Modern Steel Construction

December 2023


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ON THE COVER: What's on fabricators' minds? Welding, of course, but also a whole lot more, p. 54. (Photo: Greg Folkins Photography)

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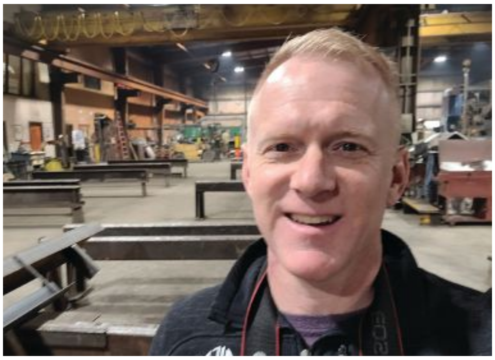


When is the last time you were in a structural steel fabrication shop?

Fabricators, I realize you're likely in one this very moment. This question is for anyone who *doesn't* work in a fabrication shop.

The winning answer is: "I visited a shop in late October for SteelDays!" (If this applies to you, well done! Your prize is a virtual high-five!) All kidding aside, if you read this publication regularly, you've likely heard us mention SteelDays before. But if not, the AISC-sponsored event serves as our annual celebration of the structural steel industry, an opportunity for steel fabricators and other industry partners to connect with AEC professionals, students, and others, allowing them to see firsthand how the U.S. structural steel industry works to build our country's buildings and bridges.

In fact, the photo of me is from Garbe Iron Works' shop. The AISC member fabricator, based in Aurora, Ill., hosted roughly 40 people in its shop for a SteelDays event, providing tours, lunch, and an inside look at one of the oldest continuously operating steel fabrication operations in the U.S. (the company was founded in 1919).

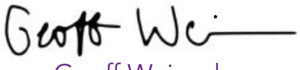
If you've never been in a fabrication shop, it's educational and you can watch the heavy machinery you've likely seen at NASCC: The Steel Conference perform a real-life job. At the Garbe event, attendees witnessed a bandsaw cutting wide-flange steel members and were even given 1-in.-thick wide-flange profiles—ground smooth upon request—as a souvenir. There are AISC member fabricators across the country, and you can search our membership database to find one near you: **aisc.org/aisc-membership/member-directory**. Our members love to show visitors what they do, so don't hesitate to reach out to set up a tour.

If you've never attended a SteelDays (formerly singular, but it has evolved into a multi-day affair) event, well, as Chicago Cubs fans like to say, "There's always next year!" This year's version took place in late October, and if you couldn't attend a shop tour, site visit, or other event, keep an eye out for a roundup in next month's issue.

Whether it's for SteelDays or just a random visit, walking through a fabrication shop or another steel-related facility—or touring a steel jobsite—gives you the opportunity see the people who create steel buildings in action. On that note, this issue of *Modern Steel Construction* allows you to hear from some of those folks and learn about topics that are important to them.

Check out this month's Business Issues column "Building Your Future Leaders" on page 24, in which Christian Crosby, senior vice president of AISC member Schuff Steel, discusses successful mentoring programs.

Speaking of future leaders, "Sounding Off" on page 54 includes thoughts from several attendees at AISC's recent Future Leaders Ideas Lab (FLIL), an event dedicated to helping the domestic steel fabrication industry's current and future decision-makers become the best leaders possible. Multiple fabricators provide their opinions and ideas on AI, automation, hiring challenges, early involvement with design teams, material flow, and more. Such discussions will ensure that the steel facilities you tour next year during SteelDays (or before!) become increasingly efficient, safe, and productive—and provide even more value to your projects moving forward.



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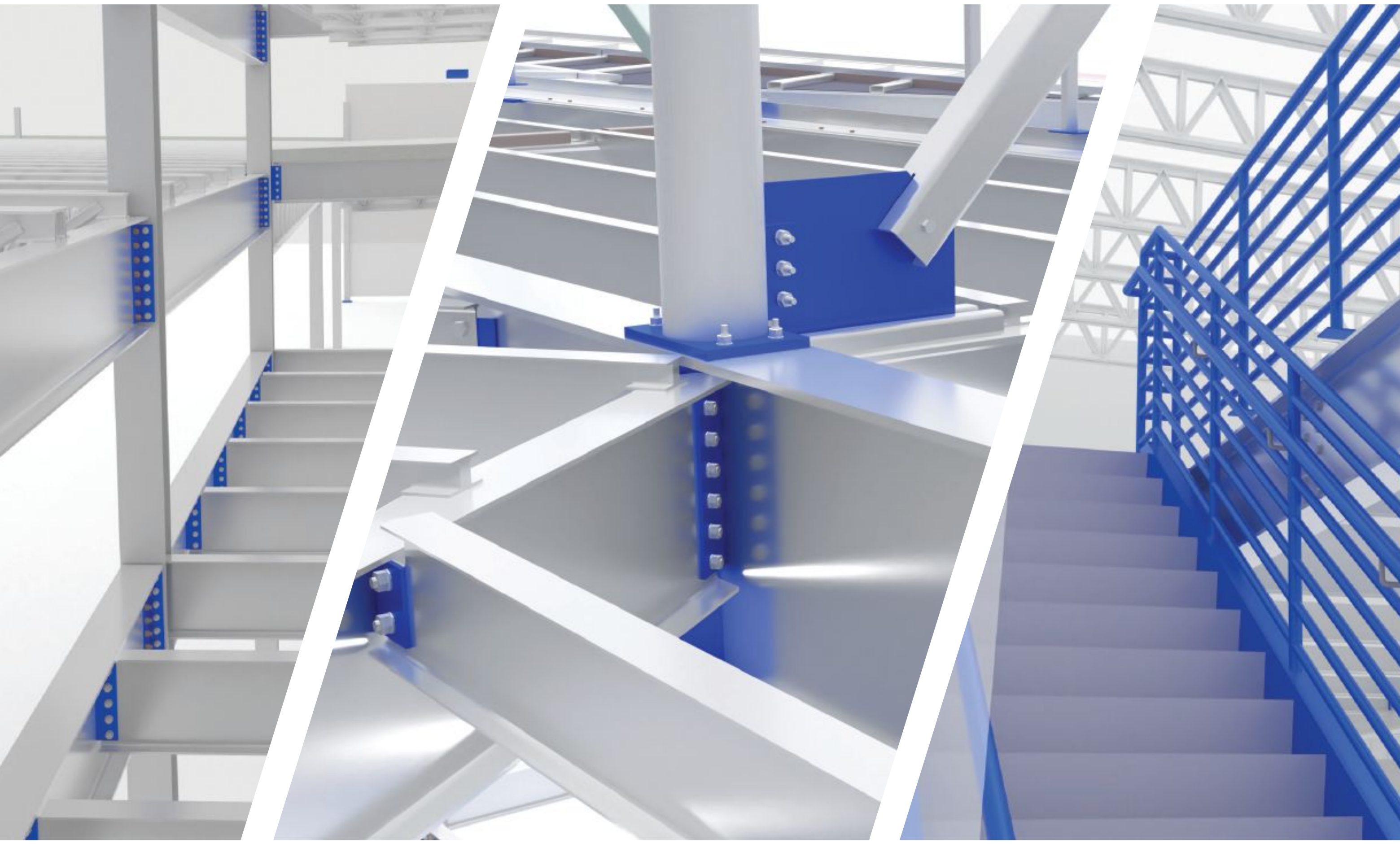

If you've ever asked yourself "Why?" about something related to structural steel design or construction, *Modern Steel*'s monthly Steel Interchange is for you!

Send your questions or comments to **solutions@aisc.org**.

Equation 10-1 Derivation

In the discussion of Table 10-2 in the 15th Edition AISC *Steel Construcion Manual*, Equation 10-1a/b has very specific constants—1.392 (LRFD) or 0.928 (ASD) in the numerator, and 12.96 in the denominator. Where did these constants come from? Are they the result of curve fitting experimental data?

LRFD	ASD
$\phi R_n = 2\left(\dfrac{1.392Dl}{\sqrt{1+\dfrac{12.96e^2}{l^2}}}\right)$	$\dfrac{R_n}{\Omega} = 2\left(\dfrac{0.928Dl}{\sqrt{1+\dfrac{12.96e^2}{l^2}}}\right)$

This equation is for the capacity of a double angle connection welded to the supporting member. Both constants can be calculated directly. The calculation of the numerator is found in Part 8 where the available strength for fillet welds is discussed. Equation 8-2a/b shows the constants 1.392 (LRFD) and 0.928 (ASD). The constant results from evaluating all known values in the equation:

LRFD	ASD
$\phi R_n = \phi(0.60)F_{EXX}\left(\dfrac{\sqrt{2}}{2}\right)\left(\dfrac{D}{16}\right)l$ $= 0.75(0.60)(70\ ksi)\left(\dfrac{\sqrt{2}}{2}\right)\left(\dfrac{D}{16}\right)l$ $= 1.392Dl$	$\dfrac{R_n}{\Omega} = \left(\dfrac{1}{\Omega}\right)(0.60)F_{EXX}\left(\dfrac{\sqrt{2}}{2}\right)\left(\dfrac{D}{16}\right)l$ $= \left(\dfrac{1}{2.00}\right)(0.60)(70\ ksi)\left(\dfrac{\sqrt{2}}{2}\right)\left(\dfrac{D}{16}\right)l$ $= 0.928Dl$

Note that phi and omega are included in the constant (1.392 for LRFD and 0.928 for ASD), which is why equation 10-1a/b does not include phi or omega.

The constant in the denominator comes from a development originally presented in Section 5.4 of Blodgett (1966) using the elastic method for weld capacity analysis. Note that Blodgett assumes that the two angles bear against the beam web between the angles for a vertical distance equal to $\frac{1}{6}$ of their length (see Figure 1). The development is shown below, using the variables from the 15th Ed. *Manual*. The derivation is the same for both LRFD and ASD.

Consider the weld configuration shown. The left side of the figure shows the weld pattern at the supporting member. If we neglect the contribution of the returns at the top, we get a stress diagram as shown on the right side of the figure.

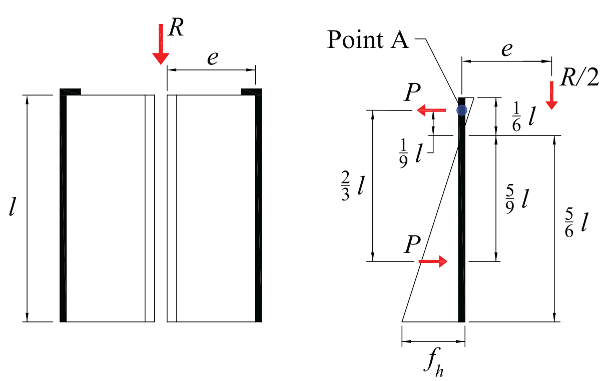

Fig. 1. Stress diagram for the weld at the supporting member (Blodgett 1966).

Summing the moments about point A, which is on the line of action of the top force of the moment couple:

$$\sum M_a = 0 = \left(\frac{2}{3}\right)Pl - \left(\frac{R}{2}\right)e$$

Solving for P:

$$P = \frac{3Re}{4l}$$

From the force triangle:

$$P = \left(\frac{1}{2}\right)f_h\left(\frac{5}{6}\right)l$$

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**.

Setting the equations for P equal and solving for f_b (in units of force per unit length)

$$f_b = \frac{9Re}{5(l)^2}$$

Each angle has a weld. Thus, one weld must resist half of the applied reaction (again, in units of force per unit length)

$$f_v = \left(\frac{1}{2}\right)\frac{R}{l}$$

Using vector addition to find the resultant weld demand:

$$f_r = \sqrt{(f_b)^2 + (f_v)^2} = \sqrt{\left(\frac{9Re}{5(l)^2}\right)^2 + \left(\frac{R}{2l}\right)^2}$$

$$= \frac{R}{2l}\sqrt{\frac{12.96(e)^2}{(l)^2} + 1}$$

To put this in its final format for LRFD, substitute ϕR_n for R and $1.392D$ for fr, and solve the equation for ϕR_n. Note that the ASD equation can be finalized similarly.

$$1.392D = \frac{\phi R_n}{2l}\sqrt{\frac{12.96(e)^2}{(l)^2} + 1}$$

$$\phi R_n = 2\left(\frac{1.392Dl}{\sqrt{1 + \frac{12.96(e)^2}{(l)^2}}}\right)$$

In the 16th Edition *Steel Construction Manual*, the capacity of these welds has been calculated using the instantaneous center of rotation method which allows for an increase in the capacity of the welds. As such, these equations do not appear in the 16th Ed. *Manual*, and the tabulated capacities in Table 10-2 are slightly higher than they were in the 15th Ed. *Manual*.

Christopher H. Raebel, SE, PE, PhD

Protected Zones

Are protected zones required to be identified with markings on the physical member or shop drawings from the fabrication documents. Where are these requirements located?

Yes. Section 1.12 of the AISC *Code of Standard Practice for Steel Buildings and Bridges* (AISC 303-22) covers "Marking of Protected Zones in Seismic Force-Resisting Systems." This section states, "The fabricator shall permanently mark protected zones that are designated on the structural design documents in accordance with ANSI/AISC 341, Section [A4.2]. If these markings are obscured in the field, such as after the application of fire protection, the ODRC shall re-mark the protected zones as they are designated on the structural design documents." The Code does not specify how to make the permanent marking, so presumably, any means that achieves a permanent mark is acceptable.

Section A4.2 of AISC 341-22 includes "(g) Locations and dimensions of protected zones" in the list of items required to be indicated on the structural design documents and specifications.

The Commentary to Section A4.1 explains further. It states, "Fabricators commonly have shop drawings that show the locations of the protected zones with the piece during the time on the shop floor. Those working on the piece are expected to be knowledgeable of protected zones and their restrictions. Similarly, the locations of protected zones are shown on the erection drawings. Should the fabricator's or erector's personnel fail to heed the protected zone restrictions, the quality control inspector is expected to identify the error. When required, quality assurance inspection of protected zones also is performed, using the design drawings that identify the protected zones."

AISC *Code of Standard Practice for Steel Buildings and Bridges*, ANSI/AISC 303 (AISC, 2022a) Section 1.12 requires that protected zones be permanently marked by the fabricator and re-marked by the owner's designated representative for construction if those markings are obscured in the field, such as by application of fireproofing. Marking and re-marking is important because the structural steel quality control inspector and quality assurance inspector have finished their tasks and are no longer present as the work of other trades (e.g., curtainwall, plumbing, electrical, HVAC, column covers, and partitions) is being performed. It is also important for subsequent remodeling or renovation of the structure over its life, particularly when design drawings are no longer available.

Yasmin Chaudhry, PE

Chris Raebel (raebel@aisc.org) is AISC's vice president of engineering and research. **Yasmin Chaudhry** (chaudhry@aisc.org) is a staff engineer in AISC's Steel Solutions Center.

Our tour of updated standards continues! This month, test yourself on the updates, whether it's a change or addition, to the 2022 version of AISC's *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications* (ANSI/AISC 358-22). Download your free copy today at **aisc.org/standards**. This month's questions and answers were developed by Jack Zheng, an AISC intern and student at the University at Buffalo.

1 Which is a welded steel beam-to-steel column connection where slots in the beam web are made parallel and adjacent to the beam flange?
- **a.** Welded unreinforced flange-welded web (WUF-W) moment connection
- **b.** Slotted web (SW) moment connection
- **c.** ConXtech® ConXL Moment Connection
- **d.** (a) and (b)
- **e.** All of the above

2 Which of the following connections is new in the 2022 edition of AISC 358?
- **a.** SidePlate moment connection
- **b.** Simpson Strong-Tie Strong Frame moment connection
- **c.** DuraFuse Frames moment connection
- **d.** Slotted web (SW) moment connection
- **e.** None of the above

3 **True or False:** The cast bolted bracket (CBB) moment connection was previously called the Kaiser bolted bracket (KBB) moment connection.

4 For a reduced beam section (RBS) moment connection, the beam depth is limited to a maximum of:
- **a.** W30
- **b.** W33
- **c.** W36
- **d.** W40
- **e.** W44

5 For an RBS moment connection, the rolled shape column depth is limited to a maximum of:
- **a.** W30
- **b.** W33
- **c.** W36
- **d.** W40
- **e.** W44

6 **True or False:** Supplemental top and bottom flange beam lateral bracing at plastic hinges is always required.

7 **True or False:** Isolation of the concrete slab from the column and connection elements at the face of the column is required for all connections in AISC 358-22.

TURN TO PAGE 14 FOR ANSWERS


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Answers reference the recently published 2022 AISC *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications.*

1 **b. Slotted web (SW) moment connection.** Chapter 14 has been updated to reflect that the slotted web (SW) moment connection is no longer proprietary. The SW connection is a welded steel beam-to-steel column connection in which slots in the beam web are made parallel and adjacent to the beam flanges. The beam web is welded to the column flange and to a shear plate allowing the web to carry both shear and moment capacity.

2 **c. DuraFuse Frames moment connection.** The DuraFuse Frames moment connection is new to the 2022 edition and is covered in a new Chapter 15. The connection is a field-bolted connection that consists of top plates, cover plates (which may not be needed for box or HSS columns), external continuity plates, shear tab, and fuse plate. The fuse plate is proportioned such that certain regions of the plate experience shear yielding when the connection is subjected to severe earthquake loading.

3 **True.** The cast bolted bracket (CBB) moment connection was formerly called the Kaiser bolted bracket (KBB) moment connection, which was proprietary. The connection has been renamed since it is no longer proprietary in the 2022 edition, and Chapter 9 has been updated accordingly.

4 **e. W44.** The connection prequalification beam limitations for RBS connections in Chapter 5 have been updated. The maximum beam depth has been updated from W36 in the 2016 edition to W44 in the 2022 edition. The maximum beam weight has also been updated from 302 lb/ft to 408 lb/ft, and the maximum beam flange thickness has been updated from 1¾ in. to 2⅛ in.

5 **d. W40.** The connection prequalification column limitations for RBS connections in Chapter 5 have been updated. In the 2022 edition, the rolled shape column depth is limited to W40, which was increased from W36 in the 2016 edition.

6 **False.** Lateral bracing of beams must be provided in accordance with the AISC *Seismic Provisions*, and requirements for lateral bracing are found throughout AISC 358. In the new edition, added guidance is provided on the location of supplemental lateral bracing in Chapter 6 on bolted unstiffened (BUEEP) and stiffened extended end-plate (BSEEP) moment connections The following exception to the supplemental lateral bracing requirement is provided: "For both SMF and IMF systems where the beam supports a concrete structural slab that is connected along the beam span between protected zones with welded shear connectors spaced at a maximum of 12 in. (300 mm) on center, supplemental top and bottom flange bracing at plastic hinges is not required."

7 **False.** Slab isolation is not required for the reduced beam section (RBS), welded unreinforced flange-welded web (WUF-W), SidePlate, and Slotted Web moment connections. All connections in the 2022 edition were updated to reflect a consistent approach to the gap between the column flange and concrete structural slab. Section 2.3.4, Isolation of Concrete Slab, was added in the 2022 edition. See the Commentary to Section 2.3.4 for more information.

