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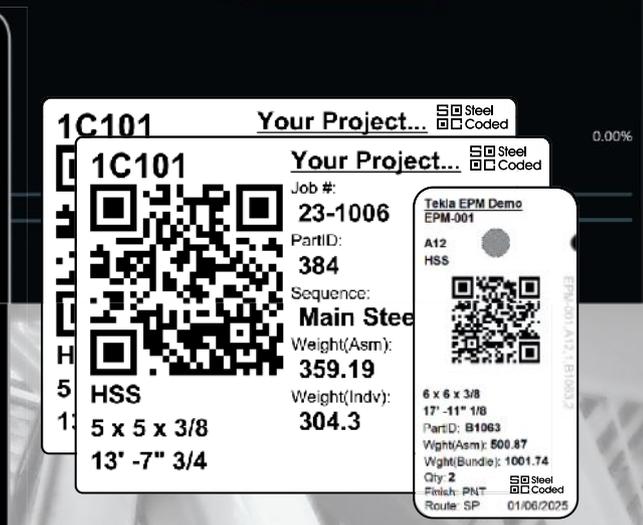
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December 2025



in every issue

departments

- 6 EDITOR'S NOTE
- 8 STEEL INTERCHANGE
- 10 STEEL QUIZ
- 60 NEW PRODUCTS
- 61 NEWS & EVENTS
- 66 STRUCTURALLY SOUND

resources

- 64 ADVERTISER INDEX
- 65 MARKETPLACE & EMPLOYMENT

features

24 **What's Cool in Steel**

Modern Steel's annual roundup of recent captivating steel projects—often smaller-scale—spans the Northwest to the Southeast and covers bridges, renovations, sculptures, structures, and even façades.

48 **Braced for the Future**

BY JULIETTE PEYROUX, SE, PE AND
KEVIN KUNTZ, SE, PE

Structural steel saved time and tonnage, created openness, and managed seismic requirements for San Diego's new airport terminal.

54 **Return of the (Big) Mac**

BY PATRICK ENGEL

A collaborative and crisp emergency repair process helped a major interstate bridge reopen just 100 days after it suffered significant fire damage.

columns

steelwise

14 **Outside the Manual**

BY BRAD FLETCHER, SE

Finding the best design for atypical HSS connections often means going beyond the *AISC Steel Construction Manual*. Start with these resources.

field notes

20 **Living the Dream**

INTERVIEW BY GEOFF WEISENBERGER

As a student, Amit Varma had visions of doing impactful steel design research. A quarter-century later, he has made significant contributions in three important areas.

business issues

22 **Strong as Steel**

BY PATRICK SCHUECK

Addressing mental health in construction starts with being vulnerable, and one company recently implemented a program that aims to encourage it.

ON THE COVER: A steel jellyfish sculpture inspired by a local species (p. 24) greets arriving passengers at San Diego International Airport's new steel-framed Terminal 1 (p. 48). (Image: Pablo Mason Photography)

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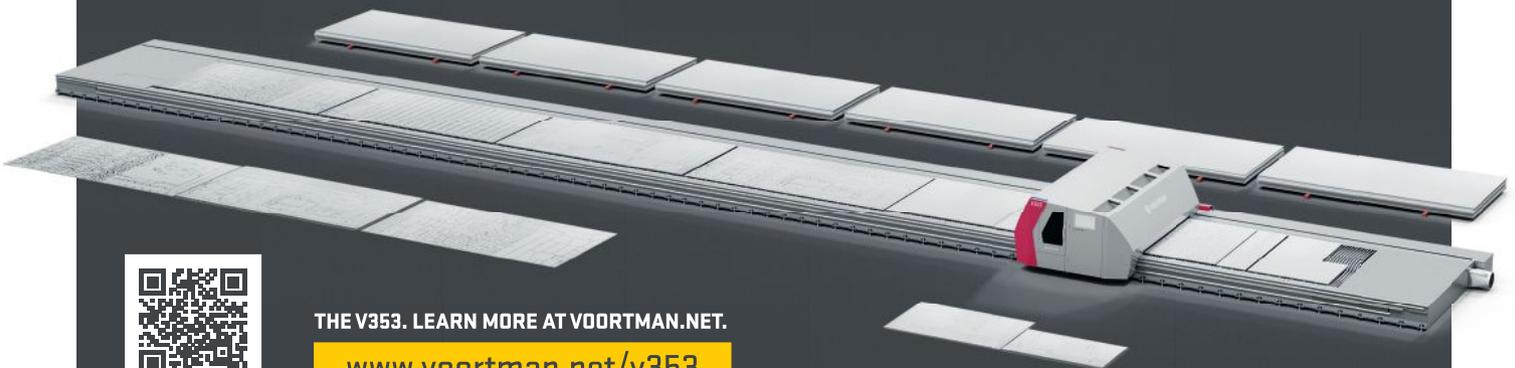
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We, along with two other families—one from Chicagoland and one from Denver—made our way to central Missouri to spend a week along the famed serpentine section of the dammed-up Osage River. The area exceeded everyone’s expectations, and we all agreed that we’d be happy to go back. Every other person I talked to asked if it was like the TV show *Ozark*—it wasn’t—and if we rented a boat; we did. I’ve never spent so much time on a boat, and now I see why people buy them, though I’m always reminded of the old saying that the best two days of your life are the day you buy a boat and the day you sell it. Renting one for a week was a happy, expensive medium.

Part of any road trip is, well, the road itself, and all the cool and sometimes weird things you can see while driving across the country. On our way back home at the end of the week, we stopped in Hannibal, Mo., the birthplace of Samuel Clemens, aka Mark Twain. Is there a statue of the famed author there? Of course. Did we do anything in Hannibal besides stop to take a photo of the statue? Of course not. Lingered too long in one spot between Point A and Point B adds to the drive time. On some trips, the pace is leisurely, and on others, everyone just wants to get home.

That said, there’s plenty of time to stop and smell the (steel) roses and take a gander at some cool things across the country in this issue of *Modern Steel Construction* in the form of What’s Cool in Steel, our annual roundup of captivating, often smaller-scale steel projects. This year’s list takes to the skies with several airport projects.

One of them, a steel jellyfish sculpture, greets visitors outside the new Terminal 1 at San Diego International Airport. Inspired by the purple striped jellyfish (*Chrysaora colorata*) found off the city’s coast, the 21-ft-tall sculpture hovers over the terminal’s curbside

As the weather here in Chicago abruptly turned to fall this past weekend (as of this writing), I was reminded of our summer trip to Lake of the Ozarks.

plaza, doubling as a performance space and shade structure.

Another cool airport project that one could argue facilitates a brief “road trip” for aircraft is on the other side of the country at Charlotte Douglas International Airport. A new 4,000-ft-long taxiway includes a bridge over a realigned roadway engineered to accommodate modern aircraft weighing up to 750 tons while providing more than 17 ft of vertical clearance over the road below.

And between both coasts, Chicago O’Hare’s International Terminal underwent a recent expansion and alteration project that increased the terminal’s capacity by 25% by adding 10 new gates and other passenger amenities—all supported by sloping steel columns and a wide-flange roof framing system that spans up to 87 ft.

You can read about these cool steel applications starting on page 24. And while not technically part of the Cool List, this month’s issue also features a cool professor, Purdue University’s Amit Varma, who was honored at this year’s NASCC: The Steel Conference in Louisville, Ky., for his research and contributions in steel and concrete composite construction (which led to the SpeedCore system), fire design, and nuclear structures, in addition to his service on several AISC committees. Check out his story in Field Notes on page 20.

Speaking of The Steel Conference, next year’s edition will take place in Atlanta, April 22–24, and registration opens January 26—something to look forward to in 2026 as 2025 winds down!

Modern Steel Construction

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Understanding Fatigue

Does the threshold allowable stress, F_{tb} , include constant steady stress from dead load? For example, if the maximum stress due to dead load is 20 ksi and 2 ksi due to live load, and the number of cycles of live load exceeds 20,000 with F_{tb} equal to 16 ksi, does fatigue need to be considered?

No. The AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-22) Glossary defines stress range as "The magnitude of the change in stress due to the application, reversal, or removal of the applied cyclic load." The Commentary to *Specification* Appendix 3, Section 3.2, states, "Fluctuation in stress that does not involve tensile stress does not cause crack propagation and is not considered to be a fatigue situation. On the other hand, in elements of members subject solely to calculated compressive stress, fatigue cracks may initiate in regions of high tensile residual stress. In such situations, the cracks generally do not propagate beyond the region of the residual tensile stress, because the residual stress is relieved by the crack. For this reason, stress ranges that are completely in compression need not be investigated for fatigue. For cases involving cyclic reversal of stress, the calculated stress range must be taken as the sum of the compressive stress and the tensile stress caused by different directions or patterns of the applied live load."

If the total stress fluctuates between 20 ksi and 22 ksi, the stress range is 2 ksi, which is well below the 16 ksi threshold stress indicated, so no further evaluation of fatigue resistance is required.

Larry Muir, PE

Seismic Design Manual Tables 1-3a and 1-3b

I am designing a building with special concentrically braced frames. While reviewing Table 1-3a and 1-3b in the 4th edition AISC *Seismic Design Manual*, I noticed a tab for $L_b \max$. Could you please clarify whether $L_b \max$ applies only to beams or to columns as well?

$L_b \max$ does not apply to the columns. The $L_b \max$ value as given in these tables only applies to beams.

The discussion of Table 1-3a and 1-3b on page 1-33 of the *Seismic Manual* states, "Also provided is the maximum spacing of beam bracing for moderately ductile and highly ductile beams, $L_b \max$,

where for moderately ductile beams, $L_b \max = 0.17r_y E / (R_y F_y)$ and for highly ductile beams, $L_b \max = 0.086r_y E / R_y F_y$."

The following discussion walks through how to use Table 1-3a and 1-3b for the three members shown in the special concentrically braced frame (SCBF; see Figure 1).

Section F2.5a in the *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341-22) requires beams, columns and braces in the SCBF to satisfy the requirements for highly ductile members in Section D1.1.

Table 1-3b indicates that a W12x120 column and the W21x147 beam are both highly ductile members, and the maximum axial load is not limited by the width-to-thickness requirements. These members meet the requirements in Section F2.5a.

Table 1-3b indicates that a W24x84 beam is highly ductile up to a $P_r \max = 413$ kips. Since the axial load in the beam, shown as 345 kips in Figure 1, is less than 413 kips, the requirement in Section F2.5a is met.

Section F2.4 states that beams that are intersected by braces away from beam-to-column connections shall be braced to satisfy the requirements for moderately ductile members in Section D1.2a. Based on where the braces are intersecting the beams, this requirement applies to the W21x147 beam, but not the W24x84

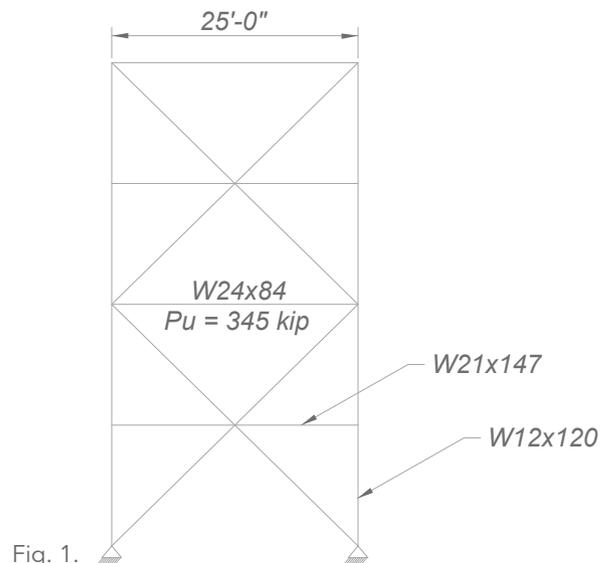


Fig. 1.

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.

beam. Checking the W21x147 beam, Table 1-3a indicates that the $L_{b\ max}$ for a W21x147 is equal to 22 ft. Since the beam length is 25 ft, a brace added at the midspan of the W21x147 would satisfy the requirement in Section F2.4.

Table 1-3 is not intended to convey information about any specific system. It is instead intended to help determine the parameters that are required to satisfy the limits in Sections D1.1 and D1.2 of the *Seismic Provisions*.

The $L_{b\ max}$ values shown in Table 1-3a and 1-3b are intended to be used to help check cases where the *Seismic Provisions* require that a beam be braced to satisfy the requirements in Section D1.2 for either moderately or highly ductile members.

Carlo Lini, SE, PE

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

Table 1-3a							
Sections that Satisfy Seismic Width-to-Thickness Requirements W-Shapes							
Moderately Ductile							
Shape	$L_{b\ max}$, ft	Moment Frames		Diagonal Braces	Braced Frames and Shear Walls		Web Access Holes
		Beams			Beams and Links		
		$P_{r\ max}$, kips			$P_{r\ max}$, kips		
		ASD	LRFD		ASD	LRFD	
W21x147	22	780	1170	•	NL	NL	E

Table 1-3b								
Sections that Satisfy Seismic Width-to-Thickness Requirements W-Shapes								
Highly Ductile								
Shape	Diagonal Braces	Braced Frames and Shear Walls						
		$F_y = 50\ ksi$			$F_y = 65\ ksi$		$F_y = 70\ ksi$	
		Beams, Columns, and Links			Columns		Columns	
		$L_{b\ max}$, ft	$P_{r\ max}$, kips		$P_{r\ max}$, kips		$P_{r\ max}$, kips	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	
W24x84	–	7.37	275	413	79.0	118	–	–
W21x147	•	11.1	NL	NL	NL	NL	NL	NL
W12x120	•	11.8	NL	NL	NL	NL	NL	NL

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steel quiz

This month's quiz tests your knowledge on the recommendations found in the *Guidelines for the Design of Steel Railroad Bridges for Constructability and Fabrication*, a collaboration document from NSBA and AREMA (American Railway Engineering and Maintenance-of-Way Association). Download your copy at aisc.org/rrbridges.

- 1 High-speed rail (HSR) encompasses railways whose maximum operating speeds are within 90 to ____ mph.
 - a. 100
 - b. 250
 - c. 150
 - d. 115
- 2 Freight railroads are categorized as Class I, II, or III, based on which of the following:
 - a. Length of track in miles
 - b. Total tonnage of freight transported annually
 - c. Annual revenue
 - d. Number of trains on the tracks annually
- 3 **True or False:** The recommended thickness for gusset plates connecting the chords and web members of a truss and connecting plates and stiffeners is ½ in.
- 4 What project contract delivery method is currently the most common in the railroad industry?
 - a. Design-build
 - b. Price plus time
 - c. Design-bid-build
 - d. Construction manager/general contractor
- 5 **True or False:** The recommended practical span length for through plate girder bridges is 0 to 70 ft.
- 6 What type of truss is characterized by parallel top and bottom chords, and all diagonals sloping upward towards the center of the truss?
 - a. Pratt truss
 - b. Warren truss
 - c. Parker truss
 - d. Howe truss
- 7 What is the recommended minimum connection angle size to ensure proper edge distance in bolted stringer-to-floor beam connections?
 - a. L3x2
 - b. L4x4
 - c. L3x3
 - d. L6x4

TURN TO PAGE 12 FOR 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.

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steel quiz : ANSWERS

Answers reference the NSBA and AREMA collaboration document: Guidelines for the *Design of Steel Railroad Bridges for Constructability and Fabrication*.

- 1 **c.** 150. High-speed rail (HSR) is a specific form of intercity railway passenger service. HSR covers railways whose maximum operating speeds are within 90 to 150 mph. Section 1.2 discusses the different types of railroads.
- 2 **c.** Annual revenue. Freight rail consists of two major categories of railroad, Class I and short lines, which includes Class II and Class III. The designation of Class I, II, and III railroad is based on annual revenues. The revenue levels are set by the Surface Transportation Board, with Class I as the highest level. See Section 1.2 for more information.
- 3 **True.** Gusset plates connecting the chords and web members of a truss and connecting plates and stiffeners have a recommended minimum thickness of ½ in. For connection plates and stiffeners, a ½-in. minimum thickness is recommended to facilitate the fabricator's use of submerged arc welding equipment that provides opposing arcs on either side of the stiffener. Keeping to a minimum ½-in. thickness helps keep the fillet welds on either side of the plate from bridging (i.e., penetrating enough that the molten weld puddles connect beneath the plate). Section 2.7 contains more information on the minimum thickness for stiffeners, webs, and flanges.
- 4 **c.** Design-bid-build. Design-bid-build (DBB) is the most common and familiar method of project contract delivery currently used in the railroad industry. In this method, the owner issues a contract to a designer for design services (unless the design is done in-house, which is less

common). Once the design package is complete, the owner advertises the package for contractors to bid. The owner selects a qualified bidder and issues a separate contract for construction. See Section 9.1.1 for more information on different construction contracting methods.

- 5 **False.** The recommended practical span length for through plate girder superstructure type bridges is 70 to 200 ft. Through-girder and through-truss spans are characterized by a floor system located above the bottom flange of through-girders or the bottom chord of through-trusses. Trains then travel between (or through) the main exterior members. Through spans are used where vertical clearance under the bridge is limited. Section 2.2 lists practical span lengths for different superstructure types and are based on AREMA Chapter 15 Article 1.2.3.
- 6 **d.** Howe truss. A Howe truss is characterized by parallel top and bottom truss chords, with all diagonals sloping upward towards the center of the truss. When a balanced live load is placed on the bridge, the diagonals are subjected to compression forces; under partial live load, positive and negative panel shears occur, so diagonal members may be in tension or compression. See Section C5.1.3 for a description of the different truss types, including Pratt, Howe, Warren, Parker, and Camelback trusses.
- 7 **b.** L4×4. The minimum connection angle size recommended in AREMA Chapter 15 is L4×4, to ensure the proper edge distance for bolted connections is maintained. Larger angle sizes will be needed for stringers and floor beams spanning longer than 10 ft. See Section 6.2.3 for more information on connections.



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Outside the Manual

BY BRAD FLETCHER, SE

Finding the best design for atypical HSS connections often means going beyond the AISC *Steel Construction Manual*. Start with these resources.

HOLLOW STRUCTURAL SECTION (HSS) connection design has evolved significantly in recent years, with a wealth of resources now available to engineers.

While the AISC 16th Edition *Steel Construction Manual* provides foundational guidance, many atypical HSS connection scenarios require consulting additional sources and applying sound engineering judgment. Here, we'll help guide structural engineers through existing *Manual* resources for HSS connections and illuminate pathways for designing connections the *Manual* does not expressly cover, focusing on adapting current resources to address atypical connection challenges.

What's in the Manual?

Before looking outside the *Manual*, it's important to understand the *Manual's* contents. It contains several areas with information related to HSS design and connection design:

Part 7: Design Considerations for Bolts. Engineers don't immediately think of bolted connections when using HSS, however, there are special considerations for HSS detailed on pages 7-12 to 7-15, including guidance on through-bolts, single-sided bolts, flow drilling, threaded studs, power nails, and screws. This section helps to understand unique challenges for bolted connections in HSS.

Part 8: Design Considerations for Welds. Welding considerations for HSS are covered on pages 8-27 to 8-30. This section provides a summary of AWS D1.1, Clause 10, which specifically addresses tubular welded connections, making it a valuable reference because many engineers may not possess a copy of AWS D1.1. Part 8 also discusses weld sizing for uneven load distribution, common in truss connections, and detailing considerations for common welded joint details.

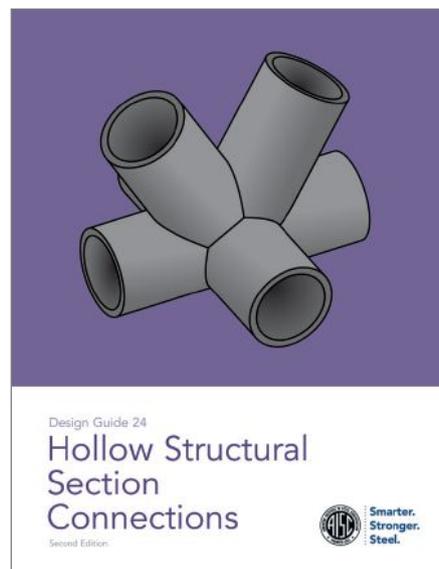
Part 9: Design of Connecting Elements. This part includes guidance on plate elements subjected to out-of-plane loads (pages 9-16 to 9-19). Although not explicitly titled for HSS, this section introduces yield line theory and how to use it to determine the capacity of a plate with out-of-plane loads. It is a crucial concept for understanding the HSS faces' behavior under concentrated loads. Yield line theory is applicable to the face of an HSS and to the web of a wide-flange member. The effective width calculation (B_e) is also introduced here, the same B_e used in the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-22), Chapter K.

Part 11: Design of Moment Connections. This section covers fully restrained (FR) connections with HSS (pages 11-20 to 11-24) and discusses how to design and detail the connection to be fully restrained. The guidance primarily focuses on wide-flange beams connecting to HSS columns, the most common scenario. For HSS-to-HSS moment connections, engineers are often referred to external resources like AISC Design Guide 24: *Hollow Structural Section Connections*, second edition (download or order at aisc.org/dg).

Part 12: Design of Simple Connections for Combined Forces. Pages 12-8 to 12-9 discuss connections to HSS members subjected to combined forces. Similar to simple shear connections, this part covers single plates, through plates, stiffened seated connections, end plates, and T- and double-angle connections, but specifically under combined axial and shear forces.

Part 13: Design of Bracing Connections and Truss Connections. This brief section (page 13-28) covers the HSS connections addressed in *Specification* Chapter K. It refers engineers to Design Guide 24 and CIDECT design guides for detailed HSS-to-HSS truss connection design. Design Guide 24 expanded its content in its second edition and is a comprehensive resource. CIDECT (an international organization that supports research and education for tubular structures) design guides, though Eurocode-centric, are aligned with the same first principles as North American code philosophies.

Specification and Commentary. The *Specification* and the *Commentary* are the basic code requirements for all design. The critical information for HSS design and connections can be found in Chapter H, Section H3 (design for torsion, with limited guidance on connection design specifics), Chapter J (general design of connections,



Part 10: Design of Simple Shear Connections. Pages 10-95 to 10-99 offer design considerations for simple shear connections to HSS, including double angle connections, single plate connections, stiffened and unstiffened seated connections, through plates, and single angle connections.

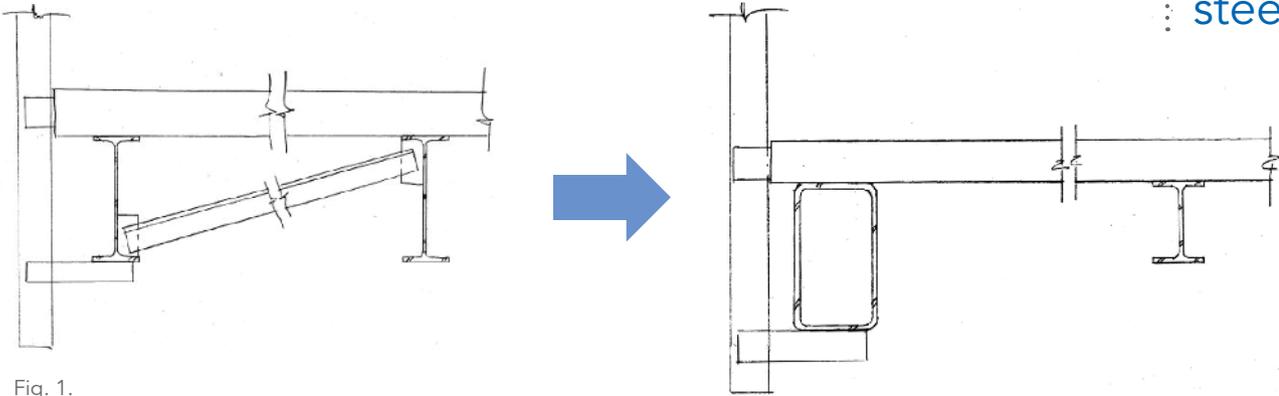


Fig. 1.

including welding and bolting requirements), and Chapter K (additional requirements for HSS and box-section connections, which details welding requirements and specific provisions for T, K, Y, X connections, including their limits of applicability).

Atypical HSS Connections

Now we can explore where to look for connections not explicitly covered in the *Manual*. It is important for engineers to adapt the existing *Manual* resources and apply their knowledge and judgment. These less common situations require looking outside the *Manual* for guidance:

Composite Floor Framing with HSS.

While not related to connections, this is a unique situation not directly addressed in the *Manual* for HSS. There are situations where the best solution is using HSS beams that develop composite action with a metal deck slab. This could be in a food processing plant or a clean room in an industrial facility, where the smooth surface of HSS helps keep the structure clean. While the guidance for composite floor framing in *Specification* Chapter I does not directly reference HSS beams, it can be adopted, with minor modifications:

- Use plastic stress distribution if webs are compact (Table B4.1b, Case 19) and the compression flange is compact (Table B4.1, Case 17). Otherwise, elastic stress distribution (Section I3.2a(b)) should be used.
- Satisfy the minimum HSS wall thickness as per the guidance in Section I8.1.
- Consider stud placement closer to the HSS edges rather than in the middle to engage stiffer sidewalls. Although formal research on this is limited, it is a rational recommendation from AISC's Steel Solutions Center.

Torsion. HSS members are exceptionally well-suited for resisting torsion, with a torsional constant approximately 200 times

that of an open section. Torsion arises when a load acts outside a member's shear center.

