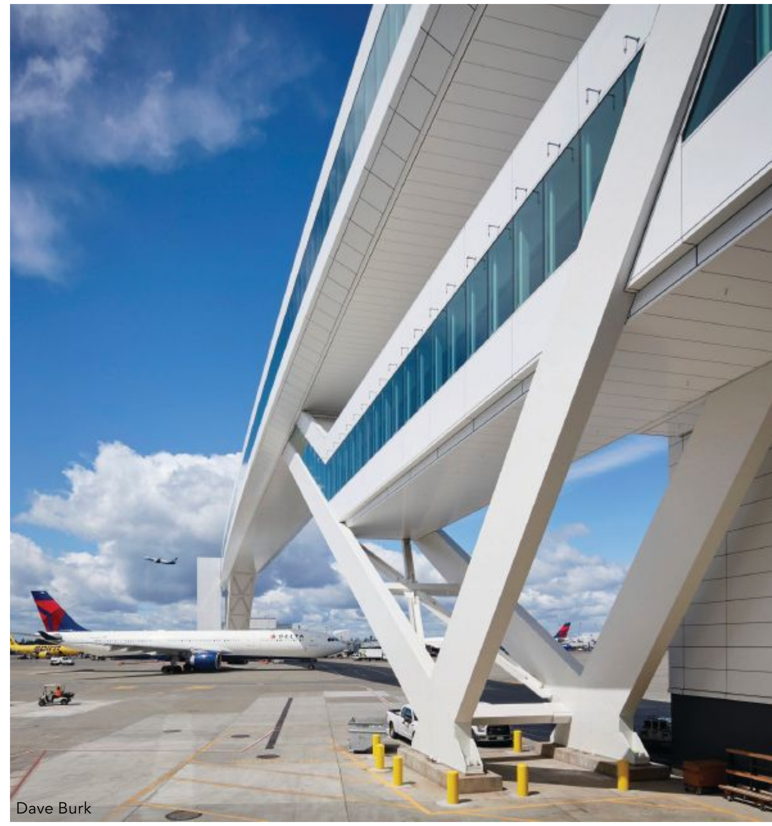
The bridge took eight years to plan, design, and construct. Steel was the material of choice due to the clear span length, seismic criteria, and need for innovative design and construction methods. The walkway contains 3,000 tons of steel, while the cores use another 160. It has 800 tons of rebar and 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.

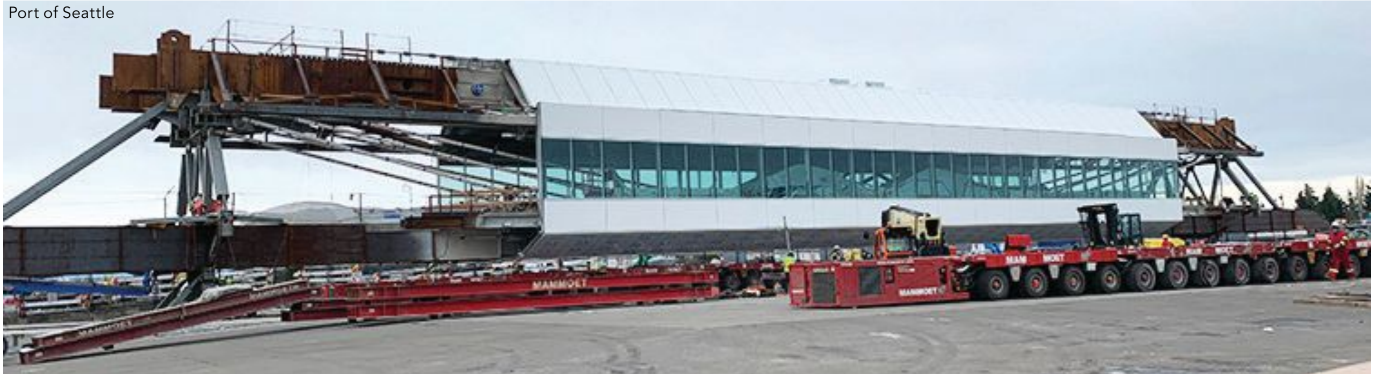
Erecting a 780-ft walkway and a 320-ft, 1,565-ton center span on site would have meant an untenable closure length for a portion of a taxiway and several gates. Instead, the walkway was built in one of the airport's cargo areas in 17 major prefabricated components, including the center span. The ABC 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, Vancouver, Wash.
Jesse Engineering, Tacoma, Wash.
Transco Industries, Portland, Ore.
Greenberry Fabrication, Vancouver, Wash.

All photos courtesy of Tom Loomis

2024 PRIZE BRIDGE AWARD

MERIT AWARD | SPECIAL PURPOSE

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

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.

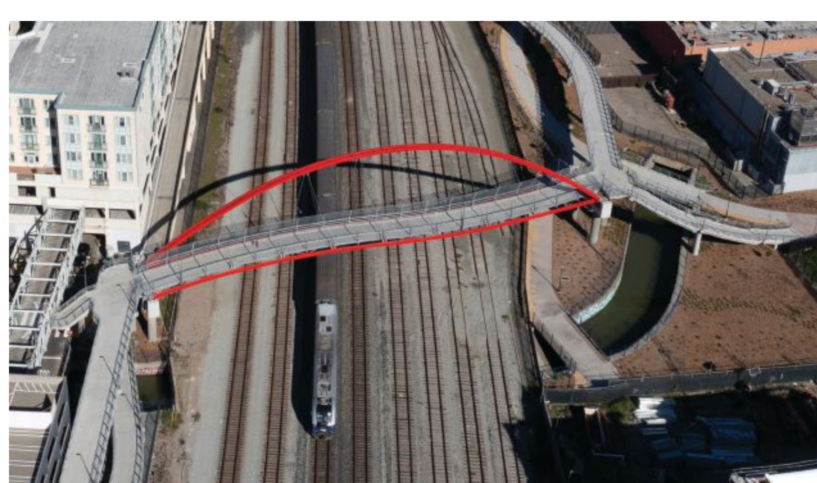
Elsewhere, a variety of water and electrical connections were removed from the project to reduce maintenance costs and prevent vandalism. The construction management team used a cloud-based system to administer the project. Team members could pull up project documents anytime through their computer,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

