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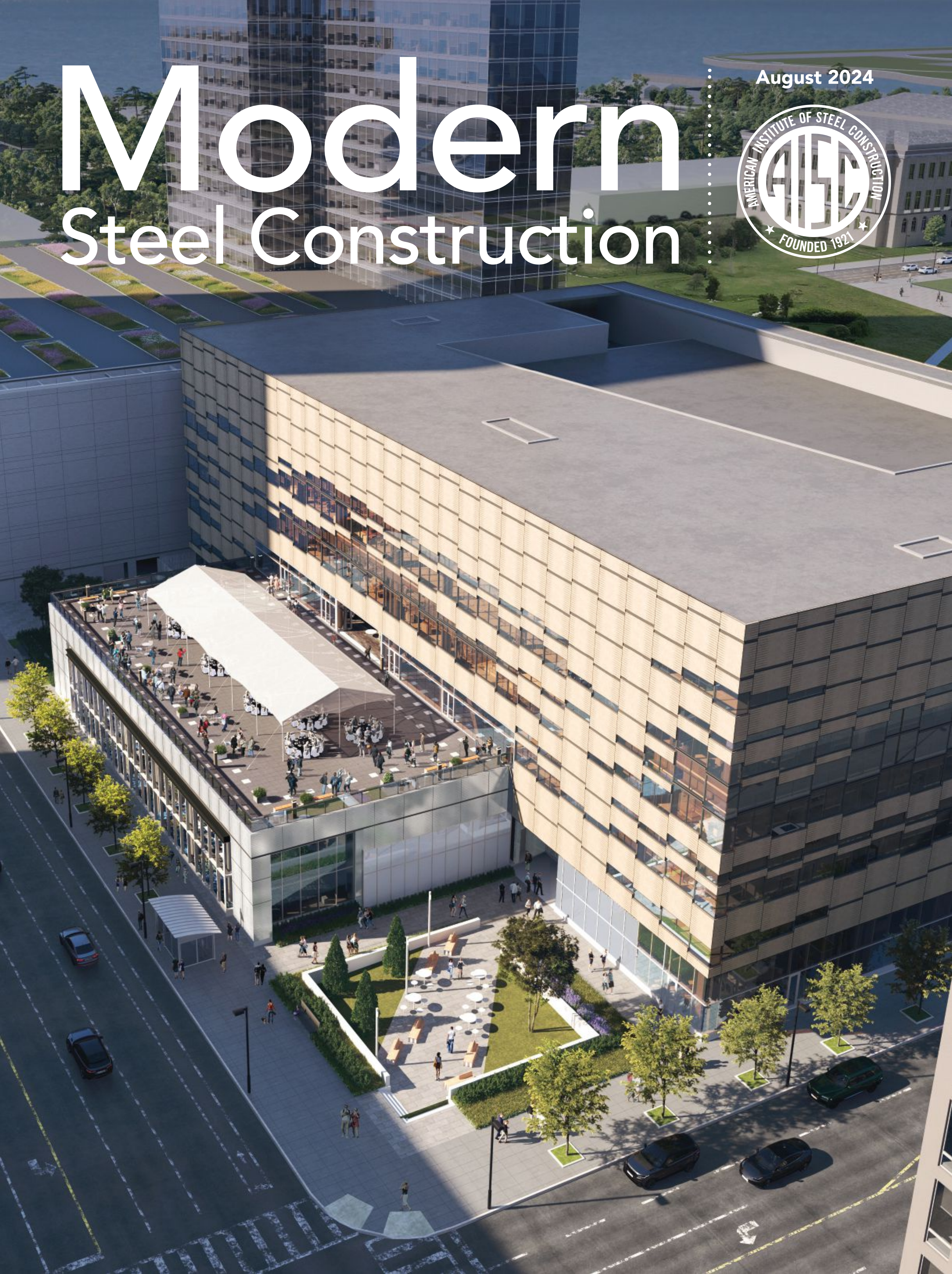


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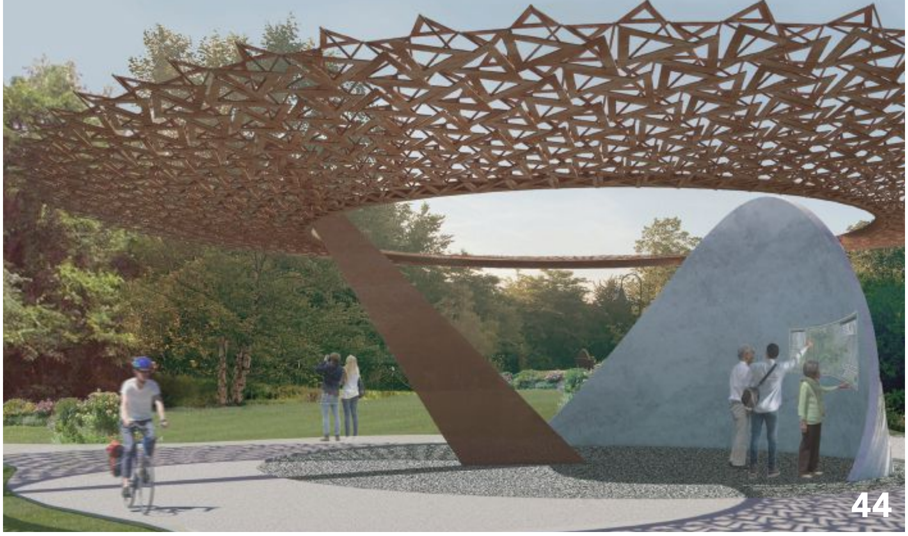

columns

features

ON THE COVER: Expanding downtown Cleveland's convention center required a significant steel overhaul, p. 26. (Photo: TVS)

MODERN STEEL CONSTRUCTION (Volume 64, Number 8) ISSN (print) 0026-8445: ISSN (online) 1945-0737. Published monthly by the American Institute of Steel Construction (AISC), 130 E Randolph Street, Suite 2000, Chicago, IL 60601. Single issues $8.00; 1 year, $60. Periodicals postage paid at Chicago, IL and at additional mailing offices. Postmaster: Please send address changes to MODERN STEEL CONSTRUCTION, 130 E Randolph Street, Suite 2000, Chicago, IL 60601.

editor's note

Do you remember where you were during the eclipse a few months ago?

You might not have even been paying attention. It wasn't a big deal to everyone, as the path of total darkness—a slow-moving ground zero where the sky went completely dark for a few minutes—was a relatively thin band that stretched diagonally across the U.S. from Texas to Maine. If you were in, say, Miami, Seattle, or a huge swath of the country (or somewhere else on the globe), it probably didn't register aside from mentions on a newsfeed or social media.

But if you were in that band and not asleep or in a cave at the time, you almost surely noticed it. Even if you were within 100 or so miles on either side of the path of totality, you were still able to get a taste of it.

The latter was the case in Chicago, where we wandered across the street to the park—along with a few hundred other stargazers (technically, that's a correct statement)—to witness the rare celestial event. It was a cloudless day, so the viewing conditions were optimal. The coverage percentage was around 94%, so it got a bit darker and looked really neat through a pair of eclipse glasses—though not as dark as I would have guessed. I realized that with only 6% showing, the sun is still awfully bright. I expected the lighting to feel like it does right before sunset. Instead, it was as if someone had turned down the dimness level on the sky ever so slightly. Anyway, it was a fun way to spend a few minutes on a weekday afternoon.

Here's another question: Do you remember where you were when the University of Florida steel bridge team achieved a four-peat in the ASCE/AISC Student Steel Bridge Competition National Finals? Likely not, and that's understandable. If you weren't at Louisiana Tech University in Ruston, La., on June 1, you weren't at the fast-moving ground zero for steel bridge building. For the fourth year in a row—an unprecedented feat in the competition's 37 years of existence—Florida took first place overall in the competition.

And when I say fast-moving, I mean it. The competition includes several categories, with construction speed being the most exciting. The winning team in that category—William Jewell College—built its bridge in a mere 4½ minutes. That's fast. But like a real-life construction project, speed isn't everything (though it helps get your buildings occupied and bridges open to traffic sooner). The overall score considers performance in the lightness, aesthetics, stiffness, cost estimate, economy, and efficiency categories as well.

You can read all about the competition—and see lots of great photos—in a roundup on page 52. And you can also read an interview with the competition's founder, Bob Shaw, on page 20.

Student-built bridges aren't the only award-winning projects in this issue. You can also read about the winner and runners-up of AISC's Forge Prize on page 40. The annual competition celebrates emerging architects who create visionary designs that embrace steel as the primary structural component. Speed is also a component in this program, as one of the goals is to explore ways to reduce project schedules.

Both competitions demonstrate steel's benefits and how to best take advantage of them. All participants deserve not only a hearty congratulations, but also a sincere thank you for continuing to push steel's boundaries.

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steel interchange

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

Minimum Bolt Pretension per AISC *Specification* Table J3.1

Table J3.1 in the 2022 AISC *Specification for Structural Steel Buildings* (free download available at aisc.org/publications) states that the tabulated values are 0.7 times the minimum tensile strength of the bolts. However, I cannot calculate the same values shown in the table.

As an example, for a 1½-in. diameter Group 120 bolt, Table J3.1 indicates a minimum bolt pretension of 118 kips. However, I calculate 111.3 kips when I checked this value.

$$0.7 \times 120 \text{ ksi} \times 1.325 \text{ in.}^2 = 111.3 \text{ kips}$$

where the bolt net area is taken as:

$$0.75 \times \frac{\pi \times 1.5 \text{ in.}^2}{4} = 1.325 \text{ in.}^2$$

Do you know why this value does not match the 118 kip value listed in Table J3.1?

The Commentary to Section J3 states, "The factor of 0.75 included in this equation accounts for the approximate ratio of the effective tension area of the threaded portion of the bolt to the area of the shank of the bolt for common sizes between ½ in. and 2 in., with ratios ranging between 0.72 and 0.80." Rather than using this approximation to determine the pretension, the *RCSC Specification for Structural Joints Using High-Strength Bolts*—and, therefore, the AISC *Specification*—uses a different approximation: the one shown in Equation (A-3-7) in Appendix 3 of the AISC *Specification*.

$$A_t = \frac{\pi}{4}\left(d_b - \frac{0.9743}{n}\right)^2 \quad \text{(A-3-7)}$$

where

d_b = nominal diameter (body or shank diameter), in. (mm)

n = threads per in. (per mm)

For a 1½-in. diameter bolt, there are six threads per inch, according to Table 7-17 in the 16th Edition AISC *Steel Construction Manual*. The net area using equation A-3-7 is equal to 1.405 in^2. Calculating the minimum bolt pretension using this net area for the bolt results in a minimum pretension equal to 118 kips, which matches the value provided in Table J3.1.

Larry Muir, PE

Wide-Flange Web Reinforcing for Shear

Is there a way other than adding a doubler plate or increasing the member size to increase the shear strength of a wide-flange beam? Would adding transverse stiffeners increase the shear strength?

There are many ways to increase the shear strength of a member, including the two methods that you mentioned in your inquiry. Some valid methods include:

- Increase the member size.
- Add web doubler plates.
- Add a series of transverse and diagonal web stiffeners that form a truss system within the web.
- Increase the web depth by adding a haunch at the top and/or bottom of the flange(s)
- Remove a portion of the load by using additional members within the span.
- Adding fiber reinforced plastic (FRP), or other types of reinforcement.

The shear strength of members with slender webs (high h/t_w ratio) can potentially be increased with the addition of transverse stiffeners if the effect of tension field action is considered according to 2022 AISC *Specification* Section G2.2. However, the web slenderness values in Section G2.2 are only applicable to built-up shapes (plate girders).

Bo Dowswell, PE, PhD

Combined Forces on Single-Plate Connections

Part 12: Design of Simple Connections for Combined Forces in the 16th Edition AISC *Steel Construction Manual* recommends two new interaction formulas for axially loaded single-plate connection (Equations 12-2 and 12-3). Why have these been added instead of using Equation 9-1 in the *Manual*?

$$\frac{M_r}{M_c} + \left(\frac{P_r}{P_c}\right)^2 + \left(\frac{V_r}{V_c}\right)^4 \le 1 \quad \text{(9-1)}$$

When $\frac{P_r}{P_c} < 0.2$

$$\left[\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right)\right]^2 + \left(\frac{V_r}{V_c}\right)^2 \le 1 \quad \text{(12-2)}$$

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

When $\frac{P_r}{P_c} \geq 0.2$

$$\left[\frac{P_r}{P_c}+\frac{8}{9}\left(\frac{M_{rx}}{M_{cx}}+\frac{M_{ry}}{M_{cy}}\right)\right]^2+\left(\frac{V_r}{V_c}\right)^2 \leq 1 \qquad (12\text{-}3)$$

Equation 9-1 provides an accurate estimate of the plastic strength of rectangular connection elements when stability and torsional effects are negligible. *Manual* Equations 12-2 and 12-3 consider the effect of torsion.

It might be helpful to first look at *Manual* Equation 10-8. Equation 10-8 is used for extended single-plate connections because it implicitly considers the effect of torsion caused by the horizontal offset of the plate shear center relative to the beam shear center. Background information on Equation 10-8 is in Muir and Hewitt (2009). Muir and Hewitt (2009) recommended the von Mises equation, which is similar to the elliptical interaction of Equation 10-8. Equations 12-2 and 12-3 are based on Equation 10-8.

$$\left(\frac{V_r}{V_c}\right)^2+\left(\frac{M_r}{M_c}\right)^2 \leq 1 \qquad (10\text{-}8)$$

Background information and limits of Equation 9-1 are in Dowswell (2016). Dowswell (2019) developed a plastic interaction equation similar to Equation 9-1 that explicitly considers the torsional load on extended single-plate connections. The resulting strengths for plastic interaction with the additional torsion term are similar to the strengths calculated with Equation 10-8.

References

Dowswell, B. (2019), "Torsion of Rectangular Connection Elements," Engineering Journal, *American Institute of Steel Construction, Second Quarter, Vol. 56.*

Dowswell, B. (2016), "Stability of Rectangular Connection Elements," Engineering Journal, *American Institute of Steel Construction, Fourth Quarter, Vol. 53, No. 4.*

Muir, L.S. and Hewitt, C.M. (2009), "Design of Unstiffened Extended Single-Plate Shear Connections," Engineering Journal, *AISC, 2nd Quarter.*

Bo Dowswell, PE, PhD

Bo Dowswell, principal with ARC International, LLC, and **Larry Muir** are consultants to AISC.

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

steel quiz

Explore the "riveting" world of steel bridge repairs and retrofits using the recently released *Guidelines for Field Repairs and Retrofits of Steel Bridges* (AASHTO/NSBA G14.2-2023). Download your copy today at **aisc.org/nsba**.

1 A review of the National Bridge Inventory shows that the average age of all in-service steel bridges in the U.S. is currently ___ years.
a. 40
b. 50
c. 60
d. 70

2 **True or False:** When replacing rivets with high-strength bolts, it is generally recommended to design the repairs with high-strength bolts intended to behave as slip-critical connections.

3 **True or False:** Rivets and high-strength bolts have comparable fatigue resistance and are designated by the same detail category for fatigue in the AASHTO *LRFD Bridge Design Specifications (BDS)*.

4 **True or False:** Section loss of a structural steel element is most commonly addressed by plating the member.

5 **True or False:** Lateral-torsional buckling was not accounted for in bridges originally designed using ASD.

6 Field repair may be required for damage occurring during bridge rehabilitation. What type(s) of damage frequently occurs during concrete removal operations?
a. Saw-cut damage
b. Impact damage
c. Corrosion damage
d. (a.) and (b.) only
e. (a.), (b.), and (c.)

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**.

Answers reference AASHTO/NSBA G14.2.

1 **b. 50.** A review of the National Bridge Inventory shows that the average age of all in-service steel bridges is currently 50 years.

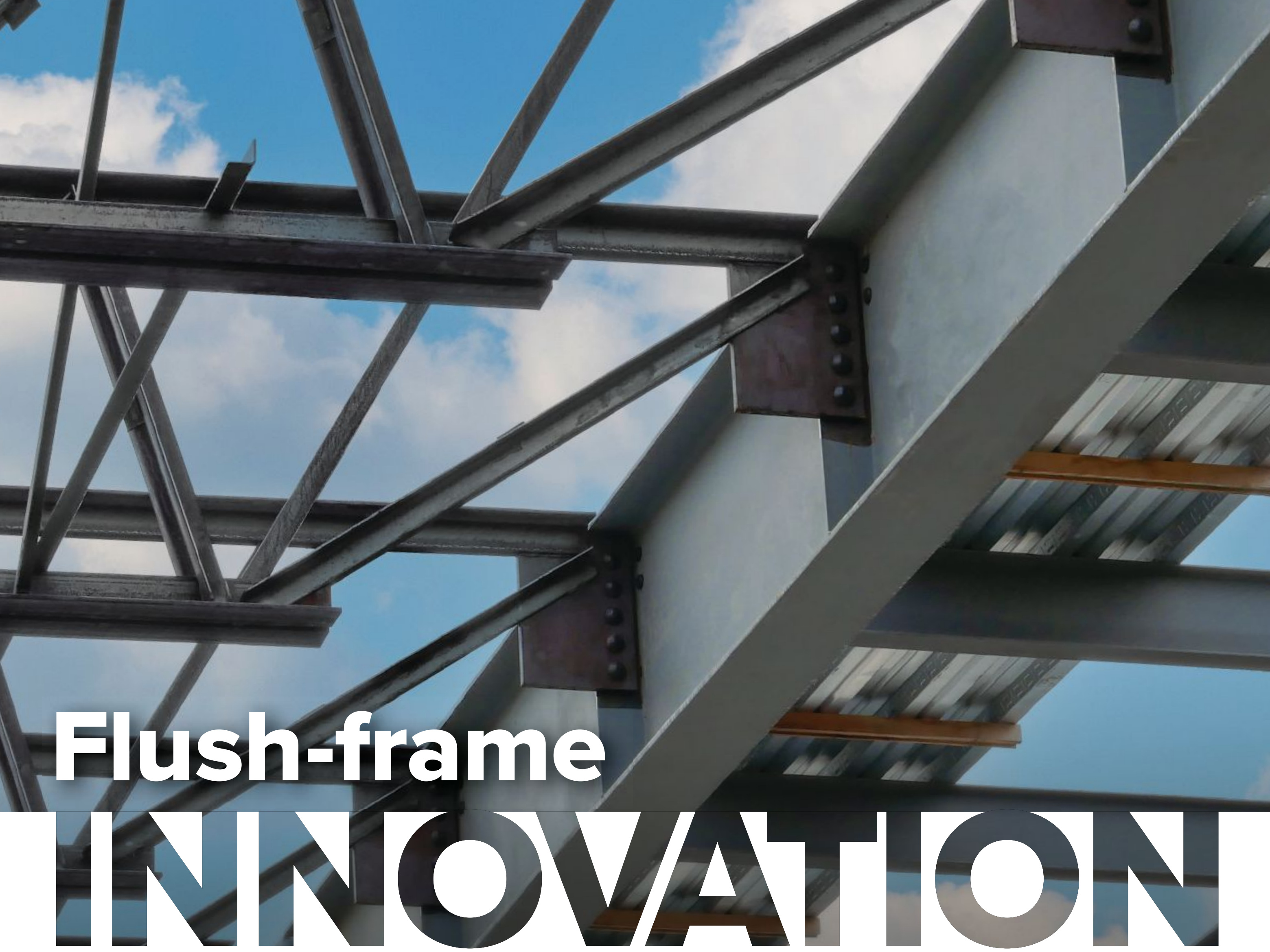
2 **False.** There are fundamental differences in the capacity of rivets and high-strength bolts, as well as in the behavior of connections having either fastener type. Rivets provide load transfer primarily through shear across the rivet shaft, while high-strength bolts used in bridges are generally designed to provide load transfer through friction between the connection faying surfaces imposed by tension in the bolts. When replacing rivets with high-strength bolts, it is important to realize that the clamping force, and therefore frictional load transfer capacity of a single high-strength bolt, may not be a one-for-one replacement for the shear capacity provided by the rivet it replaces. This is particularly true when the faying surfaces have degraded over time between the plies of a riveted connection, or more generally when the slip coefficient is unknown. Therefore, it is not always recommended to design rivet replacement repairs with high-strength bolts intended to behave as slip-critical connections. Generally, they should be designed as shear connections (Section 2.2).

3 **False.** The *BDS* designates riveted details as Category D with a constant amplitude fatigue threshold (CAFT) of 7 ksi. The high-strength bolt, however, is Category B with a CAFT of 16 ksi. These fatigue resistance values would be used for new designs for each respective fastener type. The AASHTO *Manual for Bridge Evaluation (MBE)* allows Category C for fatigue life evaluation of existing riveted connections due to member-level redundancy, with a CAFT of 10 ksi (Section 2.2).

4 **True.** Section loss is a generalized term for reduction in thickness of a structural steel element. Most commonly, it is addressed by plating the member. Plating is a repair where supplemental steel plates, or other members, are connected to the existing member to create a built-up member. It is used for strengthening and to improve the load rating. It may also result in an improvement to the National Bridge Inspection Standards condition rating of the element. In more extreme cases, or in locations where geometry makes plating less practical, partial-depth or full-depth member replacement can be performed (Section 3.2).

5 **True.** Lateral-torsional buckling (LTB) was not accounted for in bridges designed using ASD. When bridges are load-rated using the modern provisions, existing diaphragm spacing often results in reduced flexural resistance of the girders. Additional diaphragms or cross-frames may be used to reduce the unbraced length of the compression flange. However, if the flexural resistance is determined insufficient in the load rating, a more robust analysis may determine that the current system has sufficient capacity by considering the construction sequence and the stability offered by the hardened deck. (Section 4.5).

6 **a. Saw-cut damage.** Saw-cut damage to the top flange of steel girders may occur during bridge rehabilitation projects involving demolition and replacement of the concrete deck. It often comes from setting the depth of the saw blade too deep, variable depth deck fillet heights, or not adjusting the depth of the blade in negative moment regions where the flanges are typically thicker or include cover plates. Damage may range from a single shallow saw cut across the flange width to multiple, closely spaced saw cuts over a long length. Analysis and repair concepts are presented in Section 7.



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Seismic Sensibility

BY MATTHEW R. EATHERTON, SE, PHD, AND MARGARET A. MATTHEW, PE

Stay current on moment connections in seismic applications with the most recent update to AISC's seismic connections reference.