STEEL SOLUTIONS CENTER

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


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The End-All, Be-All for End-Plate Moment Connections

BY MATTHEW R. EATHERTON, SE, PE, PHD AND THOMAS M. MURRAY, PE, PHD

AISC's new *Design Guide 39* builds on two previous guides to provide a comprehensive resource on end-plate moment connections.

END-PLATE MOMENT CONNECTIONS are designed with speed in mind.

How? By allowing fast field erection of rigid connections without requiring any field welding. The new AISC *Design Guide 39: End-Plate Moment Connections* combines procedures from two previous AISC Design Guides—4 and 16—with new information to create a unified resource for designing with this efficient connection type. The new publication includes background information, design concepts, discussion of limit states, design procedures, and design examples.

End-Plate Connection Primer

What do end-plate moment connections look like? They consist of an end plate welded to the end of a beam and then field-bolted to the column (as shown in Figure 1) or to another beam end plate in the case of splice connections. In addition to allowing field bolting, end-plate connections do not need to be designed as slip-critical, thus allowing relaxed surface preparation as compared to other bolted moment connections such as bolted flange plate connections.

Figure 1(a) shows a diagram of an end-plate moment connection with a configuration referred to as an eight-bolt extended stiffened (8ES) connection. End-plate moment connections are categorized based on the number of bolts at the tension flange, whether there are bolt rows outside the beam flange (extended) or not (flush), and whether the end-plate is stiffened.

Another distinction between end-plate connections comes in the design procedure, depending on which part of the connection constitutes the controlling limit state. Figure 1(b) shows a photograph of an end-plate moment connection undergoing seismic qualification testing where the intended limit state is plastic hinging of the beam. Design procedures for gravity, wind, and low-seismic ductility can result in an ultimate strength associated with end-plate flexural yielding or bolt rupture.

When you picture an end-plate moment connection, maybe you think of metal buildings, where the columns and rafters in the frames use one to create a portal frame. However, the advantages of bolted end-plate moment connections are not limited to the metal building industry. Figure 2 shows an example of a moment frame in a conventional structural steel building that utilizes these types of connections.

Merging Two Design Guides

Design Guide 39 builds on *Design Guide 16: Flush and Extended Multiple-Row Moment End-Plate Connections*, which focused on gravity, wind, and low-seismic-ductility applications, and *Design Guide 4: Extended End-Plate Moment Connections, Seismic and Wind Applications*, which emphasized seismic design procedures.

Because the two design guides overlap—particularly related to concepts and limit states—it made sense to combine them into a unified and updated one. Besides consolidating information, *Design Guide 39* includes five new end-plate configurations, new topics, and 33 design examples.

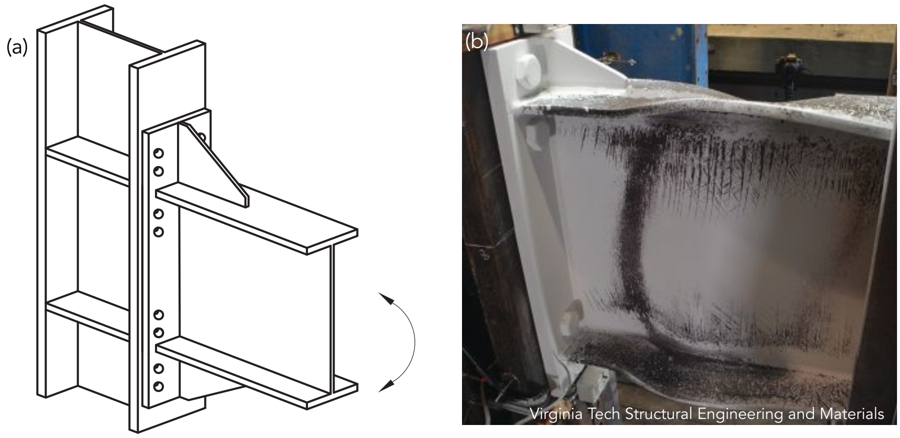


Fig. 1. Examples of end-plate moment connections: (a) Diagram showing an eight-bolt extended stiffened (8ES) end-plate moment connection; (b) Photograph of an end-plate moment connection during seismic qualification testing

Fig. 2. Photograph of a frame with end-plate moment connections for the Mayo Clinic in Rochester, Minn.

What's New?

Design Guide 39 describes in greater detail the three design procedures for end-plate moment connections shown graphically in Figure 3. The design approaches shown in Figure 3(a) and 3(b) are most common for gravity, wind, and low-seismic ductility design.

The design approach represented in Figure 3(a) has end-plate flexure as the controlling limit state, and bolts are assumed to be subjected to prying action. Because this design approach can lead to thinner plates, but potentially larger bolts, it is referred to as "thin" end-plate behavior.

Figure 3(b) demonstrates "thick" end-plate behavior, where the controlling limit state is bolt rupture without prying action. This design approach generally requires a thicker end plate, but smaller bolts. Both design approaches are presented in *Design Guide 39* along with design examples.

The seismic design approach focuses on achieving inelastic rotation capacity, which comes from plastic hinging of the beam rather than failure of the connecting elements, as shown in Figure 3(c). *Design Guide 39* includes an expanded discussion of seismic design issues and three complete design examples demonstrating seismic design procedures.

More information is also provided related to design and detailing issues for gravity, wind, and low-seismic ductility design, including expanded guidance on beam to end-plate welds, stiffener sizing, and stiffener welds. Welds of the beam web to end-plate, flange to end-plate, and stiffeners to end-plate are based on the required moment strength and required shear strength, or the yield strength of the part, depending on performance and uniformity of stresses from testing.

The design guide has sections on handling axial forces and sloping connections. One of the design examples is a sloped connection that might occur in the knee joint of a metal building frame. There is also expanded treatment of column side limit states. An appendix is provided with yield line parameters for different configurations of the column flange, whether the column is stiffened or unstiffened, and whether the connection occurs at the top of the column. Several of the design examples include design checks for the column.

The guide dives deeper into two key limit states for end-plate moment connections. Although the guide provides yield line solutions for all configurations considered therein, information is also provided about the basis and procedures for performing yield line analysis.

Figure 4(a) shows an idealized deformed shape for the four-bolt extended unstiffened (4E) configuration where plastic hinges are formed along discrete lines in the end plate called yield lines. The yield line pattern is often shown in two-dimensional (2D) drawings such as Figure 4(b) where the yield lines and facets are identified.

Prying action is also an important limit state, particularly in the thin end-plate design procedure. Like in *Design Guide 16*, the new guide considers either zero prying force on the bolts (thick end-plate behavior) or the maximum prying forces that can develop (thin end-plate behavior).

One of the most important additions in *Design Guide 39* was increasing the number of end-plate moment connection configurations included in it. A total of 15

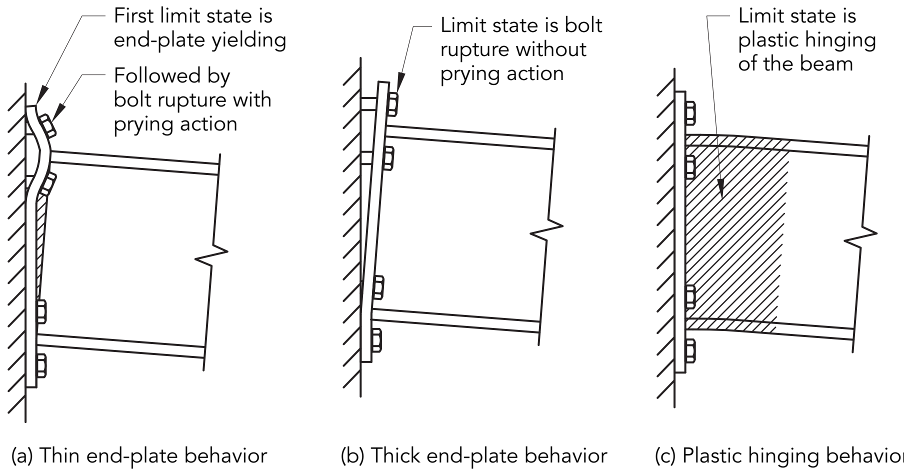


Fig. 3. Three types of end-plate moment connection behavior.

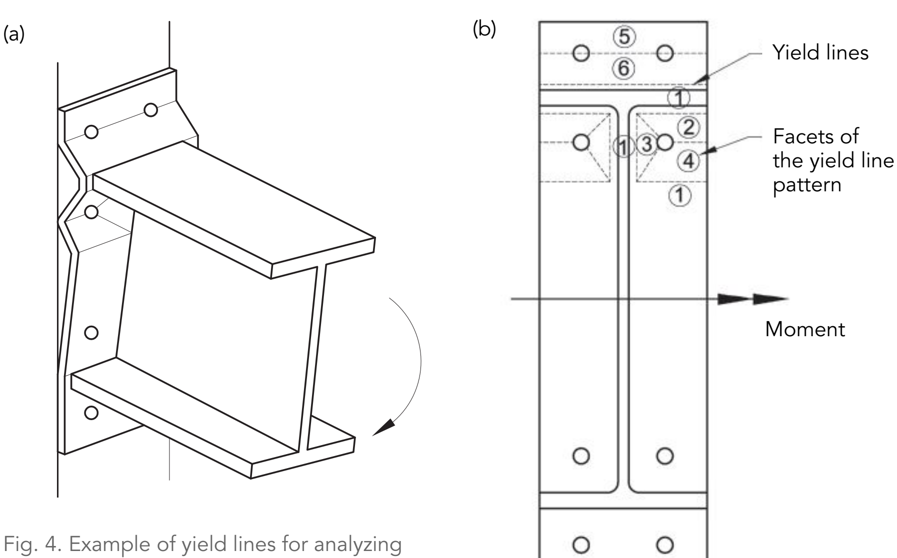


Fig. 4. Example of yield lines for analyzing end-plate flexure: (a) 3D Representation; (b) 2D Representation

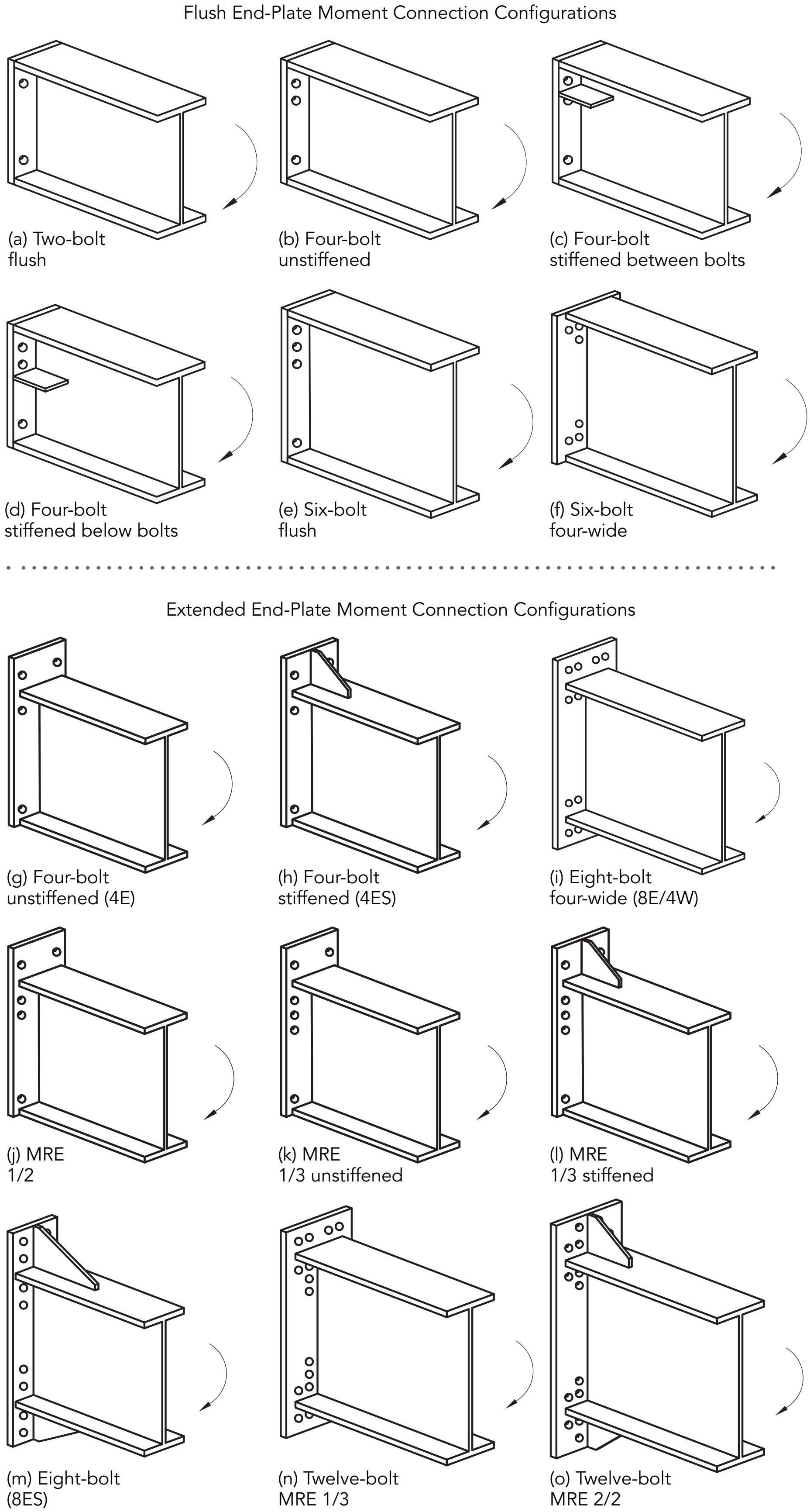


Fig. 5. End-plate moment connection configurations included in *Design Guide 39.*

configurations are considered, as shown in Figure 5, including six flush end-plate configurations and nine extended end-plate moment connection configurations. Design examples are presented for each. The design procedures for all 15 configurations have been validated through full-scale moment connection testing.

The guide includes a chapter devoted to a review of the background and state-of-the-art end-plate moment connections with more than 300 references. One section describes the literature that is the basis for the design procedures, and it involves approximately 40 research reports. This expanded literature review is intended to help engineers find information about special topics, atypical design situations, and unusual loading.

Organization and Design Examples

Design Guide 39 includes 15 design examples using the thick end-plate approach, 15 for the thin end-plate approach, and three for high-seismic ductility design. Of these 33 design examples, six include the column side limit state checks. The gravity, wind and low-seismic ductility design examples include both LRFD and ASD calculations.

Chapter 1 starts with an overview of end-plate moment connections, typical applications, and an overview of the design guide. Then, the classifications of end-plate connections are discussed, including distinctions like extended vs. flush end-plates, presence of stiffeners, and number of bolts at the tension flange. Chapter 1 also includes an introduction to seismic considerations.

Chapter 2 gives background about past research related to end-plate moment connections. The material is organized into four parts: (1) development of the design procedures in the design guide; (2) selected key experimental programs around the world; (3) investigations into specific topics; and (4) computational simulation and analytical methods for analyzing end-plate moment connections.

Chapter 3 overviews design concepts, including how to perform yield line analysis, the development of prying action formulas, and how end-plate moment connections can be defined as fully rigid. Additionally, this chapter addresses design issues, such as how to handle axial forces, how to approach sloped connections, and a detailed description of limit states.

Chapter 4 describes some design choices and detailing issues related to end-plate moment connections. Some key design choices include whether to use the thick vs. thin end-plate design approach and staying within the limits of geometry and materials that have been tested. Detailing issues discussed include fit-up, bolt and end-plate detailing, welds, composite slabs, and stiffener detailing.

Chapter 5 focuses on gravity, wind, and low-seismic ductility design and starts with a summary of the design procedures. Then there are 15 design examples of the thick end-plate design approach. The two-bolt flush, four-bolt extended unstiffened, and four-bolt extended stiffened examples include calculations for the column side of the connection. The four-bolt extended unstiffened example is a sloping connection with built-up beam and column sections.

Chapter 6 describes high-seismic ductility design, including a description of the detailed design requirements in AISC's *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications* (ANSI/AISC 358-22, **aisc.org/standards**). Design examples are presented for each of the three end-plate moment connection configurations allowed in AISC 358, including column side design checks.

The Appendices are broken into two parts. Appendix A includes column side yield line parameters for use in checking column flange flexure, while Appendix B includes 15 thin end-plate design examples.

This new publication gives designers all the information they need about end-plate moment connections in one spot. ■

Access Design Guide 39—and all other AISC Design Guides—at ***aisc.org/dg****.*

Matthew Eatherton (**meather@vt.edu**) is a structural engineering professor at Virginia Tech. **Tom Murray** (**thmurray@vt.edu**) is a profressor emeritus at Virginia Tech.

Multidimensional

INTERVIEW BY GEOFF WEISENBERGER

Georgia Tech professor and bridge expert Ryan Sherman has focused his recent research on 3D printing and its potential impact on steel construction.

RYAN SHERMAN'S present work is dedicated to a technology that may shape steel's future.

Sherman, an assistant professor at the Georgia Tech School of Civil and Environmental Engineering since 2019, has conducted extensive research on metallic additive manufacturing, also known as 3D printing. Additive manufacturing is a fledgling technology in the structural steel industry and was most notably used to build a stainless steel pedestrian bridge in Amsterdam that opened in 2021.

Sherman has studied its current and potential future use in structural steel fabrication. His additive manufacturing research earned him the 2023 AISC Milek Fellowship. The fellowship is named for William A. Milek Jr., a former AISC vice president of engineering and research. The four-year, $50,000-per-year award is presented annually to a non-tenured university faculty member.


Georgia Tech School of Civil and Environmental Engineering

Sherman recently spoke with *Modern Steel* about his background and his research. Here is a portion of that interview, with questions and answers edited for length and clarity.

How did you first become interested in buildings and engineering?

I came from a family that had many people involved in the trades and construction industry. Growing up, it wasn't uncommon to put a roof on a house or build a shed one weekend. My neighbor owned a metal shop and was my first employer. We built trailers and other metal products. I probably started working before I was even in high school, doing something simple like cutting the grass or sweeping the floor.

It continued, and I learned more skills and started grinding and welding. Eventually, I was doing everything in the shop. That probably helped solidify it. I was also good at engineering in math and physics in school. When it came time to select a career path, it all came together and made sense.

It's great to hear that you have a background and appreciation for the hands-on parts like welding.

That has greatly impacted my career path and the choices I've made as I've continued through that career and gotten into engineering. Neither of my parents have a college degree, but most of my uncles are involved in the construction industry. One of my brothers is a construction manager. The other one is a pipefitter. That definitely influenced me.

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**.


Photo courtesy of Ryan Sherman

I went to Michigan Technological University for my undergraduate studies, and AISC has a great student steel bridge program (the Student Steel Bridge Competition). That resonated with having the skill set of learning how to weld and grind through those high school jobs. That was a natural fit, and I think it has progressed to where I'm at today as well.