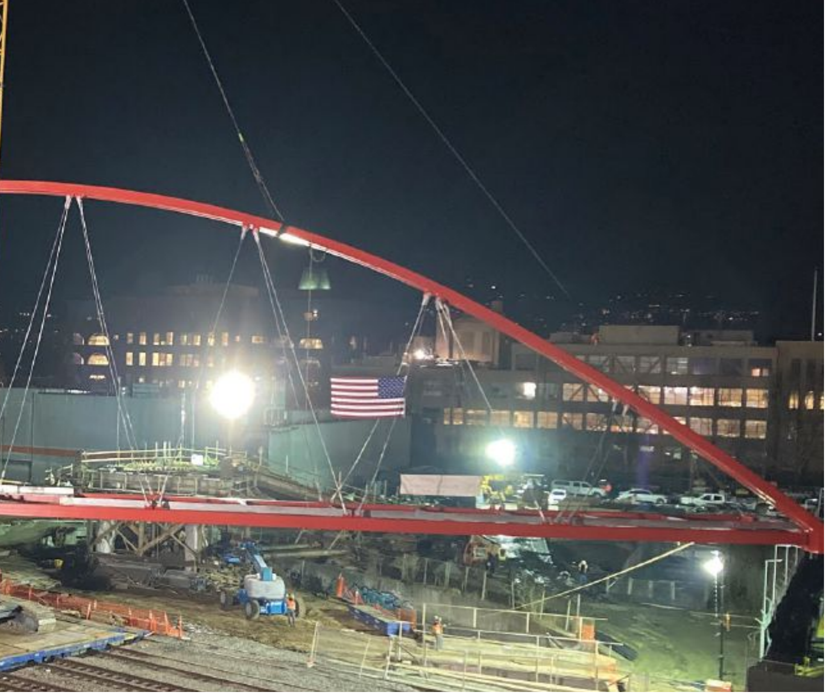
Extensive surveying was performed during the entire construction process to ensure the main bridge would fit during the final installation, including high-level surveys while installing the tie-down bolts for the bridge on both abutments piers to ensure they were consistent with the designed bridge length.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

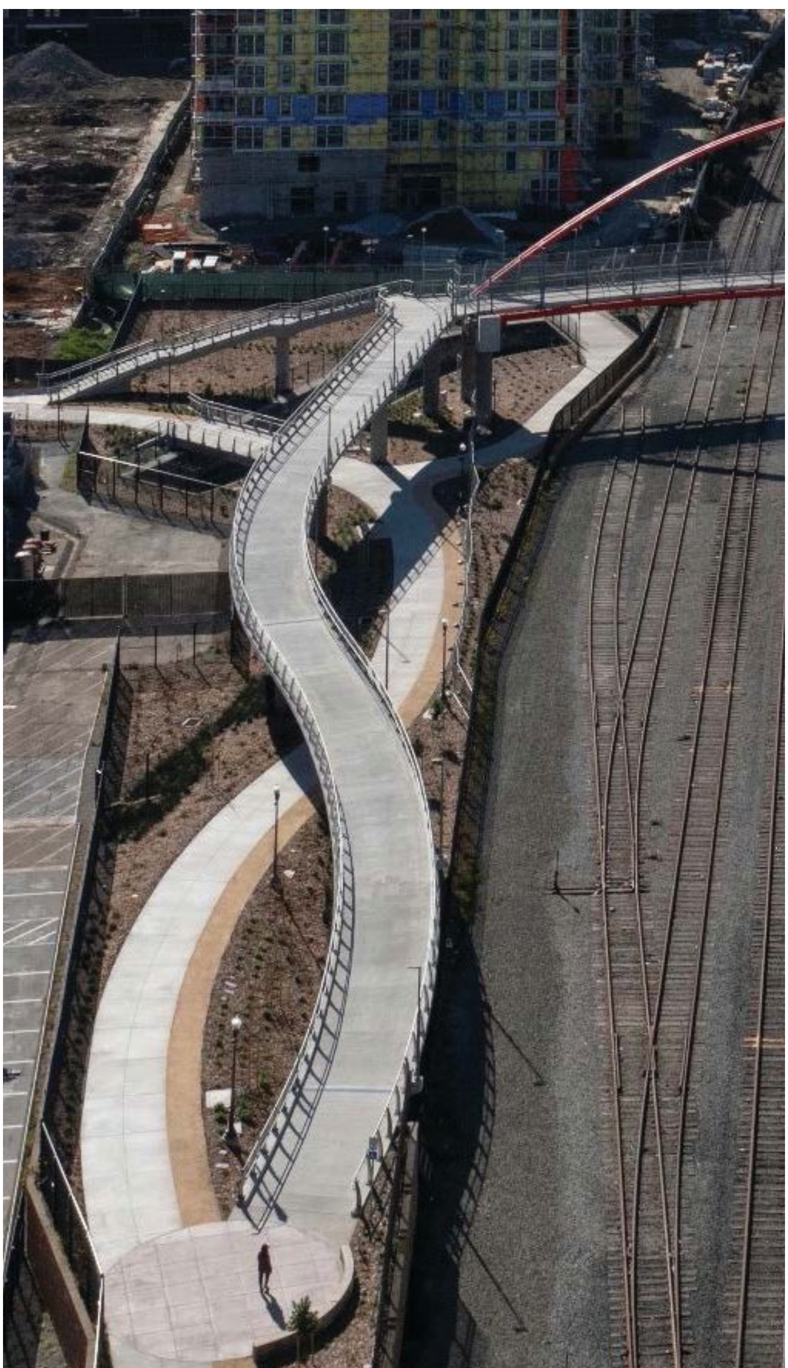
Bridge Stats

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.