- Spandrel condition and curved beams: A common scenario where HSS can be advantageous for torsion resistance is spandrel beams, which often experience torsional loads from cladding or precast plank framing. These eccentric loads can be efficiently resisted by HSS without needing additional kickers, potentially offering a more cost-effective solution due to reduced ancillary pieces and coordination issues (Figure 1 and 2). Curved beams also inherently experience torsion due to their curvature.



Fig. 2.

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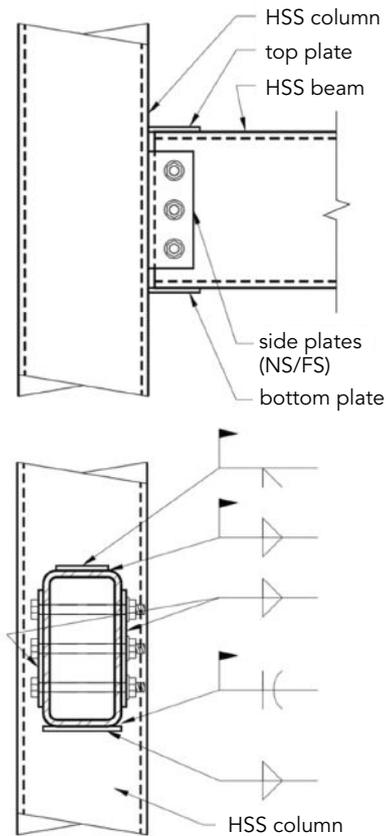


Fig. 3a.



Fig. 3b.

- Torsional connections: The challenge always comes down to the connection type needed when dealing with a member under torsional load. Pure torsional connections are less common; typically, torsion is resisted through moment connections. Any connection designed as a fully restrained connection can handle torsional loads, as well as axial, shear and flexural loads. End-plate connections that use through bolts or single-sided bolts are one connection type to consider if torsion is the primary load. A design example is in the Steel Tube Institute *HSS Design Manual, Volume 3*. Other examples of effective details are shown in Figure 3.

Laterally Offset Connections. These are T- or cross-connections where the branch member is offset from the chord's centerline. These are done often for aesthetic reasons or to support cladding.

For the design of this connection, refer to *Manual Part 9 (Plate Elements Subjected to Out-of-Plane Loads)* and use yield line mechanisms to consider plastification of the connecting face.

If this were a concentric connection, it would be fairly straightforward because it would be treated as a T- or cross-connection where plastification of the HSS wall would be considered in accordance with *Specification Chapter K*. Laterally offset connections, where one wall of the branch member aligns with one wall of the chord or supporting member, need to consider chord wall plastification and sidewall buckling. To consider both limit states, finite element analysis (FEA) might be necessary.

A conservative approach would involve ignoring the connecting face plastification contribution and checking the sidewall using *Specification Equation J10-2*. Because the sidewall has more stiffness, more load would go into the sidewall and therefore would be the controlling limit state.

Limitations for this approach are based on what has been researched, including a specific range of sizes studied, thin branch members potentially having additional failure modes (like local buckling), and assumed lateral restraint. Additional information can be found in *Laterally Offset HSS Connections (aisc.org/stioffset)*, *Laterally Offset RHS X-Connections (aisc.org/asceoffset)*, and *Rectangular Hollow Section Webs Under Transverse Compression (aisc.org/hsstraverse)*.

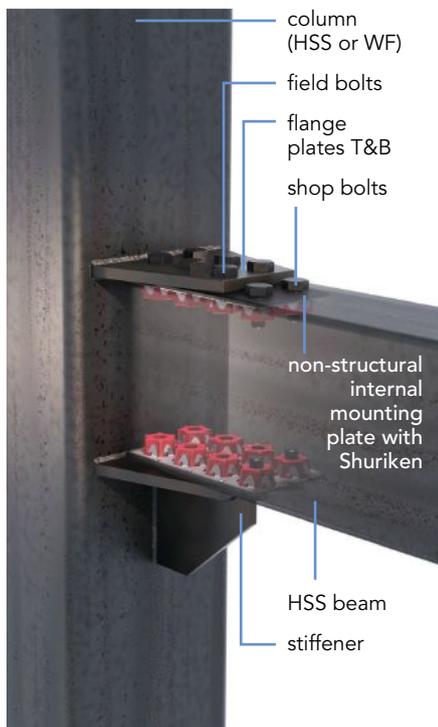


Fig. 3c. Shuriken conceptual detail: the seated moment connection is efficient and easy to erect, but requires space for the stiffener.



Fig. 3d. Shuriken conceptual detail: the end plate moment connection has clean aesthetics though capacity may be limited compared to other types of moment connection.

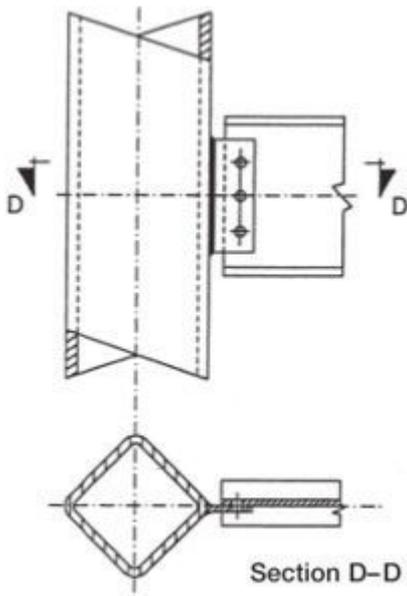


Fig. 4.

Skewed Connections. When framing into an HSS column at an angle or at the corner, engineers might be tempted to weld a shear tab directly to the corner to support the beam (Figure 4). However, welding to corners should be avoided due to fabrication difficulties, high residual stresses in the corner, and potential for cracking if proper preheating is not performed.

The alternative is to instead use a bent plate or double bent plate that connects to the face of the HSS. This approach allows for cleaner fillet welds to the flat surface of the HSS, which are generally preferred and are more cost-effective than PJP or flare bevel welds to the corner of the HSS.

Multiplanar Longitudinal Plates. For connections with multiple members coming together in one area (Figure 5),



Fig. 5.

especially where yield lines might overlap, a global approach focusing on the member's ability to support the total force in the connection region may be more appropriate than local yield line theory.

For simple shear, satisfying the minimum HSS wall requirement from *Manual Part 10* is typically sufficient. For axial force in plates that are close together, this

can be treated like a multi-planar truss and apply the concepts of those types of connections. A better approach may be to look at the global behavior (assuming one connection at the mid-point of the connection zone) rather than each individual connection. When there are high loads or the actual connection zone behavior is hard to predict, FEA may be necessary.

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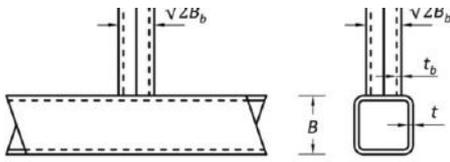


Fig. 6. Branch-rotated (BR) HSS connection

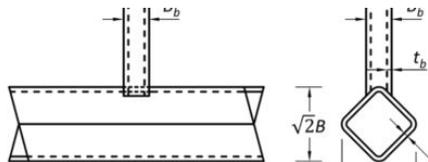


Fig. 7. Square-bird-beak (SBB) HSS connection

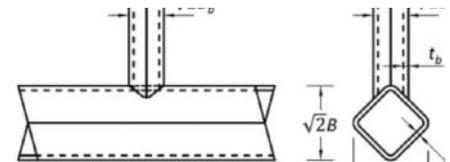


Fig. 8. Diamond-bird-beak (DBB) HSS connection

Truss Connections Beyond Chapter K. Some common truss joint types are not explicitly addressed in *Specification* Chapter K.

- **KT joints:** These occur in a modified Warren trusses where a vertical branch is introduced so that three branch members converge at a joint. While outside the original scope of *Specification* Chapter K, they are now covered in Chapter 9 of Design Guide 24, which incorporates analysis and design techniques previously published AISC’s *Engineering Journal*, 3rd Quarter 2014 (aisc.org/ej).
- **Round branch, square chord:** Driven often by aesthetics, the combination of round branch members connecting to square chord members of a truss is outside Chapter K’s scope (which covers round-to-round or square-to-square connections). The recommended solution, as researched in *Static and Fatigue Design of CHS-to-RHS Welded Connections Using A Branch Conversion Method* and now included in Design Guide 24 Chapter 9, is the branch conversion method. This method involves converting the round branch of diameter D to an equivalent square member with a width $B = (\pi/4) * D$ and the same wall thickness, then applying Chapter K equations. It provides a conservative estimate of the joint capacity.

Rotated HSS Connections. These involve rotating HSS members by 45°, which can offer structural advantages despite fabrication complexity. This discussion is on T- and cross-connections, because there isn’t much research and guidance related to diagonal branches:

- **Branch rotated 45°:** This configuration (Figure 6), where the branch is rotated 45° but still sits squarely on the chord member, increases the footprint of the branch on the chord. This increases the effective branch-to-chord width ratio (approximately $\sqrt{2}$ times the normal ratio) and the contact area, resulting in a stronger connection. The behavior of such a connection is similar to a round branch connecting to a square chord, allowing the branch conversion method to be applied. A double conversion process (rotated square to equivalent round, then to equivalent square) can be used, potentially yielding 10% to 12% more capacity of the joint.
- **Chord rotated 45°:** This type (Figure 7), where the chord member is rotated 45° and often called a square-bird-beak (SBB) connection, is more resistant to chord plastification. While there is some profiling required to fabricate this connection, there is added strength relative to a non-rotated chord. Design guidance is limited, but a conservative approach is to treat it as a non-rotated chord and use Chapter K equations, with special attention given to the weld design and welding preparation due to the profiling.
- **Chord and branch rotated 45°:** Known as a diamond-bird-beak (DBB) connection (Figure 8), this is generally a stronger connection than non-rotated squares or equivalent round HSS. T- and cross-joints in this configuration behave similarly to round HSS, so round HSS equations can be adapted. There is design guidance out there for gapped K-joints, but it is limited to branch angles of 45°.

Find more information about these three rotated HSS connections in *HSS Connections with Rotated Members* (aisc.org/stirotated).

Knee Joints. These connections are not common in HSS frames but do appear occasionally in structures that are driven by aesthetics. They primarily behave as partially restrained (PR) connections. Achieving fully restrained (FR) behavior often requires joint stiffening and stocky members. They are best suited for elastically designed structures and require compact sections.

Stiffened joints are preferred due to easier fabrication (allowing fillet welds on all four sides of the HSS to the stiffening plate), resulting in stiffer and stronger connections. This also allows the ability to use different sized HSS members on either side of the joint.

Unstiffened joints, where the HSS are essentially butt-welded to each other, demand critical edge preparation and weld quality. The strength of unstiffened joints is highly dependent on the joint angle; obtuse angles are stronger, while 45° angles are the weakest scenario.

Further details on knee joints can be found in *HSS Knee Connections* (aisc.org/stiknee) and CIDECT Design Guides 1 (2nd Ed.), 3 (2nd Ed.), and 7.

Rely On Resources

HSS open countless opportunities to carry loads efficiently and to provide unique and expressive structures. While HSS connections present unique challenges, it is a common misconception that if a connection scenario is not explicitly covered in the *Manual* or *Specification*, it cannot be used.

The large number of resources available to aid HSS design and construction help with the typical and atypical connection scenarios that arise in modern structures. Among them are Design Guide 24, Steel



Tube Institute resources (including design manuals and technical articles, which often fill gaps in the *Manual* and are a research repository), and CIDECT design guides (internationally focused but provide valuable first-principles guidance that often not found in other design guides).

Commercially available FEA software can help with complex or atypical connections where prescriptive guidance is limited. The Atlas Connections Hub (atlastube.com/hss-connections-hub) is a complimentary cloud-based program that offers downloadable typical details and

connection calculators for many HSS connections.

By understanding the scope of the *Manual* and actively engaging with additional resources, engineers can confidently design a wide range of HSS connections. ■

Find the author's recent NASCC: The Steel Conference session on this topic at aisc.org/outside-the-manual.



Brad Fletcher ([@atlastube.com](http://bradlee.fletcher)) is a senior structural engineer at Atlas Tube.



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Living the Dream

INTERVIEW BY GEOFF WEISENBERGER

As a student, Amit Varma had visions of doing impactful steel design research.

A quarter-century later, he has made significant contributions in three important areas.

MANY STEEL DESIGN PROFESSORS and researchers spend their career focusing on one specialty. **Amit Varma's** 25 years in the industry, though, have covered several disciplines.

When Varma was a student, he sought to help influence codes and specifications in whatever area became his specialty. A quarter-century later, he has done it in three important areas and garnered national recognition—including a recent AISC award.

Varma, the Karl H. Kettelhut chair professor of civil and construction engineering at the Purdue University School of Engineering, earned an AISC Lifetime Achievement Award in 2025. He was honored for his research and contributions in steel and concrete composite construction, fire design, and nuclear structures, in addition to his service on several AISC committees. He spoke with *Modern Steel Construction* about his career, research focuses, and more.

Where are you from and where did you grow up?

I'm from Thane, India, a suburb of Mumbai. That's where I was born and went to school. I went to college in Mumbai at a university known as IIT Mumbai to get my bachelor's in civil engineering.

After that, I moved to the U.S. to get my master's at the University of Oklahoma and my PhD at Lehigh University, which I completed in 2000. I went into academia



right away as an assistant professor at Michigan State University. I was there for about three years before taking a job at Purdue in 2004. I've been there since.

What steered you toward engineering in the first place?

Growing up, I realized that I was academically inclined, so I knew I was going to do something in the STEM fields. India's large population makes everything

competitive, including getting into engineering schools.

There's a nationwide exam called the Joint Entrance Examination. Just about everybody who's graduating high school takes it, but only about few thousand students in India are selected to some engineering programs. It's even more selective than some Ivy League schools. I took that exam and got placed. I wanted to go into engineering, and I felt civil engineering had my name on it.

My parents always told me engineering is a stable profession and that civil engineering will never go out of style. When I was in high school in the late 1980s, computer science, computer engineering, and electrical engineering were everywhere. But we didn't know if it would stick around. Civil will always be around. It's the oldest traditional form of engineering.

During undergrad, I fell in love with solid mechanics and strength of materials. When I got a taste of structural analysis and design, I knew I wanted to focus on it. I remember my first steel design class and immediately loving it. My undergrad classmates visited me a few years ago, and when we were reminiscing, they remembered me saying I was going to influence codes and specifications at some point. I had forgotten I said that, but I was fascinated with how codes and specifications are written, where the design equations come from, how they were they arrived at, and the research done to get equations into codes.

Back then, I knew nothing about how the codes were written. It was a process of discovery, and in the process, I forgot that was my original intent. But one of my best friends and classmates told me it seemed like I was living the dream. I asked him what he meant, and he reminded me what I said during college.

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What led you to academia and how do you like teaching in front of a class?

I was an actor in my youth. I've been in front of big audiences and had no difficulty remembering my lines. I left that a long time ago, but I think it helped teaching come naturally. The first class I taught was a summer course at Lehigh, and I loved it.

Today, I rarely spend much time planning or thinking about how I'm going to tell a story. I love telling stories about how code equations were calculated and how you implement them. Engineering students are also highly focused on academics. If they aren't, they won't survive in engineering school long enough to get to my steel design class.

What are your favorite or most rewarding research projects?

All of them. When I did my PhD, my research focused on composite columns, mainly concrete-filled steel tubes made of high-strength materials. That was in the mid 1990s, and I was doing tests with 15-ksi concrete and 100-ksi steel.

My fascination with high-strength materials and composite columns continued. I wrote my first research proposal when I started my career in 2001. I did a lot of work in seismic engineering of composite columns while pursuing my PhD, but I wanted to do something else and decided on fire design. I wrote my earliest proposals before 9/11, but when 9/11 happened, I knew my proposals would get funded because fire design and fire resistance of steel and composite structures had become an important topic.

I did quite a bit of work on fire-resistant design. I designed some of the first experiments ever done on loaded columns and beam columns. I designed an entirely new experimental method using radiant heaters to apply heating in combination with structural loading. It was a completely new testing setup built from scratch. I'm an experimentalist at heart, so I like to do large-scale tests to failure, whether they're on columns, components, connections, or something else.

Testing under fire along with mechanical loading is usually done in a furnace. But my team on this project was the first to assemble a heating arrangement around the specimens and do large-scale

tests. I continued in that vein for a little while, chaired the AISC Task Committee 8 (design for fire conditions), and helped with fire design provisions in the U.S.

In all that work, I had designed a lot of equipment for subjecting things to mechanical and thermal loading. I was presenting on composites somewhere, and some folks from the nuclear industry reached out to me and said they wanted to investigate a new type of construction called steel-plate composite construction. One of the big topics in that area is accidents with earthquakes, thermal loading, and pressure loading. I felt I had the right skill set and preparation to help design steel plate composite construction for nuclear applications.

I did a lot of work on the *Specification for Safety-Related Steel Structures for Nuclear Facilities* (ANSI/AISC N690). I was the vice chair of a special ad hoc task group to develop a steel plate composite system for nuclear design. Around the same time, the AP1000 nuclear power plant in Georgia was going through its regulatory process. The plant needed some large-scale testing and incorporated pressure loading, thermal loading, and seismic loading.

Our lab at Purdue had the right equipment and people to help. I ended up working in the nuclear industry, doing experiments, developing numerical models, benchmarking them, and presenting our work and defending it to the U.S. Nuclear Regulatory Commission. The structural portion of plant received its regulatory license to build the plant.

What led you to the SpeedCore project?

Shortly after the Fukushima accident in Japan in 2011 and subsequent nuclear industry slowdown, I met Ron Klemencic of Magnusson Klemencic Associates, who was thinking about using steel plate composite for SpeedCore. Applying steel plate composite into high-rise buildings is remarkably different than nuclear.

I kept my nuclear expertise, but I spent a lot more time working on SpeedCore, its seismic performance, its fire performance, and developing design codes and standards for it. That work made its way into the AISC *Specification for Structural Buildings* (ANSI/AISC 360-22) and the *Seismic*

Provisions for Steel Buildings (ANSI/AISC 341-22). We did a lot of large-scale testing and simulation work to develop design rules for the seismic design of uncoupled and coupled SpeedCore systems. We did a lot of fire testing as well and showed that it doesn't need much fire protection.

We're still working on SpeedCore, particularly bolted splices and the SpeedBox connection, which makes field assembly even faster. But there's a resurgence in the nuclear industry, and the small modular reactors are using steel plate composite construction. I'm back in that area again.

I'd say that's more than enough to earn a Lifetime Achievement Award.

I've had a rewarding career. I owe that to a lot of people. AISC has a full-circle connection to it. In 2003, I received AISC's inaugural Milek Fellowship in 2004, which tremendously helped my career. My fellowship was about composite construction and composite floor systems. The graduate student who worked on it with me was Devin Huber, who is now AISC's director of research.

It does feel like a lifetime of work over the past 25 years. All 35 of my PhD students have been amazing and gone on to do amazing work. I'm sure they'll continue to do amazing work. I want to keep contributing to the profession and help create the next generation of thinkers, doers, engineers, and visionaries. ■

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



Geoff Weisenberger ([@weisenberger](https://www.linkedin.com/company/weisenberger)) is the editor and publisher of *Modern Steel Construction*.

Strong as Steel

BY PATRICK SCHUECK

Addressing mental health in construction starts with being vulnerable, and one company recently implemented a program that aims to encourage it.

WHEN WORKING WITH STEEL, Building Mental Might

strength is forged through fire and precision. When working with people, though, it's forged in connection, honesty, and vulnerability.

Leaders in steel construction and fabrication are often taught to be decisive, resilient, and unbreakable—much like the steel we make and fabricate. But in my time as Lexicon's CEO, I have learned our greatest strength comes not from hiding what we feel, but rather from acknowledging it and inviting others to do the same.

Since Lexicon's founding in 1968, one of our top priorities has been taking care of our people. Our team now has nearly 3,000 employees across the United States, and as we've grown, so has my responsibility to ensure every person knows they are seen and supported. I have said numerous times that we are a people company that happens to specialize in steel construction. That's the first part of our values—people, quality, safety, innovation—and guides every decision we make.

To me, the hardest thing to hear after a long day is someone saying, "You need to leave your hard hat at work." The truth is, what our industry does is hard, and leaving it on the jobsite is easier said than done. The pressure, challenges, and risks we manage every day often follow us home. I've faced my own mental health battles, and as I walked our jobsites and listened to our teams, this issue weighed heavily on my heart.

In a high-pressure industry, too many of us carry our struggles silently. I didn't want a single person at Lexicon to feel they had to shoulder that weight alone, so we committed to creating a formalized program to reduce stigma, support our team's growth, and connect them to resources to address the issues. This was an intentional culture shift designed to bring mental health into the light.

The idea for the program took shape in August 2024, when Lexicon launched "Strong as Steel: Building Mental Might" in honor of National Wellness Month. At the time, our industry was coming to terms with the hard truth that construction workers face some of the highest mental health risks in the nation. Men and women in construction work long hours away from family, perform physically demanding jobs in tough conditions, and encounter numerous potential safety hazards. These factors were quietly taking their toll on our workforce, and Strong as Steel was a way of offering our team a support beam. It started as a month-long initiative, but has since evolved into a year-round commitment.

Lexicon took this message to the 2025 NASCC: The Steel Conference and spoke candidly about the crisis facing our industry. The construction industry has one of the highest suicide rates among professions. According to the Centers for Disease Control and Prevention, the suicide rate for male construction workers is 75% higher than men in the general population. An estimated 6,000 construction workers died by suicide in 2022, an increase from 2021, according to data gathered by the Center for Construction Research and Training.

These numbers represent people we know, colleagues we work beside, and, sometimes, close friends. It's no surprise that 83% of construction workers report experiencing mental health challenges, with anxiety, depression, burnout, and substance use topping the list, according to a 2020 study conducted by Construction Industry Rehabilitation Plan (CIRP).

From the start, Strong as Steel was about shifting from toughness as a mask to vulnerability as a foundation. Now in its second year, the program is anchored by four August "focus weeks" offering helpful

resources, content, and opportunities to connect. This year, it addressed stress and burnout; substance use and recovery; suicide awareness and prevention; and family, relationships and grief, while reinforcing that it's always the right time to speak up. We want to give our people permission to lean on each other and assure them they will be met with compassion and empathy.

The culture shift is reinforced year-round through:

An onsite health clinic. Centralized at Lexicon's Little Rock, Ark., headquarters, the on-site clinic's medical staff provides basic health services, real-time, in-person mental health support, and referrals to additional services.

Telehealth services. In addition to the on-site location, the Lexicon clinic provides telehealth services that are accessible regardless of location.

Robust employee assistance program (EAP). Among its many benefits, an enhanced employee assistance program offers free financial, marriage, and family counseling.

Expanded leave options. In response to employee needs, Lexicon offers expanded and flexible leave options, allowing employees the time they need to care for their mental health.

While we have put some great support tools in place, infrastructure alone isn't enough. Vulnerability starts with leaders. I've learned over time that admitting, "I'm not okay today," or "I've felt overwhelmed," strengthens trust. At The Steel Conference, I shared that if we expect our people to bring their full selves to work, we must model the same. It's about normalizing hard conversations.

Leading through generations—from the founding vision of my father, Tom, to our present day—I'm reminded that our truest legacy is how we treat our people.



Program-Building Tips

When we launched Strong as Steel, we didn't have a manual. We built it from the ground up, listening, learning, and adjusting along the way. Its evolution continues, and I hope sharing some of what we've learned helps others in our industry take the first step or the next one. Here's what has made a difference at Lexicon:

Start with culture, not campaigns. It's easy to post a flyer or schedule a speaker. But if prioritizing mental health isn't embedded into your culture, it won't last. Our teams needed to know this wasn't performative, and that had to start with me. As leaders, we must be willing to go first, speak honestly, and show that it's safe to be human here.

Address the real stressors. Working in construction comes with long hours, travel, irregular schedules, jobsite hazards, physical strain, and a long-normalized "tough it out" mentality. Programs must be tailored to those realities, or your team will feel disconnected from the efforts.

Build an accessible, year-round support pipeline. Temporary initiatives help, but sustained impact comes from permanent resources that serve employees whether they're in the field, at the plant, in the shop, or the office. That's why Lexicon invested in year-round access

through the clinic, telehealth options, and our employee assistance program. We've made it easy to reach out, and we keep reminding our people that these tools are there for them whenever they need them.

Use your safety culture as a platform. Safety is a key part of our DNA. If your company already emphasizes physical safety—and I hope it does—you have a strong footing to build on. We've learned to treat mental health with the same seriousness as jobsite hazards. That means integrating it into toolbox talks, safety stand-downs, health fairs, and everyday leadership conversations.

Empower peers, not just policies. One of the most powerful things we've seen is how coworkers look out for each other. Lexicon has worked to train supervisors and team leads to recognize signs of distress and start conversations early. Sometimes, it's a buddy noticing someone hasn't been themselves. That simple check-in can be a critical lifeline.

Keep it visible and evolving. Mental health can't be something we talk about once a year to check a box. Keep it front and center in team meetings, internal communications and HR practices. Listen through surveys, feedback channels, and open conversations so you can keep improving. What worked last year might

not be enough this year, and that's OK. What matters is staying committed and responsive.

Lead from the front. I shared my story at The Steel Conference because I believe vulnerability from leadership gives others permission to be honest. When executives, supervisors, and foremen speak up, it sends a message that asking for help is encouraged. That visibility matters more than we often realize.