IN SEISMIC ZONES, intermediate and special steel moment frames can be an efficient choice for lateral force-resisting systems that perform well during earthquakes. The key document required for design of these systems is *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications* (ANSI/AISC 358). The latest edition is AISC 358-22, which can be downloaded for free at **aisc.org/publications**.

There were only two types of moment connections included in the 2005 version of AISC 358. Since that time, it has undergone substantial expansion and improvements, resulting in a greatly expanded range of applicability. It now includes 11 types of moment connections with significantly increased limits on the size of members and connecting elements allowed. This article dives into seismic design of moment connections, AISC 358's contents, and the updates and changes in AISC 358-22.

How are Moment Connections Designed to Resist Earthquakes?

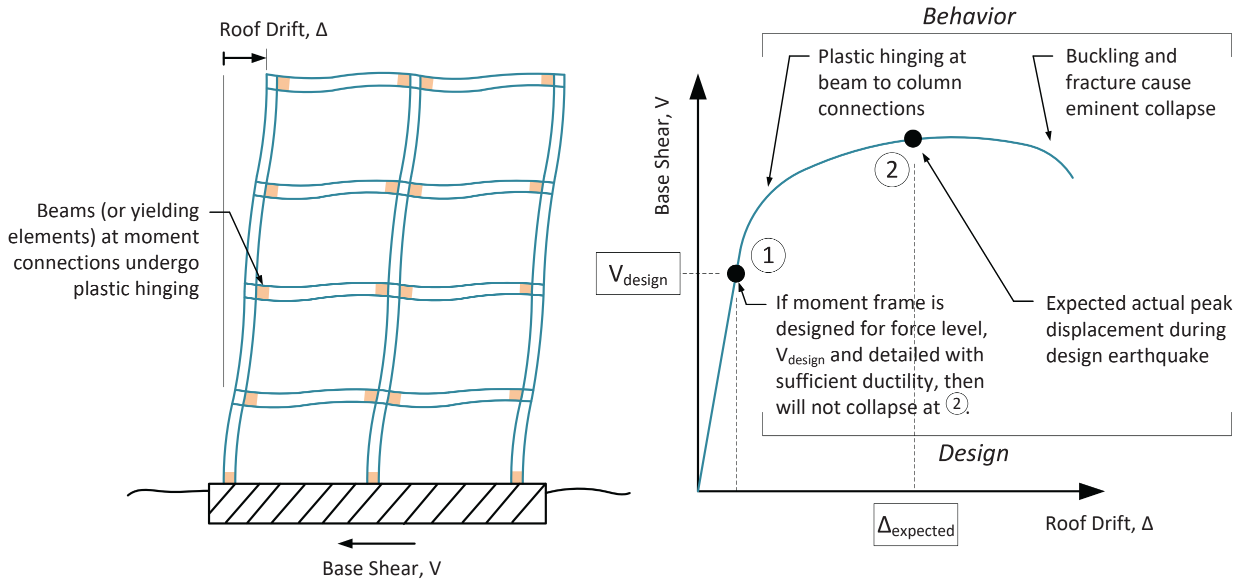
Earthquakes are fundamentally different than other types of loading events on buildings such as live loads, for which the structure is proportioned to have adequate strength and stiffness to elastically resist the load effects. Lateral forces during an earthquake occur because the foundation moves laterally, causing relative displacement between the foundation and the floors of the building.

Thus, the most important concept in seismic design is to recognize that earthquakes act more like an applied displacement on the building rather than a set of applied loads. In this design context, the most economical solution is to accommodate large seismic drifts through ductility—the ability to deform inelastically without significant loss of strength.

A ductile moment frame can undergo substantial yielding and deformation during an earthquake while retaining most of its lateral force resisting strength, meaning that the building may experience large drifts but has a high likelihood of remaining stable and protecting the lives of occupants during the maximum considered earthquake.

There are design approaches that explicitly control displacements with a design inequality given as displacement demand ≤ displacement capacity (e.g., Priestley et al. 2007). While displacement-based design approaches more accurately capture the character of earthquake actions on buildings, they require structural design models to capture the nonlinear behavior of the building up to failure.

U.S. building codes like *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI 7-22), on the other hand, have been



a. Seismic behavior of IMF and SMF

b. Seismic design approach

Fig. 1. Seismic design of steel moment frames.

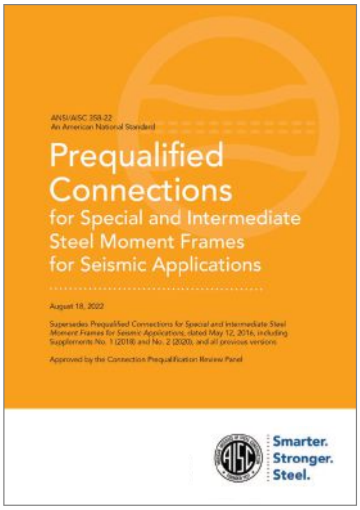
tailored to allow elastic structural analysis, which has historically been more widely accessible to the engineering community. To accommodate the use of elastic structural models to solve an essentially highly nonlinear inelastic design problem, the design approach is broken into two parts: (1) calculating design level forces that can be used with elastic structural analysis, and (2) detailing the frames to have sufficient deformation capacity to not collapse during the actual expected drifts.

These concepts are demonstrated for a ductile moment frame such as an intermediate moment frame (IMF) or special moment frame (SMF) in Figure 1. The behavior of IMF or SMF when subjected to increasing lateral drift is characterized by yielding at the ends of beams due to flexural strains, which after spreading over most of the depth of the beam section, is called a plastic hinge and is associated with a noticeable reduction in the lateral stiffness of the building. After additional drift, local buckling near the connections, fracture of some connections, or global buckling modes cause a reduction in the lateral strength of the building that leads to eminent collapse.

A design level base shear, labeled as (1) in Figure 1b, is calculated as the base shear that might develop in an elastic building with the same period, divided by a response modification factor, R, which represents the connection between elastic analysis and inelastic behavior. The R factors for IMF and SMF of R = 4.5 and 8.0, respectively, have been calibrated based on the amount of ductility expected in these moment frame systems.

The design approach is design forces at (1) are used in the design procedure, and because the ductile detailing requirements in *Seismic Provisions for Structural Steel Buildings* (AISC 341-22) and AISC 358 are followed, the building is expected to resist collapse at the expected actual displacement represented by (2) in Figure 1b.

Sufficient detailing requirements to produce ductile moment frame response are relatively new. From the 1960s to 1990s, welded steel moment frames were thought to be one of the most ductile seismic systems, but full-scale experimental evidence with detailing used in practice was lacking.



In the 1994 Northridge Earthquake, more than 100 steel moment frames experienced brittle fractures often initiating at the beam bottom flange-to-column flange weld.

One of the key conclusions of the large research effort that followed was that moment connections in IMF and SMF must be tested with a beam and column subassemblage that replicates the detailing, configuration, and scale of the connection used in practice. This need evolved into the concepts of qualification testing, which entails proving a connection type has sufficient ductility. After substantial qualification testing has been conducted, then prequalification allows use without additional testing.

Post-Northridge, the concept of prequalification was incorporated into the 2002 version of *Seismic Provisions*, based on recommendations from *Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings* (FEMA 350). Also in the early 2000s, AISC created the Connection Prequalification Review Panel, a consensus body charged with the responsibility of prequalifying SMF and IMF connections that met the prequalification requirements as specified in *Seismic Provisions*.

The basic requirement for prequalification is large-scale cyclic testing of the connection in accordance with *Seismic Provisions* Section K2, Cyclic Tests for Qualifying of Beam-to-Column and Link-to-Column Connections. The AISC 358 standard was created to officially recognize those connections that had met the prequalification requirements.

What's Included in AISC 358?

AISC 358 includes design procedures and detailing rules for 11 types of prequalified connections. Prequalification means that for each of these connection types, there has been sufficient past testing and analysis to use these connections in IMF and SMF without requiring any additional project-specific tests. The 11 prequalified connection types included in AISC 358-22 are shown in Figure 2, and each has a unique way of discouraging the brittle fractures observed in the Northridge Earthquake. Several push the plastic hinging region away from the face of the column to protect the beam to column welds, such as the reduced beam section (Figure 2a), bolted flange plate (Figure 2c), cast bolted bracket (Figure 2e), and double tee (Figure 2i).

Some of the connections incorporate yielding fuse elements that limit the forces transmitted to the surrounding elements such as the Simpson Strong Frame (Figure 2h) and DuraFuse (Figure 2k). One of the connection types, the welded unreinforced flange, welded web or WUF-W connection (Figure 2d) includes prescriptive detailing requirements that address the issues causing pre-Northridge connections to be susceptible to brittle fracture.

To demonstrate how the prequalified connections develop ductility, consider the first two connection types shown in Figure 2a and Figure 2b. Pictures from example seismic qualification tests conducted in accordance with *Seismic Provisions* are

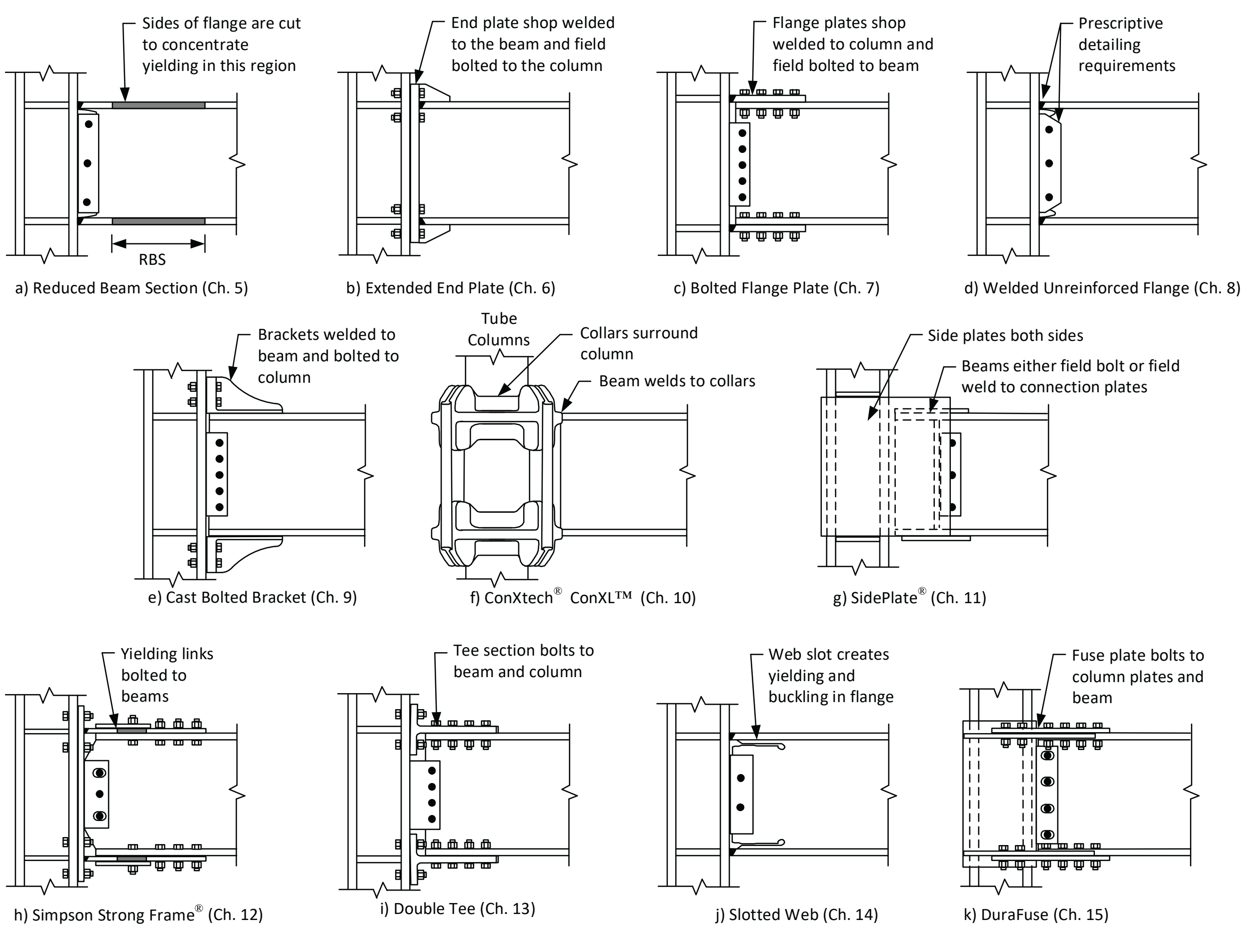
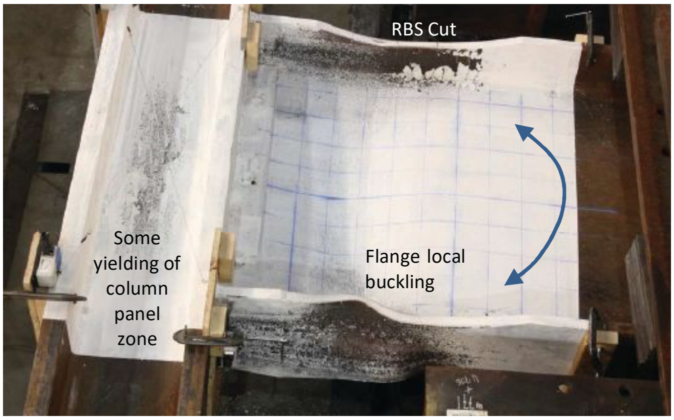


Fig. 2. Connection types included in *Prequalified Connections.*

a. Reduced beam section



b. End-plate moment connection

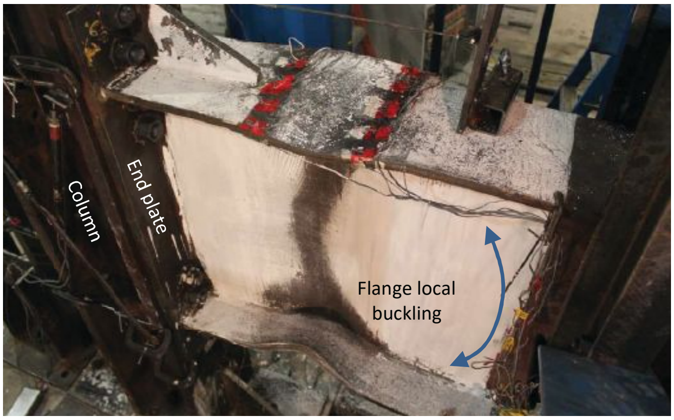


Fig. 3. Examples of moment connections subjected to cyclic testing.

shown for both the reduced beam section (RBS) in Figure 3a and the end-plate moment connection in Figure 3b.

The curved RBS cuts in the beam flanges concentrate the yielding and plastic hinging in a region away from the column flange, thus protecting the beam flange-to-column welds from fracture. Instead, typical behavior sees the beam flanges buckle after significant yielding, and fractures eventually form at the local buckle locations. Some yielding of the column panel zone is also allowed, as shown in Figure 3a from a test by Paquette et al. (2021). Some end-plate moment connection configurations similarly promote ductility by shifting the beam plastic hinging away from the end plate, but also add fracture resistance of the beam flange to end-plate welds by applying them in the shop from the outside of the flange to eliminate web access holes.

The failure modes are similar to the RBS with flange local buckling eventually followed by beam flange fractures starting at the local buckles or at the toe of the end-plate stiffeners. The specimen shown in Figure 3b was from a test by Toellner et al. (2015). Both connection tests shown in Figure 3 satisfied SMF qualification criteria by retaining a moment strength of at least 80% of the nominal plastic moment strength of the beam through a cyclic displacement protocol up to 4% story drift.

AISC 358 is for use in conjunction with *Seismic Provisions* for the design of the moment frame and the connections. The typical process of IMF or SMF design starts by selecting one of the prequalified connection types followed by selecting the size of the beams and columns to satisfy drift limits in ASCE 7-22. There are stiffness modifiers for some connection types that have reduced sections in the connection, such as the RBS and the Simpson Strong-Frame connections.

Each connection type has prequalification limits listed in AISC 358 based on the range of parameters used in successful supporting tests. For example, many of the connection types include prequalification limits on the beam depth and beam weight such as W44 and 408 lb/ft for the RBS connection, or W36 and 150 lb/ft for the bolted flange plate and welded unreinforced flange connections.

After selecting beams and columns that satisfy prequalification limits and drift requirements, there are a series of required design checks for the connection. AISC 358 contains a useful numbered design procedure for each connection type, including checks from *Seismic Provisions* and AISC 358. Finally, it is necessary to capture all the detailing requirements on the structural design documents.

What's New in AISC 358-22?

AISC 358-22 has a new connection in Chapter 15, the DuraFuse Frames Moment Connection. In this new connection, the beam and column are designed to remain elastic, a top plate on the beam defines the point of rotation, and a bottom plate on the beam acts as an energy-dissipating fuse. Beams are limited to W40 sections up to 309 lb/ft, and columns are limited to a W36 depth.

AISC 358-22 also expanded the prequalification limits for the Reduced Beam Section (RBS) moment connection in Chapter 5. The beam depth limit increased from W36 to W44, the beam weight limit increased from 302 lb per ft to 408 lb per ft, and the beam flange thickness limit increased from 1¾ in. to 2⅛ in. Column depth limits increased from W36 to W40.

Several proprietary connections have reverted to nonproprietary connections. The connection formerly known as the Kaiser Bolted Bracket connection is now the Cast Bolted Bracket connection in Chapter 9. In Chapter 14, the SlottedWeb connection is now the Slotted Web connection with no proprietary restrictions.

And finally, all connections were updated, as applicable, to reflect the following:

- A consistent approach to the gap between the column flange and the concrete structural slab.
- Clarification on shapes allowed for columns.
- Updated bolt-hole fabrication requirements.
- Net-section beam flange tensile rupture check in applicable chapters.
- Equations for determination of bolt-hole diameter updated to reflect current *Specification for Structural Steel Buildings* (ANSI/AISC 360-22) provisions.

Where to Start in Seismic Design of Moment Connections?

If you are new to seismic design of moment connections, there are many great references to help you get started and understand the steps. The 3rd Edition AISC *Seismic Design Manual* includes a detailed example for an RBS connection (Example 4.3.6) and a bolted flange plate connection (Example 4.3.7) to be used in SMF.

AISC Design Guide 39: *End-Plate Moment Connections* includes three examples of end-plate moment connection design for use in SMF. The 2021 IBC SEAOC Structural/Seismic Design Manual, Volume 4: *Examples for Steel-Framed Buildings* has an example of SMF design including RBS connection (SEAOC 2021). If using a proprietary connection type, it is encouraged that you talk to the manufacturer early in the design process. ■

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Top-Tier Teacher

INTERVIEW BY GEOFF WEISENBERGER

Bob Shaw has made an illustrious career out of teaching professionals and immersing himself in committee work, and a competition he created nearly 40 years ago has gained international acclaim.

Shaw (center) receiving his Lifetime Achievement Award from AISC President Charles J. Carter (left) and board chair Hugh McCaffrey.

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

BOB SHAW grew to love educating professional engineers and fabricators while working as an AISC regional engineer and as the associate director of education in the 1980s. In fact, he enjoyed it enough to take a mighty leap.

Shaw left AISC in 1990 to launch a company dedicated to providing resources and help to steel industry professionals. He saw a need for more rigorous technical resources and instruction. He hoped his audience had a large enough appetite for continued learning to demand his services.

Four decades later, Shaw remains the president of his company, Steel Structures Technology Center, Inc. It provides consulting services, training, and technical resources on steel-framed structures, fabrication, inspection, and quality. He has traveled the country and the world teaching and helping develop codes on his original passions: welding and bolting.

Shaw remains active on AISC and several other industry committees. He also created the Student Steel Bridge Competition, which started with three teams and has grown into a yearly spectacle and an inspiration for other countries.

This year, the lifetime teacher and educator earned an AISC Lifetime Achievement Award, recognizing his work educating designers and fabricators on bolting and welding. He spoke with *Modern Steel Construction* about his career, the bridge competition, and more.

What's your professional origin story?

I grew up around the construction world. My dad was a painting contractor, and my brother-in-law was involved in construction. But my origin story for the path into steel construction started in college when I was looking for a summer job. My university, Rose-Hulman Institute of Technology, encouraged me to find and reach out to alumni in my hometown.

I found a Rose-Hulman graduate who worked at Mississippi Valley Structural Steel in Decatur, Ill., my hometown. They were a large steel fabricator. I interviewed there, and as it turned out, the chief engineer had interned there when he was in college. He was excited to give that opportunity to me. That's how it started, back in 1973.

What were the next steps for you after you finished college?

I received several job offers, mostly in steel construction, but I returned to Mississippi Valley Structural Steel. It was what I knew and it was in my hometown.

I started full-time upon graduation in 1975, worked as a project engineer, and then moved into sales engineering for the Midwest. However, the economy became stagnant in the late 70s, and the plant was set to close. I could have moved, but I chose another opportunity that appeared: AISC regional engineer. I applied for that position and, fortunately, was hired.

I was given the choice of four locations and went to the Detroit office. I was the regional engineer for Michigan, Ohio, and half of Kentucky and served in that role for about five years. AISC reorganized in the mid-1980s to add a focus on education to teach people load and resistance factor design (LRFD). I joined the education department and worked with Bob Lorenz and Lew Burgett. We toured the country for two or three years teaching LRFD.

After we finished LRFD, we had the freedom to start teaching other topics. I came from fabrication and worked with fabricators as a regional engineer, so I went back to my passion and taught bolting and welding as part of the coursework through the education department.

I saw there was a tremendous need for more in-depth education on fabrication, erection, inspection, quality, and codes. I left AISC in 1990 to form Steel Structures Technology Center to do exactly what I had been doing at AISC: teaching professionals more about welding, bolting, inspection quality, and related areas.

What was that teaching process like when you first started?

There was a lot of travel involved and a lot of risk in booking hotels and sending out fliers just hoping people would show up to a session. Sometimes, that was successful. Sometimes it wasn't. Other companies would contact me and ask if I could give an in-house training session, whether they were a design firm, a fabricator, an erector, testing agency, association, or an owner.

The International Code Council asked me to give their structural steel courses under its banner. As a result, I regularly went to places that enforce special inspection requirements—primarily on the West Coast. That was a change because I was giving lectures on request and by contract, as opposed to hoping people would come.