Dynamic Design

BY ROBERT HELLYER, PE
AND MICHAEL STEIN, PE

Visually striking structural steel components create a geometric, vibrant museum space.

Rafael Viñoly Architects

A MUSEUM DEDICATED to the country's most accomplished veterans needed an inspiring space to honor the legacy of the more than 3,500 recipients of the Medal of Honor, the United States Armed Forces' most distinguished military decoration.

The resulting design of the National Medal of Honor Museum—located in Arlington, Texas—has a steel structural system that responded to the owner's and architect's desire for a massive column-free space. Rafael Viñoly Architects (RVA) and structural engineer schlaich bergermann partner (sbp) developed the design over a nine-month competition phase, and the National Medal of Honor Foundation selected their proposal as the winning design in summer 2020.

During the following three years, sbp's New York office worked in close collaboration with RVA to develop a novel structural system to support the primary feature of the museum, an elevated 200 ft by 200 ft by 35 ft tall steel framed exhibition hall space supported on five exposed precast concrete megacolumns.

The lower portion of the museum is itself nestled along the bank of Mark Holtz Lake and includes an extensive rotunda level that provides a large area of front- and back-of house-programs, all of steel framed construction, buried into the adjacent hillside with a continuous green roof space above. Access to the exhibition hall above is provided by a set of glass-enclosed elevators and a pair of steel spiral staircases that hang from the structure overhead. The exhibition hall contains 2,100 tons of steel, the rotunda level framing uses 600 tons, while the connecting spiral stair is 150 tons.

Due to the clay soil conditions at site, the entirety of the steel system, base slab, and perimeter concrete retaining wall is supported by 286 24-ft diameter auger cast-in-place piles. The piles' positioning had to be coordinated with the non-standard column layout in certain areas of rotunda, while also considering maximum spans for the base floor slab. The layout of the structure at rotunda level is primarily symmetric about an axis perpendicular to the lake, although a large additional back-of-house wing is included on the northeast corner.

A rendering of the completed museum.

above, left: The rotunda level framing uses 600 tons of structural steel.

above, right: Five precast columns support the exhibit hall structural steel framing.

Two larger event spaces, the theater and great hall, each have a 5,280 sq. ft steel moment frame structure and face the lake. These frames are integrated into a more typical post and beam system throughout the rest of the level. Singly curved W30×211 and W27×217 ring the space at the main circular rotunda. These curved beams are supported intermittently on fully exposed round HSS12.75×0.5 column sections, as well as through shear connections to the concrete megacolumns. The torsion induced in these curved beams is counteracted by full moment connections to radially aligned W14×90 roof beams.

Moving upward, the five hollow 50-ft-tall concrete megacolumns consist of seven independent rings, each 6 ft. Once on site, the rings were lifted and positioned, being linked together with vertical reinforcements in grouted NMB sleeves.

The top surface of the upper most ring in each megacolumn has a fully embedded steel plate and inner sleeve allowing for on-site welding and attachment of a steel "knuckle" pipe, which directly supports the bearing for the exhibition hall above. This 3-ft, 10-in.-diameter knuckle consists of a custom bent 4-in. thick steel tube with an 8-in. thick top plate, allowing for two openings (2 ft, 4 in. deep by 2 ft wide) at its top.

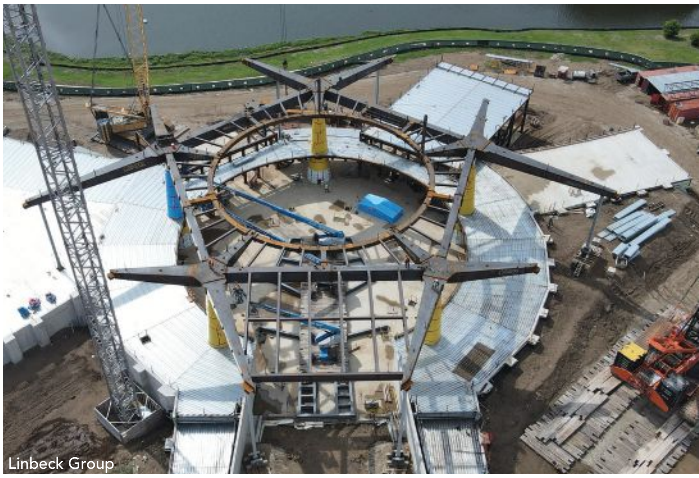
A unique feature in the design of the exhibition hall and megacolumns is that all MEP utilities in the elevated building are fed to the building through the hollow interior of the five columns, which required a large amount of coordination between the architect and MEP consultant during the design development phases to ensure all required items (and spares) could successfully navigate the column and make a hard 90° turn outside the openings in the knuckle.

A tangentially restrained disc bearing is on top of each column knuckle and directly supports the primary exhibition hall steel. The bearings are provided by RJ Watson and were designed for a maximum load of roughly 4,600 kips. The bearings allow for radial thermal expansion of the steel structure, independent of the columns, while also permitting the rotations that will occur during the erection sequence of the steel.

above: The box beam roof girders are laid out like a star.

left: Erecting a tower centerpiece.

below: The star-shaped layout allows the interior circular portion of the exhibit hall to hang from the ceiling.