Before getting into academia, were you a practicing engineer at any point?

I never became a true practicing engineer. I had a few internships between my master's and my PhD (both from Purdue). I had the opportunity to work as a research engineer. That was still in an academic setting, but with more project management responsibilities.

In your master's or your PhD, you're typically working on one project, so I had that opportunity, but never in a design firm full-time beyond an internship.

What put you on the path of wanting to be a professor?

If you ask my parents, they will probably say I was a lifelong student and never wanted to leave school. But after I finished my bachelor's, I felt like I didn't know enough to be a structural engineer. I wanted to work on challenging, complex problems. I toured grad schools. I was fortunate enough to be accepted at Purdue and get funding to work on a research project with Rob Connor, an acclaimed structural engineering professor and a 2012 AISC Special Achievement Award winner for research in fatigue and fracture.

I was finishing my master's and still wasn't quite sure what I wanted to do. But my now-wife had a year left in her graduate program at another school in Milwaukee. I don't know if Rob was playing the long game, but he offered me this opportunity to be a research engineer at Purdue to help start a field monitoring program. He previously had one at Lehigh before he moved to Purdue, and he wanted to get that started at Purdue.

I just had to stay with him for a year, and that worked out with my now-wife's timing. She applied all over the country—she's a biomedical engineer, and there are fewer areas where they can go as opposed to a structural engineer. She got a job in West Lafayette, Ind. She moved down, we were married, and I continued as a research engineer for another year.

At that time, I was working with students. I enjoyed it, I enjoyed the research, and I'm thinking, "I'm at this great institution. Why don't I get my PhD?" I didn't have any intention of being faculty at that time. But over the next five years, I grew to love research, being involved in the engineering community, and working with students.

Georgia Tech School of Civil and Environmental Engineering

Can you recall your experience and your feelings the first time you stepped into a classroom as a professor?

A nerve-racking experience. It's one thing to be in the classroom, take notes, and listen. Suddenly, you're in front of a class teaching. I had a lot of help, a lot of support, and a lot of mentorship from great faculty. AISC also put on a workshop about teaching steel design courses.

Those helped. I was nervous, but at the same time excited. I tried to bring a lot of energy. That resonates back to the students. If the faculty is excited about what they're teaching, the students get excited too.

My first class was Mechanics of Materials—our introductory course. Everyone has to take it. But at that time, a lot of our civil engineering students don't know what civil sub-disciplines they want to pursue. If we can get them excited about what they're learning in that class and how that relates to structural engineering, cool buildings and bridges, and everything they can design long-term, we can attract students in that direction.

One of the reasons you were the Milek recipient this year was for your research on additive manufacturing. What got you interested in that topic?

I first saw the bridge by MX3D in The Netherlands before it was finished. (Read more about that project on page 46). Given my background in welding and fabrication and my graduate school work, I thought it was a cool technology.

That was in my second year of being on the faculty. We need to carve out where we see things going in the future and what areas we can dive into. I saw that as something that was coming down the pipeline. I saw additive manufacturing taking off outside of steel and in other industries. I thought it could be a tool that the steel industry could leverage and put another tool in the toolbox to give us more capabilities and help us stay competitive. I wrote a couple of proposals early on and had mixed reactions. Sometimes, people are hesitant at first with a new technology and where it's going.

Lincoln Electric has an additive solutions center, and they're a service provider. When you see big-name people in the industry make investments like that, it helps push things forward. I was fortunate enough to get a project (on additive manufacturing) from the Federal Highway Administration. Now I'm honored to have received the Milek Fellowship, because it will push this forward even more.

What would it look like for actual structural projects? How did the bridge in Amsterdam come to be? What's your project with the FHWA?

I haven't visited the bridge in The Netherlands. What's cool about it, though, is MX3D is not a structural engineering firm. Obviously, structural engineers were involved in the design. But it's a technology company that had this cool new way of doing things, and they needed to showcase it to the world. Fortunately, they picked a bridge.

That's maybe a step way into the future. I think we could do that with pedestrian bridges. Realistically, this is another tool in the toolbox. We're extremely efficient at rolling our steel, but there are places where maybe this makes sense. Maybe that's connection nodes, a replacement for casting, or something in an existing bridge that needs to be replaced where the casting may take a long time to get, but additive can crank it out in short order.

If we want to get to much more expressive structures and allow structural engineers to open their minds to anything they can design and fabricate in terms of a connection, we could probably create it with additive, within reason.

In my lifetime, we probably won't be completely printing structures. I grew up watching the Jetsons and their flying cars—we don't have flying cars today. Maybe we'll get there someday where the whole structure is printed on site. I think there are going to be intermittent steps to get us there. We're probably going to start creating components. There will be challenges to work through and how we gain acceptance for those components, whether it's a node or a bearing or various things that are difficult to fabricate right now.

I think we all know there's a shrinking workforce. Labor is getting harder and harder to find these days, and fewer people are generally heading into the trades. Additive manufacturing may provide a way to help level the playing field on that. Instead of one welder welding on a component, we may have a welding cell operator or an additive cell operator running, three, four, or five cells that are working more around the clock.

Are there any other steel-related research projects that you're hoping to tackle in the future?

A lot of my focus right now is on additive. But I'm still trying to stay grounded in the traditional ways we create steel buildings and steel bridges. We have some interesting work going on right now looking at weld repairs. Occasionally, a weld needs to be repaired. How many times can you repair that weld before getting a decreased performance?

We talked to fabricators, and typically, after three repairs, owners start to question a weld, but do we know if it's three strikes and you're out? Or, if you're doing this correctly, can you repair a weld multiple times? Is there a limit? We're starting to look at that.

One of my colleagues at Georgia Tech, Don White, and I have been looking at some stability-related limit states. I've enjoyed learning about that aspect. I didn't have much experience in it before I got to Georgia Tech, but Don is one of the experts in the country.

American Iron and Steel Institute

We also have an upcoming project with the Georgia Department of Transportation where we're looking to do fatigue monitoring on some steel bridges. They want to know if there's life beyond what they assume if they do a traditional calculation. We can go out in the field, put some sensors on a bridge, take some pretty easy measurements, and in a reasonable amount of time, provide the DOT with actionable knowledge regarding the performance of that structure. Maybe it has a lot more fatigue life, and the bridge can last longer than they were initially thinking by doing classical calculations.

Outside of research, what classes are you teaching at Georgia Tech?

I'm teaching Introduction to Structural Engineering, which is a nice class to get students headed in the steel direction. I have to talk about all materials, but I don't think it's a secret that I have a passion for steel. That's a fun one. The students are young. Our students in transportation and materials take it, and it's an opportunity to grab those students and convince them that structural engineering and civil engineering are the way to go.

The other one I'm teaching is a Behavior of Metal Structures class. It's kind of everything you want to know about steel structures. It specifically looks at fatigue, fracture, and some of the material aspects. I had a similar class at Purdue, and it was one of my favorites.

This article was excerpted from my interview with Ryan. To hear more from him, check out the December 2023 Field Notes podcast at ***modernsteel.com/podcasts****.*

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

Building Your Future Leaders

BY CHRISTIAN CROSBY, PE

Strong mentoring programs have long-term benefits, because we're all in the people business.

IN THE BUSINESS of structural steel construction, we all chatter about how we are "builders." We crow about the buildings we have built, and rightfully so. Most of us have built extraordinary structures, complex buildings, and unbelievable bridges that defy the laws of physics. But rare is the occasion that we discuss the people we are building along our way.

I remember my humble beginning in this business and the long journey behind me. I reflect on the people I have met, the mistakes I have made, and the mentors who have taught me our business. I think about mentors who took time and energy away from their daily tasks to engage with me and invest in me. I am grateful for them and their desire to pass along their wisdom. Those of you who have listened to any of my sessions at NASCC: The Steel Conference or have read any of my Friday's Thoughts emails understand my gratitude toward my mentors and their indubitable impact on the development of my skill set.

Several months ago, I discussed my plans for this article with a trusted colleague. He shared a series of articles by recognized leaders from our industry as case studies around their experience with mentoring. My colleague wrote a prologue for this series, and in his preface, he outlined his discouragement with the bloated use of "mentoring" and the lack of a defined mentoring process. He also encouraged me to promote the practice of mentoring. So, Duane, if you read this article, consider it my way of saying I accept your challenge.

What is mentorship? The textbook definition is the guidance, advice, and feedback provided by an experienced person within an organization to a less experienced person. However, I challenge this definition by excluding "within an organization." Mentorships bloom between two people regardless of their organization, or lack thereof. My experience has shown that individuals who have retired from our industry make for outstanding mentors and have plentiful insight to offer.

The other exception I take to the definition is that mentorship is about the relationship between mentor and mentee. Without the relationship, the arrangement is nothing more than a training activity. A relationship driven by a common goal of conveying knowledge, skills, and abilities from one to the other separates mentorship from training.

The benefits of having a mentoring process are easy to understand. It can reduce the organization's employee turnover, enhance its culture, engage employees, and create ownership within its rank and file. An important benefit to me, though, is developing future leaders within the organization. We all lament the struggle to find people to fill our needs, let alone to find good people to join our teams. It's easy to fixate on the day-to-day struggles of serving our current needs and retaining our current team, which can lead to omitting our responsibilities in planning for the future. Within the confines of a mentoring program, we can focus on high-potential team members and provide them with the knowledge, skills, and abilities they will need as the next generation of leadership.

From the organizational perspective, a mentorship program should address the following items:

- selection of mentees
- selection of mentors
- matching of mentors and mentees
- establish goals and track progress

Selecting Mentees

I touched on the idea of a "high-potential employee" as a potential future leader within the organization. The organization needs to consider these employees as candidates for a mentorship program. Here are some characteristics that will help organizations identify high-potential employees:

- **People who take initiative.** These people do not need constant supervision or direction. They can anticipate what needs to happen next and execute. They require minimal direction. I like to say that their managers can paint with a large brush and they still understand what needs to be accomplished.
- **People who produce high-quality work.** These employees' quality of output is high relative to the others around them, regardless of the work assignment. They will produce high-quality output even with the most mundane assignments. They take pride in what they do.
- **People who foster positive relationships.** High-performance employees have positive attitudes and build relationships within the organization. If we stop and think about our ideal next generation of leaders and their characteristics, the ability to build positive relationships is at or near the top of the list. So why would we not look for this characteristic while evaluating promising mentees?

Mentee selection red flags are employees with the biggest egos, the loudest voices, an expressed love of power, and comfort slapping down those around them. These characteristics are absent in employees who are invested in the organization's success and will be the next generation of leaders.

I offer one more mentee selection tip: trust your gut feeling. We all have one, and if we are honest with ourselves, we have stories of when we listened to our gut and ignored it. The outcomes of both will prove my point.

Selecting Mentors

We talk about a mentor as an experienced, knowledgeable person who can provide structured, planned guidance to a high-potential employee and support that person. We need an experienced person with relevant expertise and knowledge in our business. But one invaluable characteristic is the desire to share more than knowledge and invest in the mentee—the desire to make time and energy to meet with the mentee and build a relationship. I have met many highly skilled and knowledgeable people in our industry who I would not recommend as a mentor because they lack the desire to pass knowledge to the next generation and invest in others. I have witnessed firsthand the train wreck that occurs when a selected mentor displays zero desire to build a relationship with the mentee.

The mentor must have excellent communication skills to be successful in this relationship. And with their communication skills, they must be able to give honest and direct feedback. Successful knowledge sharing demands high-end communication skills.

Matching Mentors and Mentees

Stop and think about the people-related challenges we deal with weekly and sometimes daily, and you'll understand many of them stem from personalities that do not mesh. Now, one personality is not right, and the other is not wrong—some simply don't mix. We need to understand whether the mentors and mentees will be a good match. Many organizations use personality profiles to understand their managers and employees better. I highly recommend them. They're readily available online.

One final note on matching goes back to my thoughts on mentee selection: trust your gut. If you can discern the difference between personality types, don't ignore what your gut tells you. If the mentee is a high-potential employee and the mentor is an experienced, excellent communicator with the desire to teach, but their personalities are oil and water, this relationship will fail. Use your lessons learned.

Establishing Goals and Tracking Progress

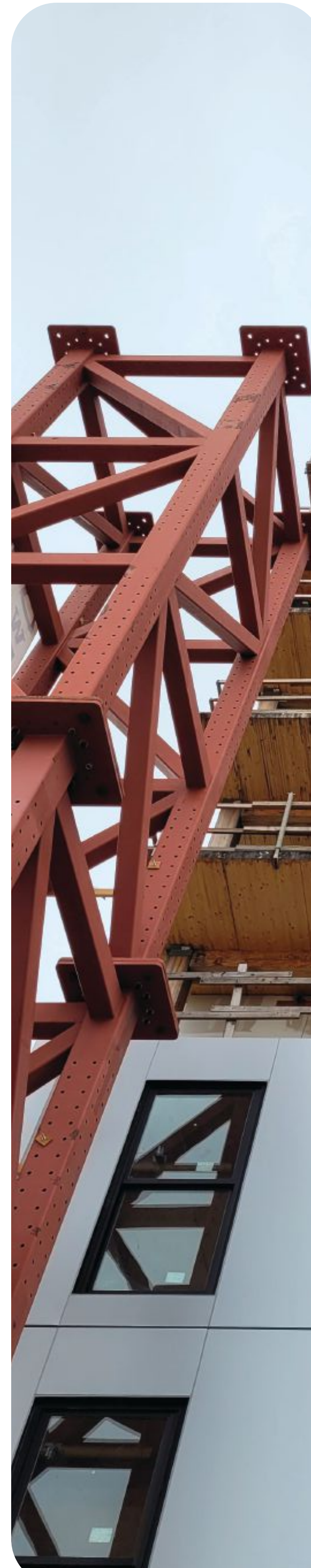
A mentorship program's goal is simple: prepare your high-potential employees for future leadership within the organization by transferring knowledge, skills, and abilities from experienced people. How is progress tracked? We can develop a matrix of the skills the mentee needs to learn and check off these boxes as they're displayed, but this is a long-term and subjective process. Establishing a regular check-in with the mentee and the mentor will provide a manager with feedback that shows both parties are headed in the correct direction or require course corrections.

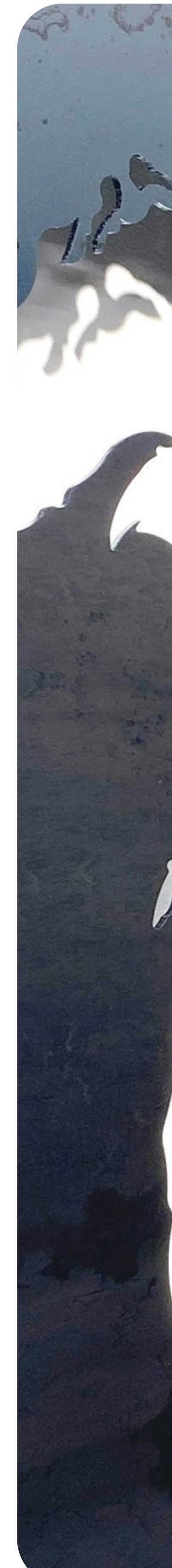
We need people now and in the future because we're in the people business. We have all had someone along our journey teach us, guide us, and coach us, and with the difficulties in the labor market, an intentional mentoring program will help secure your organization's next generation of leadership. ■

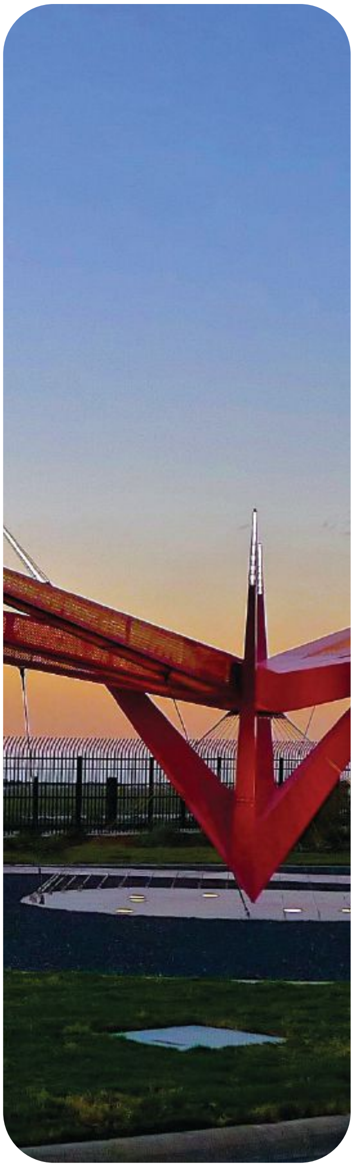
Christian Crosby (**christian.crosby@schuff.com**) is the senior vice president of fabrication at Schuff Steel.

Every year, *Modern Steel Construction* compiles several captivating developments that showcase structural steel's versatility.

What's COOL in Steel







This year's list features multiple projects, including a downtown Chicago office building constructed in tight quarters and a steel sculpture that greets airport visitors to Dallas. Going beyond projects, read about an emerging fabrication trend, one general contractor's way of helping address the trade labor shortage, a steel artist, and more.

COOL **Landmark**

Steel Takes Off

SCULPTOR ED CARPENTER'S fourth project with AISC member fabricator Puritan Manufacturing, Inc. is a guardian of sorts for Dallas' Love Field Airport.

LoveBird, a 90-ft wingspan steel structure, sits at the airport's main entrance—immediately next to the end of a runway.

"Poised for flight, LoveBird alights at the head of the runway, spreading its wingspan in a display of pride and optimism," Carpenter wrote in his description. "Its sleek contours complement the modernism of the terminal, suggesting a fantastical bird or advanced aircraft.

"To some, it may evoke the wing display of the mockingbird, the name of the adjacent roadway and Texas' state bird. Is it ascending or descending? Either way, it rises delicately from a fine point, slightly canted, stabilized only by slender cables arrayed in a fan form suggesting tail feathers."

The sculpture's position at the head of the runway meant it could not exceed the FAA's 20-ft height limit. But Carpenter felt the site demanded a bold statement, and his solution was to expand LoveBird's wings as far as possible. His design called for a 20 ft high by 90 ft wide structure evoking something landing or taking off and meeting the ground slightly angled on a base only 2½ in. wide. It was completed in October 2021 and is among the most recent projects by Carpenter, who specializes in monumental public art and is based in Portland, Ore.

Carpenter chose Puritan—based in Omaha, Neb. —to fabricate the steel for LoveBird. Puritan normally provides structural steel fabrication, platforms, stairs, and other goods for industrial-based companies. It had, though, worked with Carpenter three previous times, beginning in 2010 when the Iowa West Foundation commissioned him to provide a sculpture on a viaduct in Council Bluffs, Iowa. Puritan also fabricated his 55,000-lb. stainless steel sculpture in Lincoln, Neb., called "Harvest" and the 70-ft "Micro Macro Mojo" in Richardson, Texas, which combines stainless and hot-dip galvanized steel.