I kept that system at SSTC through the economic downturn in 2008. In 2008, the numbers were down because construction slowed dramatically. We decided to focus only on New York, Los Angeles, Las Vegas, and San Francisco—places people would gladly travel. I did those four cities repeatedly. It took a lot of travel and was getting repetitive. In 2014, I switch to giving online, on-demand seminars. I tried some live webinars. Soon after, I recorded those same seminars, cutting down on travel and time and letting me branch out.

What other education needs did you find in the industry while giving those seminars?

In those classes, you're teaching the standards and specifications like the *RCSC Specification for Structural Joints Using High Strength Bolts*. It was written at a college level and difficult for the practitioners doing installation or inspection to understand using just a few words.

That led to the creation of the Structural Bolting Handbook, where we took the requirements and put them in a step-by-step fashion for installers and inspectors so they knew exactly what was necessary to follow the RCSC *Specification*, and it fit in their pocket.

Practioners had the same problem with the American Welding Society *Structural Welding Code—Steel* (AWS D1.1/D1.1M). We created the Structural Welding Quality Handbook as an easy reference to cover most types of work typically done in structural steel. Creating those two handbooks earned me an AISC Special Achievement Award. They're a popular set of tools for the industry.

You're basically the founder of the Student Steel Bridge Competition. How did that come to be?

When I was in college, there was a new concrete canoe competition. I attended one session to work with my ASCE student chapter, but at the time, I didn't feel it offered important knowledge for structural engineers. But it was the only thing that existed for a long time.

I had some university education responsibilities at AISC, so I searched for an alternative competition. On a long late-night drive to Kentucky, I brainstormed some ideas. I started on office buildings, transmission towers, and other vertical things that use steel. Those were either rare or dangerous when building tall.

Instead, I thought horizontally and crafted the concept of a steel bridge competition, with the basic principles done before I got to Kentucky. I proposed that to Lew Brunner, an AISC vice president at the time, and he offered a $1,000 budget to create and run a pilot competition. I wrote the rules and recruited three schools.

The pilot competition was in a parking lot at Lawrence Technological University in Southfield, Mich., in 1987. The first bridge took more than two hours to build and topped 700 lb. I thought there was no way this would work. The next bridge, from Michigan Technological University, did a lot better, and the third bridge was built in about 15 to 16 minutes. By the end, it was a clear success. The next year, there were four regional competitions around the country. The year after that, there were nine. It has been a big hit ever since.

Did you simply reach out to those three schools when starting it? They had probably never done something like that before. Were they apprehensive?

They were enthused. They worked hard on their bridges. They had no guidance. Sure, they had basic rules, but they did their own thing. I wasn't providing advice to anybody. There were two truss bridges with many pieces and bolts that took a long time to build, but they were strong and stiff. We also had one stringer beam that allowed them to build quickly instead of assembling all the trusses. That showed others some potential for creativity and innovation.

The next year, we saw different styles, some of which failed. It grew from there.

Innovation is out there, and students are always being creative. They're challenging the rules writers by finding where they can push the envelope. Some newer rules have been written to address equity concerns, where people have high-level machining capabilities or additive manufacturing that give them distinct advantages. Trying to level the playing field was important.

Since then, students have been encouraged to get local fabricators to help them and supply material. I doubt anybody at that time was going out and buying materials, but I was working with the fabricators in my region to encourage them to help. One big key to success for these teams has been continuity. Certain teams have had the same non-faculty adviser from the industry who helps them every year and can share decades of experience.

Some faculty advisers have also been in their role for a while. People who built a bridge several years ago are helping their alma mater's team. I did that this year in getting Rose-Hulman back into the competition. They had stopped several years ago, but they were back competing at SSBC this year.

SSBC is not just national anymore. There are bridge competitions in Canada and Mexico. Japan picked it up, and they're on competition No. 15 in 2024. A professor from Japan came to watch national finals at Michigan State and took the idea back to Japan. They've been doing it every year since. Another competition in Asia called Asia Bricom attracts schools from Japan, Taiwan, Mongolia, Indonesia, Thailand, and Vietnam. These competitions have modified rules with shorter bridges and lighter loads, which are better for lenghty travel to the event.

A steel bridge competition held in Istanbul, Turkey, called Design and Construct, focuses on steel arch bridges, again with different rules but the same concepts. It just competed its 17th competition. Tallin, Estonia has a competition in its fourth year. Iran has an SSBC that essentially follows U.S. rules. I've been working with ASCE on taking it internationally. I'm hopeful it will happen soon.

Every time I see you at the competition, you have a camera. Did photography interest you before that, or did the competition get you into photography?

I've always enjoyed taking pictures. But I take a lot at the competition—and video—because I and others can use them as training tools, to provide information to other schools, and to promote the competition. I've presented at the Japan, Estonia, and Turkey competitions to show them what happens in the North American ones. We're trying to work with them to coordinate the rules and offer ideas to build competitions. There is strong interest in building an SSBC in South America.

What would you consider your most significant committee work at AISC or elsewhere in the industry?

I think all committee and standards activities are significant. Otherwise, they wouldn't exist. When I started training in the early 90s, I was reading codes and standards explaining not only what, but why, and I saw areas where the codes and standards could get better and clearer. I had questions about why they said what they did. I went to AWS D1.1 and RCSC committee meetings to get answers and learn.

My knowledge base grew tremendously. I got involved in writing the welding and bolting standards. If you're proposing a change, an improvement, or a need that needs solving, you end up writing those standards. After the Northridge earthquake in 1994, I was asked to help write *Recommended Specifications and Quality Assurance Guidelines for Steel Moment-Frame Construction for Seismic Applications*, now known as FEMA 353. It got me deeper into other standards and involved in AISC committees. I'm still involved with AWS and RSCS, and I've added other organizations, including ASTM F16 Fasteners.

In 2000, I got involved in the International Institute of Welding (IIW), which broadened my horizons to see standards in other countries. Through my IIW contacts, I gave seminars and training on steel construction, welding, and bolting worldwide. It was a lot of work but fun to learn their standards, so standards became an even bigger focus for me

In 2011, I helped develop a new International Standards Organization (ISO) standard on fabrication, erection, and quality of steel structures—primarily buildings, but some of it is applicable to bridges and other steel structures. It's called the ISO 17607 series and published in late 2023. It has six parts and about 500 pages. That was a ton of hard, exciting work. I was the project leader for the last three years. But I learned a lot from other industry experts from all over the world and continue to share the knowledge I gained from it.

I serve on numerous committees, but now I'm more deeply involved with IIW. I've chaired two technical commissions, one on design, analysis and fabrication of welded structures, and one on quality management in welding. I still chair the latter. I also chair a working group focused on keeping all 18 IIW commissions working in tune and improving our exchange of information on welding topics. I have served on the IIW Board of Directors for five years and am a vice president. Much of my volunteer time is focused on IIW, and I have less time for the technical side with AWS, RCSC, ASTM, and even AISC.

I'm 70 now. My mentors—Bob Disque, Omer Blodgett, Bill Milek, John Fisher, and many others—worked and contributed past 70. From my perspective, as long as someone can contribute to our industry, we should keep going.

Whenever I talk to young people in the profession seeking guidance, I always encourage them to join committees. If anything, volunteer to be the committee secretary. Young engineersss may not have the technical knowledge yet, but they will meet people who do, learn from the discussion, and soon add to the discussion. ■

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

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

Don't Get Burned (Out)

BY JESSICA RECTOR

Preventing staff burnout from becoming widespread requires a proactive—not reactive—strategy that never stops.

BURNOUT IS IMPACTING every company, position, and industry. It's an epidemic decision-makers and company leaders can no longer afford to ignore. It affects teams, leaders, and individuals of every rank.

Even if you're not the one in a bout with burnout, it still impacts you.

How do you feel the next morning when you don't get quality sleep the night before? Grumpy? Groggy? Foggy? Impatient, irritable, unfocused? Lack of sleep impacts your perspective, attitude, how you respond to others, and how you react to situations.

The same thing happens with burnout. It doesn't stay self-contained.

When a team member—we'll call her Burnout Betty—has burnout, it impacts how she leads, communicates, listens, focuses, thinks, interacts. It influences her behaviors, energy, mood, and disposition. It influences everything. When one person is in burnout, it also trickles down to others, because burned out people burn others out. Even if you don't have burnout, you're impacted by it when someone else does or is on the brink of it. But you have the power to do something about it.

What can you do?

Start a dialogue. Talking about burnout is the best place to start. Even though burnout is rampant in the workforce, discussing it still evokes nerves. People often fear coworkers and superiors' reaction if they admit they have it. Will my leaders think I can't do my job? Will they take away responsibilities or will they lose trust in me?

If Burnout Betty (BB) isn't focused, she becomes distracted, unproductive, and makes more errors. She may do the same work multiple times, miss deadlines, or forget to meet a client. Those are best-case scenarios. On the worse end, BB could easily cut corners—leading to cybersecurity attacks, safety issues, and possible injuries.

BB's declining performance impacts you. You might have to stay longer or do some of her work. Maybe your work gets pushed back waiting on her to get her part to you, which means missing dinner with your family, being absent at your kids' activities, or not meeting your deadlines.

Lean into your storytelling skills. Share your burnout story with BB, if you have one. When you were in it, what led to burnout in your life and what were the strategies you implemented to move past it? When people are in burnout, they tend to pull away and isolate themselves. When you tell your burnout story, they will start to engage.

The more you talk about burnout, the more it reduces the uneasy stigma around it. In the process, you allow others who are experiencing it to not feel alone and to know that someone, somewhere gets it and understands. You create a safe place of compassion and empathy. This lets others know it's okay to feel burned out. You can still love your job and be burned out.

Create awareness around burnout. Burnout doesn't discriminate. The more your team knows what to look for and understands preventative strategies, the less likely they will find themselves in it.

Burnout impacts mental health. It makes Burnout Betty easily frustrated or irritable, meaning it's likely harder to communicate or interact with her, because others don't want her mood to affect them. One Burnout Betty can bring a dynamic team to a halt. Talking to BB can leave the most positive person in a negative state. Every conversation takes longer than it should, which means less time for your daily tasks.

Build a task force of people who want to be the burnout eyes and ears in your organization. They can gather information, ask questions to BB and other team members, and create a strategy to combat burnout. Then, a company's decision-makers should take the information gathered and implement changes to help reduce burnout occurrences and severity.

The task force approach lets BB know she is, heard, understood, and that she matters. One of the most important qualities people want in their company is to know they matter. When BB knows she matters, she feels supported to defeat burnout.

Time off is great, but vacation won't cure burnout. Once you create awareness around it, share successful day-to-day strategies that help alleviate burnout.

Implement a burnout program. This is the key, fundamental element to eradicating burnout within a company. Talking about it is a great beginning, but it's not the end. The only way to prevent and address burnout is to be intentional and strategic with it. Workplace wellness programs often fail to address or help with burnout directly. The most successful burnout programs have four key components: accountability, support, encouragement, and employee Q&A.

As a leader, you must do your part to help your people with burnout. If you want long-term results, your organization must implement a continual program (not a one-and-done presentation or check-in) to help people like BB overcome burnout and others to prevent it.

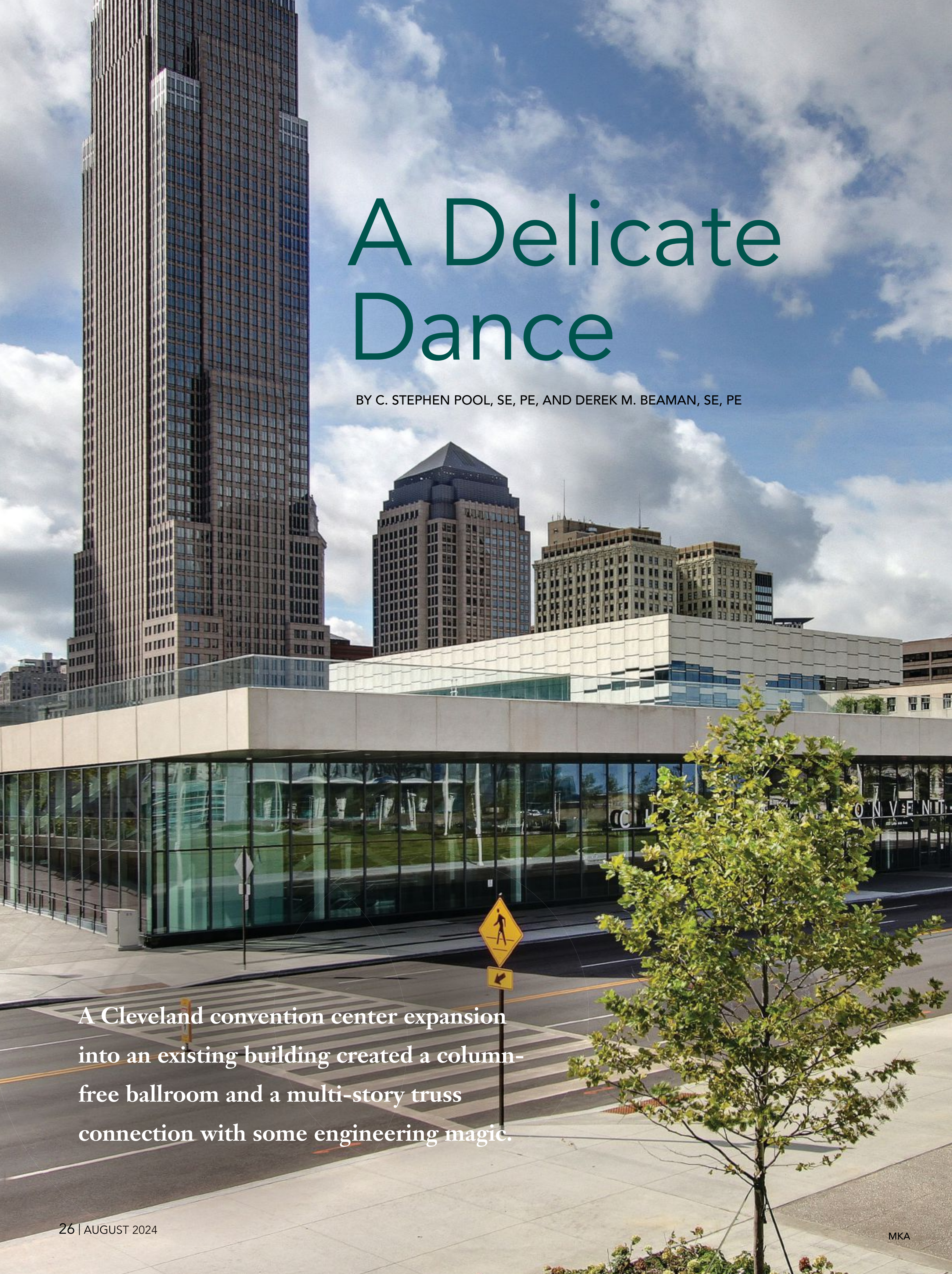
Burnout is a slow crawl, and working through it is a multi-layered process. Whether it's an online course, bootcamp or a Train the Trainer certification, burnout training is no longer simply nice to have. It's imperative for a company that wants to keep its top talent and create a happy, thriving workplace and culture.

Burnout doesn't go away on its own.

With many industries incurring staff shortages, it's up to you, as a leader, to invest in your people if you want to keep them. Burnout is among the top reasons people leave organizations, and companies have a huge opportunity to end the burnout epidemic by starting the dialogue, creating awareness and implementing a burnout program in your company.

It's a win-win for everyone.

Jessica Rector is the author of the No. 1 best-selling *Blaze Your Brain to Extinguish Burnout* and nine other books. She helps organizations, leaders, and teams eradicate burnout and enhance mental health. Visit her website **www.jessicarector.com** for more.



A Delicate Dance

BY C. STEPHEN POOL, SE, PE, AND DEREK M. BEAMAN, SE, PE

A Cleveland convention center expansion into an existing building created a column-free ballroom and a multi-story truss connection with some engineering magic.

MKA

opposite page: The expanded Huntington Convention Center is a Downtown Cleveland hub.

below: The convention center's column-free ballroom has a new piece that juts out from an existing four-story building.

TVS

ONE OF DOWNTOWN CLEVELAND'S newer gathering spaces quickly outgrew its original layout.

The 475,000-sq. ft Huntington Convention Center—with a 225,000-sq. ft exhibit floor neatly tucked beneath a lidded portion of the beautifully landscaped historic Cleveland Mall Park and promenade—immediately became popular when it opened in 2013. But changing market conditions and increased demand created a need for additional event space, which was achievable only through expansion. The venue's operators settled on the attached four-story Global Center for Health Innovation (GCHI) as the expansion space.

The $49 million, 78,000-sq. ft expansion, which broke ground in spring 2023, had three areas of focus:

- Converting a ground-level portion of the GCHI building into a hub for meeting rooms and a ballroom.
- Constructing a new expansion adjacent to the GCHI building that seamlessly connects to a new 20,000-sq. ft ballroom.
- Placing a 10,000-sq. ft outdoor terrace atop the new ballroom expansion.

At first, it seemed like a straightforward expansion project. But it proved structurally complex.

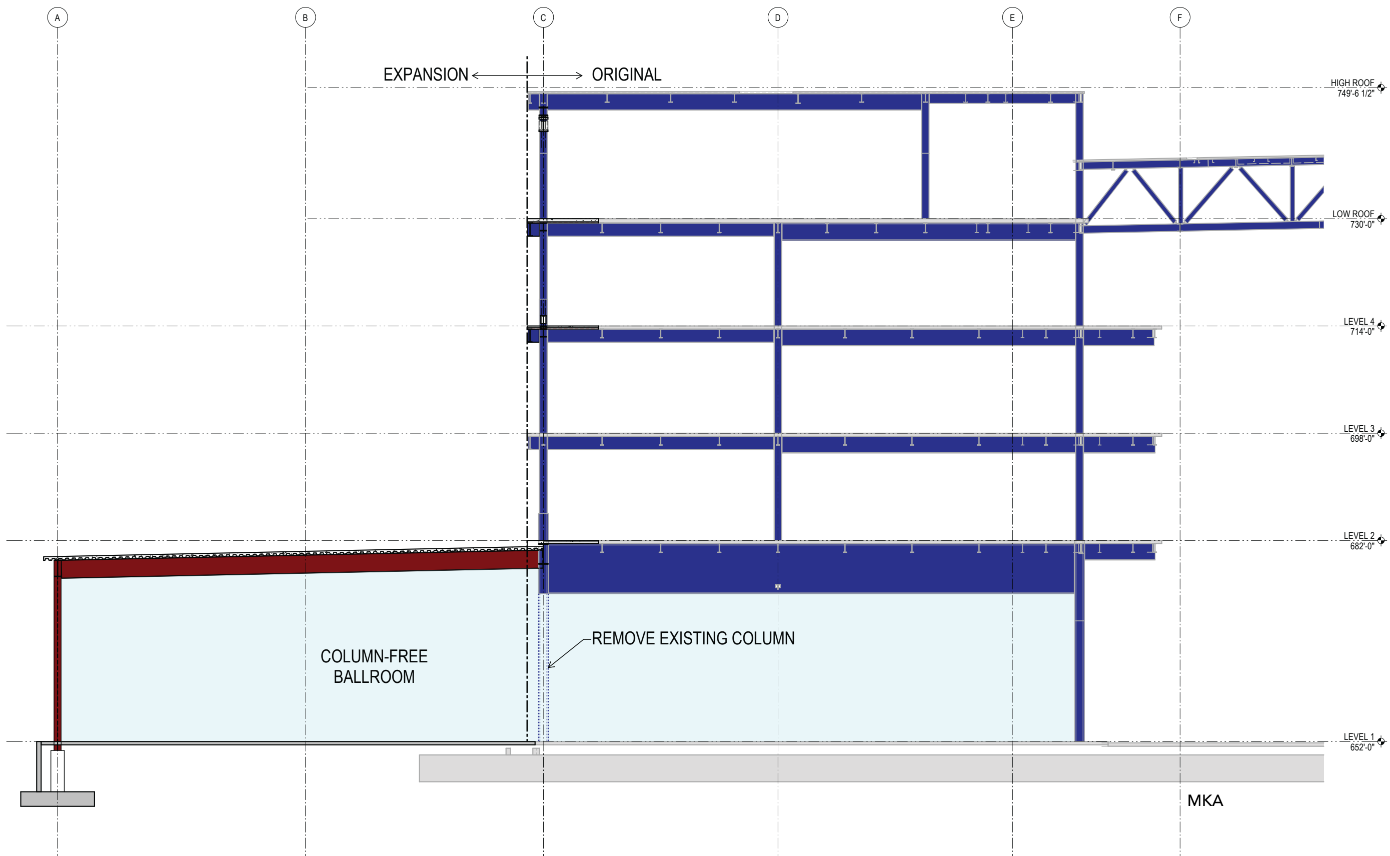
While long-span steel trusses and iconic tree columns supported the park above the original convention center, the expansion's design was different. The ballroom would extend from the new expansion into the existing GCHI building, creating a column-free space—a move that required some engineering magic for a project with approximately 335 tons of new structural steel.

Four exterior columns needed to be removed for the new ballroom space to extend beyond the original building's footprint. But these weren't just any columns; they supported large transfer girders at Level 2, and the combined load on the four columns accounted for nearly 25% of the entire building's weight.

The solution to maintaining support without those critical columns was inserting a multi-story truss into the exterior column line. Like a complicated dance move made to look easy, the truss spans the ballroom, allowing four columns to be removed below Level 2 to create the desired space. This multi-story truss supports half of the new ballroom building's outdoor rooftop terrace.

The architect and engineer collaborated to deliver an aesthetically pleasing and efficient truss layout design with several exposed structural elements. The engineer offered several variations of truss diagonal layouts, including the steel tonnage impacts for each variation, which helped the architect choose the scheme with the lowest new steel cost while still meeting design goals. Similarly, a sloping column scheme reduced the overall truss steel from 275 tons in the initial concept to 110 tons in the final design—a 60% difference. The sloping columns' large unbalanced thrust loads needed to be retrofitted to the existing braced frame lateral system and drag struts between the truss and the braced frames, producing a buttressing effect that significantly stiffened the truss and helped the design team achieve tight deflection tolerances.