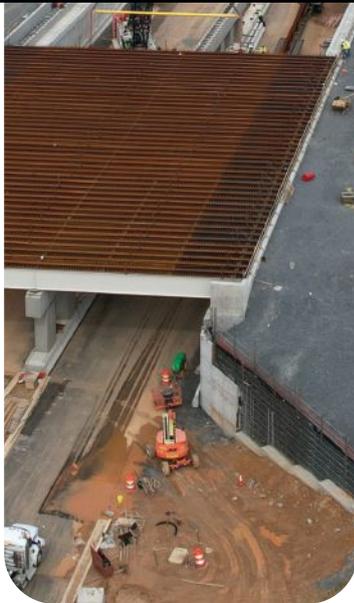
When it comes to your people, vulnerability is not weakness. Rather, it holds us together. Let's lead with humanity first and let toughness be defined not by silence, but by a willingness to speak up and bear burdens together. When we lift each other up and normalize asking for help, we build something stronger than steel: trust, connection, and resilience. ■



Patrick Schueck is the CEO of Lexicon, Inc.

Modern Steel's annual roundup of recent captivating steel projects—often smaller-scale—spans the Northwest to the Southeast and covers bridges, renovations, sculptures, structures, and even façades.

What's COOL in Steel





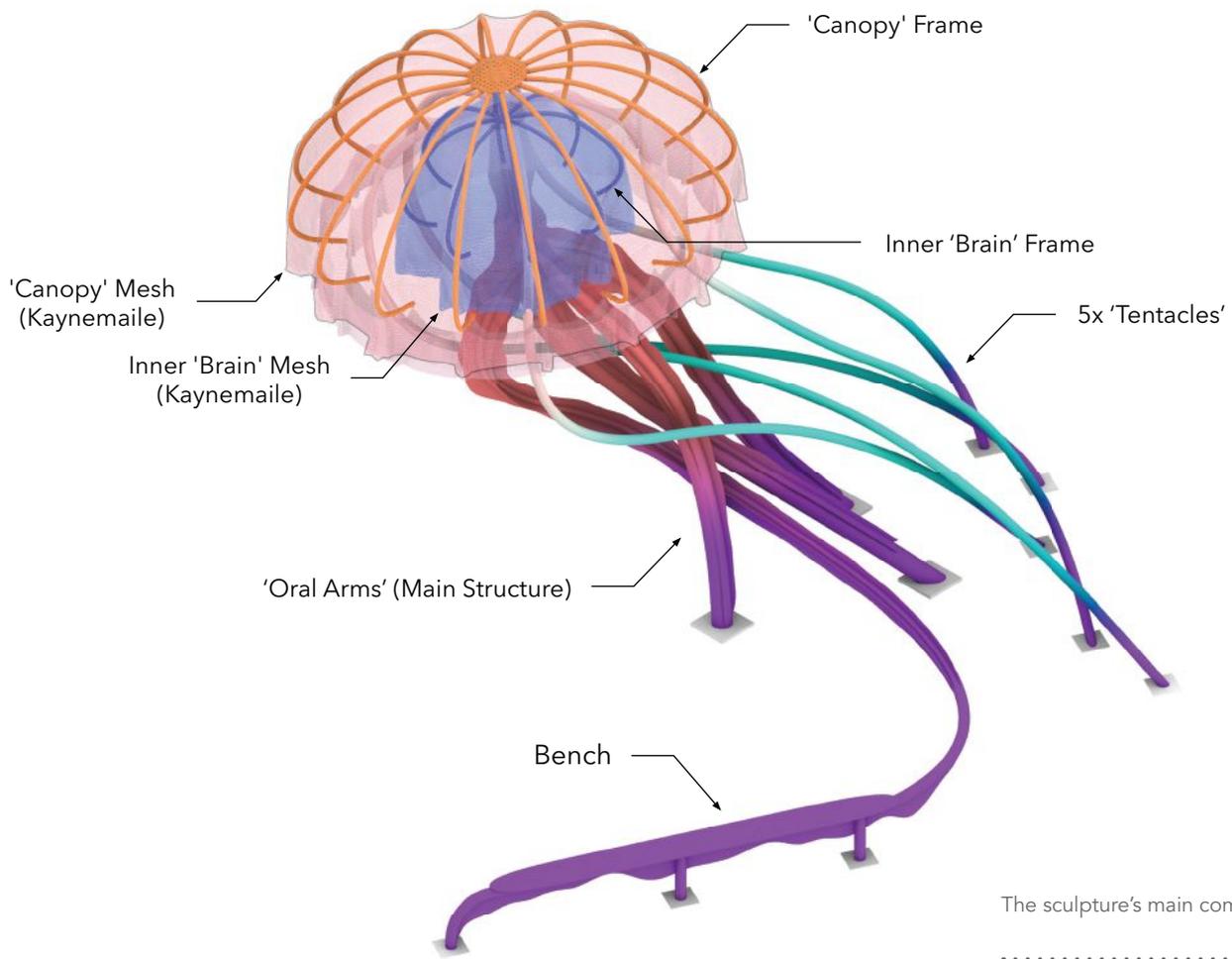
This year's list includes a taxiway bridge at a major airport, a dormitory on a North Carolina university campus, a modernized international terminal at O'Hare, a sculpture in San Diego that is locally inspired, a look at a U.S. Steel trademarked product's comeback as a façade material, and more.

Stainless Steel Sculpting



Pablo Mason Photography

A 21-ft jellyfish sculpture greets passengers arriving at San Diego International Airport's new terminal.



THE NEW TERMINAL 1 at San Diego International Airport is also an unofficial art museum. The first of its five commissioned art pieces greets travelers before they're even dropped off and uses steel to create an ode to a pair of San Diego nature elements.

RISE, a 21-ft-tall jellyfish sculpture at the new terminal's curbside plaza, is inspired by the purple striped jellyfish (*Chrysaora colorata*) found off San Diego's coast and the city's sunsets. It is artist Matthew Mazzota's second airport sculpture, following his pink flamingo at Tampa International Airport. Mazzota worked with longtime engineering partner Bryan Starr, SE, PE of Tarantino Engineering Consultants (part of TLC Engineering Solutions) to design it with painted stainless steel and polycarbonate chainmail.

Mazzota derived the concept for RISE from a prior project in Boise, Idaho, the first project that Starr engineered for him. That sculpture, GENTLE BREEZE, is a pink tree on a hill with three swinging benches connected to its limbs. The tree canopy has 743 individual "leaves" that sway in the wind. When Mazzota was standing next to the 60-ft crane arm lifting the full canopy into place, he saw a jellyfish head in the canopy for a fleeting moment and jotted it down in his notebook.

Five years later, Mazzota consulted that notebook when he identified the purple striped jellyfish for the San Diego project design. He envisioned a similar concept to GENTLE BREEZE, but leaning. Starr suggested the idea of a leaning tripod representing the jellyfish with multiple tentacles, where the front leg would be in compression and the back two legs would be in tension.

Among the first design tasks was selecting the best three tentacles to act as the primary support legs. It seemed simple to choose the three closest to the front, but the tentacles' curve made the selection less straightforward. It wasn't obvious which tentacles would be most in compression and tension where they crossed. Starr and Mazzota worked through several iterations of curving geometry of the tentacles, working to combine the structural tripod with the artistic aesthetic. They eventually settled on the three primary supports, calling them "oral arms." All others became non-load-bearing "tentacles."

RISE doubles as a performance space and shade structure. One of the non-load-bearing legs curves to support a bench at the end that's in the shade during direct sunlight hours. At the top of the oral arms, the central mast continues up to support two canopies at the top: the inner "brain" canopy and the outer canopy that is most visible. Both canopies are covered in polycarbonate chainmail (Kaynemaile), and the sculpture is supported by deep foundations.

Mazzota has used fiberglass, dichroic glass, painted mild, galvanized and stainless steel, aluminum, and Kaynemaile in prior sculptures. Steel, though, is found in almost all his work. In RISE, steel simultaneously provides the structure and the final form. Material selection was critical for the curving oral arms acting as the primary support tripod. The oral arms needed to be slender, curved to match the artistic shape of the piece, and strong enough to support the weight of the canopy. Starr immediately knew steel was the answer.



Pablo Mason Photography

Because RISE is on the Pacific Coast, its durability was an important consideration. Even though it's painted, Starr and Mazzota wanted to provide another layer of protection and elected to build the entire sculpture out of stainless steel with assistance from sculpture fabricator Elmendorf Geurts. Stainless steel can have a lower yield strength than structural steel, but in this case, the main oral arms have a high yield strength exceeding 50 ksi. AISC Design Guide 27, *Structural Stainless Steel*, 2nd edition. (download or order at aisc.org/dg) defines the yield strength of stainless steel as the 0.2% offset yield strength, and the mill test reports were used to determine that the 0.2% offset yield strengths for the oral arms exceeded 50 ksi.

A 3D analysis was quickly identified as the best approach to modeling the main support tripod's complicated curving geometry. It incorporated the dead loads, wind loads, and seismic loads experienced by the sculpture. Modeling the three primary oral arms with the curves was critical, because the curves introduce bending moments in the main tripod mechanism. The steel pipes were sized for the tension and compression loads, combined with the bending moments.

The sculpture's structure needed to resist the lateral loads of wind and earthquake loading, and being in a high seismic zone created additional challenges. By fixing the top connections of the three primary legs, the lateral system would be a moment frame, similar in concept to a building structure yet much different in configuration. Design Guide 27 was used to check the strength

of the structural members. One of the primary differences from carbon steel design is the reduced capacity of buckling in compression, approximately 60% of the capacity for carbon steel. The three primary legs were primarily governed by bending stress, so the reduced buckling capacity was acceptable.

The fabrication process concentrated all the welding in the shop, using all bolted connections in the field. Eliminating field welding simplified erection and minimized difficult touch-ups of the custom paint finish. After working through many rounds of brainstorming and shop drawing review, the team was able to use bolts for all field connections.

First the team worked through the maximum size of assemblies that could be shipped, which included shipping the entire base of the primary support tripod as one piece, welded in the shop. The top section of the central mast was added to the top of the main tripod using a sleeved connection with bolts, with the inner brain frame already shop welded to the central mast. The outer canopy frame was too large to ship with the central mast, so it was added on site and bolted to the top of the central mast. The tentacles were shipped loose and bolted to the central mast using pipe sleeves.

The layered canopy is composed of thousands of shimmering interconnected rings that move with the wind, creating a sense of life underwater as the sculpture sways and shifts. Beneath the canopy, a stage hosts scheduled and spontaneous performances for nearby audiences to enjoy. At night, the jellyfish glows warmly from within, bringing the sculpture to life for evening visitors.

Letting In Light



The new wellness and activities center at Green Hill School opened in 2023.

Ed Sozinho

AN ACTIVITIES AND WELLNESS CENTER at a juvenile facility in Chehalis, Wash., used steel's architectural benefits and long-span trusses to create an inviting multi-use space with carefully planned natural light infusions and an airy feel.

The center has a significant influence on the entire site, enhancing the experience for Green Hill School's staff, visitors, and youth. A major design goal was creating a feeling of openness, and the design achieves it in part by maximizing daylight and natural ventilation of large-volume spaces. The DLR Group design team engineered graceful clerestories and roof trusses that maintain large openings while keeping the steel structure as visually light as possible.

The design also integrates natural materials into every aspect of residents' and staff's experience moving through the space. The building's massing and sawtooth roofs echo the region's mountains and the timber industry's presence in the Pacific Northwest. Strategically placed wood finishes prompt people to touch and experience the material as they pass by.

Structural steel met design goals because it can enhance a building's technical performance and architectural expression. The steel framework is intricately coordinated with the project's rhythmic module, which shows how steel can be functional and visually integrated into the overall architectural aesthetic. The lightweight roof trusses balance structural efficiency and design elegance.

The design creates a welcoming environment, unlike most buildings found on detention campuses. It's a modern facility tailored to adding restorative spaces, creating a sense of community, and

fostering personal growth, healing, and positive development.

DLR Group's integrated design process ensured seamless coordination across all disciplines and helped everyone adhere to a strict module for building element layout. The structural engineer, architect, and interior designer worked together to determine which exposed steel best balanced interior aesthetics and structural efficiency. No structural decision was made without input from the entire design team. All exposed steel connections were designed alongside the architectural team. The engineering team also worked with MEP to coordinate duct placement through trusses and unit placement. All building components followed the module's rhythmic layout, resulting in clean lines and careful integration of all building systems and components.

King post trusses are a primary design feature for their efficiency and aesthetic benefits. The trusses minimize the roof framing's structural impact, which increased daylight penetration and added visual interest to the design. They span 59 ft, 4 in. and are 5 ft deep at their deepest point. They consist of one W10x68 top chord, two 2-in.-diameter steel rod bottom chords, and one 4-in. STD pipe king post.

The steel rods allow the trusses to span that length by leveraging steel's efficiency in tension while creating strength and minimizing visual impact. Rods minimized the steel needed in the framing, cutting down on weight and roof congestion that would have impacted natural light. Special moment frames were strategically used above buckling restrained braced frames, facilitating

unencumbered window openings and contributing to a more open and aesthetically pleasing façade.

Two truss types achieved the column-free gym—the king post trusses and a deep truss system spanning 95 ft, 9 in. The deep truss spans through the middle of the gym, supporting the king post trusses on each side and creating the sawtooth roof structure, clerestory and additional windows in the middle of the gym.

Using architecturally exposed structural steel (AESS) significantly elevates the aesthetic impact by incorporating the steel truss canopy element as a key design feature. The canopy columns are specified to AESS Category 3 (feature elements in close view), and the remaining canopy steel is Category 2 (feature elements not in close view). The exposed steel truss adds visual interest to the façade and unifies the building’s overall appearance. Integrating AESS with other materials enhances the visual appeal and reinforces its architectural identity.

Thoughtful coordination of the king post trusses’ and deep gym trusses’ structural connections ensured architectural expression was maintained and structural efficiency was met. Connections were designed with specially detailed shapes to highlight the beauty and elegance of the exposed structural system in harmony with the visual design.

Meticulous design and construction methods significantly improved the project in several ways. Using 3D building models and interoperability ensured precise alignment and coordination among different building systems, which was essential for adhering to the rigid 8-ft module layout that provides a rhythmic and cohesive architectural feel. The models were most helpful in determining steel sizes and placing the lateral systems. Frequent coordination calls with several disciplines ensured structural decisions did not impact other design principles.

Before construction, the design team used clash detection to assess all potential clashes and conflicts between ducts, HVAC systems, piping, and conduit with structural members, minimizing the number of RFIs in the field. Duct penetration through the steel joists was carefully coordinated with the mechanical engineer and the steel joist manufacturer.

Sustainability considerations were central to the project, which earned LEED Gold certification and net-zero energy status. The large window-filled volumes and clerestories that steel facilitated allow for increased natural daylight and ventilation, leading to decreased energy usage. The project was bid under budget, allowing DLR Group to allocate additional resources toward the facility’s features. Throughout construction, DLR Group maintained minimal change orders.

The \$22.5 million project was completed in August 2023 and opened shortly after.

Owner

Washington State Department of Children, Youth and Families

Architect and Structural Engineer

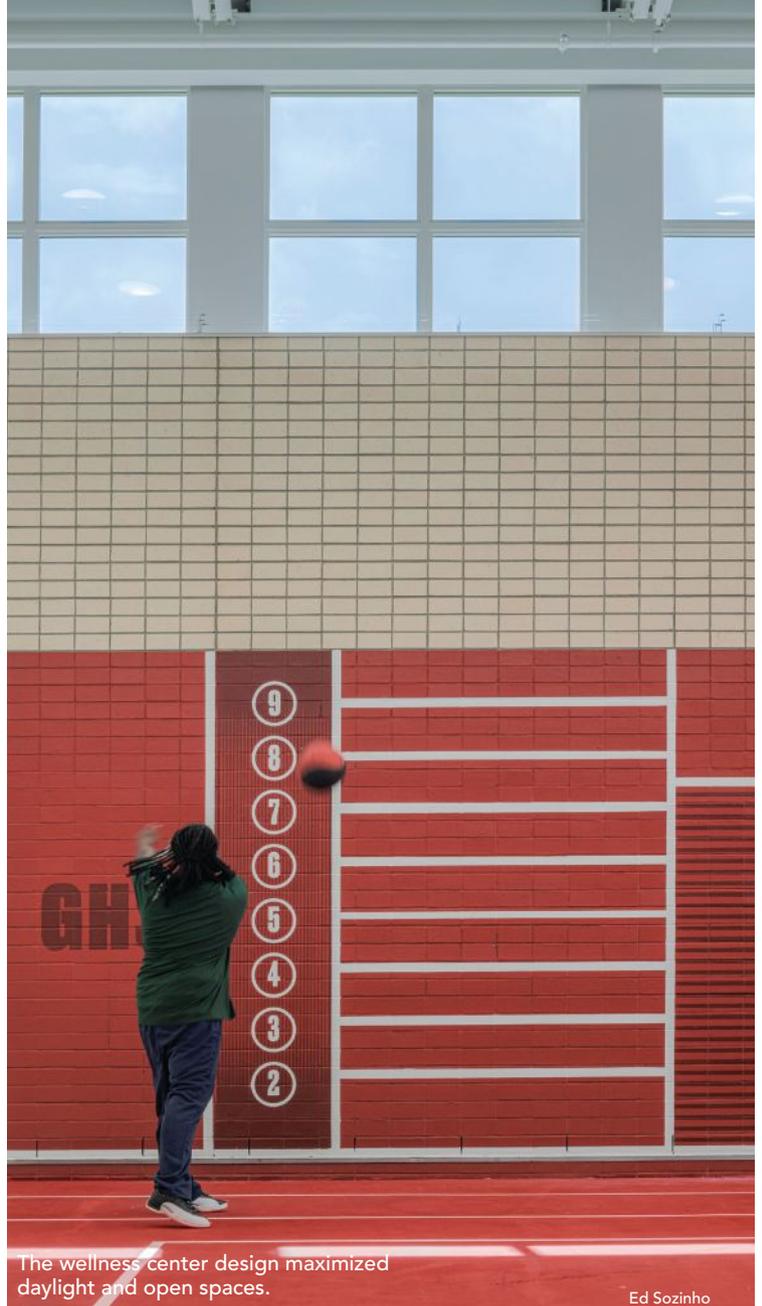
DLR Group

General Contractor

Bayley Construction

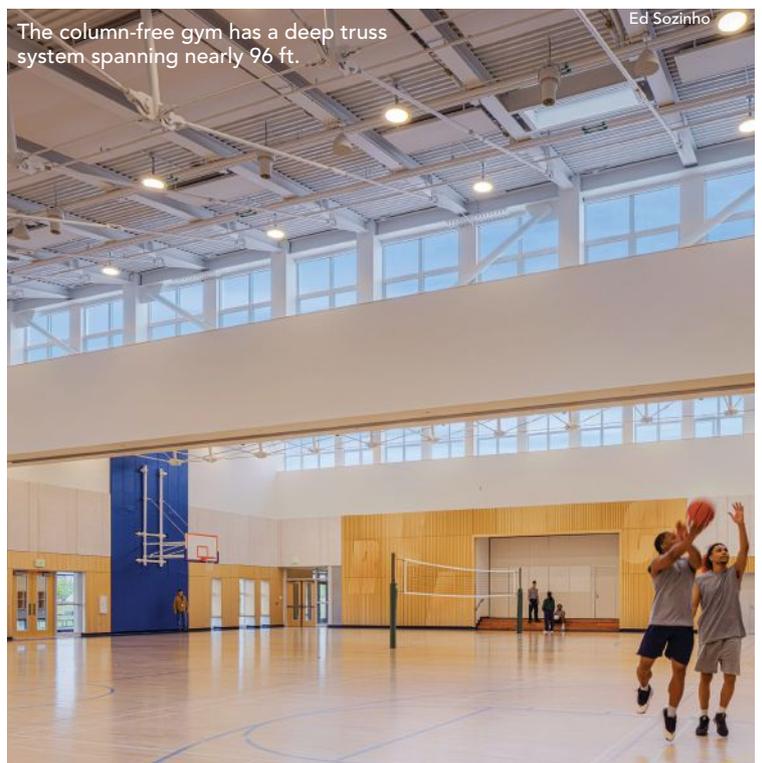
Steel Fabricator

Al’s Welding and Steel Fabrication, Inc.   



The wellness center design maximized daylight and open spaces.

Ed Sozinho



The column-free gym has a deep truss system spanning nearly 96 ft.

Ed Sozinho



The sawtooth roofs echo the region's mountains.

Ed Sozinho



The roof structure also is designed to maximize natural light intake and flow.

DLR Group



Integrating AESS with other materials enhances the project's visual appeal.

Ed Sozinho



COOL
Aircraft Bridge

Bearing the Load

Charlotte Douglas International Airport

AIRCRAFT-SUPPORTING BRIDGES have large load requirements, and the newest one in the U.S. is a strong testament to structural steel's ability to meet the demands that come with high-load applications.

A new 4,000-ft-long taxiway at Charlotte Douglas International Airport includes a bridge over a realigned roadway engineered to accommodate modern aircraft weighing up to 1.5 million lb. It provides more than 17½ ft of vertical clearance over the road and crosses the road with a slight skew angle of 7°. It features two-span continuous structural steel plate girders that extend for a total bridge length of 106½ ft and weigh a total of 950 tons.

In compliance with FAA Advisory Circular 150/5300, the bridge was designed to accommodate the entire taxiway safety area for its aircraft design group, resulting in a notably wide structure. The bridge meets FAA requirements for Airplane Design Group (ADG) V by accommodating a 220-ft-wide safety area. FAA requirements prohibit structural elements taller than 3 in. within the safety area, allowing only a short 1-ft-tall parapet just outside this zone and resulting in a out-to-out bridge width of 222 ft.

Structural steel was the ideal choice for the bridge due to its exceptional strength and versatility in supporting the immense loads that modern aircraft impose. The steel girders and plate diaphragms provided a robust, redundant load-carrying system

engineered specifically to handle large sudden loads. Steel's adaptability allowed the bridge to meet stringent FAA standards, while its durability ensured reliable long-term performance under repeated high-stress cycles from aircraft. Ultimately, steel enabled the bridge to meet and exceed all critical loading requirements, making it the optimal solution for this demanding infrastructure project.

The structural steel girders used for the bridge superstructure are 4½ ft tall and spaced at 3 ft on center. The design provided 74 plate girders made of AASHTO M270 Grade 50W structural steel. Plate diaphragms were incorporated into the superstructure design due to the close spacing, and each diaphragm features hand holes to facilitate installation of bolts to connector plates welded to the plate girders. The plate diaphragms were designed for live load distribution between the girders, ensuring a redundant load-carrying system that can distribute the large live load demands to the girder elements.

A 1-ft-thick cast-in-place concrete bridge deck was placed on the girders, creating a composite superstructure that enhances strength. The bridge deck thickness meets punching shear demands imposed by large wheel loads from aircraft and provides adequate depth for integrating steel light base cans that house the taxiway's lighting system.



The new taxiway bridge can accommodate aircraft weighing up to 1.5 million lb.



The bridge girders are 4½ ft tall and spaced at 3 ft on center.

WSP

One unique bridge feature is the bearing support system between the superstructure and substructure. The bearing system allows for the bridge superstructure to be designed as a floating plate system of structural steel elements, facilitating load distribution. The girders are supported on steel-reinforced elastomeric bearings that transfer load demands to the bridge substructure units. These bearings were engineered to allow omnidirectional movement—accommodating longitudinal and transverse movements and allowing load distribution based on stiffness across the entire system.

Steel anchor bolts embedded in the substructure units were integrated into the bearing system to limit maximum movements that may occur from an aircraft’s transverse loads. These steel-reinforced elastomeric bearings are securely sandwiched between two structural steel bearing plates, which accommodate straightforward replacement over the service life of the structure. Additionally, keeper plates were welded to the bearing plates to prevent unintended lateral movement between the steel-reinforced elastomeric bearing and structural steel bearing plates over time due to thermal movements.

An inspection report review of existing bridges on the airfield showed evidence of bird nesting between closely spaced girders, raising maintenance concerns about the potential for similar issues on the new bridge. After evaluating various options, the airport

installed removable bird deterrent netting to improve long-term maintenance activities.

The steel girders’ exposed fascia surfaces were finished with a high-performance paint coating for added visual appeal. The bridge also features aesthetic signage for the airport mounted on the southern steel fascia beam and advanced lighting elements beneath the bridge. Reverse channel signs channel letters are installed and use 4000K LED lights for backlit and front-lit illumination. RGB color-changing LED accent lighting is programmed to match the airport’s branding, creating a striking and cohesive nighttime presence.

At the time of design, there was no universally accepted structural code that established aircraft live-loading standards specifically for bridge design. Consequently, the live load criteria were determined using guidance from FAA advisory circulars, which stipulate that runway and taxiway bridges must support both static and dynamic loads from the heaviest aircraft anticipated to operate over the structure throughout its service life.

To account for future fleet growth, the FAA recommends applying a load increase factor of 20% to 25%. After coordinating with the airport, a 1.5 million lb design load distributed over two main landing gear assemblies was selected for the design. Additionally, the bridge deck was engineered to withstand wheel live loads near 100,000 lb with a tire pressure of 250 psi.



Crowder Constructors

The bridge has 74 plate girders made of Grade 50W steel.



The bridge has an out-to-out width of 222 ft.