"Each of these four projects has a different challenge in rendering an artist's vision into physical reality," Puritan president and general manager Dave Waters said.

With LoveBird, the geometry was symmetrical, but the sculpture had to be positioned at a slight compounded offset to give the illusion that the object was flying or nearly weightless.

The structure is fabricated from 304 stainless steel and was painted bright red. Perhaps the most unusual aspect is that all 10,000 lb of the stainless steel sit on a ¼ in. thick donut with a 2½ in. o.d. and a 1¾ in. i.d. It required a donut-shaped base because the electrical wires for the lights needed to come from a conduit below. Combined with the weight and deflection of the cantilevered wings spreading out from the center main structure, Puritan thoroughly deliberated a plan for something that would be within the budget but still durable and functional. Aluminum was even discussed as an option, but 304 stainless steel won out for its strength, durability, and lifespan.

Structural angle was used for the wing frames, with laser-cut ⅜ in. thick baffle connections and all-welded construction. The wing panels needed to be removable for erection and light maintenance requirements. Most useful in assembly was the RIVNUT fastening system, which alleviated the need for 3,500 ¼ in.-20 UNC fasteners to attach the wing panels to the stainless steel structure.

"We didn't want to weld threaded nuts to the structure 3,500 times," Waters said.

All components were laser cut on a Trumpf fiber, 6KW, L3040, and the structural stainless steel was produced on a Peddinghaus Q643 Anglemaster, which provided enough accuracy to locate the fasteners.

The six wings on LoveBird are almost identical. The overall structure is broken into six components:

- center base embed
- main base structure
- main mid-support assembly
- pylons
- wings
- light tips

The main base structure needed to support all the weight concentrated to this one point. Puritan used ¼ in. 304 stainless plate with a series of baffles to tie everything together. The pylons that hold together the main mid-support structure needed to be substantial enough to carry the loads. Everything leading up to supporting the wings was reinforced and fabricated from plate. Using bolted connections for everything facilitated shipping and field erection.

LoveBird's unusual geometry required measuring the exact lengths of the support cables so it could be tethered it to its circular foundation. Four main cables provide most of the support, and 28 smaller ones primarily prevent rotation.

The cantilevered weight of the wings required the main mid-support structure to have gusseted plates at every bolted connection to resist the gravity and wind forces that would be exerted on the wings. The wings are laser-cut perforated panels fabricated from 11 ga 304 stainless steel. Each wing weighs about 900 lbs. The lighted wing tip elements were bolted to the ends of the wings, continuing the tapered geometry.

Ed Carpenter

Ed Carpenter

Reinventing Steel

James Kennedy paints on steel in his studio.

JAMES KENNEDY CAME TO APPRECIATE the old Champlain Bridge and its cultural significance to Montreal even though he never saw it up close until he moved there in his 20s. He didn't need to cross it as a child or grow up near it to understand it had meaning to many.

Kennedy, now 50 and a Montreal-based independent structure designer turned steel artist, has spent the last 10 years traveling the world to take pictures of notable bridges and bases his steel art on those photos. Capturing magnificent landmarks and learning about their meaning to locals is his livelihood.

So when he heard about the plans to disassemble and replace the old Champlain Bridge, he couldn't sit idly.

"I was deeply moved by the vanishing of this iconic symbol of Montreal," Kennedy said. "I instantly knew that I wanted to create a commemorative piece."

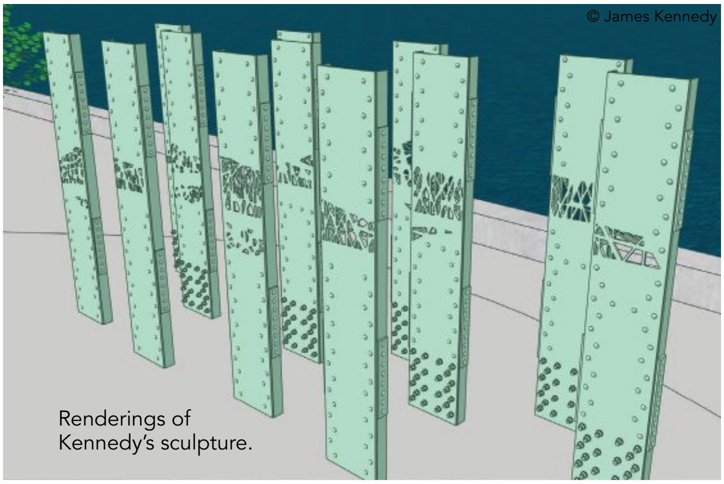
In 2019, a new cable-stayed Champlain Bridge replaced the steel truss cantilever one that countless Quebec residents crossed for nearly 60 years. The dismantling process began in 2020, and a piece of one side ramp is all that remains. The bridge portion and all the steel are gone, and a cultural symbol for multiple generations left with them. Kennedy understands what was lost, even if he didn't grow up in the bridge's shadow.

"A lot of people felt like a big landmark was disappearing," Kennedy said. "When you cross it all your life, you have memories attached to it. It touched a lot of people. I felt that and connected with that part."

The federal bridge agency in charge of the project, though, is recycling some of those pieces and awarding them to bidders who present a compelling reuse plan. And that's where Kennedy saw an opportunity to keep the bridge alive.

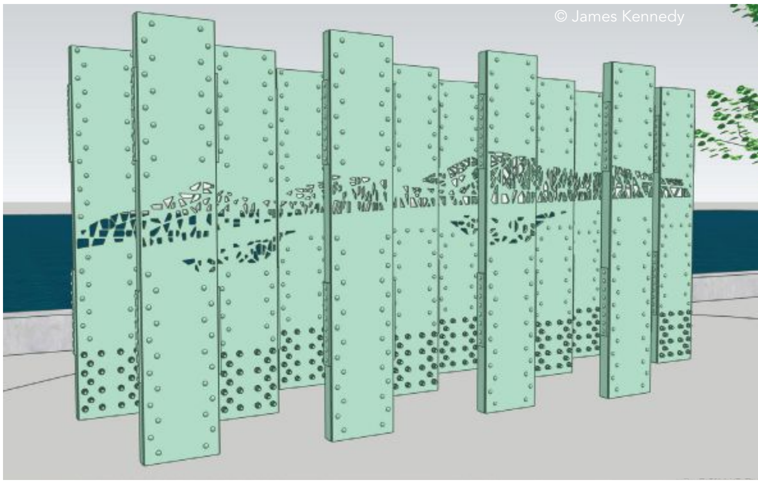
All photos courtesy of James Kennedy

A member from the old Champlain bridge to be used in Kennedy's sculpture commemorating it.



© James Kennedy

Renderings of Kennedy's sculpture.



© James Kennedy

Kennedy is building a sculpture, appropriately titled Mémoire, using recycled material from the old bridge. Montreal residents who walk near the bridge's former site—where he hopes to earn approval to place the sculpture—will see 12 to 15 vertical steel panels made from the bridge's chords and freshly repainted with a familiar teal tone. The panels will be staggered and perforated with an illustration of the old bridge across all of them.

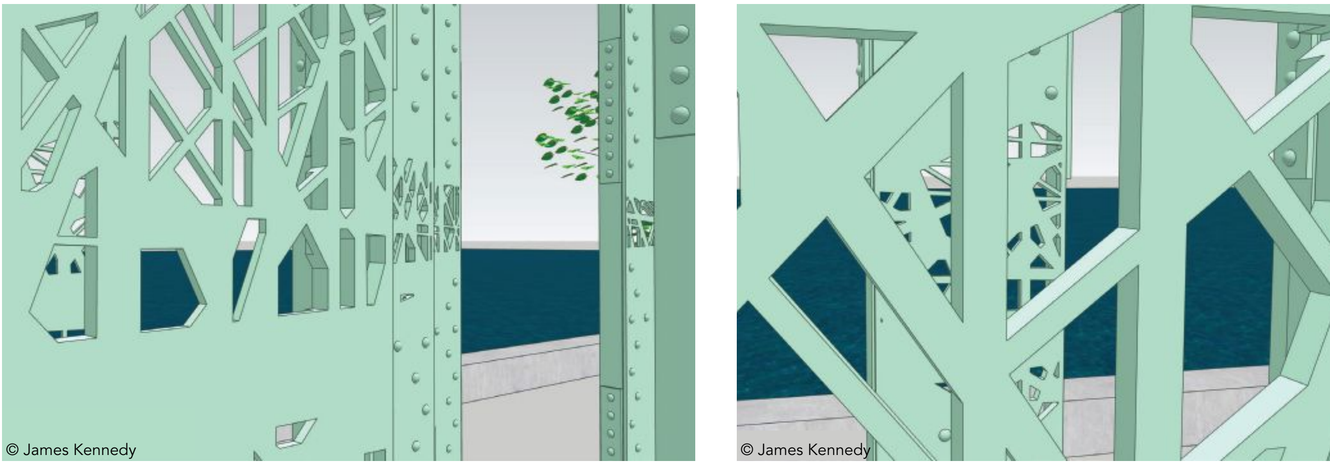
The main goal of his project, though, is to tell a story. Kennedy is not merely aiming to prop up some beams in a plaza as a tombstone for the old bridge. He wants to connect sculpture visitors with Montreal citizens' memories and stories of the bridge and, hopefully, make them recall their own. Each panel will have a QR code for visitors to scan and listen to a recording of someone describing his or her bridge memories. All told, the project is as much about discovering the stories as it is about creating the sculpture itself.

"I want to interview people," Kennedy said. "We all have individual experiences, but it's nice to see what's broader. Did someone have a baby on the bridge because they were stuck in traffic?"

About five years ago, Kennedy wrote to Jacques Cartier and Champlain Bridges Incorporated (JCCBI), which oversaw the Champlain replacement, to express his desire to commemorate the old bridge. The agency told him it was holding a material reuse competition and would award some of the steel to citizens who pitched captivating and publicly beneficial repurposing plans.

Kennedy entered his submission in 2020. JCCBI announced it as one of 11 winners in April 2023. In all, he is receiving five pieces of the bridge that weigh about 22,000 lb. All of it was sandblasted and coated with new primer before delivery to his Montreal studio.

Kennedy will not start sculpting until the structure's location is finalized, but he is targeting late 2024 for completion. The design



A close-up look at the planned perforations in Kennedy's sculpture.

One of the pieces in James Kennedy's Contours collection depicts the Great Lakes.

Kennedy replicated a photo of the Manhattan Bridge as part of his Landmarks series.

and timeline were his to determine. It will be his largest project. He has spent most of his time since starting art as a side job in 2008 crafting work that can fit in a room or hang on a wall. Art is now his full-time job.

Steel, though, is familiar material to Kennedy from his pre-artist days. In 2005, he founded his own design and production company that specialized in individual interior spaces and public installations, some of which were made of steel.

"I was fascinated by what we could do with the metal," Kennedy said. "That started my interest in materials."

Kennedy merged that curiosity with his artistic passion, which ignited as a child watching his mother, an artist, and grew when he began painting on the side as an adult. He learned many techniques from artist friends, including etching, which he has adapted to create the oxidation painting methods that are now his foundation. His early work included manipulating industrial steel panels into wall sculptures. He now uses several techniques to recreate pictures on steel.

"I'm painting on metal with acids to oxidize the steel," Kennedy said. "I'm darkening the metal with the type of acid mix I'm using, sometimes creating hues of colors within it."

His Urban Landscapes series is an assortment of recognizable landmarks he paints with acid on steel and is inspired by photos he took. His Contours series is a collection of continents, islands, and lakes carved into steel. Both include United States locations and landmarks, and he has worked with several U.S. clients. He is currently crafting a commissioned Contours series of all six continents on separate 4 ft by 4 ft steel plates for a company in New York that will occupy 30 ft of wall space.

Mémoire will tie everything together in one project—his art techniques, his prior life as a designer, and his appreciation for the steel Champlain Bridge.

"I feel like I'm going back into my old shoes," Kennedy said. "I'm building something bigger that requires transport machinery and planning. That sculpture links all the experiences I had doing my large projects before."

Fitting for a project based on unity.

"Linking people together—the point of a bridge—is the way I'm going to do this (sculpture)," Kennedy said. "I'm going to link different stories together and build a great collective memory."

COOL College Class

Going Up

A CIVIL ENGINEERING CLASS at the University of New Mexico gave a new meaning to reaching higher.

UNM students enrolled in Civil Engineering 424/524 this fall—taught by Professor Fernando Moreu, PhD—can say they learned about steel design at a higher elevation than any class in the country, and possibly the world. One of their homework assignments was to take Albuquerque's Sandia Peak Tramway to its 10,400-ft peak to detail its structural components, study its shop drawings, see its machine shop and steel shop, and learn about detailing from the tramway's maintenance director.

The class has been using the tramway for the last five years, and students are challenged to see steel sections and properties using the 16th Edition *Steel Construction Manual* in the field. The class challenges the students to think about some of the tramway's details from the perspective of its function, operations, maintenance, access, durability, and sustainability in the real field. The students were equipped with shop drawings, tape measurers, and a 16th Ed. *Manual*, and together investigated properties while asking maintenance personnel about their operations.

"Always measure down to $^{1}/_{16}$ of an inch," tramway maintenance director Augie Eischen said when he noticed students eyeballing a flange width to be between 11 and 12 in.

Eischen explained the importance of steel detailing and encouraged students to pay rigorous attention to details. Those details impact fabrication and maintenance, so students need to think of steel design in a broader context than the classroom.

above: University of New Mexico CE424/524 Students, all with the *Manual* in hand, in the headquarters of the Sandia Peak Tramway with director of maintenance "Augie" Eischen and general manager Michael Donovan.

below: Students learning about the operations and maintenance of the Sandia Peak Tramway.

Photos courtesy of Fernando Moreu

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16	Angle Heel Up	MEAN DIA.	8" x 8"x1" Angle
17	Square Tube	INSIDE DIA.	24" x 1/2" Tube
18	Rectangular Tube The Easy Way (Y-Y Axis)	INSIDE DIA.	20" x 12" x 5/8" Tube
19	Rectangular Tube The Hard Way (X-X Axis)	INSIDE DIA.	20" x 12" x 5/8" Tube
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"I was shocked when I thought about the operations of the tramway and how the steel design requires the understanding of the car movements, maintenance, safety, and the importance of all possible scenarios," senior civil engineering student Jack Dugan said.

Added classmate Ethan Kapp: "I enjoyed taking the Tram and using the day to relate equations and the code to real structures."

Tramway general manager Michael Donovan thanked the students for choosing civil engineering.

"We need your knowledge to design and maintain many outdoor infrastructures in New Mexico, Utah, and the Southwest," Donovan said. "We have a beautiful country, and you as engineers can create access for people to nature and beauty. Thank you for working with us or others on outdoor structures in nature."

The class' midterm asked students to measure the detailed connections and sections from the exposed steel section of the Media Lab at UNM's Gerald May Department of Civil, Construction and Environmental Engineering. The students sat next to this structure for five weeks and were surprised in the midterm by having to detail it. In the past, students in this class have visited a steel bridge in downtown Albuquerque that carries the Rail Runner commuter train. Their final project is spearheading a new pedestrian steel bridge that will become an iconic entry to UNM's southwest corner at Central Avenue and University Boulevard.

above: Learning about steel design and detailing at the Sandia Peak Tramway.

right: Riding the Sandia Peak Tramway.

below: At the top of Sandia Peak

COOL Construction Children's Book

Shaping The Future

EVERYWHERE CHRIS ECCLESTON goes these days, he sees a reminder of the reality that has spared no one in his industry. Like nearly every other general contractor in the United States, he feels the impact of the trade industry's labor shortage and its dearth of young workers.

One day, it reveals itself in the form of an office discussion about putting AEDs on jobsites. Another day, it hits Eccleston when he realizes only two to three masons in his region have enough staff to handle the commercial projects that his Salisbury, Md. company tackles.

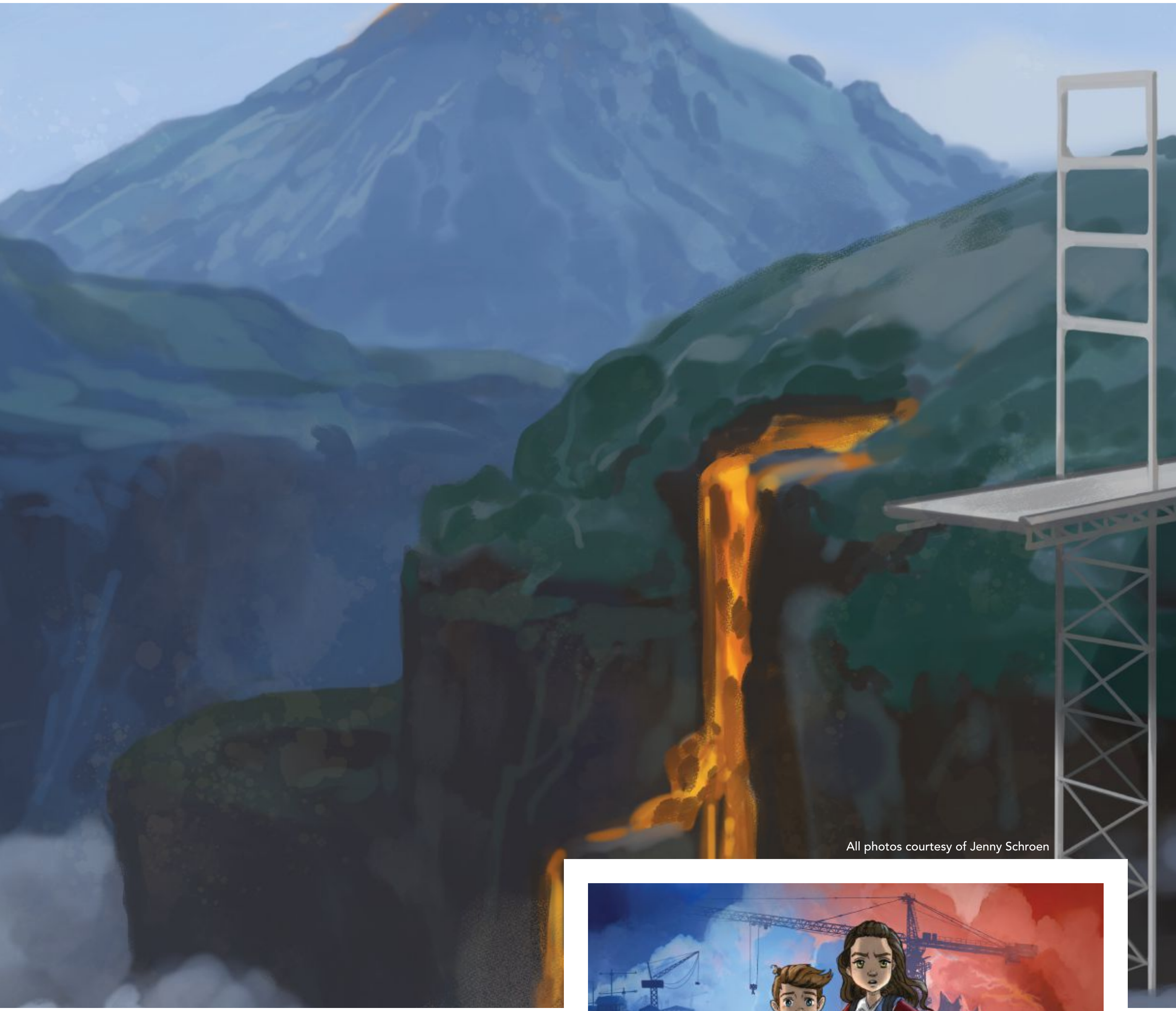
"In five to seven years, this is going to get worse," Eccleston said. "We have to start bringing attention to the issues."