The contractor and engineer thoughtfully considered the impact deflections would have on the existing building's finishes. Column removals produce truss deflection, which also moves



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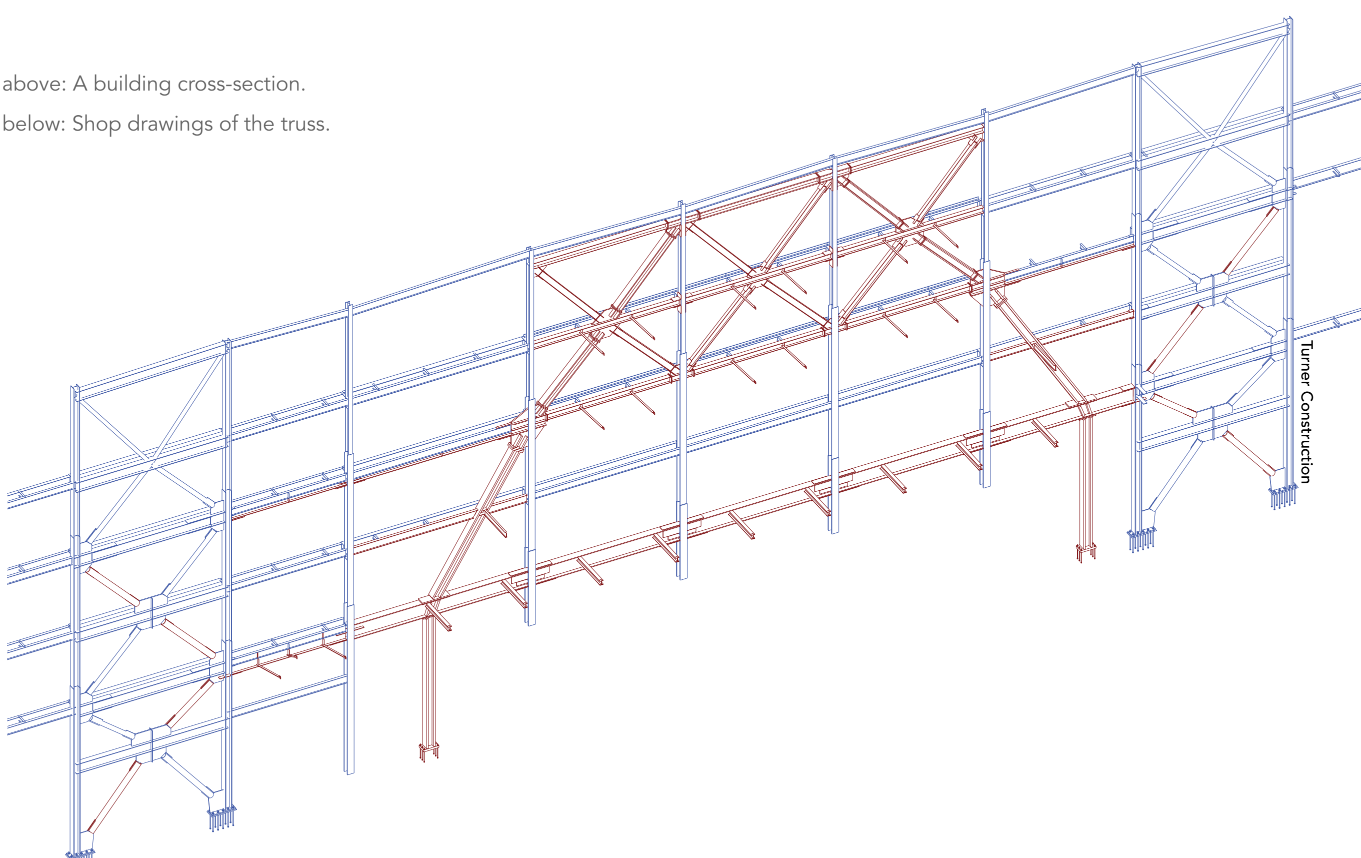
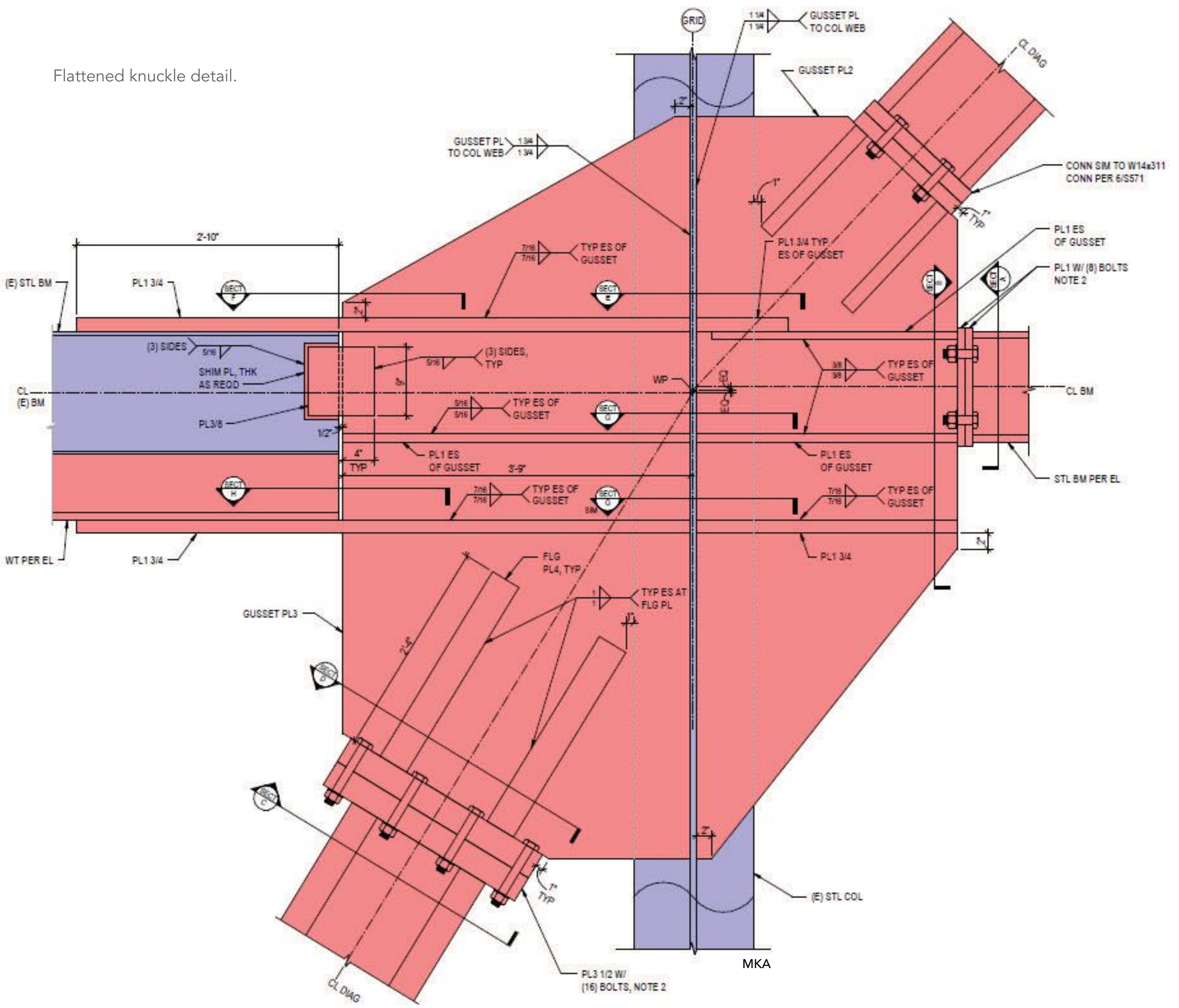
above: A building cross-section.

below: Shop drawings of the truss.



Turner Construction



Flattened knuckle detail.

finishes beyond what they were exposed to during construction, resulting in potential damage. Several strategies minimized the damage threat:

- The new multi-story truss was designed for a strict deflection limit beyond code requirements and held to a maximum deflection of 3 in. at mid-span under service loads, which is under half the code-allowable deflection limit for a truss with this span.
- The contractor pre-cambered the truss during installation, using hydraulic jacks to lift the center of the truss line nearly 1½ in. before installing the new truss members and allowing the truss to settle to nearly level under the dead loads.
- Sensitive finishes, such as the existing precast concrete panel façade, were removed and reinstalled after the truss reached its final deflected shape.

Introducing a truss connection to an existing building is complicated. In-depth knowledge of the existing structure helps, and the expansion project's design-build team included the original building's engineer, general contractor, and steel erector, all of whom offered invaluable insights. The expansion's design referenced the original analysis models, structural calculations, and steel shop drawings. Engineers created new connection details using precise geometry from the original shop drawings, minimizing the need for field surveying.

Still, two significant challenges arose.

First, limiting the removal of existing structural material minimized expensive demolition and rebuilding. It also meant building the truss around existing columns and beams left in place above Level 2. As a result, the existing structure dictated the nodes through which large design forces are transferred.

Second, new connections had to provide enough tolerance to adjust to the as-built locations of the existing structure. The engineer used constructability input from the contractor and the erector to create details with oversized bolt holes, slip-critical bolts, and adjustable weld layouts to provide the necessary flexibility for adapting the field fit-up to the existing steel locations.

above: A gusset plate being erected.

below: The new transfer trusses before ballroom construction.

right: The convention center added 78,000 sq. ft of space.

Another challenge involved a complex erection process to facilitate pre-camber within the truss. Crews installed hydraulic jacks on the existing columns, which were cut before the jacks raised the structure a variable dimension to match the expected deflections (1½ in. maximum).

Next, crews installed new truss members, support columns, and foundations in the cambered position. As the jacks released the load, the truss settled back to nearly level. The erector and engineer carefully compared notes for estimated deflections to ensure everything proceeded as anticipated.

Other complex project components installed an exposed steel staircase and escalators flanking the north and south sides of the four-story central atrium space, suspended from the existing roof trusses, and introduced operable partitions to convert GCHI space into convention center meeting rooms.

Visitors will gather inside the Huntington Convention Center Expansion's new meeting rooms, take in skyline views from the new rooftop terrace, and fill the

TVS

column-free ballroom when the venue opens to the public in the summer of 2024. ■

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Ambitious Reuse

BY PATRICK ENGEL

A LONG-VACANT HOSPITAL in idyllic Boulder, Colo., that couldn't vanish fast enough has become the preeminent U.S. venture into a newer and daring type of steel reuse.

City of Boulder officials found zero ways to give a 250,000-sq. ft, 30-year-old hospital building a second life after the city purchased the structure and three adjacent buildings in 2015 and the tenant, Boulder Community Health consolidated at another location in 2019.

But ruling out adaptive reuse doesn't mean the steel beams must go on the fast track to a furnace.

Prompted by its law but compelled by pushing the envelope, Boulder embarked on one of the first U.S. commercial deconstruction projects and the first such project to designate steel from a takedown for use in a new building.

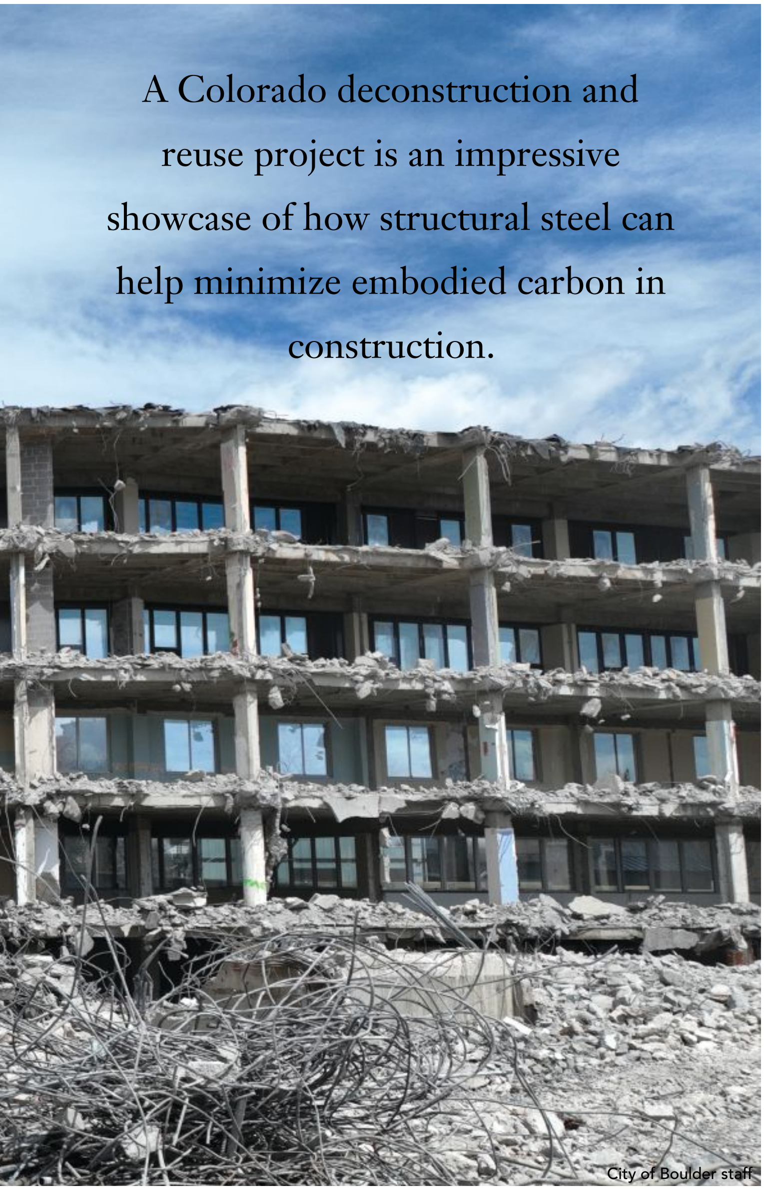
The new building, city-owned Fire Station 3, uses part of the former hospital's 161 tons of recovered steel. The rest is part of a reuse marketplace aimed at contractors, architects, and structural engineers who could use pieces in new projects, building additions, or renovations. The market remains active—some beams are already in place somewhere else, while others are on-site awaiting an interested party.

All told, it's a lot of extra effort, planning and work. Finding a new home for 161 tons of steel takes an effective marketing plan that starts long before the building is leveled. Even with some left to unload, though, Boulder officials feel their effort is worthwhile.

"It's such a success for us," said Emily Freeman, Boulder's circular economy policy adviser, "We're looking at ways we can do this for other city projects."

Boulder's efforts also showcase how steel buildings can best meet robust landfill diversion policies, deconstruction ordinances, and carbon emissions reduction goals gaining traction in some cities and states. Whether recycled or reused, steel can avoid a landfill. Reusing it, though, can slash a deconstruction project and a new building's embodied carbon.

"Steel really lends itself to reuse," said Alexis Feitel, an engineer and embodied carbon expert at KL&A, Boulder's partner for



Careful deconstruction for steel recovery proved to be effective and safe for Boulder's project.

City of Boulder staff

A Colorado deconstruction and reuse project is an impressive showcase of how structural steel can help minimize embodied carbon in construction.

Recovered steel from the former hospital building in place at Fire Station 3 in Boulder.

Feitel, KL&A

the steel deconstruction and reuse. KL&A is also the engineer of record for Fire Station 3. "It already has the advantage of recycling. However, we're able to save a huge piece of embodied carbon, because about 80% to 90% of the manufacturing impact is avoided with reuse. You still have the fabrication and installation impacts, but the actual creation is avoided. It's a huge advantage."

Deconstruction Pioneers

Boulder and Palo Alto, Calif., are the only two U.S. cities with deconstruction ordinances that cover commercial and residential properties. Boulder's ordinance, which took effect in 2020, mandates 75% of materials by weight from a deconstruction project must be diverted from a landfill.

Boulder found the cost of an adaptive reuse of the hospital building prohibitive and had no place for the former hospital in the planned housing development on the site, sealing its teardown fate. Its ordinance meant the hospital couldn't be felled with a swift smack of a wrecking ball and a stream of landfill-bound dump trucks.

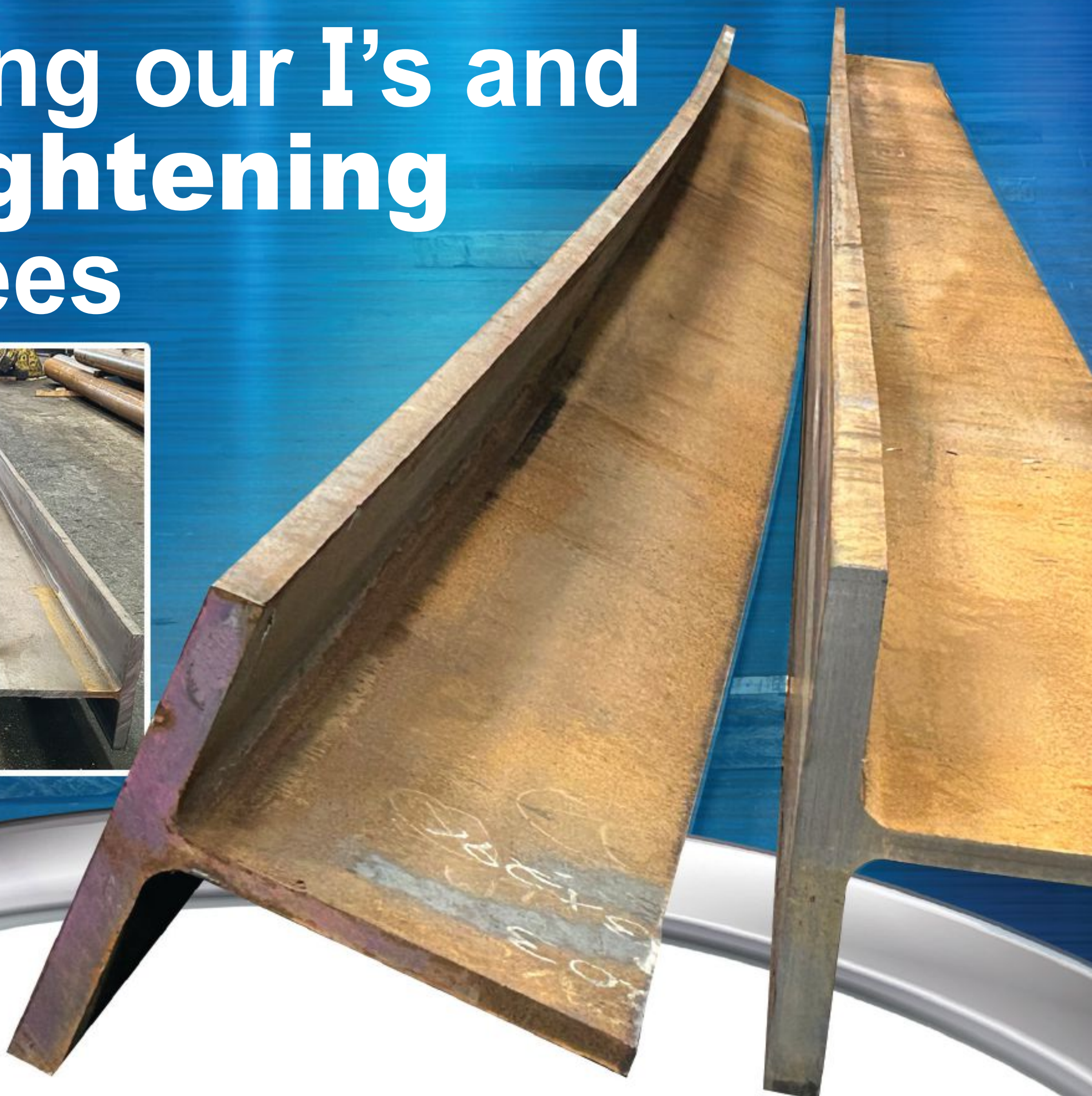
Boulder officials could have chosen to scrap the steel and send it to a mill, where it would be melted and made into new steel. But they did not launch this project merely to adhere to a deconstruction law and reach its mandated diversion percentage (the project diverted 93.5% of hospital materials, soaring past the required 75%). Rather, they wanted to embrace the deconstruction, circular economy, and embodied carbon goals' spirit.

City officials saw recovering beams for reuse as thinking bigger and greener. They also began recovery work unsure if it would reach the finish line. They were embarking on a project without U.S. precedent or codification. They identified potential hurdles that could thwart it, but it was difficult to determine how likely those were to occur. In collaboration with the general contractor, Ameresco, and local demolition expert Colorado Cleanup Corporation, KL&A helped the city imagine success and created a plan and process. KL&A has combined expertise in structural engineering, steel construction management, and embodied carbon, plus previous experience with small-scale steel reuse.


City of Boulder staff


City of Boulder staff

Splitting our I's and Straightening our Tees



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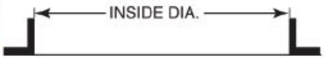
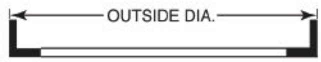
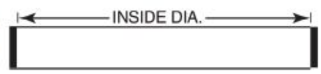


2 Angle Leg In — 10" x 10" x 1" Angle

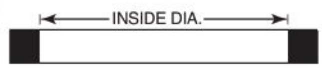


3 Flat Bar The Hard Way — 24" x 12" Flat

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

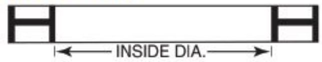


5 Square Bar — 18" Square

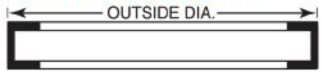


6 Beam The Easy Way (Y-Y Axis) — 44" x 335#, 36" x 925#

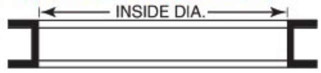
7 Beam The Hard Way (X-X Axis) — 44" x 285#



8 Channel Flanges In — All Sizes

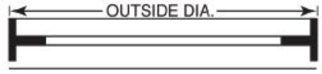


9 Channel Flanges Out — All Sizes



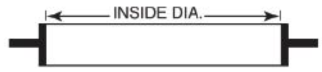
10 Channel The Hard Way (X-X Axis) — All Sizes

11 Tee Stem In — 22" x 142½# Tee

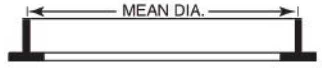


We bend ALL sizes up to:

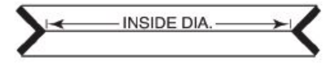
12 Tee Stem Out — 22" x 142½# Tee



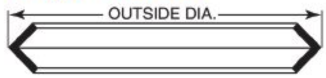
13 Tee Stem Up — 22" x 142½# Tee



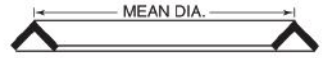
14 Angle Heel In — 8" x 8" x 1" Angle



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

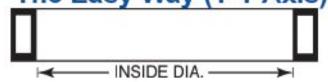


16 Angle Heel Up — 8" x 8"x1" Angle

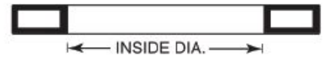


17 Square Tube — 24" x ½" Tube

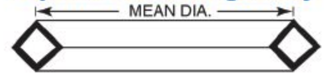
18 Rectangular Tube The Easy Way (Y-Y Axis) — 20" x 12" x ⅝" Tube



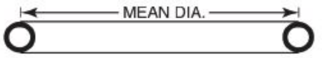
19 Rectangular Tube The Hard Way (X-X Axis) — 20" x 12" x ⅝" Tube



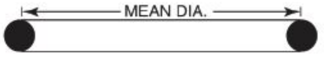
20 Square Tube Diagonally — 12" x ⅝" Square Tube



21 Round Tube & Pipe — 24" Sched. 80 Pipe



22 Round Bar — All Mill Produced Sizes



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opposite page: The former Boulder Community Health hospital site before deconstruction (above left) and after (below left).

above: All buildings at the former hospital site were deconstructed, except a corner building that will be turned into city offices.