Open Floor Challenges

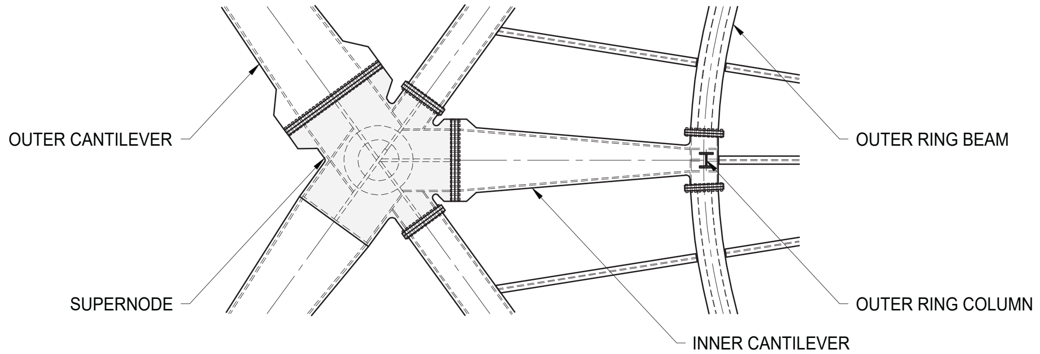
The exhibition hall steel structure contained many technical and geometrical constraints in meeting the exhibit space interior design requirements. As proposed by the architect, the 200-ft by 200-ft hall floor plan was devoid of interior columns—except for those which could be located within an interior circular service ring integrated into the exhibit experience. The center of the floor and roof required a clear 20-ft diameter circular opening running through the height of the building.

The slope and arrangement of the spiral staircases also required adequate clearances to pierce through the floor level framing, creating large arcs where no structure could be provided. A redirection of the primary load path between the structural framing at floor and roof level was required to respond to these constraints.

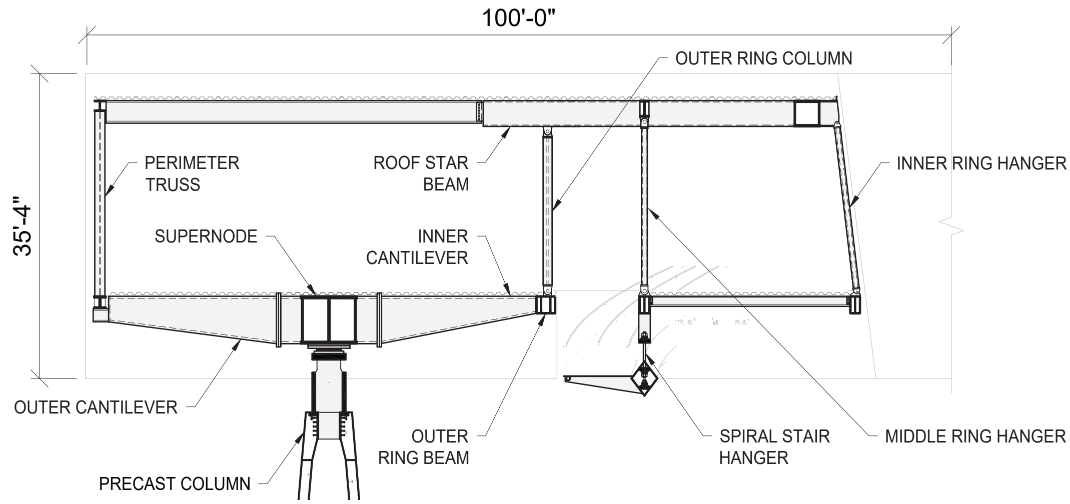
At floor level, the primary structural system consists of an arrangement of five crossing continuous girders, sitting directly atop the megacolumns, resulting in 10 outer cantilevers ranging 39 ft to 69 ft long extending towards the perimeter of the hall. Opposing these, and reaching radially inward from the megacolumns, are five 26½-ft inner cantilevers. The girders intersect above the bearing at each megacolumn, creating a five-pointed "supernode" loading in negative bending from all directions.

The inner cantilevers are connected with a rigid outer ring beam that outlines the extents of the spiral stairs and service ring. The primary cantilevering girders are 5½-ft deep built-up box sections with widths from 5 ft, 4 in. to 6 ft, 8 in. and flange plate thickness from 1¾ in. to 2 in. Because the shorter outer cantilevers are stiffer, they attract more moment and have been fully welded in the shop as part of the supernode, lifted together as one piece.

At the perimeter of the building, four 200-ft long belt trusses with a structural depth of 22 ft, 7 in. formed of standard W14 sections, link the tips of the 10 outer cantilevers and balance differential deflections within the system. These trusses are also used to support the outer ends of the secondary floor framing that span between the primary girders and perimeter. These secondary beams vary in section from W21×62 to W40×211 depending on span.



SUPERNODE CONNECTION PLAN



PRIMARY STRUCTURE CROSS-SECTION

An indirect load path was required to support the roof and the portion of floor inside the megacolumns. Due to the arc-shaped cuts in floor level from the spiral stairs at the service ring, the interior circular portion of the exhibition hall needed to be hung from the ceiling structure above.

The design team's solution for ceiling hanging was an arrangement of box beam roof girders laid out in the shape of a star at the roof level. The pentagonal opening in the middle of the star was required to frame the central oculus of the exhibition hall. The tips of the roof star girder have been supported on vertical columns that are situated in the outer walls of the service ring and land directly on the tip of the floor level inner cantilevers. Most of the roof surface is then supported by up to 70-ft long W-section girders that span between the inner roof star beams and the upper chord of the perimeter truss.

The final complication in the structural load path is supporting the inner portions of the exhibition hall floor within the service ring, another area complicated by the two large arcs of floor members that need to be removed for the spiral stairs. Two circular ring beams have been provided at floor level, each with vertical hollow structural section (HSS) elements that hang the rings from the roof star beam system above.

At the inner ring, the 10 hangers are spaced symmetrically with the star beams. At the middle ring beam, though, 14 hangers are provided to align with seven critical locations of spiral stair connections along with seven other intermediate hangers spaced to fit within a secondary service ring wall. This load path led to the construction sequence having up and down movements of the perimeter truss and inner rings that needed to be carefully coordinated to reach the desired dead load geometry. Vertical cambers of +5 in. at the perimeter truss and +3 in. at the inner nodes of the roof star beams were specified.