Eccleston, the president of Delmarva Veteran Builders, hatched an idea he hopes will create lasting change. He and Delmarva Veteran Builders creative developer Jenny Schroen wrote a children's book about construction.

It won't help Eccleston's company find more masons for a current or near-term project. Both authors, though, are thinking bigger than a short-term fix and beyond their own company. They want to help end the labor shortage by creating more passion for the trade industry in the workforce of the future. Their book, *Grit Leads to Greatness*, is an adventure story that they hope will shift perceptions about construction and the trades. They chose the adventure story approach because they felt it would best resonate with children. They wanted to show, not tell.

"We could just write about construction and explain what construction is," Schroen said. "That's cool, but how do you cause action and create change?"

Grit Leads to Greatness was published in March 2023. It's about two children, Tegan and Trig, who live in a dystopian world where the art of building is lost and mysterious glowing stones hypnotize citizens. An earthquake has pushed their home

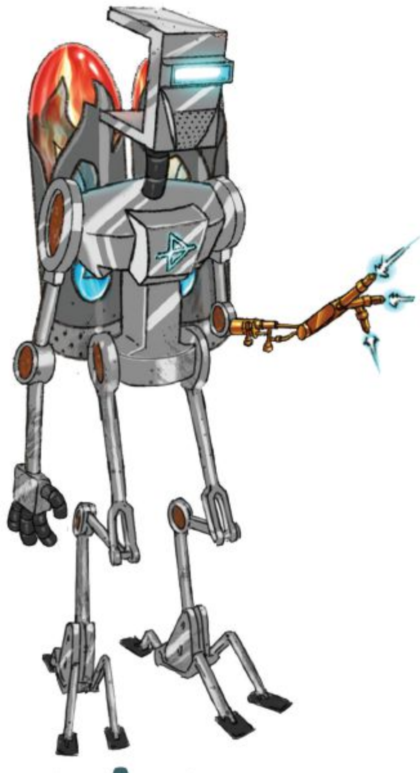


All photos courtesy of Jenny Schroen

city to the edge of a cliff, and the duo travels to a place called Greatnes, which they believe will save the city. Along the way, they encounter various obstacles. Five fanciful trade-themed creatures befriend them and teach them trade skills that help them pass the obstacles and ultimately reach Greatness.

Tegan and Trig learn masonry, electrical work, plumbing, carpentry, and welding—each from a separate character. Arc the Welder, a robot with flames for hands and a head shaped like a channel, sports a fillet weld diagram on his chest and a welding pack on his back. He teaches them how to weld girders to make a bridge that spans a ravine.

The children in the book learn that trades are essential to everyday life. Similarly, the authors want children who read it and parents who read to them to see the nobility in the profession. To them, shifting parents' perceptions about their children working in trades is just as crucial as igniting the children's interest in the trades.



Arc the Welder

"We're bringing this honor and heritage back through that heroic lens to a child," Eccleston said. "That's what the trades stemmed from thousands of years ago. These were people of high society. That's now kind of lost. The fact is, we built the world and we're going to build the future. The trades aren't going anywhere."

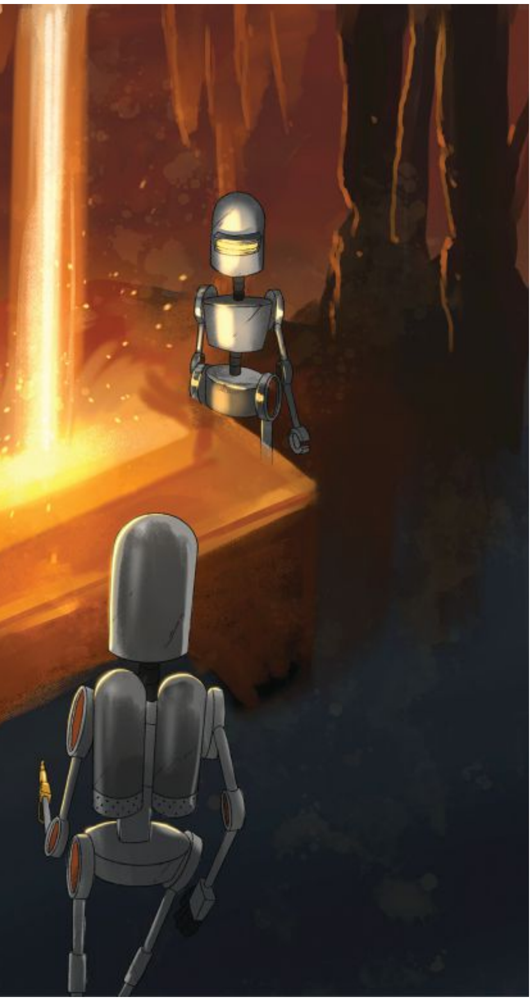
Eccleston and Schroen wrote the book with two goals: inspire the next generation and activate the current workforce. They're intertwined initiatives that started with National Read Across America Day in March. About 50 contractors bought bundles of the book and read it to elementary school classrooms in Maryland. Eccleston estimates it reached about 1,000 children that day.

The contractors and tradesmen didn't just read the book. They told the children about their jobs and their importance. It left children with a new view of the industry and invigorated passion among current workers for helping solve the shortage problem.

"One thing that blew us away is how the men and women of the construction industry responded to it," Eccleston said. "We had every part of industry represented. We're a tough group to get excited. The pride, energy, and empowerment I saw from the contractors in the classroom was very moving."

Publicizing the book and classroom reading days didn't require Eccleston to devise an aggressive marketing plan. He sent the manuscript to the Associated Builders and Contractors (ABC) and the Association of General Contractors (AGC). He and Schroen went to the ABC's conference in March to pitch it in person. He emailed local sub-contractors about the classroom readings and found most of them were eager to participate. Every outreach effort landed on enthusiastic ears and spread rapidly.

"We have contractors on the daily finding us and reaching out," Eccleston said. "We're starting to get found by different industries."

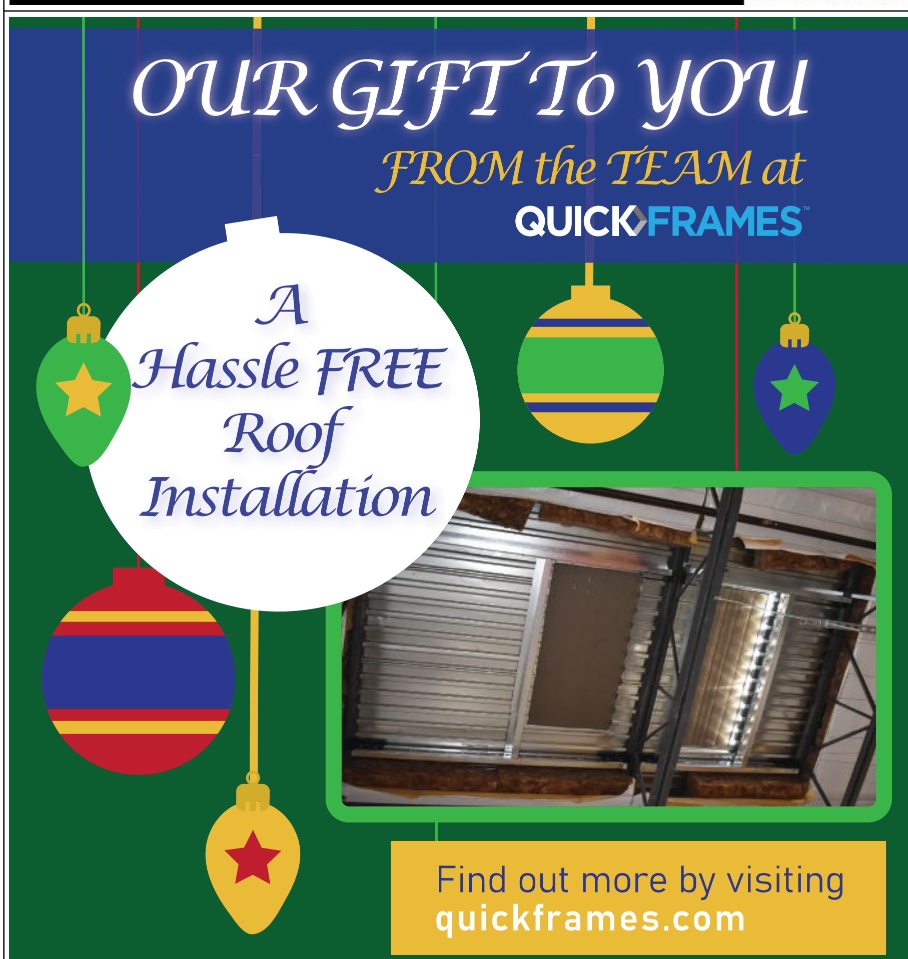


Classroom reading days will remain the focus as interest in the book and its purpose grows. The ABC and AGC participated in one in October. A bigger one is planned for March 2024. Eccleston and Schroen have a vision for their next steps too. They're exploring digitally publishing the book and creating multimedia elements. They're considering reaching out to more sections of the trade industry.

The most important next step, though, is a simple one. Get more people on board, whether that's more contractors and tradespeople in the already targeted groups or new ones. They all face the same issue that Eccleston and Schroen set out to change.

"Nobody's coming to save us," Eccleston said. "If we're not going to roll our sleeves up and do the work ourselves, we're not going to solve the problem. That's like any construction project. Nobody else is coming to fix the problem. If you don't figure it out, it's not getting built.

"This is the same kind of mentality. It's a great opportunity for us as an industry to come together like we've never done before."



COOL
Shake
Table

Shaking to the Core

STEEL BUILDINGS ARE designed to stand the test of time. Those located in high-seismic areas also need to stand the test of earthquakes.

The University of California-San Diego's shake table has become the go-to destination for the latter.

The Large High-Performance Outdoor Shake Table (LHPOST) opened in 2004 and is located 15 miles east of UCSD's main campus. It can simulate earthquakes and test a structure's performance under various seismic conditions. It is the largest outdoor shake table in the world and the second largest shake table overall. Its shake area—also called the platen—is 25 ft long by 40 ft wide. It has six degrees of freedom motion capability (6-DOF) and is often referred to as LHPOST6. It can move up and down, back and forth, left to right, and rotate on three axes.

While the action on the table itself is what researchers use to determine performance, the inner workings of a shake table facility are equally fascinating. Several AISC staff members toured the shake table in June, starting with a walkthrough of a support building next to the table and ending with a look below at the various piping channels that carry different fluids to different parts of the table.

Here's an under-the-hood pictorial tour of the shake table. Machel Morrison, a structural engineering professor at UCSD, and site manager Koorosh Lotfizadeh wrote the captions and explanations. Photos were taken by *Modern Steel* editor and publisher Geoff Weisenberger, who toured the shake table, unless otherwise noted.

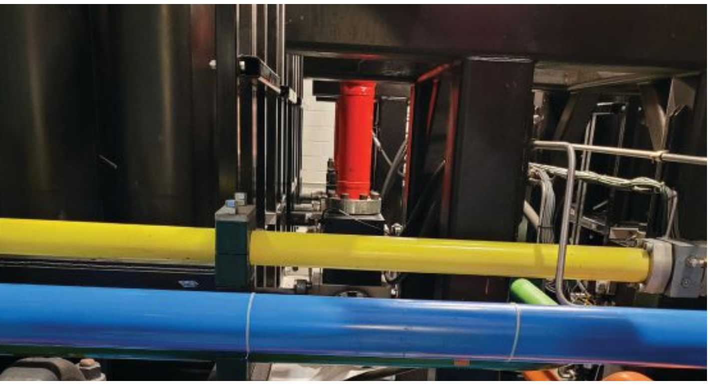
above: Professor Joel Conte and group standing at the Southeast corner of the reaction mass. Prof. Conte demonstrates six degrees of freedom motion capability of LHPOST6.

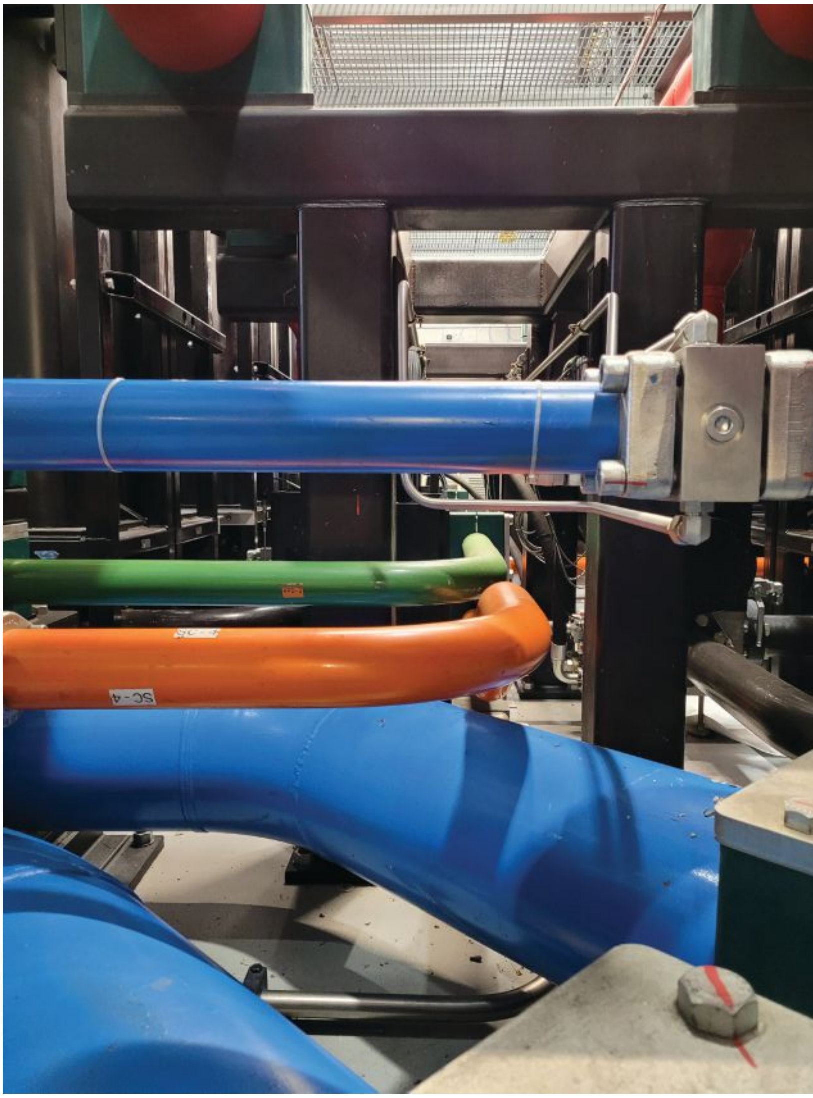
left: A view of accumulation system bottles from behind. The accumulation system consists of 75 bottles each with a capacity of 130 gallons. During a shake table test, the hydraulic power is supplied to the actuators by the accumulator system (charged up at 5000 psi before the test) through two blow-down valves, which convert the high-pressure oil from the accumulators to a system pressure output of 3,000 psi for controlling the actuators. The actuators move the shake table.

below: Manifold for one bank (of 15) of the accumulation system showing the analog and wireless pressure sensors of each bottle.

above: The view looking down at the piping beneath from the catwalk in between the accumulation system. The large (12-in. diameter) red pipes carry high pressure hydraulic fluid from the accumulators to the servovalves of all actuators.

below and right: The view when standing at the base of the accumulation system looking in between the bottles. These photos show the congestion and complexity of the piping required for this system. The large (12-in. diameter) blue pipes return low pressure hydraulic fluid from the actuators back to the surge tank.

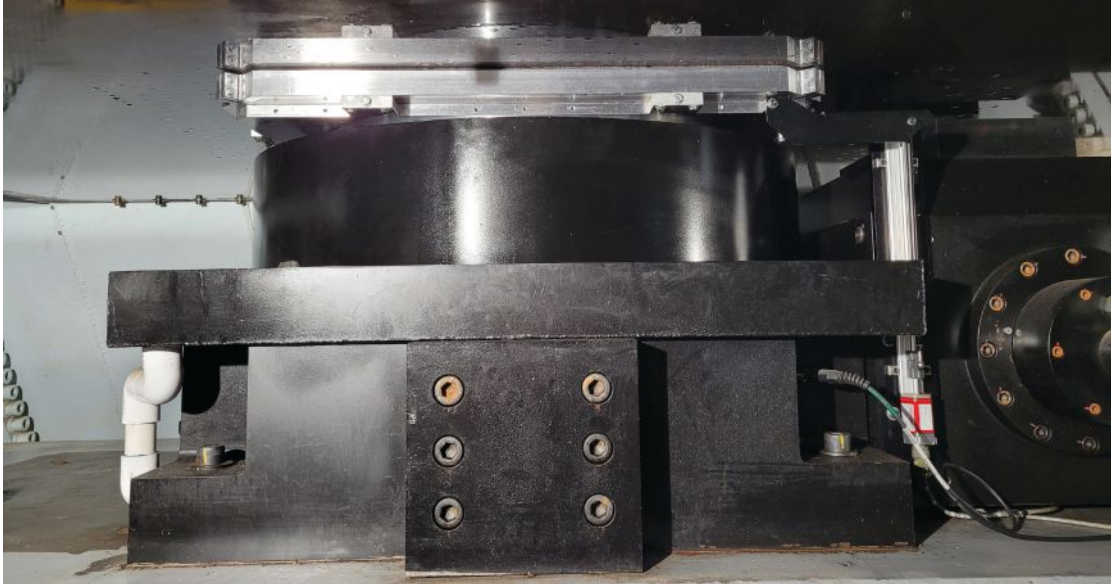




left: A look inside the tunnel under the hydraulic power building, following the high pressure (large red pipes) and return pipes (large blue pipes) from the hydraulic power building to the shake table. The bracing system and anchorage for the main pressure pipes (required to mitigate vibrations and excess stress on piping connections) are shown.

below: A view from the opposite end of the tunnel (on the shake table end) and looking towards the hydraulic power building.