WSP

below: The bearing system allows for the bridge superstructure to be designed as a floating plate system of structural steel elements.



WSP

Impact and braking forces associated with the live load were considered at 30% and 70% respectively, with the design assuming a load stress cycle of 500,000 cycles of the design aircraft to ensure long-term performance is provided. A 3D finite element model was generated to analyze force distribution of applied loads on the structure elements. Structural design checks were performed in accordance with AASHTO *LRFD Bridge Design Specifications*.

The bridge began carrying aircraft in September 2025 as part of South Crossfield Taxiway, which connects the airfield's central and east sides. It also enhances de-icing operations and flow by providing direct access from a new de-icing pad to a pair of runways.

Owner

Charlotte Douglas International Airport

Design Engineer

WSP USA, Inc.

General Contractor

Crowder Constructors, Inc.

Steel Fabricator and Detailer

Structural Steel Products Corporation



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North Carolina Museum of Natural Sciences



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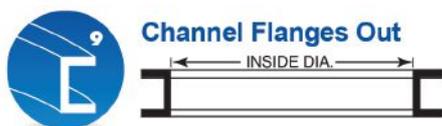
4 Flat Bar The Easy Way
 36" x 12" Flat

5 Square Bar
 18" Square

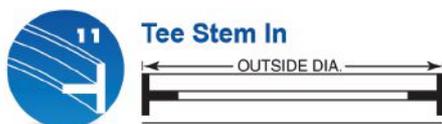
6 Beam The Easy Way (Y-Y Axis)
 44" x 335#,
36" x 925#

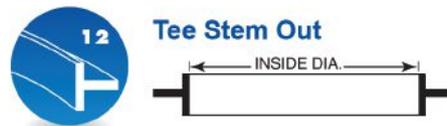
7 Beam The Hard Way (X-X Axis)
 44" x 285#

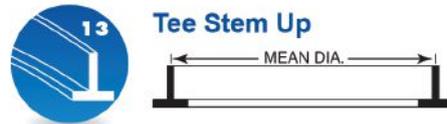
8 Channel Flanges In
 All Sizes

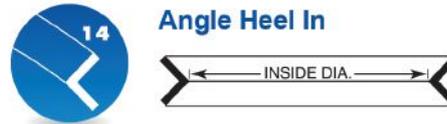
9 Channel Flanges Out
 All Sizes

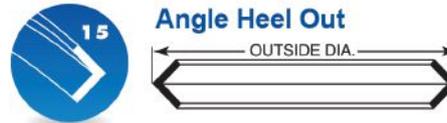
10 Channel The Hard Way (X-X Axis)
 All Sizes

11 Tee Stem In
 22" x 142¹/₂# Tee

12 Tee Stem Out We bend ALL sizes up to:
 22" x 142¹/₂# Tee

13 Tee Stem Up
 22" x 142¹/₂# Tee

14 Angle Heel In
 8" x 8" x 1" Angle

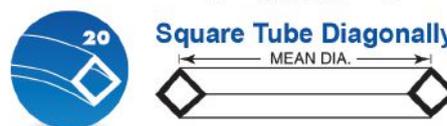
15 Angle Heel Out
 8" x 8" x 1" Angle

16 Angle Heel Up
 8" x 8"x1" Angle

17 Square Tube
 24" x 1/2" Tube

18 Rectangular Tube The Easy Way (Y-Y Axis)
 20" x 12" x 5/8" Tube

19 Rectangular Tube The Hard Way (X-X Axis)
 20" x 12" x 5/8" Tube

20 Square Tube Diagonally
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Staying on Schedule



Panther Commons and its 206 dorm rooms opened for the 2023–24 school year.

A FOUNDATION PERMIT for a new \$95 million, five-story residence hall at High Point University in High Point, N.C., was approved in March 2022. Just 17 months later, the dorm was ready to house students.

A short schedule was non-negotiable to ensure the dorm opened in time for the 2023–24 academic year. Choosing structural steel for the frame helped meet the ambitious timeline and achieve an irregular layout that resulted from its site plan.

The 175,000-sq.-ft residence hall, named Panther Commons, has 206 hotel-style dormitory rooms that provide a much-needed boost to the university's growing student housing needs. It features a two-story atrium, a fifth-floor terrace, retail shops, a hibachi restaurant, nail salon, mail service room, fitness studio, and study rooms. It is predominantly clad in clay brick veneer with precast concrete accents and FRP column wraps to conform with the surrounding buildings' Georgian style.

The main structural system is comprised of a composite concrete slab on metal deck supported by wide-flange steel beams and columns. The roof uses the same structural system but adds overbuilt light-gauge metal trusses, which give the building its Georgian hipped-roof appearance. The hipped roof conceals mechanical

equipment that bears on the structural roof slab. The lateral force resisting system is comprised of concentric hollow structural sections (HSS) braced frames, and the building has 1,174 tons of structural steel in total.

The brace sizes ranged from HSS10×6× $\frac{3}{8}$ to HSS6×6× $\frac{1}{4}$, with $\frac{1}{2}$ -in.-thick and $\frac{3}{8}$ -in.-thick gusset plates, respectively. The braces were slotted around the gusset with temporary erection bolts and field-welded directly to the gussets. At the foundation level, the gussets were shop-welded to the column and baseplate. At the supported floor levels, they were shop-welded to the beams and field-bolted to the columns with double-clip angles. Both were significant steel erection time-savers.

The engineer of record, Morrison Engineers, was engaged on the project in October 2021 and understood August 2023 completion was a requirement. From the beginning, Morrison, led by senior structural engineer Aaron Marx, PE, emphasized an open line of communication with Mercer Architecture and held regular design meetings—each crucial to a streamlined design process. Meanwhile, foundation-only drawings were submitted early to allow the contractor to begin foundations and under-slab plumbing and utilities ahead of full permit drawings.

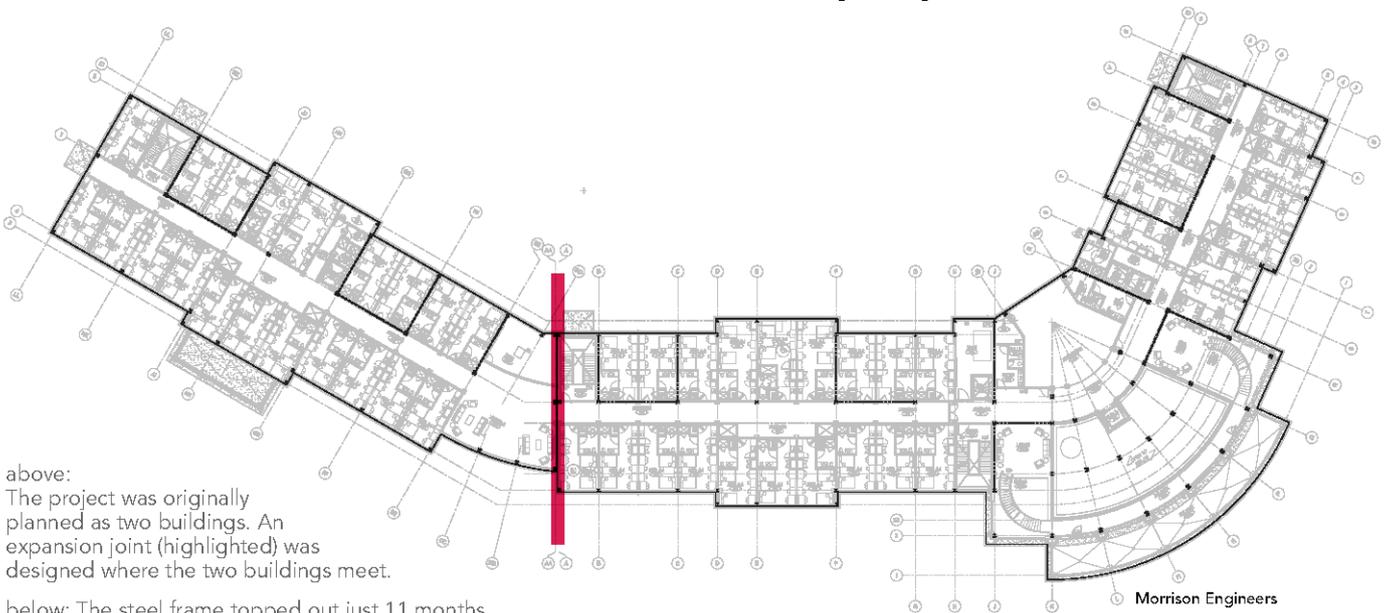
Shortening the time from design to fabrication was another important schedule-saver. It started with Morrison, which designed and detailed with common steel sizes that were likely to be readily available based on conversations with SteelFab, the project's fabricator. SteelFab was engaged early in the project, which was essential for determining where the project fell within mill rolling schedules and material lead times. Using common sizes for primary members helps combat longer lead times and creates more potential sources for acquiring those members.

"We like to get the mill order set of drawings from the engineer of record early," said Rob Johel, SteelFab vice president and Panther Commons project executive. "That entails the engineer of record locking in the main member sizes: columns, beams, and girders. It also means locking in vertical brace locations, elevations—building heights and foundation depths—and all grid and bay spacing. That's what we need in the mill order package. With it, we can give it to the detailer, which can create the advance bill of material and allow the fabricator to start ordering material."

The largest beam on the project is a W27×94 and the largest column W12×120—well within the range of readily available and widely produced. Many of the filler beams were W18×35. They were designed to be repeatable, another fabrication cost and time saver.

"In detailing, if you have something repeatable instead of 50 different pieces, you make one detail and say to do it 50 times," Johel said. "We like to put that in the shop all at once, and you knock out that beam repeatedly instead of changing for a particular nuance."

A steel mill order drawing package was released in March 2022 before full permit drawings (released July 2022) to advance the steel delivery date. Supplemental steel such as slab edges, HSS lintels, and bottom-flange bracing, were purchased after the contract drawings were complete and the sections and details were coordinated. The steel frame topped out in September 2022, just five months after the foundation permit was issued and 11 months after Morrison began design.



The building's two steel-framed monumental stairs have curved HSS stringers.

The building is on an intersection with two non-perpendicular streets, creating the irregular footprint. It has three orthogonal sections at different angles connected by two curved sections. Originally, the project was planned to be two separate buildings with a courtyard between them. However, during the schematic design phase, High Point decided to merge the two buildings into one large residence hall and commons. One building contains two orthogonal sections and a large curved section, and it's connected to the other building with a smaller curved section. Merging the buildings added a small amount of square footage while greatly improving the students' access to the amenities.

An expansion joint was designed where the two buildings meet due to the overall size and irregular shape of the building. Side-by-side W12 steel columns were implemented to provide complete separation of the building framing at the joint, which simplified the joint detailing. Slab isolation joints were added on the elevated floor slab around the fitness room to reduce vibrations from exercise equipment in adjacent dorm rooms. The concrete slab was discontinuous and supported by steel shelf angles with neoprene bearing pads.

There are two steel-framed curved monumental stairs connecting the second and third floor lobbies. The stringers are curved HSS20x4x3/8 tubes, and each terrazzo tread is supported by a pair of HSS3x3x1/4 tubes. The base of the stringers were welded to steel embed plates, which were cast-in to the second-floor slab on metal deck, providing a flush connection for floor finishes.

Owner

High Point University

Architect

Mercer Architecture

Structural Engineer

Morrison Engineers, PLLC

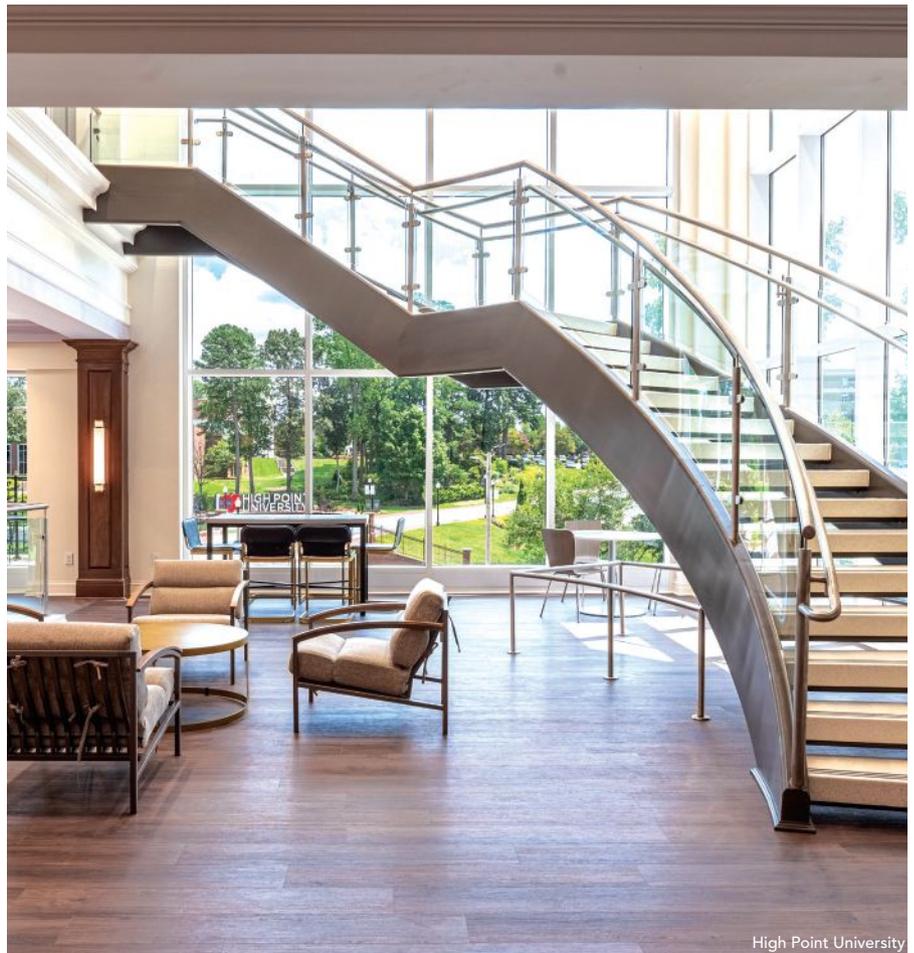
General Contractor

Samet Corp.

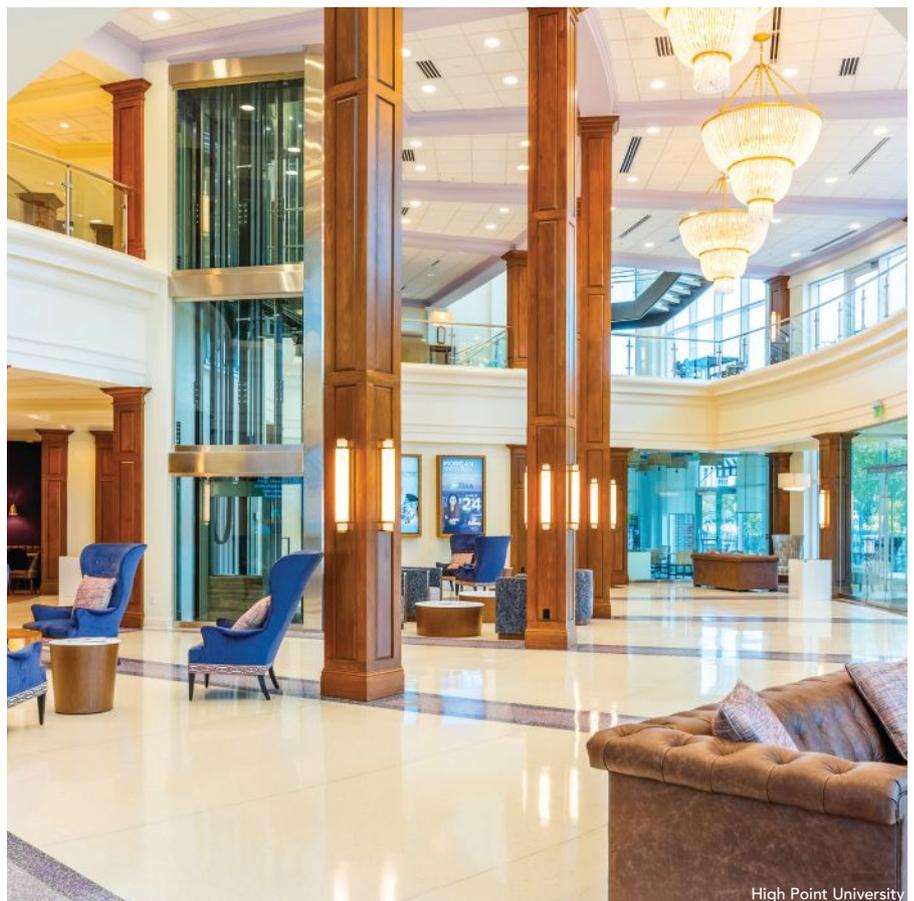
Steel Fabricator

SteelFab 

The 175,000-sq.-ft hall has a two-story atrium that greets visitors.



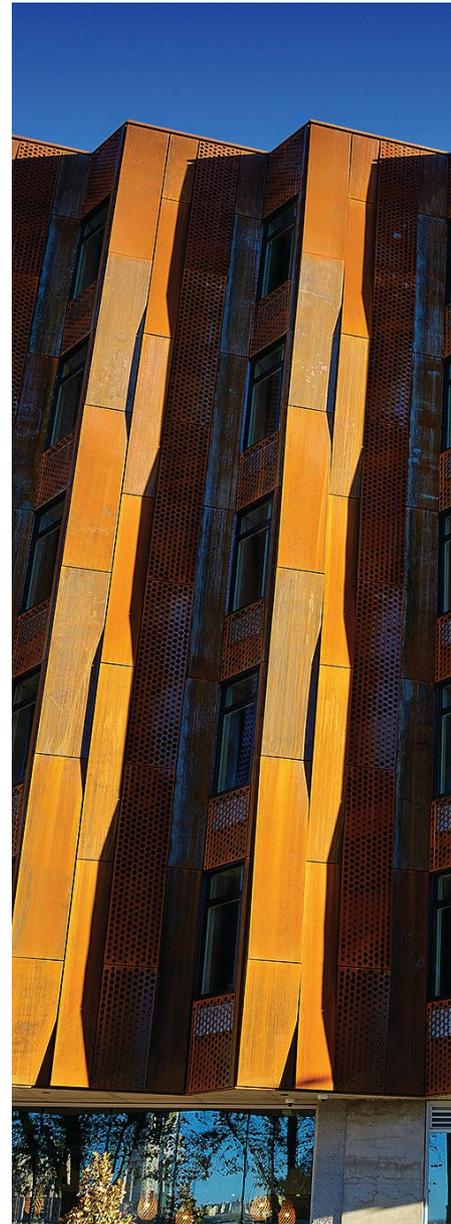
High Point University



High Point University

COOL
Façade
Material

Expressing Itself



IN RECENT YEARS, architects have returned to an idea that dates to Le Corbusier and Louis Kahn: Materials should be used honestly, with their natural qualities expressed rather than concealed. That means brick is left unpainted. Stone is not coated to look like something else. And steel, when exposed, should perform and weather on its own terms.

Weathering steel, originally trademarked as Cor-Ten by U.S. Steel in the 1960s, embodies this approach. U.S. Steel originally developed it for its corrosion resistance in industrial applications. While weathering steel has long been a common bridge girder material choice and has its own ASTM standard (A588), its other uses waned in popularity before re-emerging as an architectural cladding material. Today, it is increasingly found in façades, rain-screens, and shading systems, often as the primary façade material. Its ability to patina into a stable rust-colored finish has made it an economical and sustainable choice for contemporary projects.

Weathering steel is uniquely suited for façade applications because it solves several persistent problems that architects face with exterior finishes. Perhaps most importantly, it provides longevity. Once the patina develops, the material stabilizes, protecting

the steel beneath and ensuring the surface appearance will endure for decades. Unlike painted metals, there is no coating to peel, chip, or reapply. A finished patina looks virtually the same after six months as it will after a century.

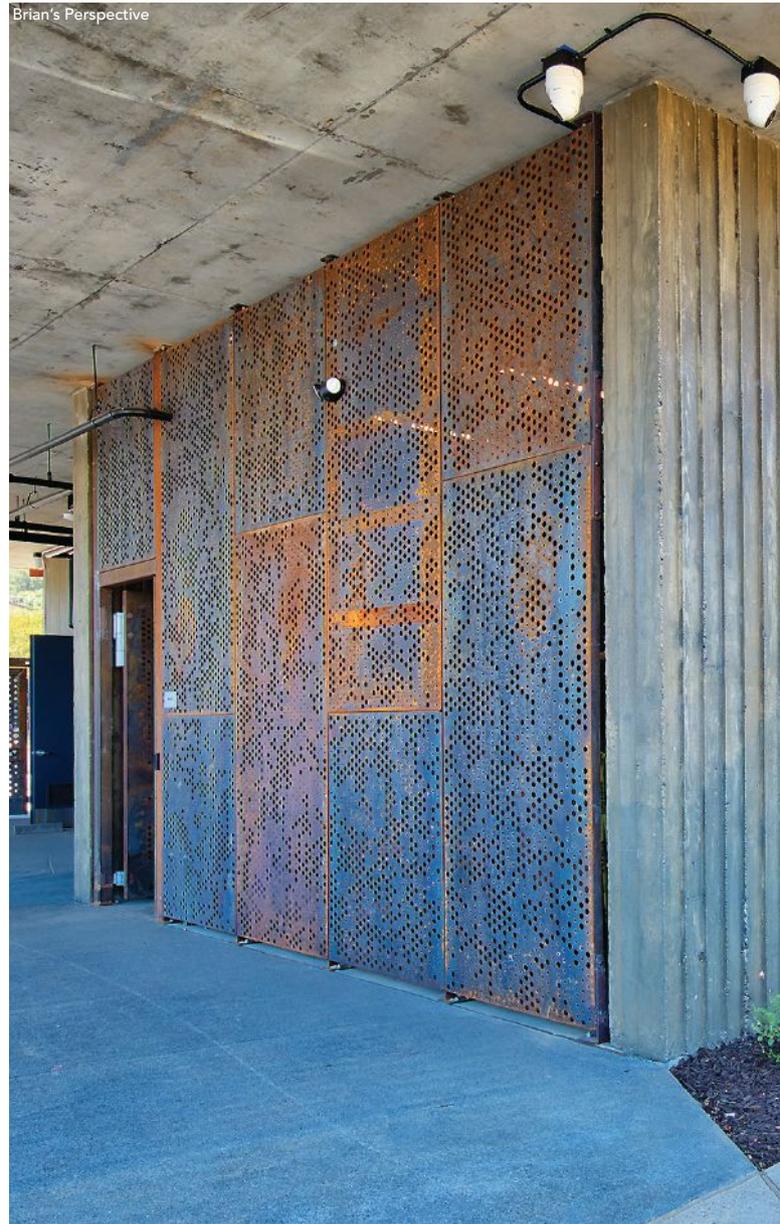
Except for the occasional rinse to remove environmental buildup, weathering steel cladding requires no maintenance. Even in the event of surface damage, graffiti, or scratches, the patina self-heals over time, blending new marks into the larger surface. The self-healing makes the material uniquely resilient amid inevitable wear when used in urban environments.

Weathering steel cladding systems bring a sustainability boost. Steel is 100% recyclable and often produced with high recycled content. By eliminating paints, coatings, or composite layers, it avoids additional processes that increase environmental impact. Compared to products such as stucco, fiber cement, or laminated aluminum panels, weathering steel offers a more straightforward end-of-life pathway and a smaller carbon footprint.

Weathering steel can be laser-cut, perforated, or formed into three-dimensional shapes that other systems cannot achieve. The



Brian's Perspective



Brian's Perspective

strength-to-thickness ratio enables long spans without requiring secondary steel support, allowing for efficient and lightweight assemblies that still meet structural demands.

One of the most frequent concerns about weathering steel—and part of its prior fall-off—is the potential for rust to drip. In its early exposure period, runoff can stain adjacent concrete or paving. In practice, most of this initial dripping occurs before sidewalks or landscaping are complete, minimizing its impact. For projects where staining must be avoided, integral gutters can be added into the panel design. These channels direct runoff into storm drains, planters, or gravel zones until the patina stabilizes.

Rather than viewing the patina process as a flaw, it should be regarded as part of the story of an honest material. Like stone that weathers or wood that grays, the change over time expresses authenticity. Panels can be pre-weathered before installation to avoid the early stages altogether.

Fabrication, Connections, and Installation

Fabricating weathering steel panels is straightforward compared to other cladding systems. The essential tools are a laser

cutter and a brake press. The laser cuts both the panel perimeter and any perforations or patterns that may be present. The brake press introduces structural folds that give the panel rigidity and eliminate the need for bulky framing.

Although the physical fabrication process is simple, the real work lies in design coordination and shop drawings. Every project requires precise planning to ensure panels align with the building geometry and accommodate waterproofing. This pre-fabrication effort enables the panels to be installed efficiently in the field. Fastening is handled with stainless steel anchors and concealed fasteners to avoid galvanic corrosion between dissimilar metals. Mounting brackets are minimized to reduce penetrations through waterproofing layers, an advantage for steel projects.

Durability in façade systems depends as much on connections as on the panels themselves. Stainless steel fasteners separate dissimilar metals and avoid deterioration through electrolysis. All visible fasteners are concealed for aesthetics and to minimize exposure. Combined with the self-protecting patina of weathering steel, these details ensure the system will perform for the building's entire lifespan.