Staircase Strategy

The most outstanding exposed structural element in the museum building is the set of two spiral staircases that provide the primary means of egress up and down into the exhibition hall. Each staircase rises 56 ft from the rotunda level, spiraling 310° in plan, for a total length of 230 ft. The stair's primary structure consists of a 4 ft deep by 3 ft wide architecturally exposed structural steel (AESS) diamond-shaped box beam located along the inner edge of the spiral, which, due to its layout, are developed from t = ¾-in. warped steel plates.

These diamonds hang directly from the exhibition hall building above from a series of seven equally spaced stainless steel tension rods. The global geometry means some vertical axes' hanger rods need to support an upper and lower level of the intertwined spirals. To support the 8-ft-wide walking surface, tapered knife plates cantilever outward from the diamond box beam, holding a folded steel plate following the risers and landings.

The curvature of the stair in plan, along with the torsional rigidity of the diamond box, carries the eccentric vertical loading on the stair, while in the horizontal direction, the diaphragm plate allows the stair to act as a deep beam for lateral loading. The treads of the stairs will be created from custom precast concrete elements, which will allow the user to experience this very special path as an entrance to the floating building above.

Ten outer cantilevers range from 39 ft to 69 ft.

Jacob Douenias

Each staircase rises 56 ft from the rotunda level, spiraling 310° in plan.

Jacob Douenias

An aerial rendering of the completed museum.

Rafael Vinoly Architects

Outside of the spiral stairs, access is provided by two hydraulic elevators protected in a singular 56-ft-tall glass enclosure. To support the enclosure, two vertical round HSS18×1 members span from rotunda level to the exhibition hall roof centered within the shaft. At the top of this column, a cantilevering steel frame allows for the connection of four stainless steel cables, one at each corner, which are pretensioned downward to the rotunda slab to a force of 68 kips each. These cables are then used to support the vertical corner joints of the glass enclosure.

All tension forces from the cable system are resolved fully within the vertical round HSS members, such that the system remains independent from the exhibition hall above. The members are restrained horizontally to stabilize the center columns from buckling, but released vertically with slotted holes from the exhibition hall floor and roof steel.

All primary structural components were assembled by March 2024. Work is currently ongoing installing the 110,000 sq. ft surface area of specially fabricated aluminum cladding panels on the exhibition hall's walls, roof, and soffit. With only the green roof, landscape, and finishes remaining, the museum is targeting spring 2025 to welcome its first visitors. ■

Owner
National Medal of Honor Foundation

General Contractor
Linbeck Group

Architect
Rafael Viñoly Architects

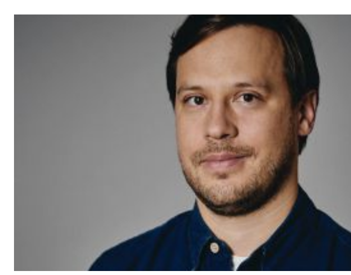
Structural Engineer
schlaich bergermann partner

Steel Team

Fabricator
W&W | AFCO Steel (AISC Certified Fabricator)

Erector
Bosworth Steel Erectors (AISC Associate, AISC Certified Erector)

Bender-Roller
Chicago Metal Rolled Products (AISC Associate)



Robert Hellyer (r.hellyer@sbp.de) is an associate director and **Michael Stein** (m.stein@sbp.de) is the North American managing director and board member at schlaich bergermann partner.

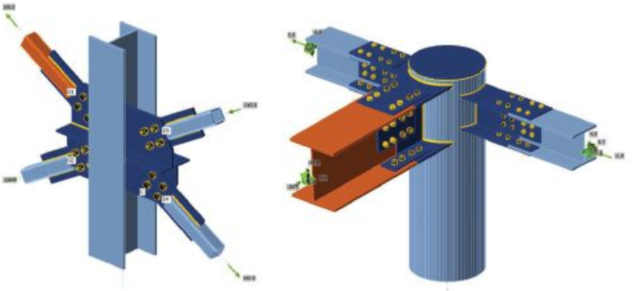
new products

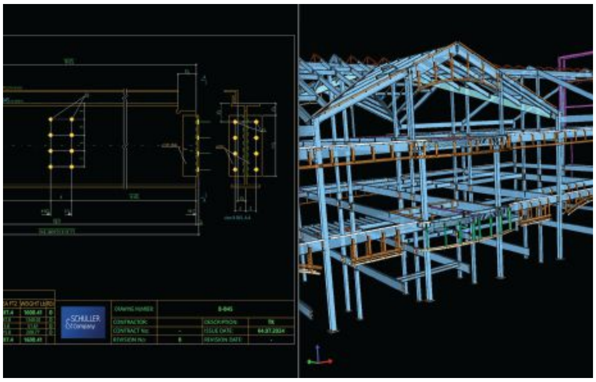
This month's New Products includes the latest versions of three detailing and connection design software options.

IDEA StatiCa Version 24.0

It's no coincidence IDEA StatiCa version 24.0 was introduced on April 24, 2024, marking a decade of engineers making the right connections using the software. Version 24.0 includes many enhancements, including:

- Partial Joint Penetration (PJP) welds: The integration of PJP groove welds within *Specification for Structural Steel Buildings* (ANSI/AISC 360-22) guidelines in IDEA StatiCa Connection addresses the specific requirements for PJP butt welds, distinct from those for fillet welds. Users can specify any weld that is edge-to-surface as a PJP weld in every manufacturing operation.
- Checkbot for delegated design: Checkbot is our integration tool that links many analyses and detailing softwares to IDEA StatiCa and is available for everyone involved in the connection design process, whether you use IDEA StatiCa Connection or not. This new free version allows the engineer of record to upload an analysis model into Checkbot and only share geometry, shapes, and reactions with the connection engineer, who doesn't have to have a license of the analysis program used on the project.
- Detailing sections—turn off/on items: IDEA StatiCa can cut sections of a connection for use in conveying the design to a detailer. In previous versions, those were sometimes cluttered. V24 can toggle off and on certain notes and symbols to clean up these sections and make them more readable. For more information, visit **www.ideastatica.com**.