Two years later, the project has turned heads and encountered no major obstacles. It has also confirmed a successful deconstruction for reuse project requires favorable underlying project factors and comes with a larger bill and longer timeline than demolition. Boulder has found the added time and cost manageable and the pioneering efforts rewarding.

"It's so exciting to show this is possible," Freeman said. "Recycling brings materials back into play, but if there are ways we can preserve the built environment in its full integrity from the start, it really helps us tell the story of creating a circular economy."

Start with a Spreadsheet

Boulder's sustainable deconstruction requirement is part of the Energy Conservation Code, which targets an 80% reduction in greenhouse gas emissions by 2050 and net-zero energy consumption by all buildings by 2031. The city conducted and published a study in 2018 that showed the greatest emission sources came from the built environment, not transportation, food production, or energy.

"If we're not able to absorb these initial carbon costs into new buildings, we'll immediately be setting ourselves back," Freeman said.

While pursuing a reuse project was an easy choice, executing it presented several hurdles. Among the biggest was finding and creating a market for the hospital's steel. The firehouse and eventual hospital site redevelopment were a necessary starting point, but the rest had to be claimed and used elsewhere to achieve the circular economy goal—meaning the first step in a deconstruction and reuse project is providing proof of market.

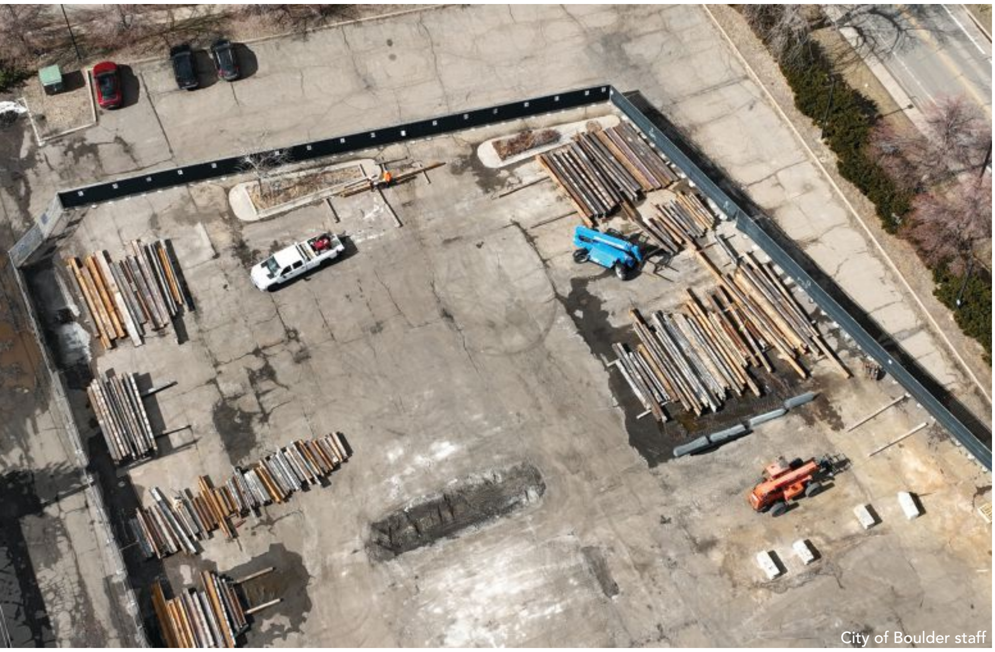
"That's key for any future project—connecting that end use and making the case for deconstruction in the first place," Feitel said.

Thinking about end use means knowing the types and quantities of steel available before it's salvaged and having that information available to potential buyers. KL&A created a digital inventory of all the pieces so buyers could scan for ones that fit their project without needing to see the stockpile—just like a mill. The fire station design team picked from that inventory during design development and used about 25% of the tonnage.

"Once (buyers) select pieces they think are best for their application, we send them a cut sheet package and material testing results," Feitel said. "Every piece has its own cut sheet page that includes geometric information and photos. It helps identify if there's a stiffener plate at a specific location, a penetration, a dent in the flange, or a sweep in the member. We send that package to the designer, and they review it before picking up the pieces.

"We felt it was crucial to have this information available to engineers designing with the steel versus individuals walking onto the site, eyeing some steel, and having to measure and go through all that validation themselves. We approached it from the end user standpoint. What information do they need and when do they need it? If the burden is on each project to vet and measure steel, that's too big a hurdle."

Finding the information is a task itself. The hospital building had two distinct sources for steel recovery, each with different steel framing systems and built at different times. One had existing structural documents and allowed the team to inventory before deconstruction. The other didn't have anything, which flipped the recovery, documentation, and inventory order of operations around.


City of Boulder staff


City of Boulder staff


City of Boulder staff

Still, it was a city-owned building with enough documents and easy access to them. The deconstruction team used architectural drawings for orientation and understanding potential joints and transitions between structural framing schemes. Once the ceilings and finishes were removed, they observed the frame to determine the best disassembly process.

"We knew what steel we had, the sizes, shapes, and strengths," said Michele Crane, Boulder's city architect for facilities, design, and construction. "Having that inventory long before we were pulling steel out of the building to market it made a difference."

An engineer partner helps with marketing in addition to planning the deconstruction, stockpiling, and reuse. The Colorado Cleanup partnership helped with the takedown and steel marketing. Those alliances and KL&A's advertising have helped spread the word locally about the available steel. Buyers must be contractors or designers and show proof of end use and proof of insurance, blocking anyone intending to sell it for scrap.

The project team expects all steel to be claimed, largely for use in local projects.

"This was not a very technically challenging problem," Feitel said. "It's a logistical task, reprioritization, and having everyone think about what's possible with deconstruction and implementation into new construction. There are a lot of steps in the process, but it wasn't technically challenging. For implementation into new construction, projects need to understand the status and properties of the steel, but it doesn't deviate much from a normal design process."

A Perfect Mix

The former hospital site had nearly every desired condition for a deconstruction and reuse project. It's a steel building constructed within the last 40 years. It's not in a tight downtown space. It had an unused city-owned parking lot next to it for material laydown. The developer of the housing complex that will occupy the site is not beating down the city's door to start construction.

Of course, those pieces won't align on every takedown project.

The laydown area for recovered steel awaiting a second use or pickup is conveniently located on-site.

"It's a case-by-case evaluation of the structure and if it lends itself to deconstruction," Crane said.

A building's suitability, though, does not guarantee a project team's willingness to incur extra costs and time.

"Given the city's goals around decarbonization, sustainable construction, and reducing landfill material, there was an acceptance of a premium," Crane said. "Part of this was learning what the premium was."

The premium was partially offset by reducing new steel material needed for the fire station. Revenue from selling the hospital steel at market rate would help more, but Boulder passed on the chance. It sold beams for $1, no matter if a customer bought one or 100.

"We could recover some of these costs if we were to sell it at a market value, but that's not the point for the city," Freeman said.

Offset factors aside, the deconstruction premium was lower than the city's expectation. Deconstruction added 2.5 months to the project and a 16% price increase for the exterior phase, when compared to traditional demolition. At the start, workers needed 12 minutes per beam to cut the steel out of the frame, tie it to a crane, and set it on the ground. That time decreased as the project progressed. The on-site storage area saved the time, emissions, and cost of putting the steel on trucks to transport to offsite storage.

"There was a system where sizes and shapes were placed so they were easy to take off the site," Crane said. "We were shocked at how quickly it went."

And pleased it was even possible.

The project team couldn't assume the building would remain safe for beam recovery before deconstruction started. If it proved too hazardous, the recovery efforts would cease and the steel would be recycled. No safety hurdles were immovable, though. The team was also unsure how many beams would be recovered without damage. If too many came out of the building unsuitable for reuse, recovery efforts would end. But only 5% of beams were lost due to damage. Those were used for testing, then recycled or claimed for non-structural use.

"We had a lot of contingencies built in that we got back when we closed out the deconstruction because it wasn't as hard or challenging as expected," Crane said. "We're still finishing the fire station. We'll do more of an economic analysis of what

Beams in the former hospital building set to be recovered

City of Boulder staff

Beams set for reuse in Fire Station 3.

we saved cradle-to-cradle. We want to know the market timing of the steel and when we would have purchased it. We're still working on that.

"As a percentage of the project, it was not that high a premium—especially if you factor in the cost of carbon, which Boulder is doing."

Even with acceptance of cost increases and a suitable building, Boulder's project isn't possible without unrelenting ambition from those involved. Putting together pieces of a logistical puzzle takes time, patience, and optimism. Shortcutting the pre-planning or accelerating the deconstruction might be tempting, but they have domino effects on the entire project scope.

Word of Boulder's success has spread to neighboring cities, and multiple city officials have presented at national conferences.

"As they become more aware of what happened here, they want to learn how we approached this project and what they could bring to their cities," Freeman said.

When other cities and projects have reached out to ask for advice, the project team has stressed collective buy-in and planning can determine success.

"Talking with other people interested in steel reuse, the biggest challenge they hear is the human behavior changes—not demolishing the building right away, being thorough with deconstructing it, taking more time to inventory what they have and find end use markets," said Leana Evenson, a construction project analyst with the City of Boulder. "We had a great team that put time and effort into this project."

Ready for More?

A steel hospital is an ideal candidate to split into dozens of second lives. Its frame has enough consistency of pieces and types and is not a hodge-podge of steel. The steel fits smaller projects best, though, because a 161-ton stockpile won't produce enough tonnage of one piece to use in a similarly sized commercial building.

Most of the buyers have been contractors with small-scale projects. A horse farm in Hartsel, Colo. learned about the stockpile from a Colorado Cleanup Facebook post and took about 55 pieces. Other pieces have gone to nearby home additions, home rebuilds, home construction, the city's fire training center, and a new modular home factory. KL&A will be using pieces in some

Feitel, KL&A

Labeled beams rest in the layout yard.

Feitel, KL&A

of its local commercial projects. If some of the steel is used in the renovation of the lone remaining building on the former hospital site into city offices, it will likely be for trimmings like screenwall or canopies rather than primary frame pieces.

The steel has largely gone down the structural use chain, but its mere reusability still makes it unique and avoids embodied carbon impacts.

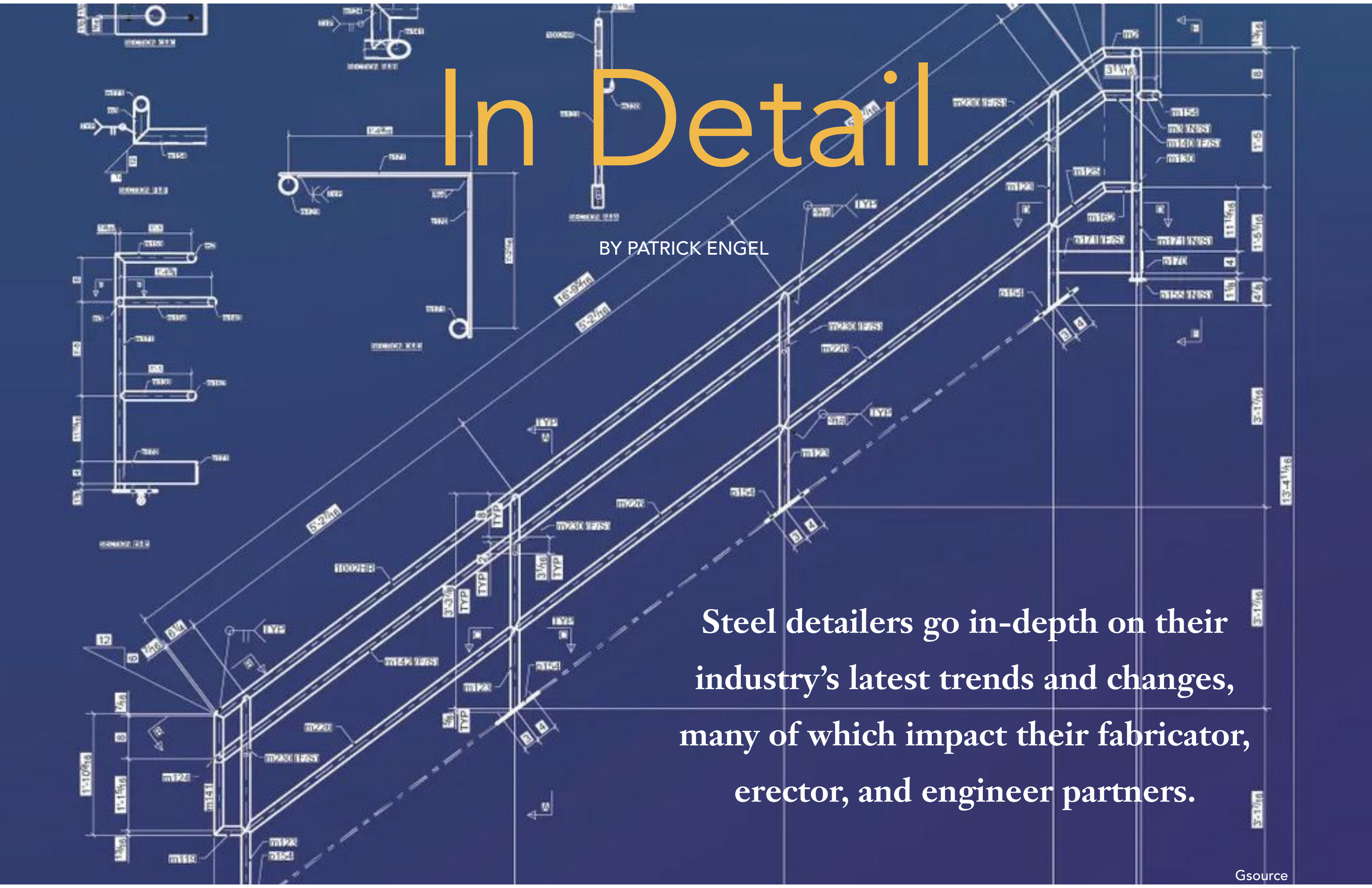
"Because steel is codified, you understand the specific sizes," Feitel said. "That makes it easy to build, deconstruct, and reconstruct with because we understand the material properties, capacities, and sizes of those pieces. Concrete is free flowing; you pour it and it becomes really difficult to reuse directly in that same application.

"Steel has this advantage of being used in the same value of its original use and not downgrading it in its reuse application."

Boulder's ambitious project has provided a roadmap for follow-ups, even if those are likely to be city projects facing carbon or deconstruction ordinances than private developers with more schedule and budget pressure and without the time or desire to cultivate a reuse market. But a growing outward interest in carbon reduction initiatives amid a nationwide teardown and rebuilding boom makes deconstruction and reuse worth strong consideration. The steel buildings set for teardown are a prime opportunity to help meet those goals.

"It's a matter of time," Feitel said, "before structural material reuse becomes more mainstream and a pillar of embodied carbon reduction strategies." ■

Patrick Engel (engel@aisc.org) is the associate editor of *Modern Steel Construction*.



In Detail

BY PATRICK ENGEL

Steel detailers go in-depth on their industry's latest trends and changes, many of which impact their fabricator, erector, and engineer partners.

Gsource

Sandeep Mahadik | Gsource

David Merrifield
Alpha Fabrication Services, LLC

DETAILING IS A HIGHLY SKILLED CRAFT that's vital to any steel project. Fabricators and erectors rely on thoroughly executed detailed drawings and plans to do their job well. Good detailing ensures a project runs smoothly. Shaky detailing, meanwhile, can veer it off course. It's a less visible step in creating and building a steel structure, even though it's a crucial piece in the puzzle.

Modern Steel Construction sought out several detailers for their insight on their trade's changes, issues facing steel detailers today, and more.

How does—or could—AI factor into steel detailing?

Sandeep Mahadik, Founder and Managing Director, Gsource: AI can assist with automating repetitive tasks such as generating detailed drawings, schedules, and reports. The time saved allows workers to focus on more complex and creative aspects of the project.

We can significantly enhance the steel detailing process by converting 2D design elements into precise 3D detail, allowing for better visualization and planning. That capability is particularly useful for identifying and resolving complex areas difficult to interpret in 2D. AI can also detect and correct errors early in the design phase, ensuring that the final structure meets industry standards and project specifications by optimizing designs for load-bearing capacity, material usage, and cost efficiency.

David Merrifield, President, Alpha Fabrication Services, LLC: We're close to AI in the detailing process. Software controls more than 95% of the output. I have heard many detailers say they can only provide what their software allows, and there's some truth to that. Most simple presentation errors are created when the model element is put on a sheet. Detailing is the translation of design thoughts into something that can be fabricated and erected. It's the application of rules, experience, and project parameters—all of which can be programed.

Today's software does most of the work already. Delegated design for connections and miscellaneous items will restrain AI. Overcoming individual state requirement that regulate design will be an impediment, even though some form of design software also governs that process. The cost of delegated design for the detailer has risen from about 10% a few years ago to 35% to 50%. You can see the rise in cost by the growing number of engineering firms doing connection design.

Kerri Olsen, President, National Institute of Steel Detailing: AI could help reduce repetitive work items and software programming. But most detailing work is custom, and AI is still new, so it's hard to understand fully and determine how steel detailers may benefit from AI.

Michael Olsen, PE, Principal and Detailing Department Manager, KL&A: In some ways, detailing software is already a form of AI, like when it generates a 2D shop drawing and applies all the dimensional information it thinks the shop needs. Or when it automatically applies connections for steel members based on input loads. But imagine a search query in a steel detailing model: "Highlight in red all member ends with failing connections" or "Find all the ___ in the model." Further automation and intelligence added to repetitious drafting tasks could speed up the detailing process.

Srinivas Pagudoji, Associate Vice President—Quality Assurance & Training, Moldtek: AI brings a touch of magic to the steel detailing process. It streamlines the design phase, reducing human error and enhancing precision. It empowers engineers to focus on creativity and problem-solving conditions, making the whole process more efficient and inspiring. AI in steel detailing isn't just a tool; it's a game-changer, transforming visions into reality with exceptional speed and accuracy.

Greg Reblin, Structural Design Group Lead, Magnum Consulting: Detailers spend enormous amounts of time and effort developing and maintaining drawing standards. One exciting possibility is feeding example drawings into an AI model and training your detailing software to output drawings in your style instead of spending hours adjusting dimensions, fonts, and line weights.

Another intriguing possibility is using large language-model AI to assist in creating applications, macros, or extensions to customize detailing software. Most detailers can think of many ways their software can be more efficient, but coding knowledge is a barrier to creating solutions for themselves. Utilizing AI to write the code could open many new possibilities.

Ryan Wunderle, President, American Steel Detailing, LLC: AI could help with specific repetitive tasks, but I think it will take a while before AI and adaptive learning work into the larger detailing profession. Detailing is complex and has a lot of variety.

How has the detailing process and profession evolved in recent years? How has it become more challenging?

Mahadik: The biggest evolution has been human awareness of how thorough detailing can significantly ease and quicken on-site work. Using 3D components in detailing helps identify potential issues early, improving the accuracy and efficiency of the detailing process.

Traditionally, detailing work was presented in 2D format, which often made it difficult to visualize complex areas and connections accurately. Now, technological advances have made 3D modeling an integral part of the detailing process.

The introduction of new materials and construction techniques has added layers of complexity to the detailing profession. Detailers now encounter a variety of materials that require specialized research and development for connection and overlapping details. The ability to visualize and accurately depict these new materials and connections in 3D ensures that all aspects of the design are properly integrated.

Merrifield: The detailing process has not changed much in the last 100-plus years, if you look only at the output drawings. An ink-on-linen shop drawing from 1911 isn't much different than one produced in 2024. The difference is how the information is provided. Detailing software provides all the data to interface with production control software, drives the equipment on the shop floor, provides models for coordination and the vast number of fabrication team requirements. Today's projects are challenging due to complex design concepts, not the detailing process. Being presented with an incomplete idea of what's being constructed causes everyone problems.

Kerri Olsen
National Institute of Steel Detailing

Michael Olsen | KL&A

Srinivas Pagudoji | Moldtek

Greg Reblin | Magnum Consulting

Ryan Wunderle
American Steel Detailing, LLC

K. Olsen: Detailing suffers greatly due to software operators who are untrained or inadequately trained to perform steel detailing. Many industry partners are unaware of the differences between shop detail and erection drawings produced by software operators versus those produced by professional detailers. The differences lie in the detailers' behavior and their editing of shop detail and erection drawings.

Editing makes the shop detail and erection drawings presentable to the shop fabricators and field erectors by industry standards. Software is not designed to do that work automatically, so each drawing must be manually modified to be presentable. Incorrect editing causes shop and field errors.

Recognizing improperly edited drawings takes someone with specific trade experience. If errors aren't caught or corrected, the fabricator will absorb repair and rework costs. Fabricators could justify rework costs by the 50% savings on drawings, but that perspective ignores total error management cost, the extent of which is so abstract that it's difficult to calculate.

Companies can consult with NISD QPP (Quality Procedures Program) certified firms, consult with sole detailers with an Individual Detailer Certification, and follow AISC's *Detailing for Steel Construction*, Third Edition. The NISD gives webinars and presentations on how to spot drawing differences and make better detailing choices. They're found online at **nisd.org/webinars**, at NASCC: The Steel Conference, and at fabricator group meetings.

M. Olsen: The ongoing rodeo of more complex projects and less time to work on them is not a new phenomenon, but architects and designers are always pushing the boundaries of what can be done with steel and how to build structures with new and complex geometries. The detailing profession must keep up with intelligent people and firms that can use the available software, can understand the fabrication process, and communicate with designers to build these structures.