Case Study

One example of weathering steel's potential is a steel modular housing project in San Francisco constructed from prefabricated boxes stacked on-site. As with many modular assemblies, misalignments of up to 4 in. occurred between modules after installation. Rather than relying on extensive secondary steel to disguise the discrepancies, manufacturer BÖK Modern engineered a weathering steel rain screen system that concealed the irregularities within the depth and folds of the panels. The result was a seamless façade that reads as a continuous surface despite significant variation in the underlying structure.

This project highlights one of weathering steel's greatest advantages: the ability to achieve complex articulation with minimal substructure. Folding strength directly into the panels created an undulating surface that delivered the architect's vision while simplifying installation and controlling cost.

Staying Honest

The resurgence of weathering steel is part of a broader cultural shift in architecture—architects and clients are once again valuing materials that reveal their inherent nature. Materials should be allowed to tell their story, to weather, and to carry their history forward into new contexts.

Projects sometimes rely on painted surfaces designed to imitate something else, such as fiber cement that mimics wood or metal panels painted to resemble stone. These solutions may be cost-effective in the short term, but they often lack authenticity and tend to degrade quickly.

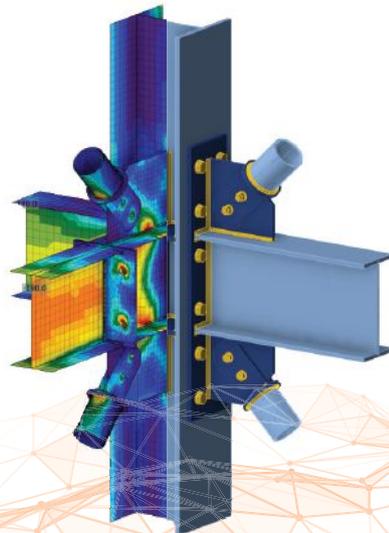
Weathering steel, meanwhile, offers authenticity and performance. Its patina conveys permanence, and its longevity makes it a practical choice for projects where budgets and maintenance cycles are critical, such as affordable housing, civic buildings, and schools.

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Bigger and Better



Nic Lehoux

The expansion to the O'Hare international terminal added 10 new gates and 350,000 sq. ft.

THE 30-YEAR-OLD INTERNATIONAL TERMINAL at Chicago O'Hare International Airport is set for decades of functionality after a steel-framed expansion.

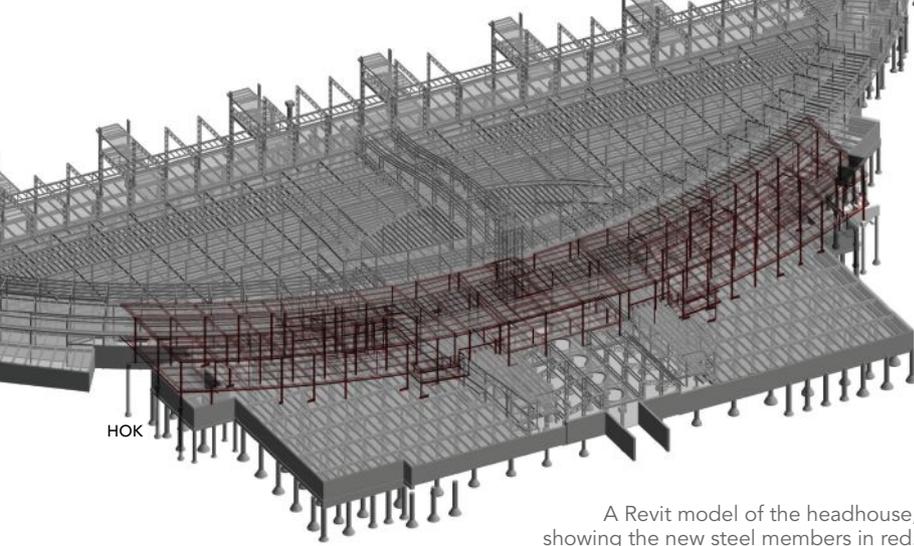
The project, completed in early 2023, delivered a reinvigorating design language of sweeping rooflines that seamlessly integrated into existing structures and circulation spaces. It consisted of two main additions to the existing terminal totaling 350,000 sq. ft: An L-shaped addition to the east concourse and an expansion of the headhouse atop the existing structure. This endeavor is the terminal's first major expansion since opening in 1993 and increases the terminal's capacity by 25% by adding 10 new gates, associated hold rooms, retail and dining, and upgrading existing gate sizes to accommodate larger aircraft.

Structural steel was the natural material choice, as it is for almost all major aviation renovations and additions, because of the concourse expansion's long-span roof and necessity to minimize the headhouse expansion's weight due to the existing structure's limitations. The existing terminal is a steel structure, and choosing steel for the renovations simplified modifications to the original frame. Speed of erection and flexibility to accommodate complex geometries also factored into the material choice.

Complex Concourse

The two-story, 46-ft-tall east concourse extension structure consists of wide-flange steel beams, girders, and columns supporting composite slab on metal deck floors and a metal deck roof. Steel moment frames discreetly provide lateral force resistance. Its clerestory is created in the interstitial space between low and high portions of a series of bent steel girders that span 67 ft across the concourse width. The depth of bend in the steel girders increases at each gridline as the clerestory deepens toward the central retail space and tapers again to the north. The central vaulted volume, located below the deepest portion of the gently sweeping roof, functions as a town square with commercial space. It's supported by four distinctive sloping steel columns and a wide-flange roof framing system that spans up to 87 ft.

Additionally, the concourse expansion includes a new 91-ft-tall ramp control tower that uses steel columns and braced frames at all levels except for the cab level, where moment frames maximize visibility. The tower connects to the ground with a narrow footprint. As it rises above the concourse, the dynamic tower form—clad in a GFRC façade—expands to a cantilevered cab level that overlooks the apron surrounding the concourse.



HOK

A Revit model of the headhouse, showing the new steel members in red.

A primary project goal from the early stages of design was to achieve the striking building geometry and open column-free spaces as economically as possible. To reduce costs, the structural team worked closely with the architectural team to select a column arrangement that allowed the geometrically complex roof with clear spans of up to 87 ft to be structured entirely with wide-flange beams and girders and avoid the need for built-up trusses or plate girders.

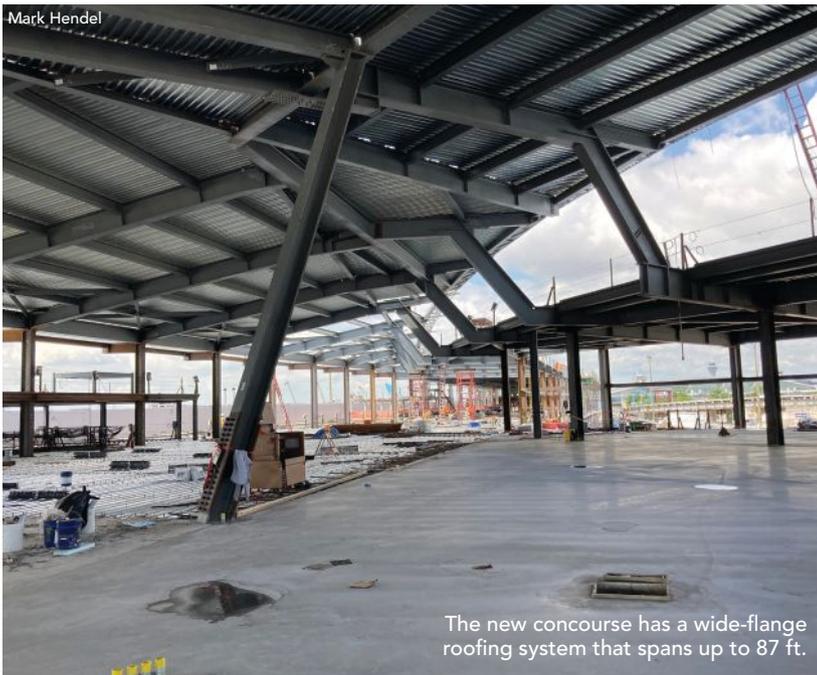
During the design phase, the HOK structural engineering team worked with general contractor Austin Power Partners to ensure that the structural strategy and associated details developed for the folding roof were achievable and reasonable from a construction standpoint.

The structural team worked with the architectural designers to define the final roof massing. The team also developed a parametric script in Grasshopper that defined a series of intersecting planes and tilted single-degree-of-curvature barrel vaults to approximate the architects' desired curved roof. The parametric script allowed the architectural team to adjust the roof massing to meet their vision while ensuring that the resulting bent girders and beams were structurally acceptable, line-of-sight clearances were met for the ramp control tower, and minimum roof slopes were achieved in all areas. The resulting geometries were then reviewed during the design phase with Austin Power Partners to ensure the constructability.

Additionally, the script produced the centerline geometry for all beams and bent girders. It was exported to the structural analysis model and Revit for modeling and documentation. It also produced top-of-steel elevations at all necessary control points to define the bent girders that cross the clerestory roof. These control points were added directly to the construction documents and used by the fabricator, LeJeune Steel, and the detailer to define the roof steel geometry.

The roof clerestory follows a parabolic path in plan from expansion joint to expansion joint, completely separating the diaphragms of the lower and upper portions of the roof. Given the distribution of moment frames along the perimeter of the building, neither the lower nor upper roof diaphragm is independently stable without connection to the other.

Therefore, diaphragm forces are transferred through the bent girders. In the direction parallel to the span of the girders, the diaphragm force is transferred through axial loads in the bent girders. In the direction perpendicular to the span of the girders, framing perpendicular to the bent girders is used to form weak-axis moment frames that transfer shearing diaphragm forces along the clerestory's edge between the lower and upper roof diaphragms, resulting in one cohesive laterally connected roof structure.



Mark Hendel

The new concourse has a wide-flange roofing system that spans up to 87 ft.

Nicholas Micheels

A light steel frame and composite slab on metal deck structure minimized the weight imposed by the new headhouse.



Weight Watch

The headhouse expansion creates new spaces for hold rooms, airline clubs, baggage handling equipment, a mechanical penthouse area, and a bus terminal for passengers transferring to other terminals. The new structure is built upon an existing basement level that extends beyond the footprint of the above-grade structure and houses the Customs and Border Protection hall. The hall had to remain operational during construction with minimal disruption to the space, so the new two-story structure above the hall was optimized to not locally overstress the existing structure below.

A light steel frame and composite slab on metal deck structure minimized the weight imposed by the new structure and enabled the addition to proceed without modification to the existing building foundations. Further, distributed moment frames avoid applying lateral force concentrations to the existing structure. Finally, at the apron level, the existing thick concrete paving was removed from the expansion footprint and replaced with a built-up lightweight concrete slab on rigid geofoam to lighten the combined new and existing structure as much as possible.

For functional reasons, the columns of the new two-story headhouse expansion did not match the existing column locations in the customs hall below the apron level slab. The existing apron level structure acts as a transfer level to support the new columns above. Support of the expansion was structurally facilitated by the existing heavy apron level structure above the basement, which was originally designed to support 200,000-lb point loads from jumbo jet landing gear by using 23-in.-deep structural concrete on W36 beams spaced at 8 ft on center.

Transfer beams were placed above the existing slab to transfer new column loads to adjacent existing framing below to avoid the need for added framing within the apron level structure where new columns didn't align with existing framing. The new transfer beams were placed within the depth of concrete previously occupied by tarmac paving and now occupied by a built-up slab on geofoam. They did not protrude into the new finished space above.

Elevate the Existing

Expanding and modifying the existing Terminal 5 allows the facility to continue operating at a high level and substantially reduces embodied carbon compared to building a new facility. The \$1.2 billion expansion project provides the airport with room to grow and a serene gateway for travelers. The design language and steel structural system create new focal points and quietly integrate with existing systems at interfaces, delivering a congruent visual experience for passengers and staff.

Owner

Chicago Department of Aviation

Architect

HOK and Muller2 (now part of GFT)

Structural Engineer

HOK

General Contractor

Austin Power Partners

Steel Team

Fabricator

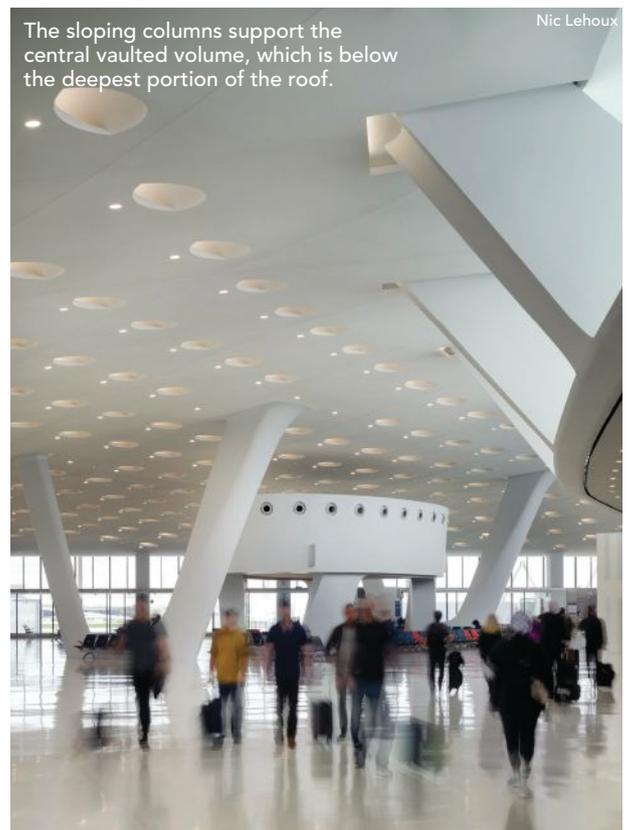
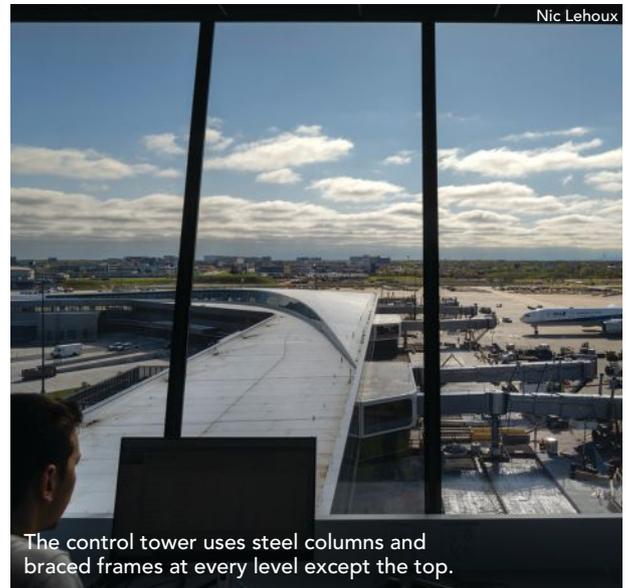
LeJeune Steel 

Erector

Complex Structures Group 

Bender-roller

Chicago Metal Rolled Products 





Steel Meets Governance

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Photos courtesy of Dan Schwalm (c) 2025 HDR unless otherwise noted.

The new three-building justice center complex totals 243,000 sq. ft.

A PUBLIC-PRIVATE PARTNERSHIP in Nebraska created a new facility that allows children and families to find numerous services under one roof. The Douglas County Justice Center in Omaha, Neb., brings together juvenile courts, the public defender's office and the county attorney.

The Omaha Douglas Public Building Commission purchased a one-block site for a new youth center and office tower immediately south of the county's 110-year-old courthouse. Together, with an existing office building, they comprise the 243,000-sq.-ft justice center.

As a material, steel took a front-and-center role in the justice center's construction and resulting benefits. Two of its buildings use composite steel systems with braced frames to achieve low floor-to-floor heights and speed construction.

The complex is organized around an inviting public courtyard filled with sculptures, benches, and trees. The tower is an eight-story building connected by a sky bridge to the courthouse. Its structural steel system was selected based on construction preferences, speed of erection, and cost. Concrete was initially considered for the youth center due to its common use for detention facilities. However, HDR's design team ultimately favored steel for its lower embodied carbon.

The third building was renovated for the juvenile probation department's offices. The renovation created a new workplace environment for a department located off-site in a Class B office building with security and accessibility issues. The new environment provides controlled access from the reception area and allows divisions to have standardized open-office workstations, conference rooms, and private offices.

Heights and Loads

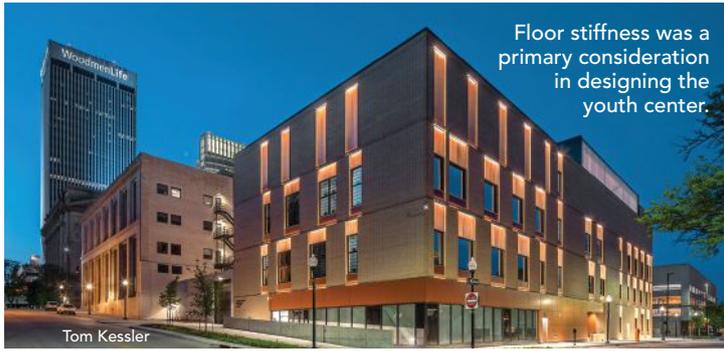
The eight-story tower contains courtrooms on Levels 2 and 3, with open office space on the floors above. Architecturally, the courtrooms are centered on the column lines. Traditionally, girders are placed on the column lines to transfer their heavy gravity load reactions directly into the columns.

To maintain cost efficiency, the floor-to-floor heights in the tower are 14 ft, 6 in. It was not possible to achieve the architects' desired 12-ft high ceilings in the courtrooms using a traditional framing layout with the girders centered on the columns. Instead, the design team shifted the girders off the column lines and placed them on either side of the courtrooms. Shallower beams were then framed between the girders, reducing the maximum beam depth from 30 in. to 16 in., allowing the full 12-ft ceiling height.

To resist lateral loads, braced frames are typically located in the building core next to stairs, elevators or mechanical shafts, so the diagonal braces have minimal impact on the floor plan. However, the tower's narrow east-west footprint caused the building core to be narrow east-west and elongated north-south, which meant locating north-south braced frames in the core that in turn posed challenges for placing east-west frames.

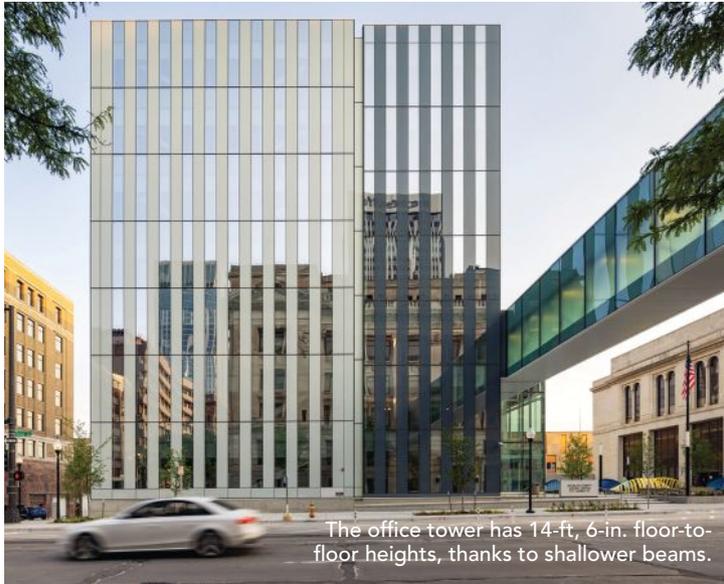
Further, the building's longer east and west sides meant larger exposure to east-west winds, which required more east-west bracing. The east-west braced frames were inefficient due to the narrow core width. To meet building lateral drift criteria, the east-west braced frames started extending into the office floor space, which would impact the layout of the open offices.

The HDR structural and architectural teams developed a lateral bracing system with two adjacent bays of east-west bracing

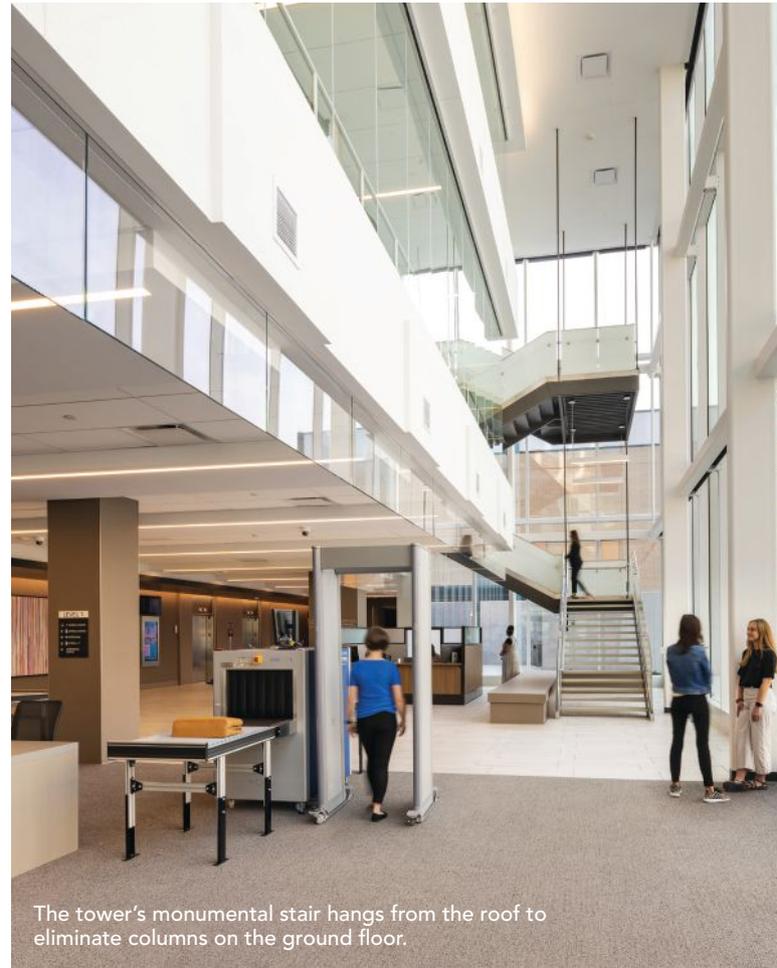


Floor stiffness was a primary consideration in designing the youth center.

Tom Kessler



The office tower has 14-ft, 6-in. floor-to-floor heights, thanks to shallower beams.



The tower's monumental stair hangs from the roof to eliminate columns on the ground floor.

located at the ends of the building. The floor diaphragms span the building's full north-south dimension between these braced frames, eliminating braced frames within the interior of the floor plate and creating 53-ft-wide by 200-ft-long open office space. The architects also liked the aesthetic created by the braced frames along the tower's north and south facades.

When wind blows on a building, the load tries to overturn the structure, creating tension on one side and compression on the other. The magnitude of the tension and compression is determined by the width between the elements resisting the overturning forces. The wider the dimension, the lower the tension and compression. As buildings get taller, the tension force, or uplift, can become larger than the gravity loads, creating a net uplift on the columns. In the justice center, the two-bay-wide braced frames resist the overturning forces over a 52-ft width, which reduced the net uplift on the columns and resulted in no uplift in most cases.

The county attorney's three divisions—previously scattered around the old campus—are now consolidated onto two floors. The public defender's office, which was previously in a windowless portion of the complex, now occupies one-and-a-half floors. The new design relocated six juvenile courtrooms and provided space for two future ones, and their sizes and arrangements are now consistent. A shared first-floor conference center can hold up to 115 people or be divided in half.

Stiffness and Slabs

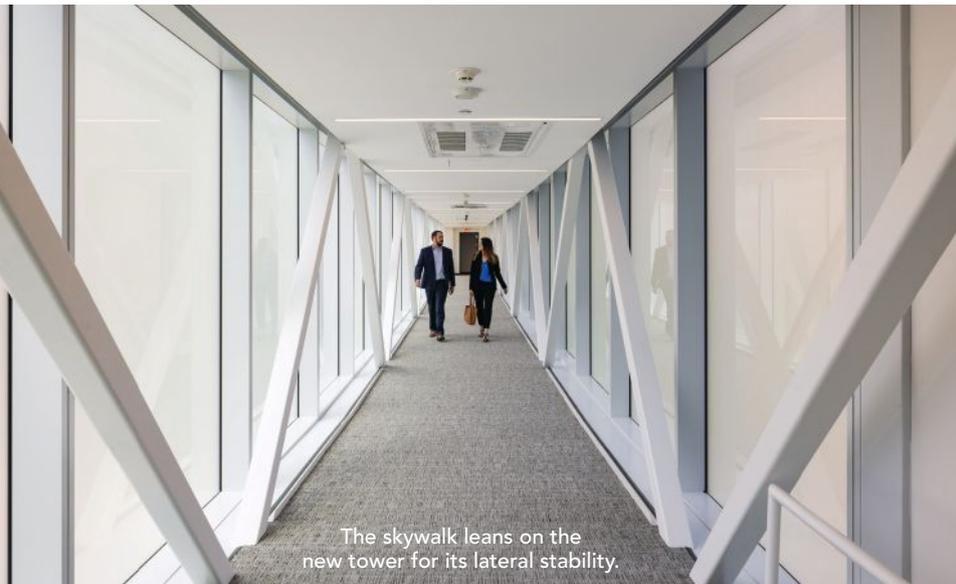
The youth center has 64 short-term beds, classrooms, a gymnasium and an outdoor secure recreation yard for pre-adjudicated

youth. It connects to the tower to allow for a private circulation path to the juvenile courtrooms.