S&C bocad

S&C bocad enables detailers to achieve exceptional levels of quality and accuracy in the automatic production of fabrication deliverables, eliminating the need for time-consuming manual editing of drawings, reducing the risk of errors, and minimizing on-site rework. It provides a unique link between 3D models and drawings.

The seamless integration of drawings and 3D models allows you to manage multiple design changes quickly and efficiently. In essence, as you develop your 3D model, your drawings evolve in parallel, ensuring that when the 3D model is complete, the associated drawings are also complete. This integration ensures consistent data and a streamlined process throughout all phases of design, resulting in error-free construction results for everyone involved in BIM projects.

S&C bocad's unique workflow can be used for any structure, from miscellaneous steel to commercial and industrial structures, cladding, curtain walls, timber, oil rigs, mining, telecom, and transmission towers. Visit **www.bocad.com** to learn more.

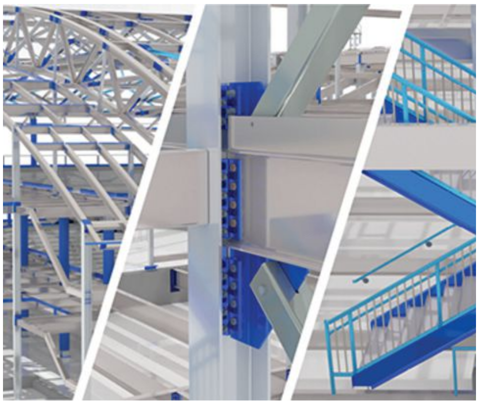
SDS2 2024

Streamline your detailing and fabrication workflows and expand the impact of your data with the latest features and enhancements of SDS2 2024. You'll get connection automation with the latest AISC and CISC design codes for worry-free compliance, along with other user-requested enhancements to improve your detailing experience.

Some of the top enhancements in SDS2 2024 are:

- Keep your projects in line with AISC 16th Edition *Steel Construction Manual* and CISC 12th Edition *Handbook of Steel Construction* standards, now built into SDS2's automated design capabilities.
- Streamline design reviews and approvals with condensed calculation reports.
- Easily manage project data with user-driven improvements to the ABM and custom properties.

To see SDS2 2024 in action, visit **www.go.sds2.com/demo** to schedule a demo.



SUSTAINABILITY

AISC Expands Sustainability Focus

When the design community has a question about steel, they naturally turn to AISC. After all, AISC literally writes the specification for the design of steel buildings. In recognition of the growing importance of sustainability in design decisions, AISC has announced a major expansion of its sustainability efforts—including creating a team of three sustainability experts and working to update steel industry EPDs.

"Surprisingly few people know that wide flange steel sections straight from the mill consist of an average of 93% recycled steel scrap (often from cars, refrigerators, and decommissioned bridges), and all structural steel is 100% recyclable without loss of properties. It's a truly circular supply chain unique among American structural materials," said newly appointed Vice President of Sustainability and Government Relations Brian Raff. "My team will also work to ensure all sustainable benefits structural steel offers remain a viable option for designers and builders across the country.

"AISC's sustainability team will work to ensure the design community has the information they need to design truly sustainable buildings and bridges. But sustainability is only part of the story. AISC is dedicated to keeping America's infrastructure moving forward with robust, long-term funding. We also support American workers and their families through Buy America requirements and protect future generations with responsible environmental policy. Finally, on international trade, we always insist if any trade action is taken, it must include downstream users of mill material like fabricated structural steel."

Raff joins Director of Sustainability and Government Relations Max Puchtel, PE, LEED Green Associate. Jonathan Tavarez, PE, rounds out the team. Tavarez has previously served as the AISC's New York structural steel specialist and a staff engineer working in AISC's Steel Solutions Center.

LEGISLATION

American Steel Industry Urges Congress to Reject Anti-Competitive Mass Timber Federal Buildings Act

In a joint letter to Congress, AISC, American Iron and Steel Institute (AISI), and Steel Manufacturers Association (SMA) voice firm opposition to the proposed Mass Timber Federal Buildings Act (S4149) and urge members of Congress to reject the anti-competitive bill.

The bill, introduced by U.S. Senators Jeff Merkley (D-Ore.) and James Risch (R-Idaho) on April 17, would give favorable treatment to the mass timber industry in awarding federal and military construction projects at the expense of other building material competitors, including steel. The letter from steel industry leaders raised substantive concerns about the potential ramifications on fair competition, taxpayer value, and sustainability practices within the construction sector.

The letter is addressed to U.S. Representatives Rick Crawford (AR-1) and Frank Mrvan (IN-1), chair and vice chair of the Congressional Steel Caucus, respectively, and outlines critical issues with S4149.

- Mandated Contracting Preferences: The proposed mandate for contracting preferences favoring wood products would disrupt the competitive bidding process and undermine taxpayer value by neglecting cost-effectiveness and project suitability considerations.
- Supply Chain Concerns: The potential strain from a surge in demand for wood products, such as increased material costs, has broader implications on the construction industry and project budgets.
- Neglecting True Sustainability: Mass timber's sustainability claims are misleading and overstated. Factors such as energy efficiency, durability, and responsible sourcing should be considered in promoting sustainable building practices.
- Safety Considerations: There is a need for thorough testing and code development to address concerns associated with mass timber construction.

People & Companies

The National Council of Structural Engineers Association (NCSEA) has appointed **Magnusson Klemencic Associates (MKA)** Chairman and CEO **Ron Klemencic** to the NCSEA Foundation's Board of Directors. An industry innovator and one of the preeminent high-rise structural engineers practicing today, Ron is sought by developers, architects, and contractors worldwide for his creativity, big-picture approach, and unique ability to consistently produce cost-effective and inventive designs.

The NCSEA Foundation Board of Directors is composed of structural engineering industry leaders who have been nominated and elected to serve. Board of Directors members support the philanthropic efforts of NCSEA, including scholarships, SEA grants, outreach, and education. Each Board of Directors term begins April 1 and ends March 31 of the following year.