Detailing is the bridge between the design world and the construction world. In the past, detailers might have been lumped in with the fabrication and construction world, but they're growing closer to the design world today.

Reblin: As industry technology evolves, detailers are asked to take on more responsibilities. Detailers today need to be experts in providing computer numerical control (CNC) data, utilizing complex survey data such as point clouds, simple connection design, model coordination, clash resolution, data export for enterprise resource planning (ERP) systems, data export for robotic welding, and so much more.

What are your thoughts on engineering firms bringing detailing services in-house? What are the advantages of working with a specialized outside detailing firm?

Mahadik: Bringing detailing services in-house can be highly beneficial for engineering firms. It facilitates better communication and coordination between designers and detailers, leading to more efficient and cohesive project execution. A detailer who knows an organization's methods and style will help on-site coordination and understand a construction staff's needs. Having a senior detailer on staff allows for greater control over the detailing quality and accuracy, particularly for complex areas and components.

Working with a specialized outside detailing firm also offers several advantages. Detailing is a highly technical and time-consuming task, and outsourcing it allows an engineering firm to focus on core business growth and strategic initiatives. Specialized detailing firms possess deep expertise and experience and should be in tune with the latest industry standards and technological advancements. Collaborating with outside detailers allows the engineering firm to leverage specialized skills while concentrating on expanding and enhancing its primary business activities.

Merrifield: I have always advocated for closer relationships with design teams. In many cases, it's the only way to understand what members of an unconnected team are thinking. Team concepts in building construction have repeatedly proven to be successful. More design firms are seeking detailing teams to provide better design documents and, in some cases, provide shop details. It's best to incorporate the fabricator and erector as well.

M. Olsen: For 30 years, KL&A has been an integrated firm with structural engineering, steel detailing, and steel construction management services under one roof. I believe we're successful because we truly are integrated and working together—not department silos working in each of these specialties. Communication flow is so much smoother when we can talk in person while looking at a model or a set of drawings together. We don't have competing interests. We're collaborating for the good of the project.

Pagudoji: Bringing detailing services in-house offers better control and coordination within engineering firms. It demands a careful balance of maintaining expertise and managing costs.

However, working with specialized outside detailing firms brings diverse expertise, fresh perspectives, and perhaps most importantly, often leads to faster turnaround times. It can also reduce the burden on in-house resources, allowing firms to focus on core competencies and project management.

Reblin: Working with in-house detailers helps reduce RFIs on a project. It's also a fantastic way to identify potential fabrication and erection issues early and revise the design or create a plan to address them with minimal project cost or schedule impact.

But working with a specialized outside detailing firm brings many advantages. Those firms tend to work with a wide range of clients and can bring a much broader perspective to the project, which can improve the design in unexpected ways.

Wunderle: Bringing detailers in-house is a great idea and has worked for us at American Steel Detailing. Due to the knowledge and execution needed for today's complicated detailing project, the detailer is getting closer to the design team. There are many areas with large information gaps on the engineering and fabrication side. If the detailer could work directly for the design team, gaps could be closed faster and with less labor, saving the owner money.

How can designers and fabricators make a detailer's job easier and help efficiency?

Mahadik: Clear and detailed initial designs, along with comprehensive specifications and standards, can help detailers better understand the project requirements. Fabricators need to ensure communication and knowledge sharing of the material and methods they intend to use during construction, which helps the designer and the detailer ensure effective deliverables to reduce revisions and ensure on site-material waste is minimal.

Effective communication and collaboration throughout the project, including timely feedback and access to necessary information, further streamline the detailing process. Designers and fabricators can make the detailer's job easier and enhance efficiency by providing pre-created templates for commonly used miscellaneous steel elements and components. Templates reduce the time detailers spend creating common elements from scratch.

K. Olsen: Designers can help detailers by providing contract drawings that follow the guidelines of the *Specification for Structural Steel Buildings* (ANSI/AISC 360-22) Section A4, Structural Design Documents and Specifications items (a) to (x). They can engage in the pre-detailing online meetings, as suggested in *Specification* Section A5 for Approvals. Both support the production of quality shop detail and erection drawings.

Designers can also specify if they used NISD QPP certified firms or require hiring NISD Senior Class I or NISD Class II detailers to ensure inadequately trained software users do not touch the project.

M. Olsen: Early engagement and open communication throughout a project are hugely beneficial. Share as much information as you can with the detailer, including schedules, fabrication constraints, and upcoming changes to the design. The best projects are ones where a designer, fabricator, and detailer can talk about issues, spin around a model together, and solve problems. RFIs have their place, but real dialogue solves issues much faster.

Reblin: Designers can provide as much information as possible on the plans and be responsive to questions or RFIs from the detailer. For simple connections, provide guidelines and parameters rather than fully designing out the exact connection. That gives the detailer and fabricator the option to fabricate the steel the way that they know best. A large shop with a beam line will prefer bolted clip angle connections, while a smaller shop without advanced machinery might choose to weld those connections.

Fabricators should involve the detailer in the project as early as possible. If they receive an RFI from the detailer, pass it along as soon as possible. They should perform regular check-ins with the detailer. Detailers sell their time, and missing information or an RFI answer that stalls a job might lead a detailer to prioritize another project without a snafu.

Wunderle: Get more deeply involved. Spend extra time reviewing the design set and the shop and erection drawings. I have always felt a project would get a massive boost if the design team spent 30 minutes on the phone with the detailer as they review the drawings. The same thing should be done with the fabricator.

Can you discuss a time your firm brought a particularly high level of success to a project?

M. Olsen: We're working on a residential project now with a 50 ft by 130 ft funnel-shaped roof that appears architecturally supported by glazing walls on all sides. The roof structure is conically rolled HSS16×16×¾ members. It can't be described with traditional 2D design drawings. We're heavily invested in coordinating and using design models and a steel detailing model to build this project.

Our firm is engaged as the structural engineer and steel detailer, but also working closely with the fabricator, steel roller, and erector on this project. From the very beginning, there have been meetings and conversations with all parties involved. To date, there have been no structural steel RFIs because everyone is in close communication. Before structural design drawings were issued, the fabricator and detailer teams reviewed and provided markups on details, dimensional information, and drawing presentation.

Pagudoji: In a large commercial building project, our firm's advanced tools and expertise in steel detailing streamlined the process, ensuring precise coordination. Proactive conflict resolution prevented delays, leading to an early, budget-friendly completion that exceeded client expectations.

Reblin: A recent high-profile project involved us detailing a large amount of airport infrastructure work where the design was done overseas. When we began detailing, we uncovered several design issues: a lack of commonality, design errors, OSHA violations, and incomplete models. The project's aggressive timeline didn't provide enough time to send the issues back to the design house, but our staff's expertise allowed us to rectify the design issues while meeting the fabricator's detailing requirements and general contractor's schedule.

Did you notice any themes or emerging trends related to detailing when talking to potential customers at The Steel Conference in San Antonio?

Mahadik: We noticed trends driven by increased competition and evolving design demands. Designers are increasingly embracing new and challenging designs. They're incorporating unique shapes and environmentally friendly materials. Both reflect a growing focus on sustainability, emphasizing green building practices and eco-friendly materials.

Additionally, many designs incorporate heritage elements, including expansive corridors, double or triple-height openings, and open-to-sky spaces. Those prioritize cross-ventilation and direct sunlight, resulting in layouts that enhance natural light and airflow, contributing to aesthetic appeal and energy efficiency.

These trends emphasize the need for advanced detailing solutions that can accommodate complex and diverse design requirements. Detailers must stay abreast of the latest materials and sustainable practices while ensuring precision and efficiency. The integration of heritage elements requires a deep understanding of traditional design principles combined with modern techniques. All told, the trends we observed indicate a more dynamic and challenging landscape in steel detailing.

K. Olsen: Our industry partners don't want to use questionable half-priced firms, but they believe their other options are limited. NISD's goal is to ease those concerns and point them to the multitude of cost-effective experienced and professional detailing options, starting with NISD QPP certified firms and IDC Senior Class I and Detailer Class II individuals.

Reblin: We noticed a growing preference for U.S.-based structural steel detailers. Many expressed frustrations with the extensive rework required when utilizing overseas detailers. A strong demand for reliability and precision in detailing services is evident, prompting a shift towards domestic providers to streamline projects and ensure quality outcomes.

Robotic welding is also coming to the forefront of the industry. Many prospective customers wanted to be sure we can provide the information they need to facilitate those processes. ■

Patrick Engel (**engel@aisc.org**) is the associate editor of *Modern Steel Construction.*

This year's Forge Prize winner is a Japanese art-inspired shade structure and pavilion marking the beginning of a multi-use trail.

Starting in Style

Emily Baker

A CONCEPT FOR a walking and biking trail rest area called Mile Zero has a fitting name and a sleek steel frame that won it the 2024 AISC Forge Prize.

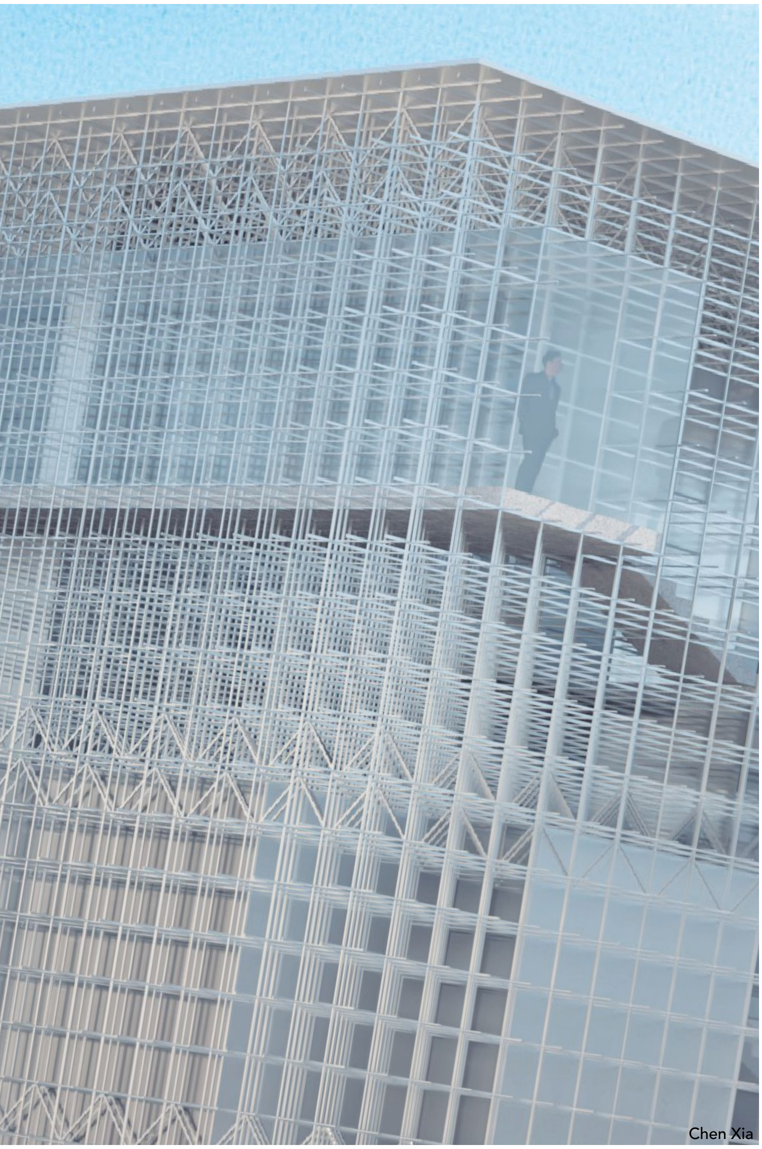
The Mile Zero concept is a steel shade structure at the trailhead of the Razorback Greenway, a trail for walkers and bikers in Northwest Arkansas. Its innovative Spin-Valence space frame system cuts, pulls, and fastens uncoated weathering steel sheets into a modular system with structural depth. The system is based on the Japanese art of kirigami, which uses folding and cutting to create 3D objects from a flat material.

The Forge Prize, established by AISC in 2018, recognizes visionary emerging architects, architecture educators, and graduate students for design concepts that embrace innovations in steel as a primary structural component. The Mile Zero collaborators are University of Arkansas professors Emily Baker, Vincent Edwards, and Edmund Harriss, Princeton University PhD candidate Isabel Moreira de Oliveira, West Virginia University professor Eduardo Sosa, and Fayetteville, Ark.-based artist Reilly Dickens-Hoffman. They will share the $10,000 grand prize.

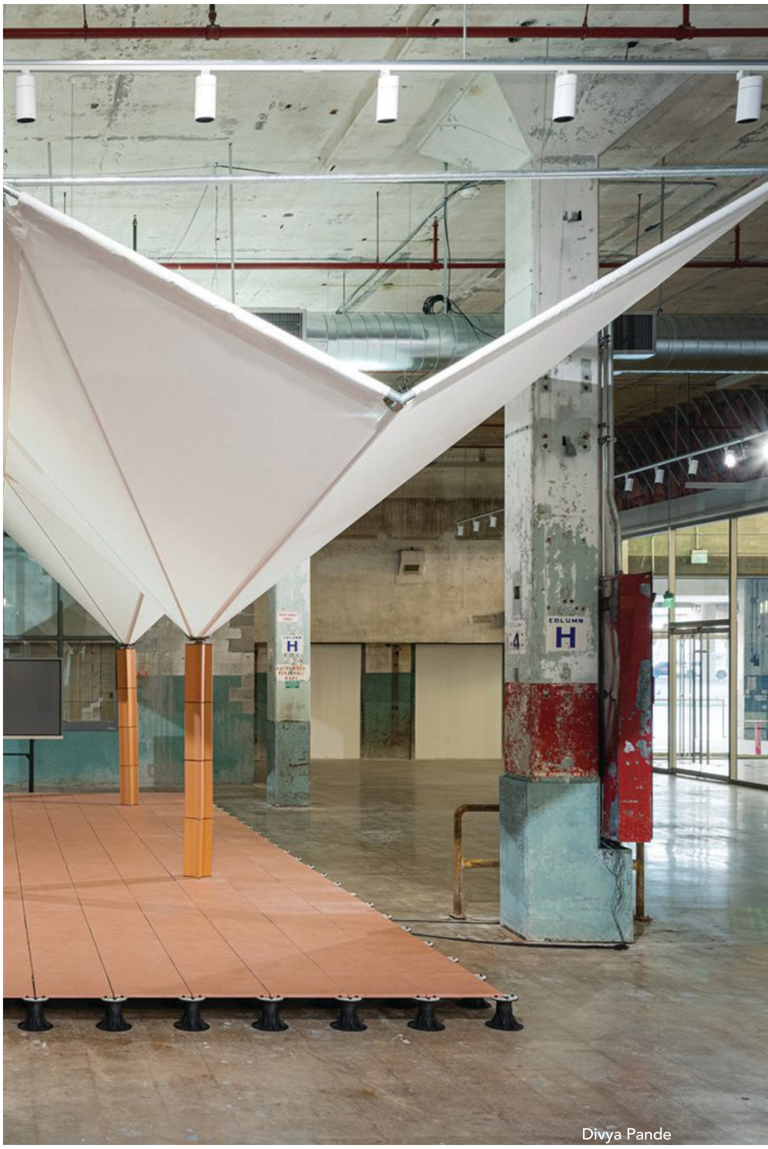
The Forge Prize's second phase requires concepts to partner with an AISC member steel fabricator to develop the idea further. The Mile Zero team partnered with Hillsdale Fabricators Chief Structural Engineer Tony Diebold, PE.

"Once Emily described the Spin-Valence concept to me, I thought it was pretty innovative and seemed like it could be a really interesting structural piece—but also architectural," Diebold said. "We intend to continue to support the design's development as it becomes a real project."

Baker, an architecture professor at Arkansas, developed the Spin-Valence system as a graduate student.



Chen Xia



Divya Pande

Mile Zero aims to replace a simple bollard that marks the Razorback Greenway's start. The concept's collaborators envision the structure—with its interplay of light and shadow—as a welcoming space for people to enjoy the outdoors together and a backdrop for a group photo to commemorate a venture on the greenway.

"Arkansas is going to be the big winner in the long-term," said Forge Prize Judge Reed Kroloff, Rowe Family College of Architecture Endowed Chair and dean of the Illinois Institute of Technology College of Architecture. "We thought the shade structure was remarkably innovative in the way that it took steel and used it in such an interesting fashion, with the folding and stacking. [The jury] thought it had great promise for steel as a building material."

Mile Zero was one of three Forge Prize finalists. It won the top honor over a runner-up concept called Community Art Center, which came from Chen Xia, an architect at Musumanoco in Boston. Xia imagined a dynamic community art center in Boston's Jamaica Plain neighborhood that is connected and open to the surrounding area. It takes the form of glass boxes in the air, and its tectonic joinery assembly detail takes advantage of steel's properties to create a grid structural system for efficient construction.

The second runner-up concept is from Rice University architecture professor Juan José Castellón. That concept, named Building Ecologies, is a modular system that uses a series of steel tubes and hollow ceramic pieces to provide cooling shade while capturing rainwater for irrigation on urban rooftops and public areas.

Corgan vice president and innovation/research team director Samantha Flores, AIA, and *ARCHITECT* editor-in-chief Paul Makovsky joined Kroloff on the 2024 Forge Prize jury.

Read on to learn about all three Forge Prize finalists.

WINNER

Mile Zero

Fayetteville, Ark.

Emily Baker, Vincent Edwards, and
Edmund Harriss (University of Arkansas);
Eduardo Sosa (West Virginia University); and
Reilly Dickens-Hoffman (artist in Fayetteville, Ark.)

AISC Member Fabricator Partner: Tony Diebold, Chief Structural Engineer, Hillsdale Fabricators

Mile Zero brings experiential light and shadow play to the public with a pavilion that doubles as a piece of public art. It marks the beginning of the 40-mile Razorback Greenway, which winds through several towns and landscapes in the hills of Northwest Arkansas.

Artwork and public places decorate its route from Kessler Mountain near Fayetteville north to a small town called Bella Vista. Hikers and bikers also encounter striking natural features, including creeks and forests, along the way. The trailhead near Fayetteville needed an aesthetically striking feature to match the rest. Specifically, the trail system's stewards wanted to mark the starting point with an inspiring piece of art.

The Mile Zero team of designers, artists, and structural engineers produced the concept, a public art pavilion sitting over a roundabout at the trailhead with a Spin-Valence frame system that made construction fast and materially efficient. The pavilion's circular lattice-like canopy combines high-tech digital processes, like computational design and CNC cutting, with hand-folding of steel parts and welded connections. The properties of steel are critical to its efficiency and beauty.

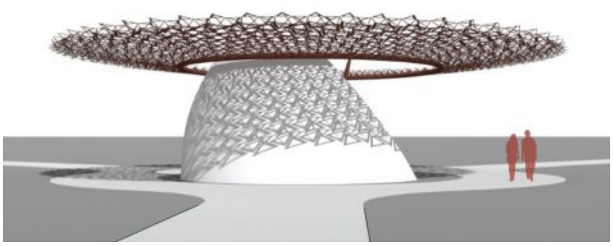
The design resembles a zero and a large tire from the air. Crafting that pattern required an initial tiling of triangular units over the subtly conical form that became its basis. The pattern of light and shadow produced by the canopy creates a memorable effect for riders and pedestrians as they set out on the trail. The oculus invites gathering ahead of a long ride and provides a place for signage and information for visitors. A sundial element has been integrated into the support system, enhancing the users' connection to and orientation with their natural surroundings.

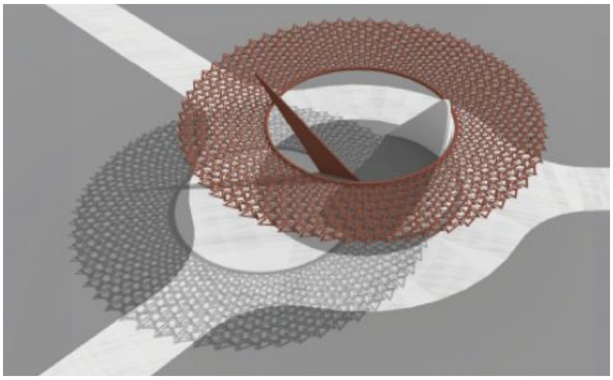
Using Spin-Valence reduces the cost of production and materials for Mile Zero, and other means of creating it would have taken much longer and been more expensive. It turns a flat sheet of material into a structural space frame. University of Arkansas architecture professor and Mile Zero team member Emily Baker developed it as a way to exploit the malleability and strength of steel and ease of cutting unique patterns using computer-controlled machinery.

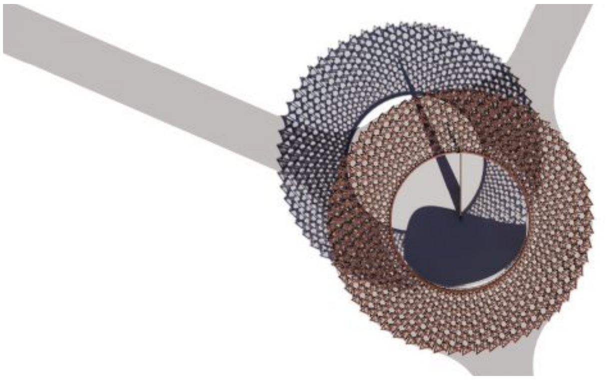
Spin-Valence units are cut into sheet steel and arrayed so the hubs of neighboring units can connect when deployed, creating structural depth over the same area as the original sheet. Deploying units involves a spin-fold, where pinch points in the steel allow it to bend past its elastic limit and fold upward to meet the edges of neighboring units. Once joined by welding, the hubs of neighboring units form a full second layer, interconnected to the base layer through triangulating legs.

Thus, Spin-Valence produces a space frame without joining hundreds of individual parts. Instead, it is made of a single part with inherent joints, producing a fast, stable, and materially efficient construction system. Preliminary structural analysis proves its viability at the architectural scale—as shown in this project—and for other applications requiring rigid panels, such as automotive design and aerospace applications.