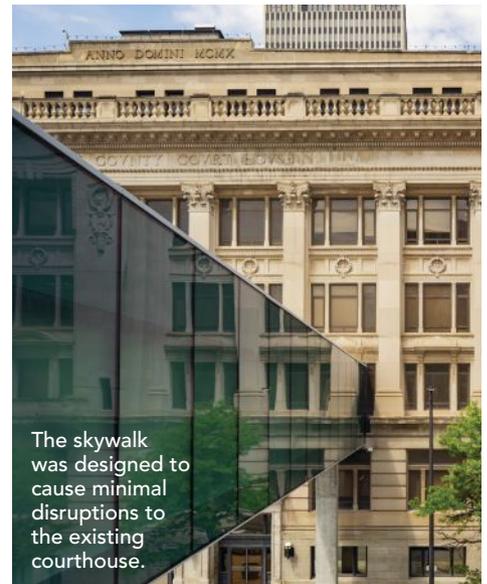
Floor stiffness was a primary consideration after choosing steel for the youth center. Concrete block walls are more brittle than gypsum board walls and require stiffer support. If the floor deflects too much, cracks will appear in the concrete block walls. Deeper beams provide greater stiffness but cost more and impact ductwork and pipe routing. The structural team constantly balanced beam stiffness, cost efficiency and depth.

The floor slab design consists of a composite metal deck with concrete fill. To accommodate high line loads caused by the concrete block walls, a thicker concrete slab was selected to enhance shear capacity and reinforcing steel was added to increase moment capacity. For security reasons, most of the electrical conduit was cast into the slab rather than surface-mounted or hung below the slab. HDR's team worked with the contractors to develop conduit placement guidelines that preserved the structural integrity of the slab and the composite steel beams. The number of cameras, access card readers, and other security-related items and their requisite additional conduits increased the complexity of this coordination effort.

Composite steel beams use headed studs to tie the beams to the concrete slab, allowing them to work together as a deeper beam. If the conduits are placed too close to the headed studs, they could reduce the capacity of the studs and the beam. The electrical contractor prepared layout drawings for the in-slab conduits, which HDR's team reviewed in addition to conducting on-site inspections before each slab pour to verify proper clearance between the conduits and the headed studs.



The skywalk leans on the new tower for its lateral stability.



The skywalk was designed to cause minimal disruptions to the existing courthouse.

Airing the Atrium, Shaping the Skywalk

The building's structural engineering is a hallmark of the overall design, most noticeably in the lobby atrium and the skywalk between the courthouse and tower. The three-story atrium features a monumental stair at the tower's main entry. Its exposed steel framing in the atrium allows the public to get close to it, and the glass becomes transparent at night to display the atrium prominently. Since the structural frame is so important to the atrium's aesthetics, the team acknowledged the stair and atrium frame detailing would require special attention.

The structural and architecture teams closely coordinated the atrium's member sizing and detailing. The columns supporting the roof are uniformly spaced and match the mullion spacing of the curtain wall. There are no columns at the corners of the atrium, allowing for more unobstructed views. The team coordinated the horizontal girts with the curtain wall mullions and the mechanical fin tube system to minimize exposed piping. The erector field-welded the horizontal girts to the columns, which was more expensive but provided a clean connection between the two.

The stairs hang from the roof to eliminate columns on the ground floor. Because they are in tension, the hangers have a smaller cross-section than a column would. Stair stringers were kept at a uniform depth and provided special details to maintain that depth back to the supporting slab edges.

The team wanted the skywalk design between the tower and courthouse to minimize impact on the courthouse. The skywalk cantilevers 14 ft, 7 in. past a concrete supporting column to meet the courthouse, so the only impact on the existing building was a hole in the wall, cut to provide access between the courthouse and the skywalk. If the courthouse supported the end of the skywalk, the existing courthouse structure would have required structural strengthening.

The skywalk leans on the new tower for lateral stability north-south. For east-west lateral loads, the floor and roof diaphragms cantilever off the tower, and at the north end of the skywalk, a concrete column cantilevers off the foundation to provide additional stiffness.

At the tower end of the skywalk, the architects aimed to preserve a clean aesthetic by avoiding the placement of a column adjacent to the building. They also wanted to maintain the skywalk's slim profile, so it was not possible to cantilever a support from the tower structure. The solution was to add a north-south joint

between the skywalk and tower and let the skywalk slide by the north 27 ft of the tower to a support at the north end of the atrium.

The truss height was closely coordinated with the mechanical team to minimize the truss depth while allowing enough room for the MEP systems. The truss diagonal spacing was coordinated with the curtain wall, so the truss panel points aligned with window mullions.

Savings Strategies

The structural team worked closely with the general contractor, Kiewit Building Group, throughout the project, so they could update estimated construction costs during design and provide constructability input. The project was issued in multiple packages to facilitate the aggressive design schedule. The structural design was issued in an early foundation and mill order package, an early frame package, and a core and shell package. Foundations were built and steel fabricated before the architectural design and drawings were completed.

Sustainability was a consideration for all disciplines throughout the project, and one of the more interesting structural examples is in the column design. ASTM A992 Grade 50 steel is the most commonly used steel for wide-flange shapes and has a tension yield stress of 50,000 psi. Most columns in the justice center are ASTM A913 Grade 65 with a tension yield stress of 65,000 psi. Although cost of the A913 steel was between 2% and 5% more than A992, the higher yield stress reduced column weight by 8% to 12%. This simple change reduced the amount of steel in the columns by roughly 10%.

The facility opened in summer 2023 and cost \$123 million to build. It has 1,565 tons of structural steel. ■

Owner

Omaha Douglas Public Building Commission

Architect and Structural Engineer

HDR

General Contractor

Kiewit Building Group

Steel Team

Fabricator

Paxton & Vierling Steel 

Detailer

H&R Steel Detailing 

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“

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Structural steel saved time and tonnage, created openness, and managed seismic requirements for San Diego's new airport terminal.

Braced for the Future

BY JULIETTE PEYROUX, SE, PE AND
KEVIN KUNTZ, SE, PE



THE NEW TERMINAL 1 at San Diego International Airport has a steel frame that facilitates grand architectural statements, allows ample light and views, and meets high-seismic area considerations with a buckling-restrained braced frame (BRB) system that also contributed to the building's open feel.

In 2020, the airport embarked on the design and construction of a new terminal to replace the existing one, which opened in the late 1960s. The new terminal, with its 10,000 tons of structural steel, is the first of the project's two phases and opened in September. A second phase that will demolish the original Terminal 1 and add gates in its place is scheduled for completion in 2028. This comprehensive redevelopment project required more than additional gates and expanded amenities. It was a re-examination of the structural systems, material strategies, and construction methodologies necessary to deliver a terminal that could meet immediate capacity needs while also providing long-term resilience, sustainability, and operational efficiency.

The airport's stakeholders developed a program definition document (PDD) that included criteria to deliver high-performance, sustainable features, efficiency, climate resilience, and inspiring architecture. The plan envisioned a striking new three-story terminal with 30 gates and more than 1 million sq. ft of programmed space, complemented by a new roadway system, parking plaza, smart curb, pedestrian bridges, and even a relocated historic hangar.

The project team quickly realized that structural steel was the only material capable of delivering the technical performance and architectural expression the project demanded. Steel enabled long-span construction, which eliminated interior columns and created open, light-filled spaces critical to the passenger experience. The team leveraged steel's ability to meet stringent seismic codes, blast requirements, and strict vibration criteria.

Typical infill framing consisted of W18 beams supporting 3¼-in. lightweight concrete on 3-in. steel deck at 9 ft spacing

RESILIENCE FEATURE STORY

The new Terminal 1 at San Diego International Airport opened in fall 2025.



Kirk Hostetter Photography



Gensler

Choosing a braced frame scheme (left) over a moment frame scheme (right) allowed for the removal of more than 100 columns.



Gensler

Braced frames are visible in the ticketing hall and security checkpoint area, which was designed to allow ample natural light.



Kirk Hostetter Photography

with W14 columns. A steel BRB system was chosen as the seismic force-resisting system. Equally important, steel offered unparalleled constructability and contributed to speedy and seamless steel erection. Concrete and timber framing were briefly considered, but structural steel offered the strength-to-weight ratio, speed of construction, economy, and the sustainability profile necessary to optimize performance.

First Impressions

The smart curb—the first passenger touchpoint—was designed to transform the departures experience. Passengers can check in and drop off bags right at the elevated departures roadway, shielded by a sleek canopy that frames the entrance.

The design appears effortless, but it represents a deliberate structural shift. Unlike Terminal 2 West's concrete smart curb structure, structural engineer Magnusson Klemencic Associates (MKA) suggested steel for Terminal 1's smart curb as a more lightweight and efficient design choice, with polytetrafluoroethylene (PTFE) canopy structures to harmonize with the

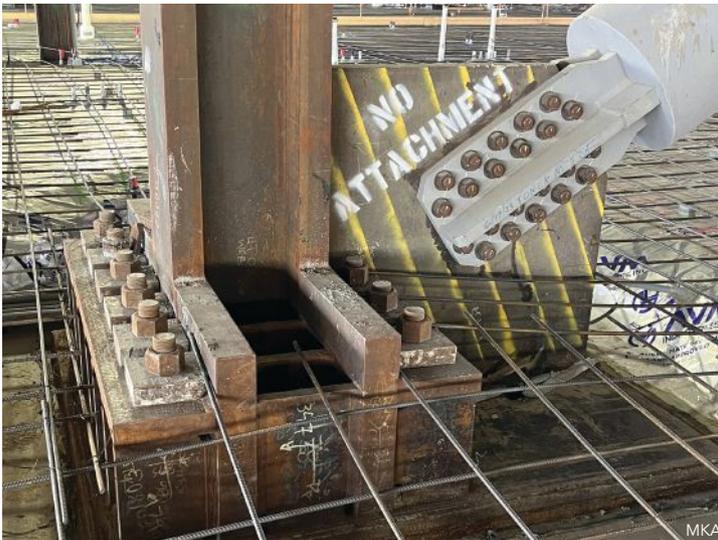
similar Terminal 2 West curbside design. The elevated canopy and supporting structure were designed by two different engineers, MKA and Enclos Tensile Structures, as a vertical combination system. A capacity approach based on the BRB structure limited seismic demand on the steel special cantilever column system above.

Perhaps the most iconic feature of the new terminal's exterior is the luminous wave wall, an 800-ft-long façade of curved glass designed by a joint effort between Gensler, the architect of record, and artist James Carpenter. The wall is hung from the roof and laterally supported by horizontal steel trusses that span between the southern building columns. It glimmers with daylight, reflecting the sky and harbor. MKA collaborated with Gensler to integrate the BRBs into the façade vision. The BRBs were laid out symmetrically to frame the center of the new ticketing hall. Casing shapes were matched, gusset plates coordinated with architectural column encasements, pin connections were used, and architecturally exposed structural steel (AESS) Category 3 was required to showcase the seismic force-resisting system.



above: The 100-ft pedestrian bridge to the terminal is comprised of steel trusses and castings.

below: Base connection of a BRB into a pile cap.



Shear plates cast into the pile cap.

RESILIENCE FEATURE STORY

After checking bags, travelers cross into the terminal via two pedestrian bridges spanning 100 ft across the arrivals roadway. The bridges are comprised of steel trusses laid out in a Warren pattern with round HSS diagonals, with steel castings provided by CAST CONNEX. They were fully assembled on the ground and lifted into place, minimizing disruption to construction operations and showcasing a joint effort across design, fabrication, and erection.

Structural Efficiency and Openness

Inside the terminal, travelers are greeted by a sweeping hall with ceilings more than 27 ft high, where light pours through tall glass and artwork creates a sense of place. Nova Jiang's *Torrey Pines* installation spans above the 13-lane security checkpoint, referencing the region's natural beauty while welcoming passengers into a space that feels open and calm.

The terminal's openness is the result of a pivotal structural choice: instead of the traditional steel special moment frame lateral system envisioned in the PDD, MKA proposed a BRB system

that allowed the removal of more than 100 columns, which had previously been used to limit drifts for the moment frame system. Instead, an expansive truss made up of W14 chords and double-angle diagonals could support the ticketing hall roof. These changes resulted in a 30% steel tonnage reduction.

The results extended far beyond aesthetics. The BRB system not only achieved the owner's vision for a more open terminal but also saved tens of millions of dollars in construction costs, shortened the erection schedule, and cut embodied carbon significantly. A two-pronged approach enabled the erection of approximately 10,000 tons of steel in just six months on an active airport site.

Beyond the checkpoint, the terminal opens into concourses defined by more openness, daylight, and views of San Diego Bay. The airside curtain wall system, composed of 30-ft-tall unitized panels, brings natural light deep into the concourse. Roof popups and angled structures further support clerestories, reducing reliance on artificial illumination and strengthening the connection to the outdoors.

Secondary members within the primary structure support concessions and retail areas, while an outdoor dining terrace made up of rectangular HSS that meet AESS Category 3 provides direct harbor views. MKA designed the concourse floor to meet stringent vibration and deflection criteria, guided by AISC Design Guide 11: *Vibrations of Steel-Framed Structural Systems Due to Human Activity*, second edition (download or order at aisc.org/dg).

Remarkable Resiliency

Travelers are likely unaware of the seismic risks beneath their feet: Terminal 1 is located on liquefiable soil directly adjacent to the active Spanish Bight Fault, part of the Rose Canyon Fault Zone. Designing for this condition shaped every major structural decision, from foundations and apron slabs to column grids and lateral force-resisting systems.

Early seismic studies and coordination with the fabricator, W&WIAFCO, ensured the BRB system complied with the *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341). The braces required were larger and longer than industry standard, ranging from 4 sq. in. to 50 sq. in. with lengths exceeding 56 ft, and outside the range of typical U.S. testing. In response, MKA worked closely with W&WIAFCO and BRB supplier Seismic Bracing Company to use non-linear finite element analysis calibrated to known test results, and then extrapolated to the larger and longer sizes to meet *Seismic Provisions* K3.3.

The models included initial imperfections due to manufacturing tolerances, modeling of weld lines, and assessment of potential fracture at the core area to connection plate interfaces. Two peer reviews verified that the 238 BRBs would perform to the highest standards. Steel procurement occurred at only 30% design, allowing design-assist collaboration to resolve difficult connection details before fabrication and ensure smooth field erection.

Seeing Green

Throughout the terminal, travelers encounter airy spaces, abundant daylight, and iconic architecture, but another central goal is behind the visible design. Terminal 1 targeted LEED Silver certification, aiming to reduce embodied carbon. A rigorous life-cycle assessment (LCA) tracked six impact categories, including global warming potential, from the earliest planning milestones.

Initially, the PDD and industry-average environmental product declarations (EPDs) from sources such as Tally, EC3, NRMCA, and the Carbon Leadership Forum were used to establish baselines. As design advanced, EPD requirements were written into specifications, and project-specific data from subcontractors refined the LCA to provide greater accuracy.

MKA led the effort to refine grid spacing, optimize loading criteria, and use efficient steel shapes. MKA also coordinated with partners to reduce the building height, minimizing steel tonnage and concrete volume. The Buy America project requirements guaranteed that all structural steel was domestically produced, which inherently resulted in a more sustainable structure. Most domestic steel is made with an electric arc furnace, which uses an average of 92% recycled content and is 100% recyclable at end of life. EPDs were required from suppliers for all structural materials, ensuring accountability and transparency across the supply chain.

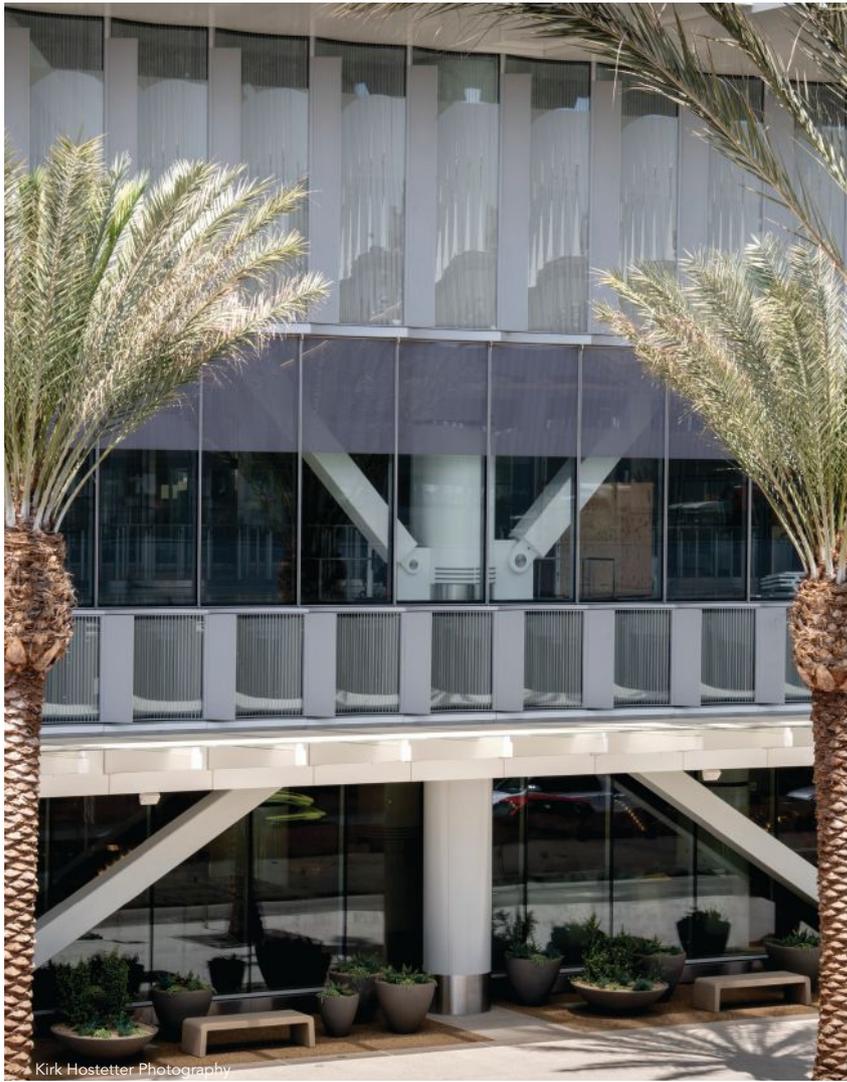
These measures achieved a verified 30% reduction in global warming potential while also extending the structure's life.



above: The outdoor dining terrace area is made of rectangular exposed HSS.

below: The airside curtain wall system is composed of 30-ft-tall unitized panels.

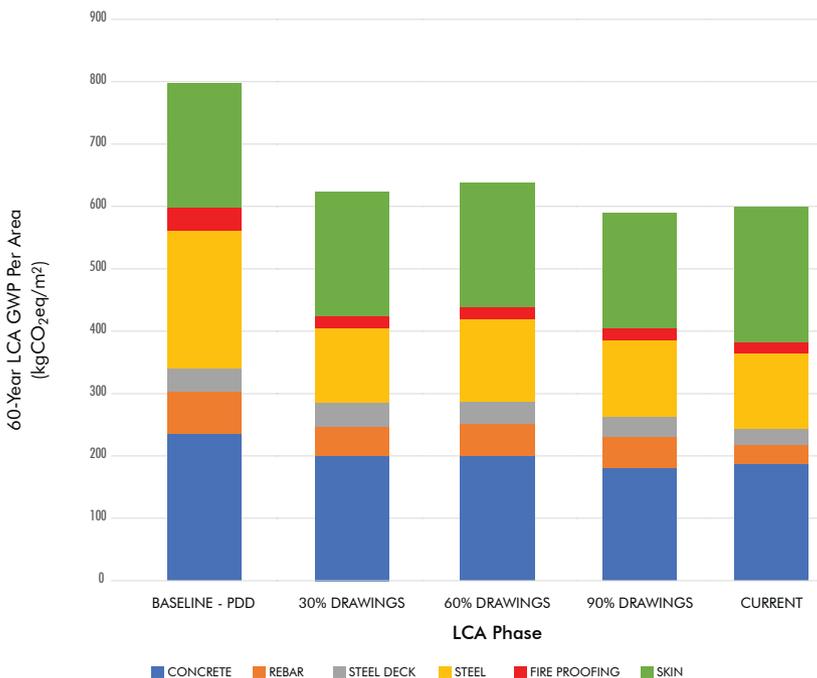




Kirk Hostetter Photography

above: Visible braced frames are AESS Category 3.

below: A 60-year LCA tracked six environmental impact categories, including GWP.



RESILIENCE FEATURE STORY

The piles' 100-year lifespan was confirmed through design calculations and consultation with a corrosion specialist due to the salt-rich soil adjacent to the bay. Iconic features like the wave wall are functional strategies for maximizing daylight harvesting and reducing operational carbon footprints.

A Terminal for the Future

Walking through SAN T1 is more than moving from curb to gate. Its design and construction illustrate how engineering decisions directly shape the passenger experience. At the gate, more than 25 million travelers a year will experience generous hold rooms, expanded amenities, and panoramic views of planes taking off and landing from the nation's busiest single runway. What feels like a seamless flow from curb to gate is the product of an integrated team that prioritized structural efficiency, architectural expression, and environmental responsibility in equal measures. ■

Owner

San Diego County Regional Airport Authority

Architect

Gensler

General Contractor

Turner/FlatironDragados Joint Venture

Structural Engineer

Magnusson Klemencic Associates

Steel Team

Fabricator and Erector

W&W|AFCO Steel 

Detailer

Pro Draft 



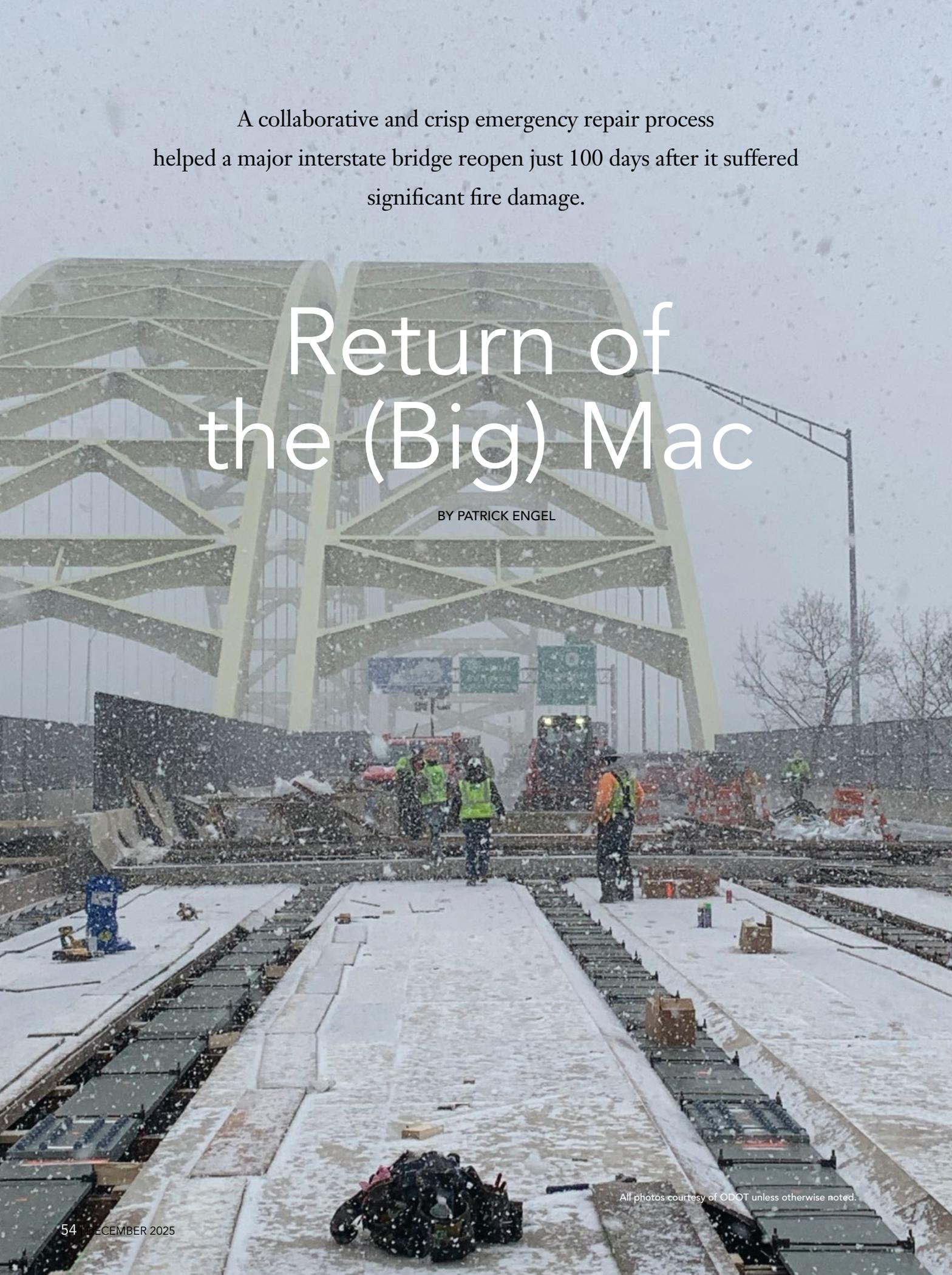
Juliette Peyroux (jpeyroux@mka.com)

is a principal, and **Kevin Kuntz** (kkuntz@mka.com) is an associate, both at Magnusson Klemencic Associates.