Zekelman Industries, the largest independent steel pipe and tube manufacturer in North America, will invest up to $120 million to expand the manufacturing capabilities and product offerings of its subsidiary, Atlas Tube, in Mississippi County, Arkansas. The project will bring Zekelman's total number of employees in the area to more than 300. During the unveiling, the manufacturer also announced it will partner with Arkansas Northeastern College on a new workforce training initiative.

"Education and skills training are crucial to developing the next generation of workers. Our goal at Zekelman is to prepare, nurture and inspire students entering the thriving and well-paying steel industry," said Tom Muth, chief operating officer. "Our commitment is representative of our partnership with the Blytheville community and ongoing dedication to domestic-only manufacturing."

ENGINEERING JOURNAL

Third Quarter 2024 *Engineering Journal* Now Available

The third-quarter issue of AISC's *Engineering Journal* is now available at **aisc.org/ej**. It includes papers on torsional design of round hollow structural section (HSS) members, lateral-torsional buckling modification factors, and tensile coupon testing and residual stress measurements of high-strength steel built-up I-shaped sections. Here are highlights of a few papers.

Torsional Design of Round HSS Members—A Critical Review
Bo Dowswell

Shear yielding is the controlling limit state for most round HSS members subjected to torsion. Buckling is a limit state that can reduce the torsional strength of members with high diameter-to-wall thickness ratios. This paper summarizes the available research on the torsional performance of round HSS members and evaluates the applicable provisions in the AISC *Specification for Structural Steel Buildings* (AISC 360-22). A historical review of the available research revealed 125 experimental tests from seven projects, leading to evolving design methods over the last century. An evaluation of the *Specification* provisions indicated an appropriate reliability level for the yielding limit state; however, the target reliability for buckling is met only for long specimens. A new equation is proposed to predict the buckling strength of intermediate-length members.

Lateral-Torsional Buckling Modification Factors in Steel I-Shaped Members: Recommendations Using Energy-Based Formulations
Namita Nayak, P.M. Anilkumar, and Lakshmi Subramanian

Lateral torsional buckling (LTB) is of concern in long-span flexural members, particularly in the negative flexure regions of continuous-span steel I-shaped members and during construction. While the elastic critical LTB capacity of a simply supported I-shaped member subjected to uniform moment has a closed-form solution, most LTB modification factors for beams subjected to moment gradients in the literature are empirical and work well only for specific loading and boundary conditions.

This paper investigates the suitability of the different LTB modification factors in literature and design specifications for various loading and boundary conditions, accomplished via comparisons with analytical solutions using the Rayleigh-Ritz method and numerical solutions from finite element analyses. The analytical LTB modification factors are derived for doubly symmetric I-shaped members with different combinations of ideal flexural and torsional boundary conditions (simply supported and fixed) and subjected to different loading scenarios. The validity of the LTB modification factors determined using the Rayleigh-Ritz method, and other formulae in the literature are also assessed for realistic intermediate restraint conditions, which are neither fully pinned nor fixed, by examining laterally continuous beams.

Tensile Coupon Testing and Residual Stress Measurements of High-Strength Steel Built-Up I-Shaped Sections
Kara Stall, Andrea Culhane, Likun Sun, Rachel Chicchi Cross, and Matthew Steiner

High-strength structural steel with yield stresses greater than 65 ksi may have notably different material characteristics when compared to conventional building construction material, such as ASTM A992/A992M or A572/A572M Grade 50. This paper presents findings from an experimental program that investigated the material characterization of ASTM A656/A656M Grade 80 plate steel.

The results obtained were compared to conventional ASTM A572/A572M Grade 50 steel. Two types of testing were performed for this work: tensile coupon testing and residual stress testing. The tensile coupon testing was carried out for the A656/A656M Grade 80 and A572/A572M Grade 50 plate material. The A656/A656M Grade 80 plate material showed more variation between the two different plate thicknesses in mechanical behavior and microstructure due to differences in steel production. The ⅜-in.-thick plate exhibited a clear yield plateau with an ultimate/yield stress ratio similar to the Grade 50 material.

In contrast, the ½-in. plate did not have a yield plateau and reached lower ultimate strain. The residual stress testing was performed using a sectioning technique for one A572/A572M Grade 50 and five A656/A656M Grade 80 built-up sections fabricated from ½-in. and ⅜-in. plate material. Residual stresses obtained from measurements were compared to previously published predictive models.

When comparing the Grade 50 and Grade 80 specimens of the same cross-sectional geometry, the residual stresses were similar, implying that cross-sectional geometry is more prevalent than the nominal yield stress in determining residual stresses in built-up I-sections.

ENGINEERING JOURNAL

Explore *Engineering Journal* in a New Way

AISC's *Engineering Journal* website got a makeover. Over the past year, AISC developed a new home for *EJ* that streamlines access to its online collection of journal content. The new site includes improved searching and browsing. And best of all, content is free—no more paywall!

Visit **aisc.org/ej** to browse the new site.

FABRICATOR TRAINING

AISC Launches Fabricator Education Training Program

The first track of AISC's Fabricator Training Program is live.

The program gives AISC members another way to help new employees learn the basic concepts they need to work in a fabrication shop. It's designed to supplement in-person training and help new hires quickly acquire simple but necessary skills.

AISC members can access the program at no additional cost. The first track covers fabricator basics, with 14 online courses totaling five hours of training time. Those courses range from 10 to 45 minutes each. Members can access the program via AISC's learning management system (LMS), which allows them to manage student rosters and track training results.

The Fabricator Basics courses focus on the training during an employee's first 90 days at a shop and demonstrate how to do essential tasks.