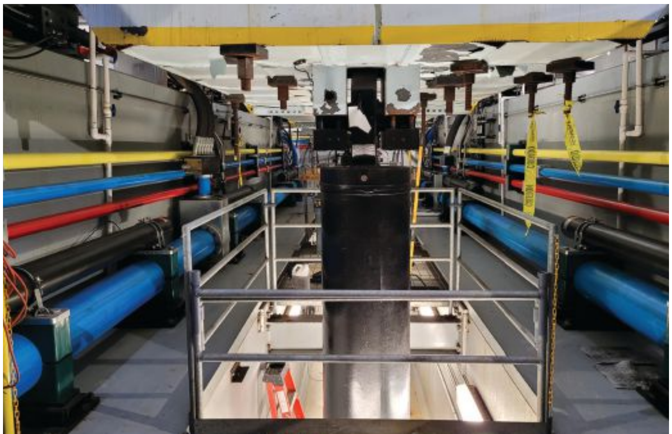
right: The vertical actuator and high-flow three-way servovalve (5,000 gpm). The "glide plate" on the underside of the shake table can be seen here. This plate mates with the bearing surface of the 32-in. diameter vertical actuator piston so the platen can slide along the top surface of the vertical actuators.



above and below: A view from the catwalk in the reaction mass beneath the horizontal actuators. Prof. Conte describes the V-shaped mounting of the horizontal actuators, and the advantages of this configuration (the four horizontal actuators, two on east and two on west, provide the ability for longitudinal and lateral translation of the shake table in addition to yaw rotation). Overhead, the composite steel and concrete protective cover and the galvanized steel moat protection cover plates are visible.

above: The walkway in the reaction mass along the length of the platen, looking east. This picture shows how the main pressure hydraulic fluid is applied to the servovalves of the vertical actuators, the large red pipe forms a ring around the shake table, main pressure is branched off from the large red pipe to each of the six vertical actuators (three on the south and three on the north).

below: Standing directly under the shake table platen, one of three hold down struts is visible along with the hydraulic return pipes (large blue pipes) and flexible hoses for the low-pressure return of hydraulic fluid from the vertical actuators.

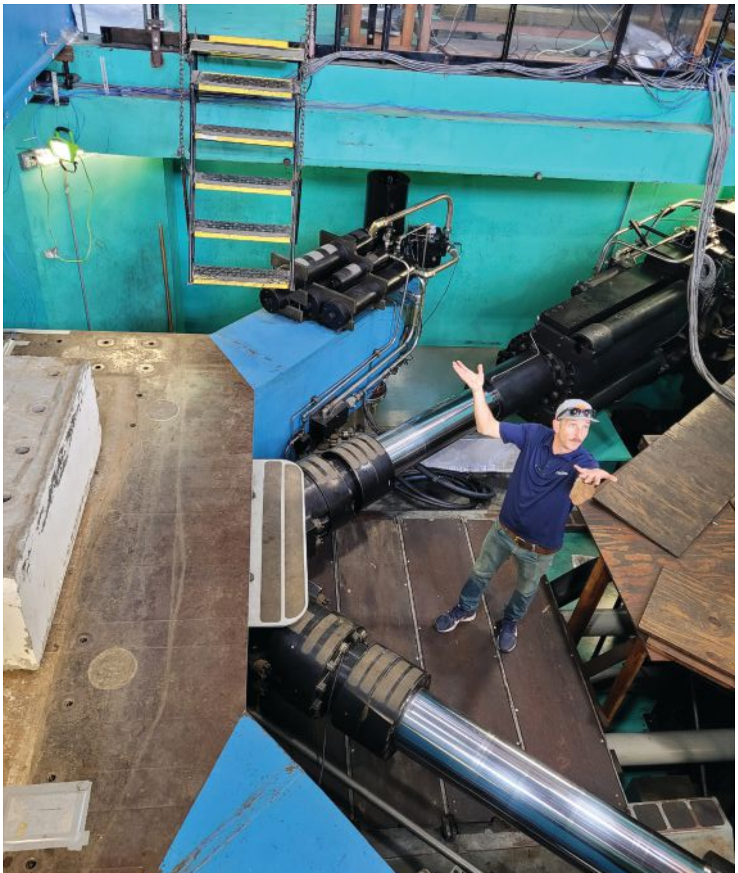


above: Standing in walkway under the shake table. The trapezoidal profile of the platen, the flexible hoses for the low-pressure return of hydraulic fluid from the vertical actuator to the large blue pipe, and two of three hold-down-struts are visible. The hold-down struts provide overturning moment capacity for the shake table.

above, right: The large low-friction castor wheel at the end of the galvanized steel moat protection cover plates. Each plate (20 total) has a castor wheel at the end that allows the plate to roll on the surrounding concrete of the reaction mass during shake table operation.

right: Professor Chia-Ming Uang shows a previously tested steel column.

below: The seismic response modification device (SRMD) facility showing the shake table platen and large hydraulic actuators.



above: Testing the performance of the seismic collectors.

left: Modular TestBed Building (MTB2): A reconfigurable shared-use equipment resource for use by researchers at LHPOST6.

COOL Construction Challenge

Tight Confines

A BUILDING OVERHAUL that involves tying three floors to a structure next door and anchoring framing into an existing foundation is complicated enough on its own. Perform it on what project manager Greg Riccio characterized as "a postage stamp of a jobsite," though, and erecting a 107-ton structure becomes an even more complicated undertaking with a longer timeline.

Danny's Construction (an AISC member erector), with Riccio's oversight, helped construct a three-story steel building with 26-ft bays on an existing basement frame across from Chicago's Millennium Park that topped out in May 2023. It replaced a vacant building that was torn down to its basement and sat on an 80-ft by 70-ft plot between Michigan Avenue to the west, Randolph Street to the south, Beaubien Court to the east, and the Millennium Plaza apartment and retail building to the north. It's in a commercial district with plentiful foot and car traffic during normal construction hours.

"The congested nature of the project was the biggest challenge for us to overcome," Riccio said.

It was navigable, though. Danny's and general contractor Power Construction obtained a permit to close Beaubien for about two months, which was enough time to accept just-in-time delivery from AISC member fabricator LeJeune Steel, set framing for all three floors into the existing basement concrete foundation, put up screen wall above the third floor, tie channel pieces into the next-door building's shear wall to transfer some of the weight, and drill in anchor bolts. Beaubien is a one-block street that sees marginal car traffic compared to the other three.

The crane stayed on site for three segments, each about two weeks, to unload and help erect the framing. It left while workers detailed, bolted, and decked each floor. Steel delivery trucks backed down Beaubien from Lake Street, which sits one block north of Randolph and has less vehicular traffic after it crosses Michigan to the east. Beaubien had sufficient width to fit the crane, but multi-story buildings on two sides of the street gave the crane boom limited range.

"We're holding these large (up to 16-ft) channel pieces with the crane, so you're talking about the boom of the crane getting relatively close to the existing structure," Riccio said. "Trying not to hit the structure took a lot of effort with our ironworkers communicating not only among themselves, but with the crane operator as well to make sure everybody was safe.

All photos courtesy of Greg Riccio

"There were a handful of channel pieces where we were working next to a window with an existing business on the other side. Take the extra time, communicate the plan well, and execute the plan. We didn't have any issues with breaking windows or affecting the businesses."

Congestion posed problems beyond ground level. The tight space gave ironworkers few safe places to stand while tying the connections to the building next door. Danny's and Power developed an access plan for the ironworkers to reach the tie-in points along the existing building's shear wall, which had tight clearance between the building and the crane boom. The plan included a boom lift on Beaubien that served as a safe platform to reach the connections. The workers could also safely stand on top of scaffolding on the site's west side.

Danny's started its work in January 2023 and topped out the building in May 2023. That's longer than normal for a small project, but the extra time ensured safety on an unusually tight jobsite.

"You never want to see damage to an existing building or crane and never want to see anybody get hurt," Riccio said. "The sensitive nature of working along that building and the amount of channels that had to get installed along the face of that building, it takes time, and you want to do a good job and be careful."

Lamar Johnson Collaborative was the architect, and TS Engineering PLLC was the structural engineer.

COOL
Printed Bridge

Print Preview

THE BIGGEST BREAKTHROUGH yet in 3D printing structures began not as a bid for a construction job, but as an art project created by a software company.

The 39-ft MX3D Bridge over a canal in Amsterdam's Red Light District made history when it was installed in July 2021. It became the world's first 3D-printed bridge and the largest structure created using 3D printing. All told, it's about five tons of structural stainless steel and is the result of collaboration between Dutch structural engineer Arup, Dutch robotic 3D metal printing software company MX3D, and designer Joris Laarman Lab.

Its purpose? Tout a technology that might be a staple of future construction projects. Carrying pedestrians over a canal is a bonus. It was not designed because a government entity that oversees bridges chose 3D printing as its preferred fabrication method for a new canal bridge. Rather, MX3D and collaborative partners Arup, Autodesk, automation technology company ABB, Luxembourg-based steel manufacturer Arcelor Mittal, French industrial gas company AirLiquide, and Dutch construction services business Heijmans birthed the project, and they earned approval for installation over one of Amsterdam's many canals.

"For us, it was always about the moonshot, not so much about the bridge," MX3D CCO René Backx said. "It was about showing this technology to the world and having the world work with it."

Two and a half years later, the Amsterdam bridge remains the largest one constructed with robotic 3D metal printing, also known as additive manufacturing. MX3D remains at the forefront of 3D printing and is active in the United States. It enables companies to print in-house and does on-demand printing. It has U.S. clients and recently printed a stainless steel lunar floor for the European Space Agency designed by Skidmore, Owings & Merrill. The U.S. Army Engineer Research and Development center acquired MX3D technology in October.

Lincoln Electric Additive Solutions is also a prominent 3D printer in the United States and uses a similar technology to fabricate large-scale industrial metal parts. It's a small operation in a giant company, but a corporation of that size investing in 3D printing turns heads.

MX3D printing robots in action.

Joris Laarman Lab

“When you start to see big-name people in the industry make investments like that, it certainly helps push things forward,” said Ryan Sherman, a Georgia Tech civil engineering professor who has extensively researched 3D printing.

MX3D’s successful venture has sparked curiosity about 3D printing’s potential to become more prominent in the structural steel industry, especially with bridges. All told, it’s still a fledgling technology, but one that has researchers’ attention. Sherman, whose research earned him the 2023 AISC Milek Fellowship, sees it as part of the future. But not the entire future.

“It could be a tool that the steel industry could leverage and put another tool in the toolbox to give us more capabilities,” Sherman said.

3D printing manufactures solid objects layer by layer while working directly from a digital model. It’s called additive because it does not need a block of material—such as steel—to create a three-dimensional item. Printing steel parts or structures requires turning welding machines (or welding robots) into 3D printing robots that turn welding wire into steel.

“You just need to connect the welding machine to a robot,” Backx said. “On the robot, you need to control the kinematics, like how every robotic joint is positioned. On the welding machine, you only need to set the start and stop of each weld line. Together, that enables 3D printing.”

If only it were that simple.

“Starting to print is easy,” Backx said. “Quality prints take good tools, good workflow, good knowledge, and good materials.”

The more complicated and specialized parts of 3D printing start with the robots’ settings. Each type of wire and each design requires different parameters.

“You need to know what settings are required for specific wires to get quality prints,” Backx said. “For instance, if you want to make thinner lines, you need to go slower with different settings. Aluminum needs to have a lower temperature for welding than steel. Temperature control is always important.

“The wire feed speed is another parameter setting. How fast do you want the spool to get? If you go too fast, you could have a lump.”

The MX3D bridge in place over a canal.

Thea van den Heuvel

Developing those parameters and programming welding robots to 3D print metal took time and trial-and-error. MX3D specializes in robotic wire arc additive manufacturing (WAAM) and created software to go from a CAD model to a printed part. The software contains parameter settings for various materials and printing strategies, so a user only needs to upload the design and select the specific robotic setup, wire type and strategies. The software generates the optimal robotic print path to start printing in a controlled manner.

Any weldable wire is suitable for 3D printing, but the wire quality makes a difference in the final product. MX3D printed everything but the bridge's non-metal deck with stainless steel 316L wire at a warehouse. A team of four robots and five people—two were robot supervisors—began printing the bridge in March 2018 and finished in about six months. It was printed in several pieces.

MX3D hit the six-month timeline working only during the daytime. Newer technology allows printing at all hours, and one operator can supervise four robots.

The Amsterdam bridge was MX3D's first venture into structural steel. It worked with Joris Laarman Lab, an art collective that 3D prints metal sculptures in organic shapes. One of Joris Laarman's early projects was a chair designed in organic shapes and printed in small sections with laser powder bed fusion in 2006. The lead artist wanted to make something bigger upon the release of more sophisticated technology. Joris Laarman and MX3D settled on a bridge.

Printing a usable and sound bridge, though, is a rigorous test compared to small parts or sculptures. The bridge is a mix of artistic ideas with structural engineering principles, and the latter took priority.

"You can go crazy with 3D printing, but in the end, you need to get it certified and prove it's structurally strong enough," Backx said.

At the time, nobody could say with certainty that a 3D-printed bridge would be stable, pass tests, and earn certification. There was no precedent for building a bridge with additive manufacturing. There are no additive manufacturing building codes. One test or certification failure could have ended the entire project and shifted the construction industry's view of 3D printing. MX3D wanted to try anyway, and the necessary City of Amsterdam governing bodies approved the project for placement.

Olivier de Gruijter

A close-up of a 3D printing robot.

Olivier de Gruijter

A segment of the bridge being printed.

"We're grateful for the risk they took, because at that time, there was no clue if we could make the certification or even print it," Backx said.

MX3D put the bridge project through three years of tests, enlisting a network of partners that included Arup, researchers from Imperial College London and certification experts from Lloyd's Register (now LRQA). It has previously worked with inspection and testing company Bureau Veritas and classification society DNV to certify strategies and parts used in energy and maritime projects.

The certification checklist is lengthy. The printing strategies needed to be certified. Material needed to be tested for strength in a lab, chemical tested, and load tested after construction. Every connection was tested. MX3D had to prove the material would not corrode, which Backx said was the most difficult test to pass. The wire type dictates the printing strategy, and a less commonly used alloy might require a rare or exclusive printing strategy that needs certification.

"There are no standards yet, and that's a main reason [3D printing] is not widespread yet," Backx said. "Whenever it has standards for how strong 3D printing is for specific materials, we're sure the technology will grow in construction and other industries.

"When there are no standards, more time and money are required to certify specific parts and structures."

But MX3D proved the whole process is navigable and met its goal of introducing a new technology. Widespread adaptation will take time. And even when it arrives, nobody is predicting a takeover.

"3D printing is not there to replace all conventional technologies," Backx said. "Speed, money, time, cost—all of that is important. But it's an alternative way to do fabrication. If you need a part that's more complex or optimized, or have a project where lead time or material waste is high, 3D printing will help. It can also create designs that are not possible with more conventional technologies.

"Where we see the future is a combination of these different manufacturing processes. For steel, robotic 3D printing will be used where it offers the best value and when other technologies simply can't fabricate it." ■

Industry collaboration and steel's reparability help the steel business deliver in emergency bridge repair situations.

All Hands On Deck

BY PATRICK ENGEL

JOHN O'QUINN needed a moment to remember who first alerted him at 7:30 a.m. on a Sunday to a tanker crash and explosion that wiped out half of an Interstate 95 overpass in Philadelphia. After all, the days and hours following the accident made his phone feel like an overly persistent restaurant pager. O'Quinn, the president of High Steel Structures in Lancaster, Pa., might have an easier time listing people who *didn't* contact him in the days following the June 11, 2023 incident. (Joe Connor, a High Steel finance group controller, initially texted him about it, he recalled).

Among the callers and texters were steel fabricators who compete with High Steel. This time, they were offering help.

The moment O'Quinn heard that a tanker carrying more than 8,000 gallons of fuel lost control, overturned, and combusted while exiting the highway—collapsing the northbound lanes of an overpass near Cottman Avenue and rendering the southbound side unsound—he figured High Steel would likely be tabbed as the fabricator because of its proximity. Other fabricators made the same assumption. But nobody knew right away if High Steel had the right material in stock to fabricate replacement girders in short order.

"I received phone calls from two or three of our competitors and two mills saying, 'If you need anything, let us know,'" O'Quinn said. "We all talk to each other and share inventory information in these emergencies."

High Steel received a commitment from Cleveland-Cliffs' mill in Coatesville, Pa., to have materials at the Lancaster fabrication shop within two weeks and did not need to buy a competitor's steel. But the offer and how it has become standard practice are statements themselves. O'Quinn, for example, recalled High Steel shipping plate to a California fabricator for use on the 2018 emergency repair of a San Francisco transit center. He said it has also supplied steel to several competitors in repair situations.

The steel and construction industry does not root for emergency repair projects to arise. Their mere existence means that something failed and, in some cases, resulted in injury or death. To view them as only an opportunity is to ignore their context. They are, though, perhaps the strongest showcase of the steel industry's collaboration and ability to act with urgency. That's a byproduct of its collective desire and obligation to reopen a closed major thoroughfare as soon as possible.

"Day 1, the outreach from the steel community was instant," said Rich Runyen, the Pennsylvania Department of Transportation chief bridge engineer. "They understand it's not an opportunity to make money or shine a spotlight on them. They understand the situation we got thrown into. It's such a vital artery through the East Coast."

The I-95 bridge collapse is the most notable recent example. The 2021 repair of a crack in the Hernando De Soto bridge that takes I-40 across the Mississippi River between Arkansas and Tennessee and a summer 2023 repair of a collapsed railway bridge in Montana also underscored the industry's speed during emergencies and steel's repairability.

W&W|AFCO and Stupp Bridge Co. supplied the steel for the Hernando De Soto rehabilitation, which spanned 83 days from crack discovery to reopening. TrueNorth Steel provided materials for the railroad bridge over the Yellowstone River near Columbus, Mont., which returned to service in about a month.

PennDOT reopened six of I-95's 12 lanes 12 days after the crash by constructing a temporary foamed glass aggregate fill where the bridge once stood. The temporary fill closed the less busy roadway that passes under the bridge and on which the tanker traveled.

As of press time, Stage 1 of the building new steel bridge was set to end in November. High Steel sent the first fabricated girders to the jobsite in late August and finished all of them eight weeks after starting. O'Quinn said all 16 could have been on site by late August if contractor Buckley and Company's construction schedule had required it.

All told, High Steel fabricated 16 106- to 108-ft girders that will be installed in two stages. The first eight were placed on the sides of the temporary roadway in late August. Construction crews are building a roadway over those girders that, as of press time, was set to open in November. They will then demolish the temporary fill and install the other eight girders in that spot. The roadway over those is expected to be complete in 2024.

The northbound lanes of an I-95 overpass near Cottman Avenue in Philadelphia collapsed after a tanker rolled over and caught fire.


PennDOT

The new bridge's design is identical to the old one, except for the bottom flange plate thickness increasing by $\frac{1}{16}$ in. because of a new permit load that did not exist when it was originally constructed in 2016.

"Typical procurement is eight to 12 months," PennDOT district bridge engineer Din Abazi said. "Here, we're going to get it in eight to 12 weeks. That's a testament to the industry."