A collaborative and crisp emergency repair process helped a major interstate bridge reopen just 100 days after it suffered significant fire damage.

Return of the (Big) Mac

BY PATRICK ENGEL



All photos courtesy of ODOT unless otherwise noted.

The girder damage following the fire set to playground equipment below the bridge.

SPEED FEATURE STORY



WHEN OHIO DEPARTMENT OF TRANSPORTATION (ODOT) officials gained a clear picture of the arson-induced damage to the Interstate 471 bridge over the Ohio River, they initially envisioned an eight-month reopening timeline. That was their optimistic view.

A November 1, 2024 fire set to a playground below the southbound lanes of the Daniel Carter Beard Bridge in Cincinnati, known locally as the “Big Mac Bridge” because its yellow double-arched design evokes the McDonald’s logo. The fire damaged the steel superstructure and deck badly enough to require girder and deck replacement. A replacement meant ordering, fabricating, and delivering new steel, among many other steps, and starting the process in the weeks leading into the holiday season. ODOT’s gauge of the project scope and initial feedback on steel delivery birthed their conservative first estimate.

“We were floating the internal goal that it’d be nice to get this thing open in the summer,” said Chris Tuminello, ODOT District 8 area engineer.

Within two weeks, though, Stupp Bridge, a fabricator with ODOT projects and emergency repairs on its résumé, said it could deliver the seven necessary girders the week of January 13. Stupp met that date, and with the rest of the project team in lockstep, helped reopen the bridge to traffic on February 9, exactly 100 days after the fire and nowhere near even the rosiest of initial outlooks. The steel repair portion of the project also came in under budget, Tuminello said.

.....
opposite page: Crews worked through winter conditions to help the bridge open just 100 days after the fire.

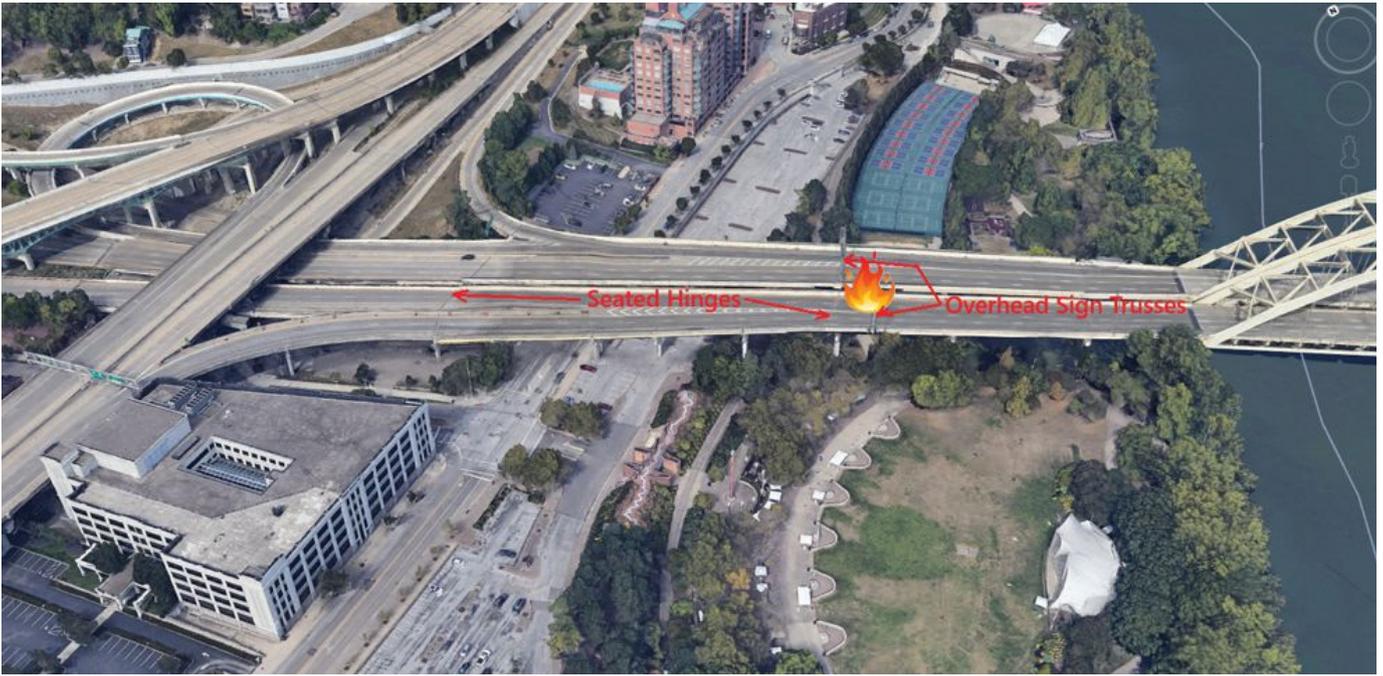
ODOT, like other DOTs, has an obligation to serve its state’s traveling public. When responding to unpredictable incidents, that means having an unbending sense of urgency to reopen critical infrastructure like the Big Mac Bridge, a primary artery through the Cincinnati region and one of five bridges connecting the city to Kentucky. A DOT’s job during an emergency becomes much easier when a fabricator and steel supplier feel that same obligation to the public, and this repair project is among the latest examples of steel partners prioritizing an emergency repair and collaborating to finish it quickly.

“On a normal job, it often takes a year to get plate girders from the time the contract signed to the time they’re going up in the field,” Tuminello said. “The commitment from the steel industry was the main reason why we got that bridge open in the time frame we did.”

Rapid Roundup

As is customary for fabricators working on emergency repairs, Stupp said it would devote extra hours to the project and make it a top priority at its Bowling Green, Ky., shop. Its plan for meeting the ambitious delivery date hinged on ODOT, general contractor The Great Lakes Construction Co., and owner’s design representative E.L. Robinson treating it similarly.

“Everybody that was a part of this project pushed work aside,” said Tom Hackett, a project manager at Great Lakes. “We shut down another job to take those resources from that project and shift them to the repair. Stupp did the same thing. It was basically part of the criteria to work on the project. This is going to take priority in your company.”



above: The fire was below the southbound lanes.

below: Identifying the extent of the damage and the necessary repairs took several days of inspections and tests.



Emergency repair projects create time savings by expediting lengthy processes, not by cutting corners and letting hasty work slide. Normal specifications and rules still apply to physical work. The bridge owner starts the time-saving chain by speeding up pre-design and pre-construction processes.

ODOT's typical project development process involves a phased approach. A scope and concept are developed in a planning phase, then the design and cost estimate are finalized in an engineering phase. The project is advertised, awarded to a general contractor, and the physical work is performed during a construction phase. Add them up, and it's a multi-year project timeline.

Emergencies are different, though. ODOT declared an emergency, allowing it to pick the contractor and sign an agreement with Great Lakes the day after the fire. The project team, led by the general contractor, then identifies the longest pathway to completion and how to shrink it. In many cases, that's material procurement, fabrication, and delivery. With steel bridges, it's an easy piece to shorten because of fabricators' and producers' eagerness to help during emergency repairs and help each other.

"A lot of times, fabricators are competitors," Hackett said. "I was surprised to see how well they collaborated, worked with each other, and recommended each other for certain things. It was impressive to see them come together and prioritize an emergency repair within their industry."

Stupp also felt inclined to help ODOT, even if it didn't earn the bid. Stupp sales engineer/territory manager Derek Manz and project manager Jeremy Stice visited the site November 8 to assist with visually inspecting the girders and determine the extent of the damage. At that point, ODOT and Great Lakes still weren't sure whether the northbound lanes needed replacing or the scope of the southbound lanes repair. And Stupp had not yet been awarded the bid.

"We wanted to help a good owner get a bridge reopened," said Adam DeMargel, Stupp senior vice president of sales. "Whether or not we ended up doing the job, we wanted to offer any insight we could."

Expediting With Precision

Great Lakes contacted Stupp three days after the fire, and Stupp's site visit came four days after that. Stupp provided its delivery timeline on November 22 and operated in good faith with the interest of keeping the project moving forward, even though it did not get a formal notice to proceed until December 13, when E.L. Robinson had finalized enough steel details to submit a materials order.

Great Lakes vetted the timeline to confirm it was achievable, submitted it to the state, and gave Stupp a notice to proceed on November 25. Stupp and E.L. Robinson's first step was to expedite design. Instead of the designer picking material arbitrarily that it liked for its own reasons, the pair finalized a design using readily available steel Stupp ordered on November 27.

"You kind of do it backward," Hackett said. "The fabricator identified which material it could get fastest and told the designer to use that."

Even before earning the bid, Stupp knew it could quickly obtain the primary structural steel based on conversations with Nucor, along with some steel inventory from Cleveland-Cliffs for the miscellaneous detail work. Before Stupp told Nucor it was working on the Big Mac Bridge repair, Nucor had mentioned it preemptively

rolled Grade 50 slab without contracts because it anticipated emergency orders for bridge repairs. Nucor's instinct was based on the damage Hurricane Helene inflicted on North Carolina and eastern Tennessee in September 2024, but it also benefited the Big Mac Bridge project. Stupp proposed the mid-January delivery date with Nucor's proactivity in mind.

"We were trying to get ahead of the game with raw material without knowing what the final plans would be," Manz said.

The project team decided the new members would be steel plate girders, matching the original bridge. The damaged plate girders had a 3/8-in. web thickness. The readily available plates, though, were 1/2-in. thick. E.L. Robinson's calculations confirmed the thicker steel was still suitable for the design, and the order was placed.

"As we were working on demolition, the designers started working on the girders," Hackett said. "Instead of designing a plan for the entire bridge, the designers said to order the available steel and that they were going to design the girders with it. We can't wait until they're done designing the girders to make the order. We needed to order before they were finished. Think about it like a unique table. You might not know what your table will look like, but you know you're going to need a bunch of wood."

The rest of the design process was spent adapting the thicker plates to the girder design, which aimed to act the same as the original bridge. The thickness increase allowed for fabrication savings, namely by significantly reducing the number of stiffeners compared to the existing girders. Handwork at the hinge on the original was eliminated when concerns about fabrication efficiency at the hinge detail and fatigue cracking arose. Flange transitions were significantly reduced to save time.

"Instead of copying a bridge that was designed nearly 60 years ago, we had a joint conversation to see if we could shorten the fabrication time by optimizing the design," Manz said. "The key component with that was taking out a majority of the stiffeners. Traditionally, bridges from that era had a lot of stiffeners, because labor was a lot less expensive back then compared to steel. Now, it's the opposite. Steel is relatively inexpensive compared to labor costs."

Expedited shop drawing approval is also an important step. The normal approval process often takes one or two months, a non-starter for an emergency project. On a typical project, Stupp provides the shop drawings as part of its process and submits them directly to the contractor for review and stamped approval. The contractor forwards the stamped shop drawings to ODOT for review, and then ODOT sends them to the department's Office of Materials Management for final approval.

Instead, E.L. Robinson and Stupp worked together on "over-the-shoulder reviews" without an independent engineer review or general contractor stamp. Stupp created shop drawings by December 2 and sent them to E.L. Robinson two days later. E.L. Robinson stamped the drawings after two days of review, zero surprises, and minor tweaks. Stupp began fabrication on December 17.



above: Cutting camber into the web at Stupp's fabrication shop.



below: The new girders had only a few stiffeners compared to the original ones, which saved time.



Faster drawing approval doesn't mean skipping steps. It's often a matter of prioritization to ensure drawings don't sit in a review pile for weeks.

"I don't think we bypassed steps," Hackett said. "I think we modified steps. Nobody was making decisions in a vacuum. Our proposal to the state was that it makes the most sense for the people who designed the bridge to review the shop drawings. They know what they're looking for."

Trust Factor

Trust in project partners is essential during emergency repairs. Stupp was unbothered ordering steel without a signed project order and receiving an emailed notice to proceed instead of a written one. Stupp had worked with ODOT and Great Lakes before and felt assured everything would be settled. Those three were also part of the daily conference calls with project team members, a common timeline acceleration tactic for emergency repairs. Putting the important parties in the same virtual room to make decisions in real time limits RFIs and email back-and-forth.

"I don't think anyone was ever in fear of something getting dropped," Stice said. "The open communication and ability to make a phone call saying where we were at and what we need was big. The relationship really did expedite the whole project."

Added Manz: "Normally, most companies, especially fabricators, wouldn't operate without a written purchase order. We were fabricating the steel and we don't even know if everyone has agreed on the price."

Perhaps the best example of the relationship's strength was Stupp inviting ODOT's in-house media team to the Bowling Green shop on December 26 to take video of ongoing fabrication and share it with the traveling public. Stupp also held a press conference that day to say it devoted extra labor and time to fabrication, with the day-after-Christmas peek behind the curtain as proof. The goal was to help ODOT show the public that bridge work was ongoing and prioritized, even if they weren't seeing cranes hoisting steel into place on the bridge. Stupp also sent ODOT a picture of the first girder being shipped, which ODOT posted on its social media channels.

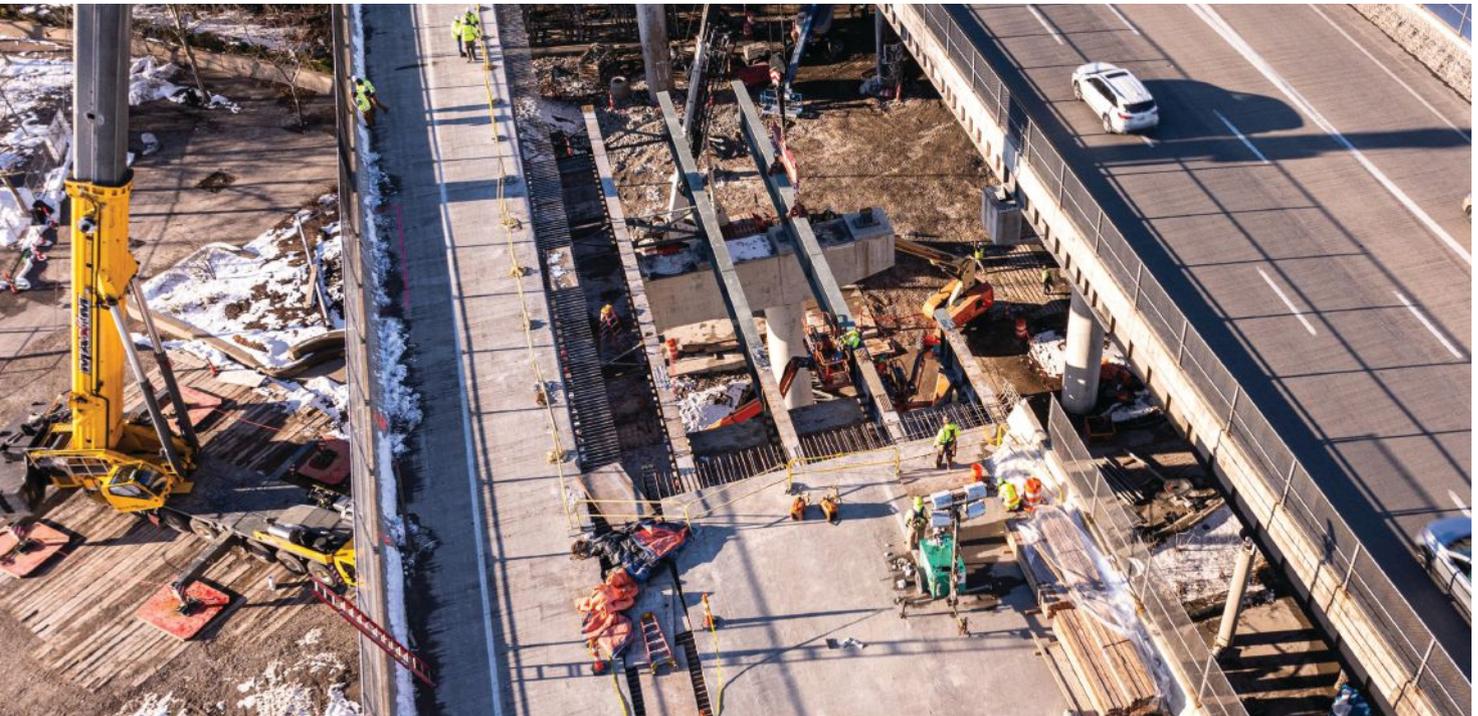
The first girder was delivered to the jobsite on January 12.



SPEED FEATURE STORY

above: Girder setting stayed on schedule despite snow.

below: All girders were on site by January 15, a slightly early arrival from the initial time frame.



“That was the turning point when the public became excited,” Tuminello said. “At the beginning of the job, everybody was frustrated because of the significant impact on their life. Once they saw that press conference from Stupp, that’s when we noticed public perception went from frustration and anger to hope and excitement that we were near the end.”

All told, Stupp fabricated seven girders that totaled 104 tons. The four largest girders were between 92½ ft and 98¾ ft long, while the other three were just under 61 ft long. The first was delivered to the jobsite on January 12, followed by the final one on January 15, a slightly early arrival that led to reopening one month ahead of schedule.

“Everybody in the city and traveling public was head over heels,” Tuminello said, “when we told them that was the expected delivery date.”

Owner

Ohio Department of Transportation

Bridge Designer

E.L. Robinson

General Contractor

The Great Lakes Construction Co.

Steel Team

Fabricator

Stupp Bridge Company 

Detailer

DBM Vircon Services 



Patrick Engel
(engel@aisc.org)

is the associate editor of *Modern Steel Construction*.

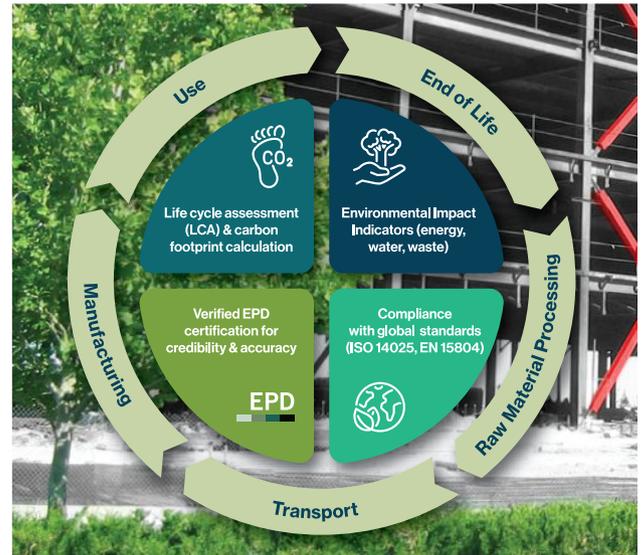
new products

This month's new products include an environmental product declaration for a seismic product, a wind-controlled connection, and viscous dampers.

CoreBrace EPD for BRBs

CoreBrace has released an industry-first environmental product declaration (EPD) for its buckling-restrained braces (BRB). Developed through SCS Global Services and independently verified, this EPD provides detailed and transparent data on the environmental impacts of CoreBrace's buckling-restrained braces from raw material extraction through manufacturing. It aids structural engineers, sustainability consultants, and other stakeholders as they conduct life cycle assessments (LCAs) and demonstrates compliance with green building standards, such as LEED, WELL, Buy Clean California, and other domestic and international standards.

With the EPD's development, CoreBrace reinforces its commitment to transparency, innovation, and supporting the structural engineering community in designing more resilient and sustainable structures. For more information, visit corebrace.com/resources/design-aid.



DuraFuse Wind-Controlled Connection

Looking for the easiest and most economical way to design and build a steel moment frame? DuraFuse Frames has developed a field-bolted, wind-controlled connection that minimizes steel tonnage, simplifies shop fabrication, and shortens the erection schedule. Coupling DuraFuse's design assist services with this connection results in 10% tonnage savings in the lateral frame weight. A simple swing-in and bolt-up erection process makes for rapid and safe erection and minimizes crane hold-ups.

Let DuraFuse's engineering team demonstrate the value DuraFuse can bring to your next project. The team will provide a complimentary no-risk assessment of the cost and schedule savings that can be realized. To learn more, call 801.727.4060 or email contact@durafuseframes.com.

Enidine Viscous Dampers

Enidine's viscous damper components provide solid and reliable protection for critical infrastructure around the world with proven results. Viscous dampers (also known as seismic dampers, earthquake dampers, or fluid viscous dampers) are hydraulic devices that dissipate the kinetic energy of seismic events and cushion the impact between structures. They are versatile devices that can be designed to allow free movement and controlled damping of structures to protect them from wind load, thermal motion, or seismic events.

The Enidine viscous dampers are well-suited for large displacement and large load applications such as bridges, buildings, and other large structures. They are available in ratings up to 1,000 kips. For more information, visit www.enidine.com.



SAFETY

AISC Accepting Annual Safety Awards Submissions

An AISC Safety Award is one way to show colleagues and customers that safety matters at your company. Any AISC full member steel fabricator or associate member erector is eligible for this annual award, provided that their safety record meets AISC criteria. The awards, given in the fabricator category and erector category,

include the Honor Award (DART=0)—the top safety award, presented for a perfect safety record of no disabling injuries—the Merit Award (0<DART≤1) and Commendation Awards (1<DART≤2).

The primary, secondary, and safety contacts on file for eligible members will receive an email with submission informa-

tion in mid-December. All applications are due to AISC by the end of January, when OSHA Form 300A is required to be posted.

For more information about the program and safety resources available for the fabricated and erected structural steel industry, please visit aisc.org/safety or contact safety@aisc.org.

CERTIFICATION CORNER

AISC certification sets the quality standard for the structural steel industry and is the most recognized national quality certification program. It aims to confirm to owners, the design community, the construction industry, and public officials that certified participants, who adhere to program criteria, have the personnel, organization, experience, documented procedures, knowledge, equipment, and commitment to quality to perform fabrication, manufacturing, and/or erection. Find a certified company at aisc.org/certification.

The following U.S.-based companies were newly certified or renewed certification in at least one category from September 1–30, 2025.

Newly Certified Companies (September 2025)

- Addington Steel Builders, Canton, Ga.
- All-Steel Fabricating, Grafton, Mass.
- Concorp, Inc., Kansas City, Mo.
- General Welding Company, Inc., Upper Marlboro, Md.
- Hanover Iron Works, Hanover, Pa.
- Martelli Companies, Ivyland, Pa.
- Southern Industrial Contractors, Rayville, La.
- Tony’s Welding & Fabrication LLC, Washington Court House, Ohio

Certification Renewals (September 2025)

- Adams & Smith, Inc., Lindon, Utah
- ADF International Inc., Great Falls, Mont.
- Allstate Tower Inc, Henderson, Ky.
- Altra Division 5, LLC, University Park, Ill.
- Area Erectors Inc., Rockford, Ill.
- AXIS Automated Ironworks, Logan, Utah

- Blue Star Steel, Salt Lake City
- Boman & Kemp Mfg., Ogden, Utah
- Cardinal Fabricating, Inc., Williamston, Mich.
- Casco Bay Steel Structures, Inc., South Portland, Maine
- Central Steel, Inc., Wichita, Kan.
- Cianbro Corporation, Brewer, Maine
- Cianbro Fabrication & Coating Corp., Pittsfield, Maine
- Cives Steel Co., Augusta, Maine
- Cives Steel Company, Winchester, Va.
- Clark’s Machine Shop, Clinton, Maine
- Con-Serv, Inc., Brunswick, Ohio
- Contech Engineered Solutions LLC, Greeley, Colo.
- Contech Engineered Solutions, LLC, Fort Payne, Ala.
- Doherty Steel, Inc., Paola, Kan.
- Donahue McNamara Steel LLC, Boise, Idaho
- East Coast Erectors, Inc., New Castle, Del.
- Ecco III Enterprises, Inc., Yonkers, N.Y.
- EPIC Steel Company, Solon, Ohio
- Falcon Builder, Inc., Brooklyn, N.Y.
- Gerber Construction, Inc., Lehi, Utah
- Glenridge Fabricators, Inc., Glendale, N.Y.
- Grempe Steel Company, Posen, Ill.
- Hennegan and Associates, Ltd., Crest Hill, Ill.
- High Plains Steel Services, LLC, Windsor, Colo.
- Integrated Structures Corp., Bellport, N.Y.
- Intermark Steel, LLC, Price, Utah
- J&B Fabricators LLC, Auburn, Wash.
- Jennmar Specialty Products, Cedar Bluff, Va.
- JPW Structural Contracting, Inc., Syracuse, N.Y.
- JT Steel, Inc., West Jordan, Utah
- K&K Iron Works, LLC, McCook, Ill.
- Littell Steel Company, New Brighton, Pa.
- Lundahl Ironworks Company, Franklin, Idaho
- Meyer Utility Structures, Hager City, Wisc.
- Mid-Atlantic Steel, LLC, New Castle, Del.