The 14 courses are:

- Introduction to steel fabrication
- Career success: your first 90 days
- Read and use a tape measure 1: fractions
- Read and use a tape measure 2: measuring
- Grinding basics
- Bolts and bolting basics
- Handtool fundamentals: clamps
- Handtool fundamentals: squares
- Identifying detail pieces
- Crane and rigging basics
- Torch cutting basics
- Welding basics
- Career success: beyond 90 days

The AISC Board of Directors developed the vision for the training in response to the industry's workforce development needs. Many of the nearly 1,000 AISC member fabricators have expressed frustrations with recruiting, retention, and training. With the support of a world-class training curriculum, they are better positioned to promote themselves and their career opportunities and keep valuable employees in their shops.

The program is aimed at new employees, especially those new to steel fabrication. The training follows the journeys of several employees as they learn about fabrication from trusted mentors. Beyond teaching the skills, it exposes the employees to the vast knowledge of industry veterans.

The program can help new hires arrive at in-person learning sessions with more familiarity with their job. Additionally, it can prepare the training staff for some questions trainees might ask. If a new hire feels productive and supported early in the job, the more likely he or she is to develop pride and loyalty to the company.

The second phase of the program is in development and will cover layout and fitter training. Those courses will teach drawing reading, construction math, layout, and fit-up strategies, among other topics.

Contact AISC at **fabtraining@aisc.org** or go to **aisc.org/fabricatortraining** for more information and to sign up.

PEOPLE IN THE NEWS

Engineering Icon and 2022 Kimbrough Award Winner Dave Ruby Retires

Dave Ruby, one of the world's leading experts on constructability and the founder of Ruby+Associates, a Degenkolb Company, has officially retired from the firm, ending a structural engineering career that spanned more than 60 years.

Ruby is the company's former chair and a founding principal. He started his namesake company in 1984 to fill a gap and provide structural engineering services to the construction industry. He became an internationally known expert in steel construction and constructability in his decades leading Ruby+Associates, receiving numerous awards from industry groups. He earned the J. Lloyd Kimbrough Award in 2022, AISC's highest honor for designers. He became just the 12th person since 1941 to receive it. He also received an AISC Lifetime Achievement Award in 2011.

"Dave built American icons throughout his career and has contributed the knowledge he gained in doing that freely and relentlessly," said AISC President Charles J. Carter, SE, PE, PhD. "Our profession, our industry, and our country are all better because of him."

Elsewhere, Ruby won the ACEC/Michigan Felix A. Anderson Award in 2019 and was named the Structural Engineers Association of Michigan (SEAMi) Outstanding Structural Engineer of the Year in 2010. He has served as the chair of the Council of American Structural Engineers, a past director of the National Council of Structural Engineers Association, and was past president and founder of the SEAMi. He was a member of AISC's Code of Standard Practice Committee, Committee on Research, and was past co-chair of the Blast & Impact Resistant Design Task Group.

Ruby's lengthy resume of published work includes AISC Design Guide 23: *Constructability of Structural Steel Buildings*. He also wrote a six-part *Modern Steel Construction* series titled "But it Worked in the Model!"

Before founding Ruby+Associates, Ruby worked for the American Bridge Division of U.S. Steel, where he was a structural project engineer for the John Hancock building, Sears Tower, and Standard Oil building in Chicago. He was also the chief structural engineer for John Portman and Associates. He worked on several notable steel stadium projects while leading Ruby+Associates, including Comerica Park and Ford Field in Detroit, State Farm Stadium in Glendale, Ariz., Guaranteed Rate Field in Chicago, and loanDepot Park in Miami.

advertiser index

Building to Win

STEEL BRIDGES FIT FOR COMPETITION were designed and built across North American college campuses this spring.

The 2024 Student Steel Bridge Competition (SSBC) held 20 regional competitions from early March to late April, with more than 200 university steel bridge teams vying for a trip to the national finals in Ruston, La., hosted by Louisiana Tech University. The University of Wyoming, whose steel bridge team is pictured above, was among the regional participants and hosted one of the SSBC regionals.

In both regionals and finals, bridge teams must assemble their previously designed bridge in a timed environment. The bridges must span 20 ft and support 2,500 lb during a weight test. They're also judged on aesthetics.

The regional competitions produced 49 national finals qualifiers, 47 of which competed in Ruston. Among them was the University of Florida team, which won the last three national finals, including last year's competition at the University of California San Diego. To read all about 2024 national finals and see pictures of finalists' bridges, check out the August issue. And to learn more about the competition and its rules, visit **aisc.org/ssbc**. ■


www.HotDipGalvanizing.com
1 (800) 801-3648
Zinc Protects Steel®
V&S GALVANIZING
BRIDGING THE GAP FOR STEEL EXCELLENCE
With over 100 years of hot-dip galvanizing experience, our team of experts dedicate themselves to providing quality work and reliable service. Our investment in our people, our equipment and our experience ensures total customer satisfaction as we drive towards protecting America's infrastructure one dip at a time.
113
TONS
OF GALVANIZED STEEL
NATIONAL STEEL BRIDGE ALLIANCE
NSBA
FOUNDED 1995
2024
PRIZE BRIDGE
AWARDS
MERIT AWARD WINNER - SHORT SPAN
Indiana SR 32 Bridge Over Stony Creek
OUR LOCATIONS:
Johnstown, PA | Columbus, OH | Memphis, TN | Owego, NY | Taunton, MA
Detroit, MI | Perth Amboy, NJ | New Castle, DE | Lebanon, PA


CALLING ALL
INNOVATORS!
If you recently worked on an amazing project that featured structural steel, we want to hear from you. Submit it for a 2025 IDEAS² award! Entries are due September 30, 2024.
aisc.org/ideas2
2024 IDEAS² Excellence in Engineering
Nashville International Airport Terminal Lobby and International Arrivals Facility Addition
Nashville, Tenn. | Photo: Jordan Powers
1-7
Pick-Up Zone
8-15
NO UNATTENDED VEHICLES
LOW OVERHEAD CLEARANCE
AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISC
FOUNDED 1921
2025
IDEAS²
AWARDS
Innovative Design in Engineering and Architecture with Structural Steel