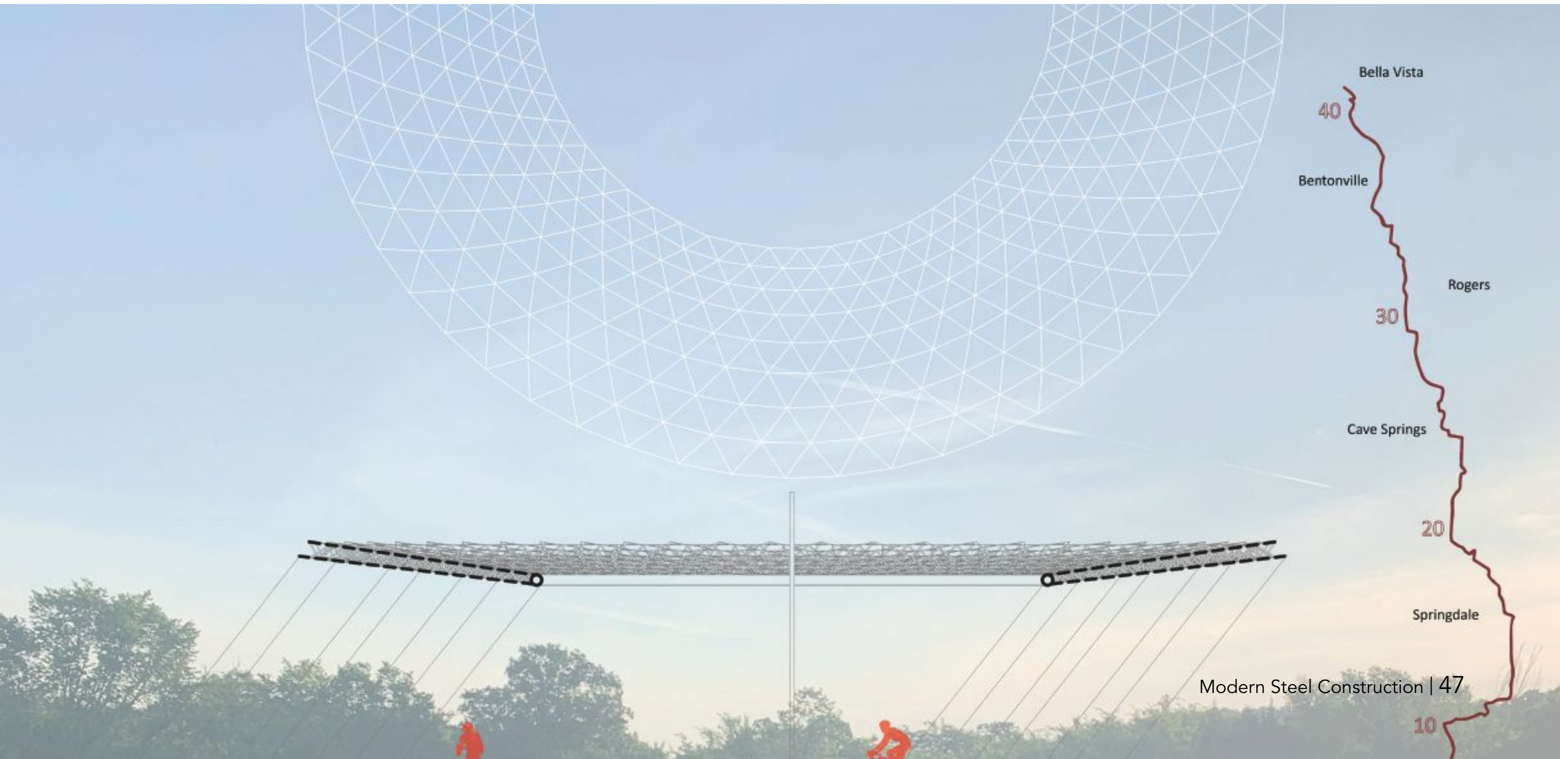
Spin-Valence was not designed to produce the interplay of light and shadow that Mile Zero exhibits. Rather, the interplay emerged from the tuning of system functionality to produce structural capacity. Spin-Valence has been refined through iterative making of models and mockups and has evolved to its current state of elegant efficiency.







All graphics on this spread by Emily Baker


Bella Vista
40
Bentonville
Rogers
30
Cave Springs
20
Springdale
10

FIRST RUNNER-UP

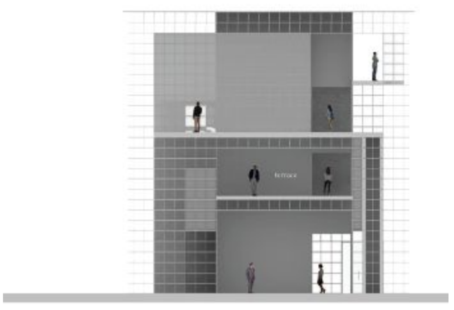
Community Art Center

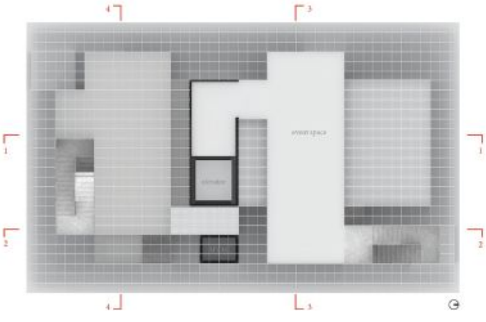
Boston

Chen Xia, Musumanoco

AISC Member Fabricator Partner:
John Peshia, President,
Garbe Iron Works

All graphics on this spread by Chen Xia





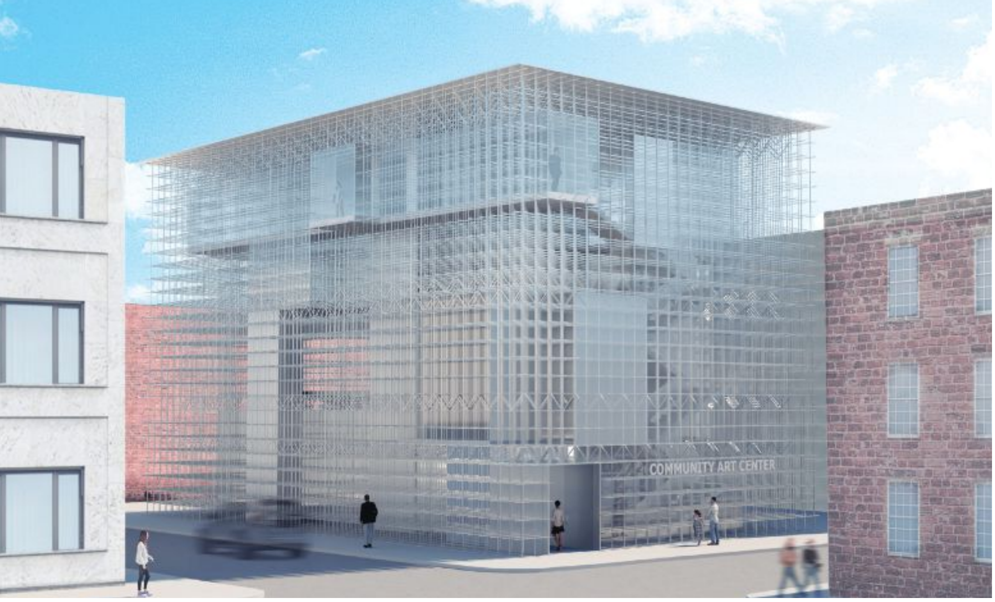
Boston's Jamaica Plain neighborhood is a quintessential urban area with a mix of residential, retail, office, and other public buildings—and it's filled with ethnic and cultural diversity that births an intriguing fine arts scene. The Community Art Center concept would give the area a platform for art exhibitions and local gatherings.

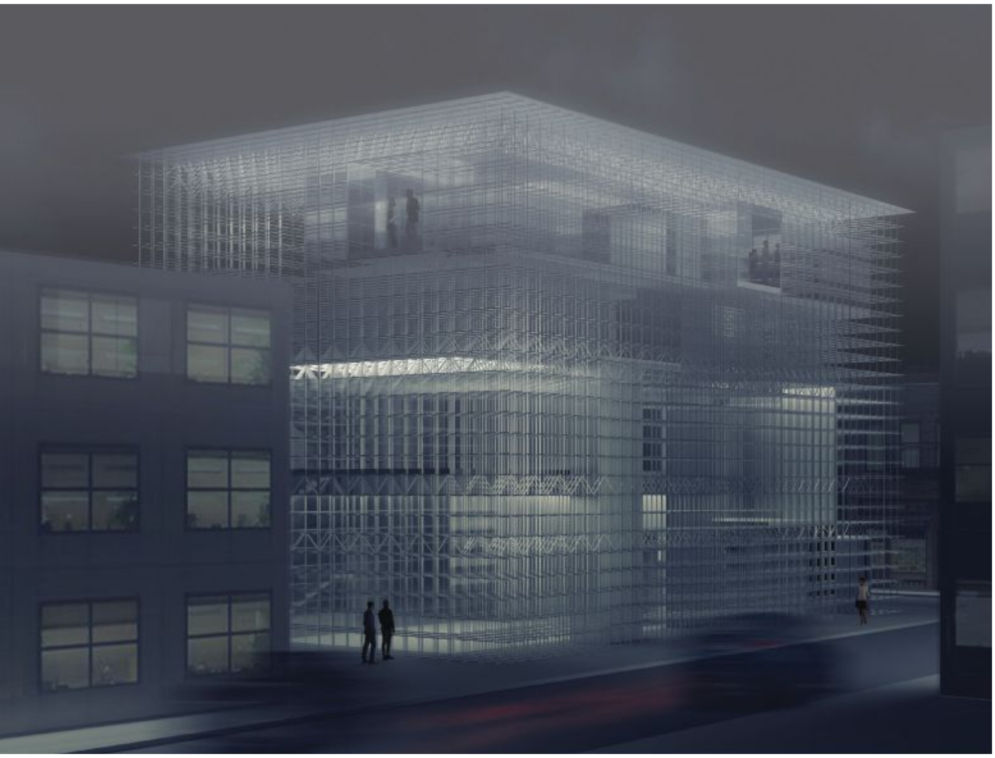
The concept is designed to accommodate large-scale event exhibitions and performances with 3,500 to 4,000 sq. ft of event and performance space. It would have 1,500 to 1,800 sq. ft for a coffee stand, restrooms, and other necessary public space. The COVID-19 pandemic prompted the client to request a public building open to the surrounding neighborhood, providing a safe and comfortable public space environment for the community.

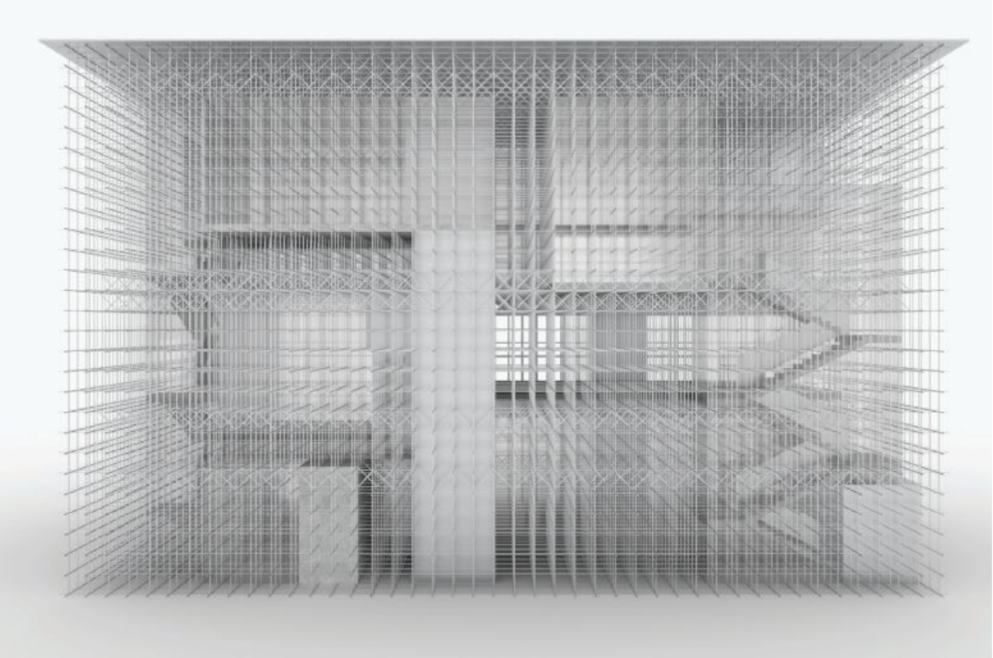
In line with the desired openness and connection to the neighborhood, the concept elevates and anchors several glass boxes in the air—which serve as public event spaces—by using a supporting structural system with a sense of lightness. It imagines the supporting structural system as an evenly translucent space sandwiched between the glass boxes and the urban environment. The design team's choice is a regular cubic steel grid system with negative voids and thin positive grids that create a sense of homogeneous translucency at the urban scale.

The proposal includes four large-scale glazed event spaces (glass curtains fixed to the steel grids) at different levels and orientations, an open terrace surrounded by the steel grid structural system, and a glazed corridor with urban views located on the top floor that runs through the west side of the building from north to south.

Solid partitions are limited in their use as structural shear walls in conjunction with the cubic steel grid structural system, floor slabs, and steel trusses to ensure structural stability. As a result, the whole building







appears as a translucent box within the solid context of an urban neighborhood, open and welcoming to the local community. Inside, visitors will feel more connected to the external urban environment due to the building's translucent nature.

Steel is the ideal architectural and structural material to achieve the design. The design's crucial and most innovative piece is the tectonic joinery assembly method for constructing and assembling the three types of thin cuboid-like structural components. The grid structural system construction is based on the tectonic joinery assembling detail. The cube grid module measures 2 ft by 2 ft by 2 ft, and the three grid structural components have a typical cross-sectional size of 1¼ in. by ⅝ in.—thin enough to create large negative voids between the grids for the sense of homogeneous translucency at the urban scale.

Applying steel to this grid structural system is more practical and feasible from the perspective of structural engineering and construction costs. The community arts center concept attempts to introduce an innovative joinery assembly method applied to the steel construction industry to explore new possibilities for using steel in architecture.

All three structural components must be mass-produced and prefabricated with accurate and specific details. Moreover, to fix and stabilize the numerous tectonic joineries, it is necessary to fill and fix the gaps between the prefabricated structural components on site. Steel and casting fillers on steel practically meet the technical and cost requirements of mass production, prefabrication, and on-site assembling construction.

Glass, wood, and most building materials are easily constructed and fixed with steel by using simple assembly elements and methods. If casting concrete slab is required, the steel grid structural system can be used as part of its structure.

From an aesthetic perspective, stainless steel fits into the desire for lightness and transparency at the urban scale. It meets the concept's architectural aesthetic pursuit. In this case, most vertical solid partitions are finished with stainless steel. When stainless steel cooperates with glass, it creates an aesthetically inclusive environment that can easily accommodate a variety of art and local events.

Divya Pande

SECOND RUNNER-UP
Building Ecologies
Houston
Juan José Castellón, Rice University

AISC Member Fabricator Partners:
Michael Moore, Vice President of Business Development,
and
Tomas Kotynek, Vice President of Project Management,
Thompson Metal Fab

Building Ecologies is an installation that proposes new models of urban infrastructures and collective spaces for social interaction based on integrating multiple architectural, technological, and ecological systems. It's a result of a collaborative and interdisciplinary research model at Rice University involving the School of Architecture, the Department of Civil and Environmental Engineering, and the Shepherd School of Music, with the support of the Carbon Hub Initiative.

The exhibited modular installation lends itself to operating as a prototypical flexible module that can be deployed onto any pre-existing urban rooftop or public area. The modular system is fundamentally comprised of steel tubes and hollow ceramic pieces acting as structural columns and water collectors, a modular ceramic floor system elevated on pedestals, a space-truss steel structure, and a lightweight tensile membrane structure.

The membrane structure captures and cleans rainwater through its expansive surface and carries it through the hollow columns. Water is diverted from the hollow columns to pipes below the elevated floor for irrigation purposes. The water management system generated by the proposal

Frau Recerques Visuals

Brandon Martin

Divya Pande

Divya Pande

would work to alleviate the effects of flooding and drought through storage, as well as release and reduce runoff by capturing water and redirecting it into irrigation tanks. The materiality of the modular columns—with their high thermal inertia—also provides energy-saving cooling benefits. Finally, the system incorporates soil as an essential material that absorbs water and grows food for the community. The resulting hybrid prototype integrates food, energy, and water infrastructures into a minimum-loss and minimum-waste circular system while fostering a sense of community and social interaction.

The membrane structure design followed two main premises: using the minimum possible amount of material and achieving a highly efficient and lightweight structure that is easy to assemble, transport, and disassemble. Consequently, a space-truss steel structure emerged as the ideal solution to achieve these fundamental goals. A space truss is highly efficient because of its triangulated geometry based on a tetrahedral grid. Accordingly, the triangular arrangement of the structural steel tubes makes it statically stable and resistant against deformation.

The first structure of this type was conceived by the inventor and scientist Alexander Graham Bell, who patented a system of prefabricated steel tetrahedrons that could be assembled to construct space trusses of different forms. The space truss typology was also masterly applied by architects and engineers such as Buckminster Fuller, Robert Le Ricolais, and Konrad Wachsmann in the design and construction of highly innovative and environmentally aware lightweight structures.

The proposed canopy structure for the Building Ecologies installation is a space truss composed of four triangulated modules with steel tubes and steel knots.

A mockup of the system was assembled as proof of concept. It was then disassembled and shipped to POST Houston, an old post office that was recently renovated into a community gathering space. It was rebuilt there—successfully achieving the design's second premise. ■

Student engineers at the University of Florida secured their team's fourth straight first-place finish at the Student Steel Bridge Competition National Finals.

Louisiana Tech University hosted the 2024 Student Steel Bridge Competition National Finals.

Four in a Row

BY KATE DUBY AND PATRICK ENGEL

All photos courtesy of Bob Shaw

THE UNIVERSITY OF FLORIDA'S grip on first place in the Student Steel Bridge Competition (SSBC) National Finals is approaching ironclad.

Florida was crowned the John M. Parucki National Champion for the fourth straight year, breaking its own record of three consecutive first-place finishes. Its run began with the 2021 COVID-19-induced "Compete from Campus" format and has continued with three straight in-person wins: the 2022 national finals at Virginia Tech, 2023 at University of California, San Diego, and 2024 at Louisiana Tech University.

"The competition weekend was a huge success," said Christina Harber, SE, PE, AISC senior director of education. "There were so many excellent bridges, and I was impressed with the high level of competition. These students worked all year on design, fabrication, and construction and competed with the best. AISC is proud of all of them, and they should be proud of themselves."

This year, teams from universities across North America were tasked with designing, fabricating, and constructing a bridge that crosses a hypothetical man-made river on a disc golf course in the host city, Ruston, La. The conceptual bridge is designated for disc golf players, walkers, bikers, park employees, and maintenance vehicles. Piers in the river were not allowed, but temporary barges could be added during construction at an added cost.

Twenty SSBC regional competitions across the country produced 47 National Finals participants, which built bridges under timed conditions and tested them at Ruston Sports Complex.

Florida's first-place finish netted it $5,000 in scholarship money. It also took first in economy and lightness. University at Buffalo was the overall runner-up and won $3,000 in scholarships. It won second place in construction speed and third in economy. Lafayette College came in third place overall, earning $2,000 in scholarships. Lafayette also received the Frank J. Hatfield Ingenuity Award, which recognizes innovative approaches to competition rules. Lafayette took advantage of a new SSBC rule requiring rigid containers for loose nuts and bolts by wearing the containers on their arms for efficient access to the bolts.

The 2025 SSBC National Finals will be at Iowa State University from May 30 to 31.

Florida builders work on their bridge in a construction lane.

Florida's two builders constructed their bridge in 11 minutes and 37 seconds.

Race to the Top

As two Lafayette College bridge builders strolled to their starting points before construction, one turned to the other and summarized the stakes:

"It's like Game 7 with two minutes left."

Lafayette entered the day as one of the top challengers to Florida's reign. Before Florida's rise, the competition ran through Lafayette, which took first place in 2018 and 2019. It had three straight top-five finishes coming into 2024. The team of four builders outlined their carefully crafted construction plan to the judges, unwavering in their confidence in executing it. They met the moment and built their bridge in 7 minutes and 49 seconds, the fourth-fastest construction speed.

Around the same time, though, two builders constructed Florida's bridge in 11 minutes and 37 seconds with zero violations—setting it up for high finishes in the efficiency and economy categories. Florida also finished fourth in stiffness and first in lightness. All told, it safely put them above Buffalo and Lafayette.

Florida originally planned a three- or four-person build like most other teams. But when it practiced with three, the builder running most of the pieces from the staging yard to the construction zone often had down time.

"We figured we could improve the time and have nobody standing around," Florida senior co-captain and builder Donald Stowell-Moore said. "That's where we optimized most. We made sure if there was any spare time, we'd figure out a way to either change the piece order or stage pieces for the other person. Spare time is what kills you."

Florida put a builder on each side of the river, constructed the spans upside down after bolting them to the piers, unbolted them, and rotated them 180° into place.

Assembly and testing at the national finals are the last steps in a yearlong journey. Florida had about ten students involved in modeling and designing the bridge, which began in the fall. It gave plans to the fabrication manager in March, and about 15 students were involved in fabrication.

"We made sure to give ourselves a lot of flexibility in how we could design our bridge," Stowell-Moore said. "That flexibility comes in handy later. We talked about different approaches, but making sure we had a lot of options for assembly later was a huge part of the design process."

Lafayette College's bridge under construction.

University of Nevada, Las Vegas builders construct their bridge.

Many construction teams, including the University of California, San Diego, had a cheering section in the stands.

University of Minnesota-Duluth constructed its bridge in 11 minutes and 44 seconds with three builders.

2024 Winners

SSBC National Finals results:

John M. Parucki National Champion
University of Florida

Overall
University at Buffalo (2nd)
Lafayette College (3rd)

Construction Speed
William Jewell College (4:30)
University at Buffalo (6:06)
University of California, Davis (6:22)

Lightness
University of Florida
Liberty University
University of Connecticut

Aesthetics
Virginia Tech
University of Michigan
University of Texas at Tyler, Houston Engineering Center

Stiffness
University of Wisconsin, Platteville
University of Alaska, Fairbanks
University of California, San Diego

Cost Estimate
University of Texas at Tyler, Houston Engineering Center
University of Connecticut
Pennsylvania State University, University Park

Economy
University of Florida
William Jewell College
University at Buffalo

Efficiency
University of Alaska, Fairbanks
University of Florida
University of Wisconsin, Platteville

Team Engagement Award
University of Nevada, Las Vegas

Robert E. Shaw Jr. Spirit of the Competition Award
South Dakota School of Mines and Technology

Frank J. Hatfield Ingenuity Award
Lafayette College

John M. Yadlosky Most Improved Team Award
Arizona State University

Video Awards
University of British Columbia
Universidad Nacional Autónoma de México
University of North Carolina at Charlotte

University of North Dakota builders work on their bridge.