- Mid-City Steel, Inc., La Crosse, Wisc.
- Mike Owen Fabrication, Bakersfield, Calif.
- Nick’s Welding & Fabricating, Inc., Hixton, Wisc.
- NYC Constructors LLC, New York
- Pacific Stair Corporation, Salem, Ore.
- PennFab, Inc., Morrisville, Pa.
- Pioneer Erectors, Grand Rapids, Mich.
- Premier Technology, Inc., Blackfoot, Idaho
- Prime Steel Erecting, Inc., North Billerica, Mass.
- Puma Steel, Cheyenne, Wyo.
- Quality Bridge & Fab., Inc., West Middlesex, Pa.
- Quality Electrical Systems Inc., West Jordan, Utah
- R.G. Steel Corp., Pulaski, Pa.
- Rule Steel Tanks, Caldwell, Idaho
- SAC Incorporated, Clearfield, Utah
- Schuff Steel Company, Lindon, Utah
- Seiko Iron Works, Inc., Glendale, N.Y.
- Shane Felter Industries, Inc., Uniontown, Pa.
- Shure-Line Construction, Kenton, Del.
- Sippel Steel Fab, Ambridge, Pa.
- SME Steel Contractors, West Jordan, Utah
- Spartan Steel, Pocatello, Idaho
- Steel America, Norfolk, Va.
- Steel Skies LLC, Hyde Park, Vt.
- Steel West, Inc., Pocatello, Idaho
- STEELFAB, Anchorage, Alaska
- Stony Brook Manufacturing Company, Inc., Calverton, N.Y.
- Sure Steel, Inc., South Weber, Utah
- Toral Welding, Inc., Jersey City, N.J.
- TRC Fabrication, LLC, Idaho Falls, Idaho
- United Structural Works, Inc., Congers, N.Y.
- Universal Industrial Sales, Inc., Lindon, Utah
- Utah Steel, Cedar City, Utah
- Veritas Steel, LLC, Eau Claire, Wisc.
- Veritas Steel, LLC, Wausau, Wisc.
- Weldon Steel Corporation, Weldon, N.C.

AWARDS

Fatigue and Fracture Expert Selected for 2026 Higgins Lectureship

AISC will present the 2026 T.R. Higgins Lectureship Award to Caroline Bennett, PE, PhD.

Bennett is the Charles E. & Mary Jane Spahr professor and chair of the Department of Civil, Environmental, and Architectural Engineering at the University of Kansas. Her research has addressed some of the most pressing challenges in structural engineering, including fatigue and fracture performance of steel infrastructure, constraint-induced fracture in steel bridges, and innovative structural retrofit strategies for a wide range of structures.

“The Higgins jury was very impressed by Dr. Bennett’s accomplishments, particularly her research leading to extending the life span of critical infrastructure,” said AISC vice president of engineering and research Christopher Raebel, SE, PE, PhD. “In particular, her work in improving the quality of galvanized steel has been very impactful. I look forward to hearing her insights this spring.”

AISC will present the award, which

includes a \$15,000 honorarium, at the opening session of NASCC: The Steel Conference in Atlanta on Wednesday, April 22, 2026. She will also present the closing keynote on Friday, April 24 and repeat her presentation on request throughout the country. Contact AISC senior director of education Christina Harber at harber@aisc.org to inquire about scheduling a T.R. Higgins lecture.

Bennett has led national projects with the Federal Highway Administration, the National Cooperative Highway Research Program, the U.S. Army Corps of Engineers’ Engineer Research and Development Center, and several state departments of transportation, delivering solutions that extend the service life of structures and improve infrastructure performance.

She serves on AISC’s Committee on Research as well as the TC10 Materials and Fabrication Committee. She recently served on AISC’s Game Changer panel. She also contributes to the American Iron and Steel Institute (AISI) Steel Bridge Task Force and Transportation Research Board committees, strengthening connections between research and practice.

Bennett received AISC’s Special Achievement Award in 2024 for her work on advancing knowledge about the behavior of hot-dip galvanized steel structures as well as AISC’s inaugural Early Career Faculty Award in 2016. In 2013, AISI named her the Robert J. Dexter Memorial Lecturer.

Each year, AISC invites a distinguished panel of industry experts to judge Higgins Lectureship Award nominations. The jury reflects a blend of professional insight, industry experience, and academic excellence. This year’s jury had six members: Ted Goldstein of Atlas Tube, Jordan Jarrett of Colorado State University, Amit Kanvinde of the University of California-Davis, Kerry Kreitman of Pivot Engineers, Brett Manning of Schuff Steel, and Thomas Murphy of Modjeski & Masters, Inc.

People & Companies

Gale Associates, Inc. has appointed Alan Craig as the new leader of its Florida office and Arno Skalski as the leader of its Portland, Maine, office. Craig joined the firm in 1997 and is a senior project manager in the building enclosure consulting and commissioning group. He has 28 years of consulting experience in Florida and is a registered professional engineer in Florida. Skalski joined Gale in 2023 as an associate and a member of the building enclosure consulting and commissioning group.

Machitech has expanded its U.S. manufacturing presence with the acquisition of Victory CNC Plasma Systems. With the acquisition, Machitech expands its U.S. capabilities with added manufacturing capacity, an experienced American team, and stronger local support. Already well-established with a Florida office and a nationwide service network, Machitech reinforces its long-term commitment to the U.S. market and its role as a trusted partner to fabricators across the country.

AISC full member and certified fabricator Steelhead Metal & Fab, LLC is building a new fabrication facility at its Salem, Ore., headquarters. The 7,200-sq.-ft space will feature new state-of-the-art plasma cutting equipment and a 10-ton overhead crane. It will be the fifth building on the Steelhead campus and will push the company’s total production and administration buildings area over 40,000 sq. ft. Steelhead has also hired steel design veteran Pedro Rodriguez to manage its steel design and detailing team. In addition to decades of proven steel design leadership, Rodriguez is fluent in the use of Tekla Structures software, another strategic acquisition that will integrate with Steelhead’s existing suite of CAD software.



AISC
AISC Elects New Board of Directors Chair, Vice Chair



Glenn Tabolt



Dan Kadrmas



Steve Knitter

AISC elected new leadership and a new board member at its Annual Business Meeting in September.

Glenn Tabolt, president of STS Steel in Schenectady, N.Y., was named board chair following two years as vice chair. Dan Kadrmas, president of TrueNorth Steel in West Fargo, N.D., and a board member since 2013, is the new vice chair. Steve Knitter, president of Geiger & Peters, Inc. in Indianapolis and a prior board chair, was named treasurer.

Tabolt replaces Hugh McCaffrey, president of Southern New Jersey Steel Co. in Vineland, N.J. McCaffrey spent two years as chair and remains on the board. Tabolt and his colleague, Jim Stori (AISC's board chair from 2003–2005), founded STS Steel in 1984. He began his career with Pittsburgh-Des Moines Steel in 1978 and has been STS Steel's president and CEO since 2009. He was named to the board in June 2017 and has served on multiple AISC committees and task forces, including many years as the chair of the NASCC: The Steel Conference planning committee.

Most recently, Tabolt was instrumental in the development of AISC's Fabricator

Education Training Program. He graduated from Clarkson University with a bachelor's degree in civil engineering and has an MBA from the University of Pittsburgh. He is a licensed professional engineer in New York and Connecticut and a certified welding inspector.

Kadrmas has served as president of TrueNorth Steel since 1999. The company has grown to 11 locations across five states during his tenure. He also previously served as president and is currently on the board of the National Corrugated Steel Pipe Association. He graduated from the University of North Dakota with a bachelor's in business administration.

Knitter was named to the board in 2017 and preceded McCaffrey as chair. He is also on the AISC Education Foundation board of directors. He became president of Geiger & Peters in 2010.

The board's newest member is Wade Lewis, president of Puma Steel in Cheyenne, Wyo. He replaced Hollie Noveletsky, president of Novel Iron Works in Greenland, N.H., who resigned from the board to run for office in the 1st Congressional District of New Hampshire.



Wade Lewis

news & events

EDUCATION FOUNDATION

AISC Board to Match \$50,000 in Year-End Gifts to Education Foundation

For the second straight year, the AISC Board of Directors has authorized a match of up to \$50,000 in donations to the AISC Education Foundation through the end of 2025.

To provide support for as many deserving scholarship and grant applicants as possible, the foundation will use every gift—coupled with its dollar-for-dollar match from the board—where it will make the most impact, rather than restricting funds to one program.

“The Education Foundation’s amazing supporters have the opportunity once again to see their gift doubled, which is a remarkable feeling to know you’re making twice the impact,” AISC director of foundation programs Maria Mnookin said. “I am grateful to have the support of the AISC Board of Directors, and I look forward to sharing

updates about the life-changing support our donors are providing to students, educators, and young professionals.”

It has been a busy, exciting year for the foundation and an especially meaningful one for foundation-supported students, educators, and young professionals. This academic year, AISC administered scholarships totaling \$410,025 to undergraduate and master’s-level students—a feat that would not have been possible without support from donors.

Throughout 2025, gifts to the foundation also supported undergraduate research grants, student field trips to steel facilities, and speaker events and campuses across the country, bringing our total administered to more than \$500,000. But we can’t do this without you.

Your donation, which will be doubled if you give by December 31, will not only give the invaluable gift of industry exposure; it will make its way to the person or program it will benefit most, whether that’s a student needing financial support to attend college, a faculty member planning an educational field trip, or our next cohort of Innovation Scholars traveling to AISC’s Chicago headquarters.

If you would like to contribute and see your gift doubled, please make checks payable to the AISC Education Foundation and mail them to PO Box 8671, Carol Stream, IL, 60197—or donate online at aisc.org/giving. Checks must be postmarked by December 31 to qualify for matching funds. Gifts are 100% tax deductible, and every penny supports students, educators, and education programs.

AWARDS

Steel Bridge Task Force Honors Industry Veteran with Annual Award

The Steel Bridge Task Force has recognized Gary W. Wisch, PE, engineering and business development advisor for AISC full member fabricator DeLong’s, Inc., for his outstanding contributions to the steel bridge industry over the last four decades.

The Alexander D. Wilson Memorial Award, presented to Wisch in Lafayette, Ind., on September 24, honors individuals whose work has significantly advanced steel as the material of choice for steel bridge supply, production, design, fabrication, or construction.

“We are all better off for Gary’s involvement in many of our industry efforts,”

said AISC vice president of bridges Brandon Chavel, PE, PhD. “He has always been willing to share his experience and expertise with engineers and designers in the bridge community, both during his tenure at DeLong’s and through his support of the National Steel Bridge Alliance (NSBA), American Iron and Steel Institute, the Short Span Steel Bridge Alliance, and the AASHTO/NSBA Steel Bridge Collaboration. Gary has been a fixture on several NSBA committees and contributed to many of our most important projects. It’s always a pleasure to work with him, and I congratulate him on this award.”

In 2021, AISC recognized Wisch’s contributions to the AASHTO/NSBA Steel Bridge Collaboration and the NSBA Executive Council with a Special Achievement Award.

Since 2022, the Steel Bridge Task Force—which includes NSBA, the American Iron and Steel Institute (AISI), and the American Association of State and Highway Transportation Officials (AASHTO) Steel and Metals Technical Committee—has presented this annual award in honor of Alexander D. Wilson, who chaired the Steel Bridge Task Force for more than two decades.

advertiser index

AGT Robotics	15	Controlled Automation	17	SketchDeck.ai	10
Atlas Tube	67/foldout	CoreBrace	13	St. Louis Screw and Bolt	12
Automated Layout Technology	19	DuraFuse	9	SteelCoded	3
Birmingham Fastener	7	IDEA StatiCa	40	Voortman	5
Bull Moose Tube	11	New Millennium	back cover		
Chicago Metal Rolled Products	insert	Peddinghaus	2		



Fabricate steel in Big Sky Country!

Looking for a business opportunity in beautiful western Montana? The owner of R.T.I. Fabrication, Inc., in Plains, Mont., is considering retirement and planning to sell.

A few highlights of this well-established AISC full-member, Certified structural steel fabrication plant:

- Certified Advanced Bridge and Fracture-Critical endorsements
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- Equipped to specialize in fabrication of welded plate bridge girders
- Equipment includes, among other machines, advanced Ogden welding systems, Kinetic plate processor, CNC beam drill, CNC press brake
- Substantial material handling in place to handle heavy girders
- Several large beam rotators

The shop currently has a one-year backlog and a skilled crew in place and is continuing to bid on projects.

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marketplace & employment

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The company has spent 19 years forming strong relationships with repeat customers, General Contractors, Construction Managers, and Developers. The forecast for the next few years in this geographic area is strong.

Inquiries, please email fsawyer6595@yahoo.com

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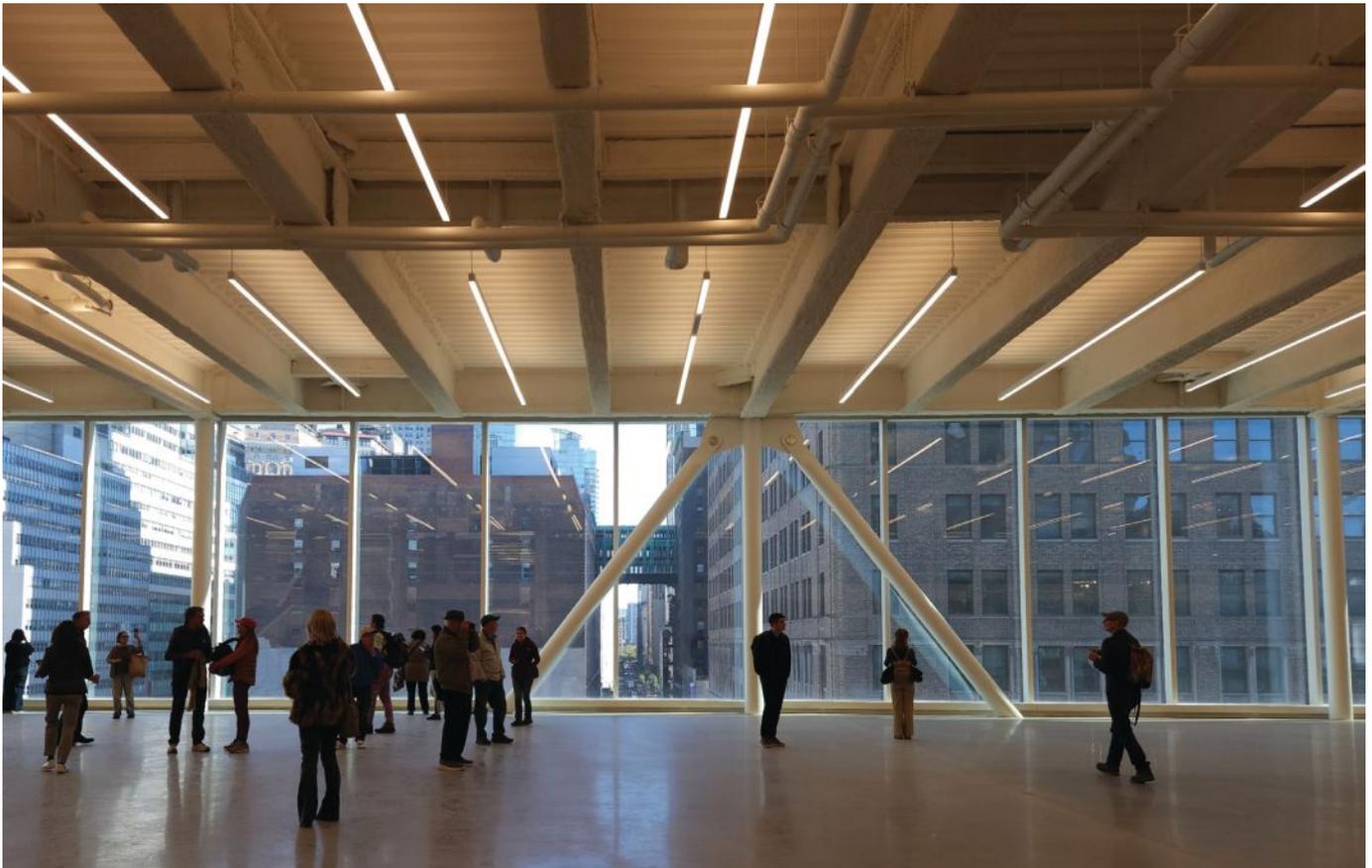
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Modern Steel Construction

All of the issues from *Modern Steel Construction's* 65 years are available as free PDF downloads at modernsteel.com/archives.



In the Midst of Midtown

THIS STEEL-FRAMED BLANK SPACE will soon be home to meetings involving Taylor Swift.

Universal Music Group, Swift's record label, recently signed a 22-year lease to occupy the fourth through seventh floors of PENN 2 in Midtown Manhattan. And even more notably, PENN 2, originally constructed in 1968, received a 2025 AISC IDEAS Award in the Excellence in Engineering category for its multi-story addition hovering 50 ft above the Manhattan sidewalk and supported by 14 sloped columns.

So why are we talking about the project, which was featured in the May 2025

issue (modernsteel.com/archives), now? Because as part of this year's SteelDays festivities and Open House New York (OHNY) celebration, groups of engineers, architects, and the public were allowed to tour the building.

The tour, led by project structural engineer Severud Associates and AISC full-member Crystal Steel Fabricators, showcased the 100,000 sq. ft. of column-free office space made possible in part by steel trusses comprised of 14-in.-diameter round hollow structural sections (HSS) with cast steel pin connectors, as pictured above on the building's

sixth floor. The addition stretches the width of the building, extending almost 40 ft beyond the north and south ends of the tower, which are also set back from the sidewalk.

You'll find additional photos from many of the more than 40 SteelDays events held around the country during October in the January issue. And if you attend the 2026 NASCC: The Steel Conference (April 22–24 in Atlanta), you'll have the opportunity to be the first to see the next crop of innovative steel projects honored in the annual IDEAS Awards program. ■

GROWING PAINS

How timeline and space pressures inspired a new model for parking garage design and construction

An overall shot of the new parking garage during construction. The site was squeezed between two other active sites.

Growing Pains Drive Reimagined Parking Structure Design

Utah State University is growing. That means more students, more classes, and more parking. To meet growing demand, the University commissioned a new parking structure with an ambitious 12-month schedule. Meeting that schedule was essential to handle the flood of students returning to campus in the Fall.

Sean Thompson with Elliott Workgroup, the project's architect, and Jerod Johnson with Reaveley Engineers, the structural engineer, started by investigating a typical cast-in-place concrete garage with post-tensioned floor plates, but site constraints quickly led them to reevaluate that approach.

"To say the site was tight is an understatement", said Thompson. It was confined by student housing construction on one side, a business school building under construction on the other, a state highway on a third side, and a utility tunnel that ran along the edge of the proposed building footprint on the fourth side. The typical practice of locating concrete shear walls at that edge of the building would have imposed load on the tunnel which it was not designed for. But moving the shear wall off the building's edge would have impeded traffic flow and sight lines. Even if an acceptable location for the shear walls was identified, the high seismicity of the site would have required massive foundations.

Thinking Outside the (Concrete) Box

The team faced a problem inherent to any concrete shear wall system: the walls' rigidity results in a building with a very short period of vibration, and thus very high base shear. Often, this problem is overcome by pouring massive concrete footings, but the tight site conditions called for a more elegant approach. The solution was to pair the efficiency and ductility of a steel frame - comprised of HSS columns and buckling-restrained braces - with post-tensioned slabs well-suited to vehicle traffic and deicing salts. The hybrid system, according to Johnson, "naturally moves slower, which means it attracts less acceleration, and that means less force."

The relative flexibility of a buckling restrained brace frame (BRBF), and its higher ductility (reflected in an R-value of eight, compared to five for special concrete shear walls), resulted in an approximately 70% reduction in base shear, and cut the foundation volume from 235 cubic yards at each line of support for a shear wall system to only 64 cubic yards. The switch to a hybrid system also allowed the lateral frame to be placed on the interior of the floor plate, away from the utility tunnel, without blocking sight lines for drivers and pedestrians. Should a major seismic event occur, use of BRBF's will allow the building to be repaired rather than requiring replacement. The material savings and repairability made for a more sustainable and resilient building.



The use of square HSS columns reduced the total steel tonnage compared to wide flange columns because there is no weak axis governing axial capacity. But there were additional benefits of HSS that are specific to outdoor application. “[Using HSS] is one of the best ways to combat corrosion in exposed steel structures”, said Johnson. “You want to minimize the amount of exposed surface and relief, and an HSS just doesn’t have nearly as many nooks and crannies and exposed surface compared to a wide flange.”

The Secret Weapon

Traditionally, using HSS columns in multi-story construction would require field-welded splices. But the demanding schedule and desire to avoid welding galvanized steel led the team to select Shuriken, the structural nut keeper from Atlas Tube that enables field-bolting of HSS splices and other inaccessible connections.

The erector, Steel Krest, had never worked with Shuriken before, and was skeptical at first. “When we first saw this, I thought you guys had lost your mind”, said Trent Carillo, Steel Krest’s general manager. “But it was such a clean connection. The guys loved it.” The use of bolted connections with Shuriken allowed crews to erect up to 14 columns a day, an impossible pace for welded splices.

The Odd Couple

The process of marrying steel gravity and lateral systems with post-tensioned concrete floor plates offered interesting challenges and surprising benefits. To introduce punching shear



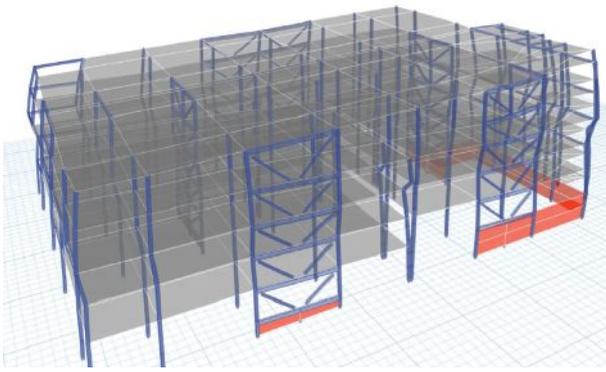
(Top) An elevation of the buckling-restrained brace frames. Post-tensioning anchorages for the slab are visible.

(Inset) A close-up of a slip-critical bolted splice installed with Shuriken.

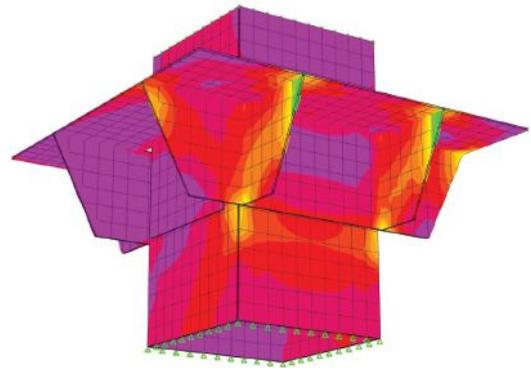
capacity to steel columns passing through the slab, fabricators shop-welded stiffened collars to the HSS columns at each floor level. Whereas in concrete construction, stud rails would generally be required to achieve adequate punching shear capacity over slender columns, in this case the size of the collar could be adjusted so that additional slab reinforcement was not required.

The team also had to plan for floor plate shrinkage caused by compression from the load of the post-tensioning. In typical concrete construction, that requires leaning the formwork for the columns and walls outward to accommodate for the anticipated shrinkage of the slab. Because a single steel column supports several floors, they had to be canted outwards to accommodate the anticipated shrinkage of all the floors they would support.

“We could have done a 55-foot-tall column” said Johnson, “but if you imagine each deck from Level 2 through the roof being cast and stressed, every time you do that it’s pulling the column a little bit more toward the interior. So by the time you get up to the roof, you got nearly 6 inches of out of plumb at that column.” Splicing the columns reduced required canting. And unlike welded splices, the Shuriken-installed bolts could be installed finger-tight initially, allowing for rotation at the joint, and then pretensioned after the slab above had been post-tensioned.



4D analysis was performed to evaluate the effects of slab shrinkage caused by post-tensioning. Horizontal displacements are magnified in this image.



Finite element analysis was performed on the collars supporting the concrete slab using SAP 2000

The canting process was simplified by the lack of floor beams. “The erection went so well”, said Mike Sutton with Tech-Steel. “It’s easy to get right when you don’t have anything tying in except the concrete.” But that’s not the only reason steel erection went well. “We were part of the conversations from the very beginning”, Sutton continued, “and were able to raise concerns so other options could be evaluated. That created a more holistic picture of what the project would look like in its operational phases.”

Another benefit of the hybrid system was faster cycle times between floors. Since the HSS columns passed through each floor level, minimal time was required to survey and layout column locations once a floor was poured. The steel frame also meant that no time was spent tying rebar or building formwork for walls and columns, further reducing cycle time. In all, construction time was reduced by two months from the original 12-month schedule.

A Model for the Future

The embrace of a novel approach allowed the team to design and construct a parking facility that had better visibility compared to one using interior shear walls, making it safer for drivers and pedestrians. It was also more sustainable, more

resilient, and cut the schedule from 12 months to ten. While site constraints drove the development of the hybrid steel-concrete system initially, the project’s success shows the potential of a hybrid system using HSS columns, BRBF’s and Shuriken.

“The moons kind of aligned for this project”, said Thompson. “The site constraints were so great that people were open to alternate solutions. We have to give credit to the whole team, whose combined perspectives and experience was critical. In meetings with Jacobsen Construction, Tech-Steel, Steel Krest, Reaveley and ourselves, we tried to find the Achilles Heel to this approach. In the end, other than the novelty of the approach, we only found benefits. Going forward, we can collectively point to this one and say: ‘look how well that went.’”



Use of BRBF’s instead of concrete shear walls allowed the lateral elements to be placed within the floor plate without obscuring sight lines for drivers and pedestrians.

Visit www.atlastube.com/hss-connections-hub/ to explore fabrication-friendly, fully code-referenced, and reliable HSS connections.

About Atlas Tube

Atlas Tube, a division of Zekelman Industries, produces a wide range of steel tubular products and is the leading provider of hollow structural sections (HSS) in North America. Other offerings include HSS Design Tools and straight-seam electric resistance weld (ERW) pipe piling.



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