Fabrication is a short window of that normal timeline, though. The competitive bid process required for state department of transportation projects, creating shop drawings, and ordering the steel from the mill account for most of the differences between a project that's completed in one meteorological season instead of a calendar year.

"The speed difference is not faster welding," said Ronnie Medlock, High Steel vice president of technical services. "It's not shop floor operations. There are things that can help there too, of course. But the real opportunities for faster completion on most jobs are all these up-front activities. And for those to happen quickly, you need cooperation."

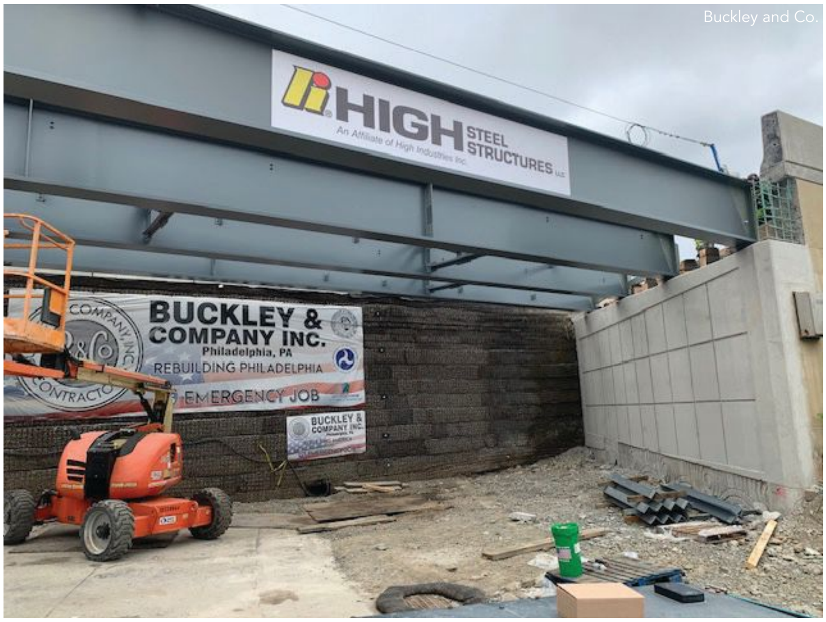
Some of those up-front steps are circumvented or accelerated in emergencies. Pennsylvania Gov. Josh Shapiro declared a state of emergency, which allowed PennDOT to award the bid to Buckley immediately. Daily collaboration between all parties involved in shop drawings slashed the timeline for the drawings' approval from a few months to a couple weeks.

"In emergency situations, we ask that all the parties involved in the engineering side have regular collaborative calls," O'Quinn said. "We can ask questions or clarify RFIs and things like that daily so we can get the shop drawings turned around in a week or two."

Had Cleveland-Cliffs not been able to prioritize fast delivery, High Steel would have looked to borrow from a competitor or reallocate on-site steel slated for use on another project. The latter is preferred because transporting material from one shop to another involves no extra cost.

"The first thing we do is look to see what inventory or pieces are left over from other projects over the years," O'Quinn said. "Or we look at upcoming projects that we've already received material for but haven't started working on yet. It's a rob from Peter to pay Paul scenario.

High Steel Girders are set into place in Phase 1 of the I-95 overpass repair.
Buckley and Co.



Buckley and Co.

High Steel girders are set into place next to the temporary fill.

MBI

above: The repaired Hernando De Soto bridge.

below: The cracked member discovered in the Hernando De Soto bridge in May 2021.

TDOT

MBI

above: The temporary plate over the fractured member.

below: A newly installed plate after the last phase of the repair.

TDOT

"Let's say we're doing a job for New Jersey or New York state, and the sizes of those plates would fit perfectly for this emergency Pennsylvania job. If that were the case, we'd get on the phone with New Jersey and New York and say, 'Your project has the same size steel we need for this emergency project,' then ask their permission to utilize and replace their material for the greater good."

That's how W&W|AFCO sourced the grade 70 steel it provided for the Hernando De Soto repair. It had material at its shop for the 30 Crossing project in Little Rock, Ark. that included a new I-30 bridge across the Arkansas River. Fabrication for that 23,000-ton project, which included grade 70 steel, had not started when the crack was discovered.

Hernando De Soto was built with grade 100 steel, which general contractor Kiewit initially wanted to use for the repair. W&W|AFCO told Kiewit that grade 100 was scarce, more difficult to weld, and would take longer to get on site. Grade 70 sufficed for the repair and, perhaps more importantly, was available right away.

"We called the state of Tennessee, the state of Arkansas, both DOTs, and the Governor's office in Arkansas," said Amy Rogers, W&W|AFCO senior vice president for bridge sales and estimating. "We said we had the fix sitting in our shop. The state of Arkansas owns the plate already, it's not needed on 30 Crossing for two years, and it's going to another Kiewit job site. After preaching that message for a few days, that got approved."

Stupp also had grade 70 available at its shop, but did not need to borrow from another project. It began fabricating before TDOT even sent a formal contract.

"It was a matter of opening up some time in the production schedule to help a terrific owner get their bridge open again," said Adam DeMargel, Stupp's senior vice president of sales.

Stupp's steel was part of Phase I, which stabilized the tie girder on the truss that contained the crack. Plates were put around the cracked area to strengthen the member so crews could replace it with W&W|AFCO's steel in later phases.

"One of the biggest reasons you should only put steel on the interstate on these major thoroughfares is because it can be repaired and replaced quickly," DeMargel said. "You can cut out the bad sections and put the new sections in. You can occasionally heat straighten in the field. It's repairable. If we don't act quickly, we lose a lot of that advantage over alternative material."

Emergency repairs are fluid jobs where the original plan does not always remain the plan. Part of speeding up fabrication means being available to shift focus immediately and working beyond traditional hours.

"Eighty-three days seems like a long time, but it wasn't like, 'Here's the design, this is what we need. Go back and make it." Rogers said. "As [Kiewit was] working, X-raying, discovering, and checking on the bridge, they would call and say, 'What if we needed three plates? No, we actually need four plates. Maybe two plates.' It was constant change. Nobody could not answer their cell phone during that time."

W&W | AFCO was on site before it even started fabricating. One Sunday, less than two weeks into the job, Kiewit called Rogers to say the pre-existing grade 100 was eating up its drill bits. Rogers left a cousin's wedding to go to the shop, get the drill, and drive it to the jobsite. Other W&W | AFCO workers left church.

"One of our office guys was fabricating with the shop guys on the weekend," Rogers said. "Nobody ever said, 'That's not our job' or 'Are we getting paid for this?' or 'It's Sunday' or 'It's the middle of the night.'"

Similarly, TrueNorth Steel stayed on call 24/7 when it earned the bid to repair two 48-ft sections of a single-span rail bridge that collapsed in June 2023. It modified spans from older bridges that the owner, Montana Rail Link, designated for use on the repair. It fabricated plate girders that were jump span components to go between the new span and old span, as well as angle pieces and plate pieces. It provided bolts as well.

TrueNorth had most of the necessary steel plate in stock, some of which was allocated for non-imminent projects. The railroad provided the spans, and TrueNorth ordered most of the necessary Grade 50 angle and channel from warehouses.

TrueNorth allocated more manpower and overtime hours to the job to help with the one-month turnaround. Constant communication with the engineer of record, though, ensured the time was worthwhile. TrueNorth contacted the engineer when steel arrived at its shop, the engineer provided modifications within 24 hours, and TrueNorth made those repairs the next day.

"Steel is predictable," TrueNorth Steel construction development manager Nick Zacher said. "If the engineer and fabricator are collaborating, you can often make the repairs out of material that is readily available. I don't know another substrate that acts that way. We're fabricators. We do custom fab work all the time. To speed that up, it can easily be done just by adding manpower. We're not reinventing the wheel."

From emergency job to emergency job, that's a constant.

"That's a big perk of steel, the flexibility—what can we do with what we have?'" Runyen said. "It's very helpful when you're trying to get something done in a small period of time. You can't spend a lot of time in that detail and design phase and procurement of materials." ■

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

Fabricators weigh in on important industry topics, from AI to the value of collaborating with engineers.

Sounding Off

BY PATRICK ENGEL


Christian Crosby of Schuff Steel

COLUMBUS, OHIO, was the steel fabrication industry's epicenter in late September.

About 60 fabricators in management or executive positions at AISC member companies, ranging from small one-shop operations to multi-state enterprises, attended AISC's Future Leaders Ideas Lab (FLIL) for three days of leadership and business seminars, designed to help steel fabrication's current and future decision-makers be the best leaders possible.

Modern Steel asked four fabricator attendees to share their thoughts on several industry topics that are relevant to engineers, architects, and general contractors who work with them. Answers have been lightly edited for length and clarity.

How prominent is AI in your shop? How do you anticipate it being incorporated in the future?

Tyler Cannell, Garbe Iron Works (Aurora, Ill.): I haven't really dabbled in it much, but it could be super useful. I've seen a virtual reality screen where you're able to project through AI the layouts of how things would look for fitters. That can be useful in the future. The potential to integrate AI into VR tech is something I am interested to follow in the industry. Not as a replacement for people, but for training for newer fitters who do not have the 40-year fitter mentality. AI is on the cutting edge right now. We may see everyone using it in the next 10 years.

Christian Crosby, PE, Schuff Steel (Phoenix): We've had cursory discussions about it, but nothing definitive. It's on senior and executive leadership's radar. But as far as plans to implement it and how to utilize it in the next year, it's not that relevant. When we talk about it, we acknowledge it's something we need to think about how it will impact the future of our industry.

Tim Bradshaw, PE, Owen Steel Company (Columbia, S.C.): It's not impacting us much currently, but we see a lot of opportunity for it down the road. We recently implemented robotic welding. The robot isn't as smart as we'd like in some cases. In the future, AI should give a lot more capability to that type of production equipment, which will really impact the industry. Robotics have been around for a while, but they're just starting to come into their own. AI could make a big difference if implemented correctly with robotics.

We're also starting to see detailers who are using tools bordering on AI to apply connections within a model. They can build a model or scan a set of drawings or PDFs, and turn that into a model. AI can learn what different things look like within a model and apply appropriate connections in a model. Obviously, there has to be a second set of eyes on it.

On the flip side, that's my concern—making sure we don't give it too much control. AI won't always make the right decision. There must be a set of checks and balances, because we're dealing with life safety issues and building codes.

Joe Connor, SteelFab (Raleigh, N.C.): It's not an active portion of our production stage. But we're looking into it at a higher level and for an estimating impact. It can cut out a lot of remedial work and raw counting. Hopefully it can pivot to production and connection design and more labor-intensive things where you're applying data to locations.

I wasn't aware of the quality control potential of augmented reality before hearing about it at FLIL. I'm curious to see how effective and accurate that can be. I don't think you can replace welding inspections from a certification standpoint. But if you can have a welder with a few hours of training overlay shop drawings onto fabricated steel and AI can point out things that need further inspection, that's a big production gain and a lot of time to cut out.

How have you automated your fabrication process more and where else do you foresee automation coming to the shop floor?

Cannell: For our shop size, we're pretty automated. We have a 30,000 sq. ft shop, but we have a plasma/plate automation machine and an angle master. We have a drill-saw combo that has a liberator for notching and coping. For our size, we really push automation. Our workers don't always have to worry about hand-torching and cutting stuff.

Crosby: We have quite a bit of automation in our fab shops. We have several robotic welding stations in several different shops. The challenge of finding people is not going away anytime soon. We still have to get the product out the door. Automation is the tool we have the close the gap between the labor shortage and market demand.

Bradshaw: We've automated in other ways besides robotic welding. Some of our processes use robotics to cut things to the appropriate length, cut holes and slots, and prep the material. That has come a long way. Our first piece of robotic equipment could only handle certain pieces of material and could only cut on three sides.

We're seeing robotics with a lot more capabilities within material processing machinery as well. It saves time. It's more accurate. The burning and cutting process is cleaner than by hand. It improves the process from a quality and efficiency standpoint.

Connor: We have three production facilities. The newest acquisition is in Fayetteville, N.C., which is the least automated. They're about to launch a new production line that has a lot of automation—plate production coping and drilling.

Our Emporia, Va. facility is highly automated. We have some of the nation's cutting-edge equipment. We work directly with automated vendor reps to develop how they design equipment to meet our needs. It's a national showcase location.

Garbe Iron Works, Aurora, Ill.

Greg Folkins Photography

A worker at a SteelFab, Inc. shop in Durant, Okla.

How have you been impacted by the trade labor shortage and what have you done to work around it?

Cannell: We're going to continue to see it. You have people who are retiring every seven seconds—that's a crazy fact I heard at FLIL—and they're taking 40 years of knowledge with them.

I was talking to one of our miscellaneous metals sub-contractors, and the owner said she asked two of her 40-year fitters to write down the process of how they do things. They gave every aspect, from putting on their gloves to getting the fabrication print. That's a big deal and it's hard to undersell the value of those people. These processes can be passed along to new fitters.

Training is a big aspect. You might find someone who you think you can implement into a job directly. But you may also find someone who is willing to learn and who you can mold. You might have someone who arrives with zero steel knowledge, but if you invest the time, that person could be the best fabricator you have in five years. If you don't take the time to try, you never know. You must have drive and desire.

Crosby: We're constantly going to job fairs, visiting schools, trying to network at the vocational-technical schools in the areas where we have shops. We're building those relationships. It has an impact. But it's still a challenge. Automation is the tool we have.

When we're hiring, sometimes we find people who are just jumping from shop to shop to get another $0.50 or $0.75 an hour. We're changing our hiring practices to combat the high turnover rates among employees who have been with us for less than a year. Let's be more strategic, because hiring someone, putting them through the training program and losing them in six months is not giving us anything.

Bradshaw: Part of it is robotics. We have a fitting and welding robot that does the work of five to six people, depending on the complexity. But we didn't replace anybody. We simply supplemented our workforce. That was a fear we overcame when we implemented the technology. Guys on the shop floor were concerned they would lose their jobs. It actually enhances their jobs and gives them the opportunity to learn different skills.

We've also been much more proactive. We've gone to a local community college and high schools, met some of the instructors, and gone into classes. We're trying to be proactive in our market promoting our opportunities to local trade schools.

Connor: Automation helps. You need more targeted focus on your training programs and your labor sources. You can work with local schools and trade companies to help develop curriculums that will produce a more complete employee. You're ideally getting people who complete their certification and are ready to make an impact because they have the skill set and understand expectations.

Quality of life and pay are at the forefront of everything. We're aggressive about rewarding production gains. If you put the effort in, you'll be properly compensated and have some of the industry-leading benefit packages.


Garbe Iron Works, Aurora, Ill.

What do you look for when hiring for shop floor jobs?

Cannell: Trainability. We can't always assume someone will be a superstar and fit right into the role we pegged that person to hold. He or she may not. You have to be trainable for cross-training. We may have this guy running the plasma table, but he also has to be able to run the angle master. That's big for shops in general. If you're a small shop with five fabricators and you lose one of them, you need to have people who are willing to understand something outside of the box they work in.

Crosby: We're always looking for people who have skills, but we're trying to focus more on fit for the organization. Do we think it will be a long-term hire? We want people who are interested in careers, not making an extra $0.50 an hour.

Bradshaw: We're looking for the hard skills. We try to get someone out of a trade school or someone who has welding experience. Most people we hire are going to be a welder, fitter, or quality control. But we will also hire people who don't have prior knowledge or skills and train them.

Connor: You don't want to get into a position where you're beating bad habits out of someone. You want a problem-solver and motivation. The mechanical skills have to be there—do you know how to use a tape measure and understand degrees? That seems like it should be a given in our industry, but traditional education has moved so far away from manual and trade-related education. It's just not as common. We want people who are mechanically inclined, willing to learn and don't have preconceived notions that limit their growth.

Greg Folkins Photography

SteelFab, Inc., Durant, Okla.

Can you give an example of how early involvement or close collaboration between your shop and a design team helped improve a project?

Cannell: It's hard to get the general contractor and the architect/engineer team on board early enough with the fabricator. But when we can, it's huge.

One time we received a screenshot of a multi-story building project's floor beam design. We looked at it and were asked for our feedback. We said the beams have too much camber in them. If you put too much camber in a beam, we can't run it through our automated machine. If you can upsize the beam and eliminate some of the camber, you can save money, time, make the shop work faster and get steel to the jobsite sooner. If you can get in on the ground floor and your feedback is implemented into design, it goes a long way.

Crosby: We have several large projects where we have a team of people working with the design team, and the general contractor. We're involved early. We're helping with the design to look for cost-effective designs and details to help the owner. We're looking at different details. It's not just fabricating—how are we going to erect it?

Bradshaw: We've been involved in several design assist projects where we have suggested specific connection types, changing members from trusses to girders, or even a change in material grade for certain sections. We've also sold work with the anticipation of adding a robotic thermal cutting and material preparation station that can do heavy shapes. We're installing that now.

Connor: The under-construction Contemplative Commons project at University of Virginia is the crown jewel, and not just from a steel standpoint. Early on in estimating, our sales and pre-construction team told our production manager there were some unique pieces we hadn't seen. We thought about how to approach it in our fabrication processes so we could properly bid, plan, and budget it.

We told the design team about a couple areas where we could be more efficient given their intent. We started working directly with the engineer of record and the engineers for the timber company and the concrete company. We mentioned that the erector might have trouble with a piece and solicited thoughts about changing a connection or the entire support condition. The team tackled several problem areas in a short time.

The interface between timber and steel was a significant real-time connection design. We took default connections, compared some of the fabrication processes we identified earlier and applied them with erector feedback.


Garbe Iron Works, Aurora, Ill.

What's your biggest challenge on the shop floor with material handling and flow?

Cannell: If you pick up a beam and move it twice or move it to six different stations, you're never going to make any money. It helps to bring in people who have ideas or reliable methods for peak efficiency. You have to be open to ideas and realize we can sometimes do things a better way, or someone may have a better idea. But the saying "If it ain't broke, don't fix it" is big for us too.

Crosby: A lot of it is how the shop is laid out. Not too often in our business does someone build a greenfield fab shop where you can plan it out. Our customers pay for value that we add to the steel. They don't pay for us to move it around.

Sometimes you're confined to the building and ground you have. How do you plan around that? You have to plan the work so you're touching steel less and less when it's flowing through the shop.

There's not a perfect layout. It's hard to tell what's coming next. Maybe it's a stadium. Maybe it's an office building. We determine where we want to put the project among our different shops based on our plan and how the material flows.