Liberty University was a first-time national finals participant.

Auburn University student engineers Ethan Lowrey (center) and Brian Roche (front) work on their bridge.

South Dakota School of Mines and Technology was top-15 in construction speed.

Bridge members must be laid out in a staging area before construction.

First Finals Foray

One first-time national finals participant has University of Florida roots.

Auburn University's steel bridge team is on the upswing after a few years off the map. The school's last regional competition appearance was in 2021, but its bridge was not in shape to be assembled, earning an automatic disqualification. An Auburn bridge had not passed load tests at a regional since 2011.

The team's resurrection can be traced to the four-time reigning champion.

Auburn engineering PhD student Brian Roche was part of Florida's 2021 national championship team as a senior. Florida faculty adviser Taylor Rawlinson, who holds a bachelor's and master's in civil engineering from Auburn, suggested Roche look into Auburn's grad program and possibly re-launch the bridge team upon enrolling.

Software Sponsor Bridges Generations of SSBC Competitors

Julie Van Portfliet brought a piece of SSBC history to the 2024 national finals: herself.

Van Portfliet traveled to this year's competition as a representative of software sponsor Bentley Systems, where she serves as director of education for North America. It was her first SSBC since she competed in the inaugural event 37 years ago.

It has changed a lot since then. In 1987, SSBC was a three-school competition hatched by then-AISC regional engineer and associate director of education Bob Shaw. He recruited the schools to participate in his experiment and hoped it would work. He had doubts even on competition day (as he discussed in the Field Notes column on page 20).

Van Portfliet, then a civil engineering major at Michigan Technological University, took an all-day bus ride with her team from Michigan's upper peninsula to Southfield, Mich., where they competed in a parking lot against Wayne State University and the first-ever host school, Lawrence Technological University.

Shaw's creation made a lasting impression on her.

"I remember the competition being one of my favorite things back from my college years," Van Portfliet said. "We had a great team. I remember long nights of going over different structural systems that we might consider—lots of pizza and camaraderie. I am still friends with some of those folks today."

As an underclassman team member, Van Portfliet held a supporting role in the design of Michigan Tech's bridge but was closely involved in its construction during the timed competition. She was the only woman on her team.

"Back then, that was pretty common with civil engineers," she laughs. "I was the one who they were able to hoist over the bridge."

Van Portfliet spent the 2024 competition season providing teams with state-of-the art software to speed up their design, fabrication, and construction processes. When she arrived at the national finals, she was pleasantly surprised to see so many female students on the competition floor, with several serving in leadership roles for their teams.

"It has really been heartwarming," Van Portfliet said. "I have been in the industry for 35 years now, and the parity with women in the workforce has taken a really long time to get to where it is today."

Her favorite part of national finals was meeting students and seeing their excitement about their bridges. Her conversations with this year's competitors took her back to her own SSBC experience.

"It's crazy nostalgic," Van Portfliet said. "It hasn't changed nearly as much as I thought it would. I suspect a lot of the design elements have changed with improved software, and there's a lot more safety, but overall, [rules like] not being able to cross the river, designing a bridge for a specific scenario—those things are still very much intact."

Julie Van Portfliet (center) with Michigan Tech steel bridge teammates at the inaugural SSBC.

Virginia Tech's bridge won first place in the aesthetics category.

Three years later, Roche is the driving force Auburn's first-ever national finals team, even though he's not its captain. Auburn placed 18th overall, highlighted by a 12th-place finish in lightness. It joined two other first-time National Finals participants this year: Liberty University and William Jewell College.

Roche's work to recruit a team began in March 2023 at an Auburn baseball game, where he saw a vaguely familiar face in the stands. It was Ethan Lowrey, then a sophomore he recognized from engineering school events.

The conversation starter was a group of foreign exchange students Lowrey was hosting. By the end of the game, they had discussed a steel bridge team and exchanged information. Lowrey, the Auburn ASCE chapter symposium chair, had long wanted to revive the team. Auburn had important resources for starting a team: a brand-new facility called the Advanced Structural Engineering Lab and supportive faculty.

"We just didn't know where to start," Lowrey said.

An experienced steel bridge team member like Roche was the missing piece.

"One of the biggest skills you can have, especially as an engineer, is knowing when to ask for help," Roche said. "These guys have done an awesome job saying they need help."

Lowrey advertised and campaigned for team members at Auburn ASCE student chapter meetings and found a core of about five people willing to put in time to design, analyze, redesign, fabricate, and practice building.

"It's a lot of time," Lowrey said. "Throw school in there too."

Roche put them on a schedule Florida followed: finalize the bridge design by Thanksgiving and order the parts in time for the spring semester. Auburn also load-tested its bridge before regionals, another Florida strategy done at Roche's suggestion. It cruised to a first-place finish at the Gulf Coast Regional Competition and earned a spot at national finals.

"Having success at regionals is proof of concept," Lowery said. "To me, Auburn should be at the forefront in the Gulf Coast Region with the steel and structural facilities we have nearby. This year helped us lobby our organization's leaders and professors to make some investments in our bridge program. We made a lot of big-time investments because of our success at regionals." ■

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CALLING ALL
INNOVATORS!
If you recently worked on an amazing project that featured structural steel, we want to hear from you.
Submit it for a 2025 IDEAS² award!
Entries are due September 30, 2024.
aisc.org/ideas2
2024 IDEAS² Excellence in Engineering
Nashville International Airport Terminal Lobby and International Arrivals Facility Addition
Nashville, Tenn. | Photo: Jordan Powers
1-7
Pick-Up Zone
8-15
LOW OVERHEAD CLEARANCE
AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISC
FOUNDED 1921
2025
IDEAS²
AWARDS
Innovative Design in Engineering and Architecture with Structural Steel

new products

This month's New Products include a direct tension indicator, a lightweight drill, a turn-of-nut wrench, and a nut made of high-strength steel.

Applied Bolting Technology Squirter DTIs

Applied Bolting Technology is revolutionizing bolt installation and inspection globally thanks to their Squirter® Direct Tension Indicators (DTIs). These innovative DTIs ensure bolts are tightened correctly by expelling semi-permanent orange indication media when proper tension is achieved. This means erectors are provided with Visual Verification of Bolt Tension, allowing them to do their job quickly and accurately without using a feeler gauge.

The bright orange media makes it easy to see that all bolts are tightened properly. Inspectors benefit from the clear visual cue, eliminating the need for close-up inspections or torque wrenches. This allows nearly 100% inspection of connections, vastly improving efficiency and reliability in structural steel projects. Squirter® DTIs are the best way to bolt. For more information, visit **www.appliedbolting.com**.

HYTORC lightweight LITHIUM SERIES II

Mobility, convenience, reliability, and efficiency are paramount in bolting applications on steel structures. HYTORC's lightweight LITHIUM SERIES II (LST) Electric Torque Tool offers the perfect blend of strength and portability for your structural steel projects. Its intuitive user interface, complete with easy-to-follow menu options, ensures streamlined operation for all users. Combined with a long lasting 36V battery and a capacity up to 5000 ft.-lbs., the LST is the right tool for any structural job.

When used with the LST, HYTORC's innovative J-Washer takes performance to the next level. There's no need for a reaction arm thanks to the J-Washer's strategically placed ridged band that prevents the loosening of pre-loaded fasteners. The J-Washer's knurled surface securely locks the nut during torquing, guaranteeing it doesn't loosen. Secure your bolting applications now by contacting your local HYTORC specialist at **www.hytorc.com** or calling 1.800.FOR.HYTORC.

CSC Anbo-X Nuts

When it comes to critical construction projects, ensuring structural integrity and safety is paramount. Anbo-X Nuts are engineered to meet the highest standards, providing a secure and dependable solution for anchor bolts that don't project high enough above a concrete foundation to engage a regular nut. Crafted from high-strength steel, these elongated nuts are designed to offer unparalleled reliability, ensuring your structures remain safe and sound, and your projects remain on track.

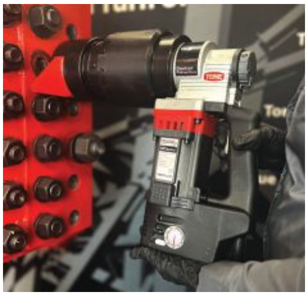
The Anbo-X Nut's unique design not only facilitates a secure attachment but also maximizes the tension capacity of steel anchors. By securely fastening to the anchor bolt for a length equal to the bolt's diameter, Anbo-X Nuts guarantee a robust and stable connection while avoiding project delays.

With a commitment to quality and precision, Anbo-X Nuts are made in the U.S. and are available in various dimensions to suit different project needs. Special orders can accommodate oversized threads, providing even more flexibility. By choosing Anbo-X Nuts, you're investing in a product that not only reduces jobsite delays and costs, but also upholds the highest standards of safety and reliability in construction. Visit **www.cscsteel.com** to learn more.

GWY GPTN-451E Wrench

GWY, LLC, offers an exclusive line of wrenches designed for the turn-of-nut method, which automatically tightens each bolt assembly to the preset rotation. The company's decades of expertise in bolt fastening, coupled with TONE's quality wrench manufacturing, has led to these turn-of-nut wrenches' custom design. Corded models with standard and minimal clearance options are available and comply with high state and federal standards for structural fastening.

The latest addition to the wrench series, the GPTN-451E, is engineered for up to 1½ in. A490 hex bolts with an impressive maximum torque of 5,160 ft-lb. (7,000 N-m). The GPTN Series is equipped with overload prevention to safeguard against motor burnout and an integrated reverse kit to release stuck bolts. Additional features include clockwise and counterclockwise torque control, an angle setting dial with controllable range, and LED indicator lights. For more information, visit **www.gwyinc.com**.



DESIGN GUIDES

AISC Publishes Design Guide 1 Third Edition

AISC has released the third edition of Design Guide 1: *Base Connection Design for Steel Structures*.

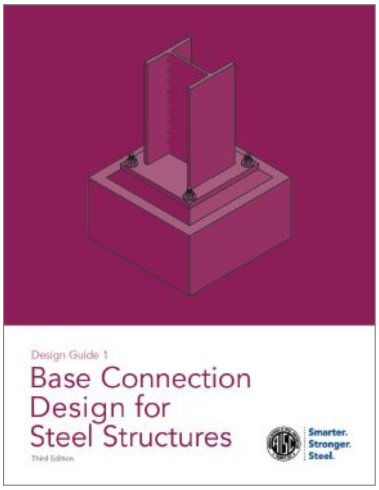
The first edition of Design Guide 1 was published in 1990 and titled *Column Base Plates*. The second edition, titled *Base Plate and Anchor Rod Design*, was published in 2006.

This third edition is more than 200 pages long and incorporates and updates the content of the previous editions while also providing significant expansions in coverage related to base connection design.

The significant expansions include the addition of Chapter 3 addressing the relationship between the structure and base connections; the addition of Chapter 5 pertaining to embedded base connection design; the addition of Chapter 6, which focuses on seismic design of base connections; and the addition of Appendices C and D, which provide guidance regarding the simulation and representation of base connections. This edition also significantly expands upon the number of design examples.

The third addition has three authors: Amit Kanvinde, PhD, a professor of civil and environmental engineering at the University of California, Davis; Mahmoud Maamouri, SE, PE, PhD, executive vice president at CSD Structural Engineers; and Joshua Buckholt, SE, PE, vice president at CSD Structural Engineers.

Members can download it for free at **aisc.org/dg**.



AISI

Iowa County Engineer Earns 2024 AISI Market Development Industry Leadership Award

The American Iron and Steel Institute (AISI) presented the 2024 Market Development Industry Leadership Award to Brian Keierleber, PE, county engineer of Buchanan County, Iowa, to recognize his significant contributions to advancing the competitive use of steel in the marketplace—specifically in the construction market.

The award was presented May 14 by AISI chair Lourenco Goncalves—chair, president and CEO of Cleveland-Cliffs Inc.—at AISI's General Meeting in Washington, D.C.

Michael Worswick, PE, PhD, professor in the Department of Mechanical and Mechatronics Engineering at the University of Waterloo, was also presented with the award for his accomplishments in the automotive market.

"We are pleased to recognize the leadership and unwavering dedication of Brian and Michael and their passion for conveying the benefits of steel as the material of choice in these key markets. Their expertise is a tremendous asset to the steel industry," Goncalves said. "Providing durable steel solutions to meet the challenges faced by the infrastructure and automotive industries is paramount to American steel producers and our customers. We appreciate the continued leadership and significant contributions of these two individuals."

People & Companies

Hatfield Group Engineering (HGE), a New York-based, WBE-certified, multidisciplinary engineering firm, has launched a Chicago studio. HGE Chicago is led by Koz Sowlat, SE, PE, and Robert J. Diebold, SE, PE, two world-class structural engineers who have co-led their firm, Sowlat Structural Engineers, since its founding in 2004. HGE Chicago was established on May 4 to better serve HGE clients by leveraging Sowlat and Diebold's structural expertise and by bringing HGE's structural, MEP/FP, and facade engineering services to the Midwest.

Cleveland-Cliffs Inc., announced new greenhouse gas (GHG) emissions reduction targets. The Company's prior commitment to reduce absolute Scope 1 (direct) and Scope 2 (indirect) GHG emissions by 25% by 2030, relative to 2017 levels, has already been successfully achieved. Its new goals, relative to 2023 levels, are reducing Scope 1 and 2 GHG emissions intensity per metric ton of crude steel by 30% by 2035 reducing material upstream Scope 3 GHG emissions intensity per metric ton of crude steel by 20% by 2035, and a long-term target to reduce Scope 1, 2, and material upstream 3 emissions intensity per metric ton of crude steel to near net zero by 2050.

Scott Roux has joined **HNTB Corporation** as national bridge practice leader and senior vice president. Roux is working with HNTB's bridge experts on a range of complex bridge programs. He brings more than two decades of experience in leading teams in delivering complex bridge projects. He has experience in the design, construction and inspection of hundreds of bridges for various domestic and international public and private transportation authorities. His experience includes project development, preliminary and final design, design-build, construction engineering and contract administration for those bridge projects.

AWARDS

AISC Accepting Submissions for 2025 IDEAS² Awards

Just a handful of projects in the country will receive the structural steel industry's top design honor next year. Will yours be one of them?

AISC's flagship competition for buildings, the IDEAS² Awards, is now accepting entries.

AISC's Innovative Design in Engineering and Architecture with Structural Steel (IDEAS²) Awards recognize outstanding projects that illustrate the exciting possibilities of structural steel. They are the industry's most prestigious design honor for building structures.

"Last year, six projects across the country won an IDEAS² Award—and they represent the finest in structural steel innovation," said AISC President Charles J. Carter, SE, PE, PhD. "We are once again looking for your great ideas that highlight specific unique advantages of working with structural steel—things like sustainability, adaptability, cost, speed, reliability, and resilience—while making a lasting impact on the communities they serve."

The judges will present IDEAS² Awards for:

- Excellence in Engineering – for projects that take full advantage of the flexibility of a steel structural system and demonstrate the use of new design and construction techniques
- Excellence in Architecture – for projects that use structural steel to create breathtaking structures that inspire and serve the communities around them
- Excellence in Sustainable Design and Construction – for projects that use design and construction methods that reduce a project's carbon footprint
- Excellence in Adaptive Reuse – for projects that capitalize on how easy it is to use steel to give a structure a second life
- Excellence in Constructability – for projects that utilize innovative design, project management, and construction methods that simplify, economize, and speed up the design and construction of steel buildings

What's at stake? Winners will be invited to present their project to the industry at the Architecture in Steel conference, which is incorporated into NASCC: The Steel Conference (April 2–4, 2025 in Louisville, Ky.). They'll also be featured in the May 2025 issue of *Modern Steel Construction* magazine and in other AISC media throughout the year.

The IDEAS² Awards showcase the innovative use of structural steel in:

- the accomplishment of the structure's program
- the expression of architectural intent
- the application of innovative design approaches to the structural system
- leveraging productivity-enhancing construction methods

IDEAS² Awards don't only go to high-profile projects. In recent years, AISC has honored everything from public transit projects to monumental stairs to jaw-dropping high-rises. We're looking for innovation and imaginative design in all its forms!

Entries are due by September 30, 2024. AISC will announce finalists late this year and unveil the winners in early 2025.

Visit **aisc.org/ideas2** for more information and to enter.

Eligibility Requirements

- Any member of a project's team can submit it for an IDEAS² award. However, a fabricator, erector, detailer, or other firm eligible for AISC Full or Associate membership submitting a project themselves must be an AISC member in good standing at the time of entry.
- New buildings, expansions, and renovation projects (major retrofits and rehabilitations) are eligible. Sculptures, art installations, and non-building structures may also compete in the regular categories.
- Building projects in the 2025 competition must be located in the U.S. and must be completed (either occupied or ready for occupancy) between January 1, 2023, and August 31, 2024.
- At least 75% of the structural steel for the project must have been produced and fabricated in the U.S. by companies eligible for AISC full membership.
- A significant portion of the framing system of a building must be wide-flange or hollow structural steel sections (HSS).
- Pedestrian bridges entered in the competition must be an intrinsic part of a building and not standalone structures. If you would like to submit a bridge project, we encourage you to enter the National Steel Bridge Alliance's 2026 Prize Bridge Awards.

History of IDEAS² Awards

AISC's award programs have celebrated landmark structures built with structural steel since 1960. These architectural icons span generations and stand the test of time. AISC recognizes and promotes these projects in recognition of their impact in terms of structural innovation, advances in safety, benefit to the local community, and environmental consciousness.

The prestigious list of winners includes such enduring landmarks as:

- One World Trade Center, New York
- The Gateway Arch, St. Louis
- Willis Tower, Chicago
- The National Museum of African American History and Culture, Washington
- The PanAm Passenger Terminal at John F. Kennedy International Airport, New York

SUSTAINABILITY

AISC Launches Fabricator Sustainability Partner Program to Drive Green Projects

AISC's new Fabricator Sustainability Partner Program is a win for specifiers, fabricators, and—of course—the environment.

"Few people recognize that structural steel fabricators are the key player for a project's sustainability," said AISC Director of Sustainability and Government Relations Max Puchtel, SE, PE. "Fabrication itself accounts for less than 8% of structural steel's cradle-to-gate carbon footprint, but a fabricator's procurement responsibility means that their upstream influence is far greater."

The AISC Sustainability Partner Program is the first in the country to leverage the expertise and connections that structural steel fabricators bring to the table—and AISC does the legwork to make it easy for specifiers to make an informed choice when partnering with a fabricator. Just look for the Sustainability Partner Program logo. A list of sustainability partners is also published dynamically on **aisc.org/why-steel/sustainability**.

Sustainability Partner fabricators undergo specialized training to equip them with the tools and skills they need to navigate a sustainability-focused project, as well as carbon footprint reduction strategies that make a difference.

The list of participating fabricators is rapidly growing. Fabricators interested in joining the program can learn more at **aisc.org/sustainable-fabricator**. It's open to all AISC full member fabricators, and participation is free.

Learn more at **aisc.org/partnerprogram**.

NSBA

Brandon Chavel Returns to NSBA as Vice President of Bridges

AISC and the National Steel Bridge Alliance (NSBA) are thrilled to welcome back a familiar face: Brandon Chavel, PE, PhD. Chavel is the new NSBA vice president of bridges, leading the Bridge Initiatives Department.

"The steel bridge industry is continuously innovating, with many exciting projects on the horizon," Chavel said. "Our team is excited to continue to collaborate with bridge owners, designers, consultants, contractors, researchers, and steel bridge fabricators to address our nation's current infrastructure challenges and develop the next generation of industry leaders."

"Brandon's years of experience and leadership in the bridge design community make him the perfect person to serve as the voice of America's steel bridge industry," said AISC Senior Vice President Scott Melnick. "His expertise will help our Bridge Initiatives Department make a difference for our country—and everyone who relies on anything transported by vehicle or rail."

Chavel, one of the nation's leading bridge designers, has spent the last few years as a technical adviser with Michael Baker International. Prior to that, he served as NSBA's Director of Market Development. He also worked as a senior bridge engineer at HDR for 17 years. His extensive steel bridge design experience includes skewed and curved bridge analysis and design; erection and construction engineering; refined analysis; rehabilitation and repair design; and load rating. He has been a contributing researcher on several state-of-the-art projects related to the analysis and construction of horizontally curved steel girder bridges.

During his time away from NSBA, he remained involved in NSBA committees and chaired the NSBA Committee on Bridge Initiatives and AASHTO/NSBA Collaboration Task Group 11: Steel Bridge Design. He actively serves on several industry committees, including AREMA Committee 15 – Steel Structures, the TRB Standing Committee on Steel Bridges, and the Executive Committee for the International Bridge Conference. Recently, he was the bridge instructor for the SEAOI SE Exam Refresher Course and as an adjunct bridge engineering lecturer for the University of Pittsburgh Department of Civil Engineering.

Chavel, a licensed professional engineer, has led updates to and co-authored portions of the NSBA *Steel Bridge Design Handbook*. In addition, he has co-authored several articles, papers, and presentations related to steel bridge design and construction. Chavel earned his bachelor's, master's, and doctorate in civil engineering from the University of Pittsburgh. He is based in Cleveland, Ohio.

advertiser index

Severud

Decent Exposure

STEEL'S MULTI-PURPOSE NATURE is visible in many modern buildings. In addition to being a sturdy structural material, it can be an aesthetically appealing component in a building. Steel used in that dual purpose is called architecturally exposed structural steel (AESS), and it's everywhere, including in the roof trusses of New York City's Moynihan Train Hall pictured above.

The train hall—a 2023 AISC IDEAS^2 award winner—is an expansion of New York's Penn Station into a former post office building. Exposed steel is a central part of its design—and countless other buildings' designs. Next month's issue of *Modern Steel Construction* construction will explore AESS in detail.

The September issue will highlight multiple projects that incorporate AESS. It will dive into the curved steel elements of two recent projects and provide a steel bender-roller's perspective on designing with curved steel, which is a common type of AESS.

Be sure to read next month's issue for a wide-ranging look at AESS. And if you're eager to dive in before then, the November 2023 Field Notes podcast featuring AESS expert and University of Waterloo architecture professor Terri Meyer Boake is a good place to start.