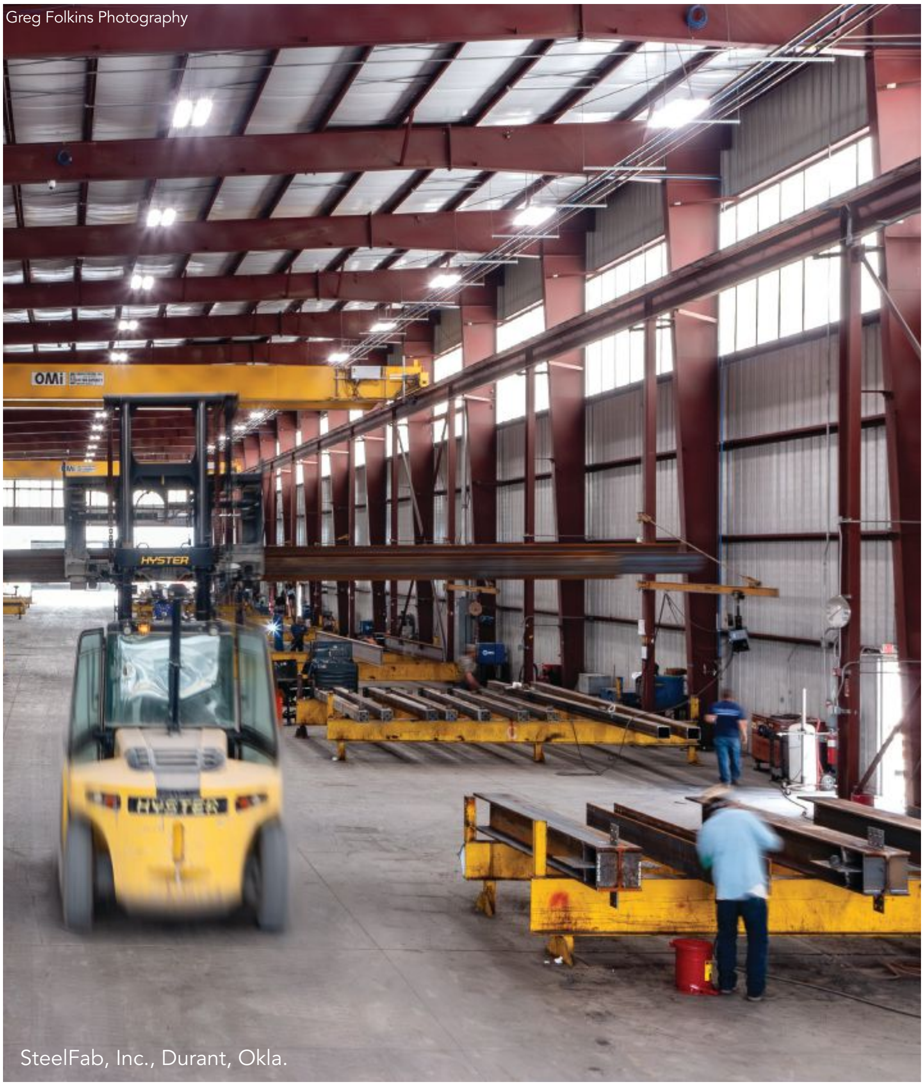
Bradshaw: One of the big bottlenecks for us is material preparation. We recently took on some work where we rethought and reoriented the layout in one of our shops based on the project. You can't just say, "This is the way we've always done it and the way we'll keep it." Technology changes. The type of work changes. The labor market changes. Skill sets change.

Our shop is set up for heavy work. A typical project for us is 8,000 to 10,000 tons of steel. The members tend to be larger and heavier. When we do a job that has smaller and lighter members, we really have to think about handling. We've changed the layout and workflow in one area of our shop before.

For example, we're building trusses for a project. We set up an assembly line process, which we don't typically do, but it felt more natural for this specific project. Everything was right there. We weren't moving material to different parts of the shop. Any time you're picking up a piece and moving it, you're not adding value. You're adding time.

Connor: Our vice president of operations is really focused on getting everyone onto the same style of shop layout. One of our more recently acquired shops might have been doing something a certain way for 30 years that isn't necessary wrong, but there are better ways of doing it. You can move a saw here, put an extra table there, move some welding rigs where they're more accessible, whatever it is. We've taken some of the lessons from our Emporia facility and applied them to newer locations. That has helped increase efficiency without any changes in manpower.

Greg Folkins Photography



SteelFab, Inc., Durant, Okla.

When you replace equipment, do you often stay with the same manufacturer?

Cannell: If we have to go get a new machine and train someone to learn new software, that's a large learning curve for someone who used the same software for 10 years. We'd have to pay someone to come in and train everyone on the new software. That's a big deal and a big expense.

It's also loyalty. Not that you have to be loyal because a company has been loyal to you, but if it has given you a good product and good service, you don't need to find something new.

Crosby: We're rigorous in evaluating the technology on the market. We're all job-specific shops, so it's hard to forecast what we'll be doing. You try to look at what we've done and what our marketing and sales teams say might be coming. What's going to be the best purchase for the organization? We have quite a bit of equipment from the same manufacturer and standardization across our plants, but we have a lot of rigor in evaluating everything to make sure it meets our needs.

Bradshaw: We use Peddinghaus equipment and typically stay with Peddinghaus. But anytime we replace anything, we try to get the latest and greatest.

We don't want to be first with a new piece of equipment. We want to be second, third, or fourth, when hopefully the bugs are worked out.

Connor: A lot of the decisions come from production managers' feedback. What didn't they like? What's working? Where do we need to improve? Most of that is communicated back to the vendors. We'll take that old equipment and source it to a different production facility or integrate it into a different line.

We usually stick with the same style and same brand, so we don't have to re-train. The shop guys know it. If there's an obvious bust, then we'll have serious conversation about getting rid of it entirely because it's a net loss. ■

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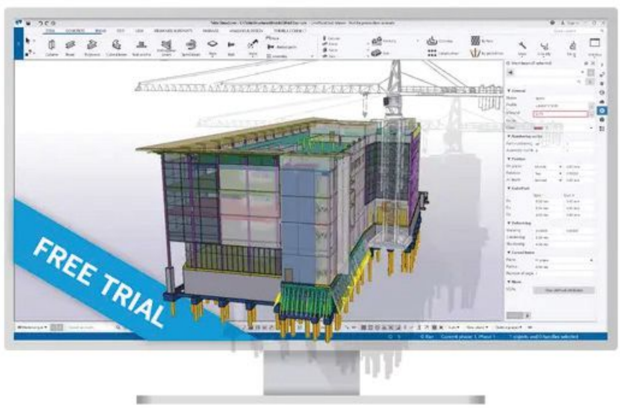
new products

This month's new products section features the latest versions of three major detailing software packages.



Tekla Structures 2023

The 2023 version of Tekla Structures helps new and existing users quickly learn and adopt the software's time-saving functionalities. The upgraded user experience for working with drawings makes the software easier to learn and use.

Tekla Structures 2023 improves project communication and advanced detailing in fabrication workflows. In rebar detailing, complex bar shape designs are now easier to communicate to procurement, manufacturing, and the construction site. Steel fabrication customers now benefit from covering even more detailing options with bolts and holes for specialized industries. The outputs and exports serving detailing for the fabrication of many projects and material types have been updated too. Better project location coordinate handling, support for drawing versions in Tekla Model Sharing, and more reliable IFC export improve project coordination and collaboration.

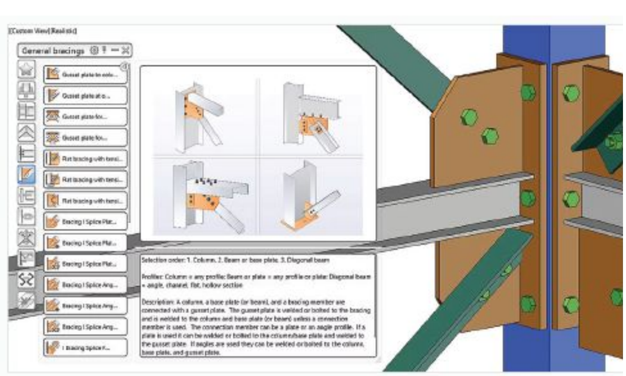
Visit **support.tekla.com/tekla-2023/tekla-structures** to see a full list of new features and improvements in the 2023 version, which has six types of service packs.

SDS2 2023

SDS2 2023 has new tools and enhancements in everything from modeling, drawings, connections, the API, and more. Users can tackle unique design challenges with modeling enhancements for material fit operations and other specialized elements. They can add more valuable data to a model—including surface finishes—to feed their fabrication management systems. They can share design data more clearly with new display options for the model and drawings.

SDS2 2023 also has newly automated connections. Its top features include new surface finish tags, cut layout enhancements for web penetrations, fittings, and cutouts, more automated connections that the proprietary design engine can handle automatically, and API enhancements that allow for creating custom applications.

Visit **www.sds2.com/sds2-2023** for more information.



Autodesk Advance Steel

Autodesk Advance Steel allows users to automate repetitive tasks with an intelligent toolset and generate complex structures in fewer steps with the Dynamo Extension. Users can automatically generate and update steel fabrication deliverables and create model-driven shop deliverables and NC files to streamline fabrication and installation.

Advance Steel is included in Autodesk's architecture, engineering, and construction collection, which shares, refines, and syncs designs with Revit, AutoCAD, Navisworks, Robot Structural Analysis, and Autodesk Docs. Users can connect steel detailing and design data to BIM and CAD workflows.

Visit **www.autodesk.com/products/advance-steel** to learn more.

T.R. HIGGINS AWARD

Johns Hopkins Professor Wins 2024 T.R. Higgins Award

AISC will present Benjamin Schafer, PhD, of Johns Hopkins University with the 2024 T.R. Higgins Lectureship Award for "Review of Local Buckling Width-to-Thickness Limits."

"Dr. Schafer's work in structural stability and local buckling in hot-rolled structural members is consistently outstanding," said AISC Vice President of Engineering and Research Christopher H. Raebel, SE, PE, PhD. "His reputation as a researcher, professor, and lecturer is similarly remarkable—in fact, the jury's selection was unanimous. It is a privilege to have him represent AISC as a T.R. Higgins Lectureship Award recipient."

Schafer will give the final keynote address at the 2024 NASCC: The Steel Conference, where he will also receive the $15,000 honorarium. He will present his work on request throughout the country over the year as well. Organizations interested in hosting a T.R. Higgins Lecture can contact AISC Senior Director of Education Christina Harber at **harber@aisc.org**.

AISC would like to thank the members of the 2024 T.R. Higgins Lectureship Award jury for their time and thoughtfulness:

- Michael Kempfert, PE, PhD, CSD Engineers, Milwaukee
- Jason McCormick, PE, PhD, University of Michigan, Ann Arbor, Mich.
- Chia-Ming Uang, PhD, University of California, San Diego, La Jolla, Calif.
- Brian Volpe, SE, PE, PhD, LEED AP, Cives Engineering Corporation, Alpharetta, Ga.
- W. Duff Zimmerman, PE, Cooper Steel, Shelbyville, Tenn.

AISC's T.R. Higgins Lectureship Award recognizes an outstanding lecturer and author whose technical paper or papers published during the eligibility period are considered an outstanding contribution to the engineering literature on fabricated structural steel.

The award is named for Theodore R. Higgins, former AISC Director of Engineering and Research, who was widely acclaimed for his many contributions to advancing engineering technology related to fabricated structural steel. The award honors Higgins for his innovative engineering, timely technical papers, and distinguished lectures.

Schafer is the director of the Ralph O'Connor Sustainable Energy Institute and the Hackerman Professor in the department of civil and systems engineering at Johns Hopkins. He is also active in engineering consulting and is currently a consulting principal at Simpson Gumpertz & Heger. He holds master's and doctoral degrees from Cornell University in structural engineering and a Bachelor of Science in engineering from the University of Iowa. Schafer has led numerous research projects on the behavior and design of thin-walled steel structures.

He is dedicated to the codes and standards process with over 20 years of service to AISC, AISI, and ASCE, and currently serves as Chair of AISC TC4 on Members, Vice Chair of the AISC Committee on Structural Stainless Steel, and Chair of ASCE 8 on cold-formed stainless steel. He has previously served as Chair of the Department of Civil Engineering at Johns Hopkins, Chair of the Structural Stability Research Council, President of the Cold-Formed Steel Engineers Institute, and North American Editor of the Journal of Thin-walled Structures. He is an award-winning teacher, dedicated runner, regretfully retired youth soccer coach, and facilitator for a middle school maker program. He currently resides in Washington, D.C. , with his wife and son.

People & Companies

Scotchman Industries and **Steelmax Tools**, two leading providers of steel fabrication equipment and solutions, announced today that they have joined forces to form the SMX Industrial Solutions group of companies with the investment support of Emko Capital. Under the SMX Industrial Solutions umbrella, Scotchman and Steelmax will bring a broader portfolio of industry-leading solutions to customers while maintaining each company's strong individual identity and expertise.

The new company will leverage Scotchman's and Steelmax's existing product portfolios, internal technology development, and additional acquisitions to offer a comprehensive and expanding portfolio of steel fabrication tools and solutions to customers in various industries, including manufacturing, construction, and energy.

Owen Metals Group has opened its new **Paxton & Vierling Finishing (PVF)** facility in Carter Lake, Iowa. The company's latest, most advanced line combines ten years of powder coating experience at their Northern Plains Finishing (NPF) division in Casselton, North Dakota, with the latest innovations in coating technologies.

"Our new PVF line significantly increases finishing capacity while reducing costs for our customers in the lower Midwest," said Tyler Owen, CEO/President of Owen Holdings Co.

The new system integrates part-specific instructions driven by barcoded hooks that travel with the parts. These hooks trigger automation, including four robots that perform custom paint applications. PVF line robots spray super-cooled powder with a technology that significantly increases the powder transfer rate. The PVF line integrates several borrowed and upgraded facets of the NPF system that have proven successful, including the 5-Stage Wash pretreatment system and a 10-gun auto paint booth.

DESIGN GUIDE 39

AISC Releases *End-Plate Moment Connections* Design Guide

Structural steel designers have a valuable new resource for designing end-plate moment connections in AISC *Design Guide 39: End-Plate Moment Connections*, now available at **aisc.org/dg**.

"It's a great addition to the AISC toolbox of publications," said Cives Steel Corporation Chief Engineer Brian Volpe, PE, SE, LEED AP. "The team did a fantastic job unifying Design Guides 4 and 16 and adding the latest research."

The new design guide, written by Virginia Tech's Matthew Eatherton, SE, PE, PhD, and Thomas Murray, PE, PhD, reviews how to use yield line analysis to determine end-plate strength, details design procedures for determining required bolt strength, and provides 15 end-plate moment connection configurations.

"Researchers have extensively explored the design of end-plate moment connections since the publication of AISC's previous two design guides about end-plate connections," said AISC Vice President of Engineering and Research Christopher H. Raebel, SE, PE, PhD. "*Design Guide 39* incorporates the latest information to create the go-to resource for designers."

The new design guide also includes 30 design examples for gravity, wind, and low-seismic-ductility design; three examples for high-seismic-ductility design; and a comprehensive literature review.

Design Guide 39 is available for download at **aisc.org/dg**. It's free for AISC members, and printed versions are also now available for purchase. To learn more about its features, see the SteelWise article on page 16.

BRIDGES

High Steel's John O'Quinn Receives Steel Bridge Task Force Honor

The Steel Bridge Task Force has presented the 2023 Alexander D. Wilson Memorial Award to John O'Quinn, president of High Steel Structures, LLC.

The award honors individuals who have made significant industry contributions to advance steel as the material of choice for steel bridge supply, production, design, fabrication, or construction.

"His direct support has enabled significant technological advancements for the steel bridge industry," said Dan Snyder, vice president of the construction program at the American Iron and Steel Institute. "John is highly respected and greatly appreciated by his peers, and it is an honor to recognize his contributions and lasting impact on our industry with the 2023 Alexander D. Wilson Memorial Award."

"John is passionate about steel bridges and strives to improve the entire industry on a daily basis," National Steel Bridge Alliance Senior Director of Market Development Jeff Carlson said. "I'm thrilled to see him recognized for everything he does."

O'Quinn currently serves on the American Institute of Steel Construction's Board of Directors and is vice-chair of AISC's Government Relations committee. He has also served as chair of the National Steel Bridge Alliance's Market Development Committee.

He started his steel career with an entry-level position in 1980, working his way up from material handler to management at Carolina Steel. In 1993, he founded O'Quinn Enterprises, his own steel fabrication and erection company, before returning to Carolina Steel/Hirschfeld Industries as vice president. He has served as president of High Steel since 2016.

The Steel Bridge Task Force has coordinated research that establishes safe, cost-effective steel bridges and worked to implement those developments into steel specifications (specifically the AASHTO design codes) for the last four decades. Its members include the NSBA (a division of AISC), AISI, the AASHTO Steel and Metals Technical Committee, steel producers, steel organizations, steel bridge fabricators, bridge owners, university faculty, consultants, and representatives from the Federal Highway Administration.

RUNNING FOR OFFICE

AISC Board Member Announces Congressional Campaign

Hollie Noveletsky, a member of the AISC Board of Directors and president/CEO of Novel Iron Works in Greenland, N.H., is running for the Republican nomination for the 1st Congressional District of New Hampshire in 2024.

Noveletsky has worked full-time for Novel Iron Works since 1999, after working part-time while in college and graduate school. Her father, Ralph, started the company in 1956. She joined the AISC Board in 2015 and is also a past chair and current member of the AISC Government Relations Committee. She is the CEO of Novel-affiliated fabricator Rose Steel, also in Greenland, N.H., and previously served as president of the Structural Steel Fabricators of New England.

Noveletsky studied nursing and was a practicing nurse before she transitioned to full-time work in the steel industry. She served in the U.S. Army Reserve for 10 years as a nurse practitioner.

AISC advocates for policies that support the U.S. steel fabrication industry but does not endorse individual candidates for public office.

SAFETY AWARDS

AISC Now Accepting Annual Safety Awards Submissions

To a customer, visiting an unsafe shop or jobsite is like visiting a messy house. Even if safety is not an explicit requirement, its absence makes a poor impression. On the other hand, seeing a shop or jobsite with a commendable level of safety leaves a good impression.

It's reasonable to think that a company managing safety is also successfully managing production and quality. Safety management is becoming an increasingly important part of many customers' selection criteria, and it is the law. AISC encourages you to manage safety to achieve that commendable record, and we want to help you display your success with an AISC Safety Award.

AISC member steel fabricators and erectors are eligible and encouraged to submit their company's safety record for AISC's annual Safety Awards. The awards, given in the Fabricator Category and Erector Category, include the Honor Award (DART=0)—the Institute's top safety award, presented for a perfect safety record of no disabling injuries— the Merit Award ($0 < \text{DART} \leq 1$) and Commendation Awards ($1 < \text{DART} \leq 2$).

"AISC's annual Safety Awards program recognizes excellent records of safety performance, and we commend these facilities for their effective accident prevention programs," AISC director of safety Tom Schlafly said. "Periodic recognition of safety in the workplace has been demonstrated to provide worker incentive and a reminder of the importance of safe practices."

The AISC Safety Awards program is open to all full fabricator members and erector associate members of AISC. An email with submission information will be sent to the Primary, Secondary, and Safety Contacts of eligible members in mid-December. All applications are due to AISC by the end of January, when OSHA Form 300A is required to be posted.

"Owners and clients pay attention to these awards," said Kathleen Dobson, safety director for Hillsdale Fabricators/ J.S. Alberici Construction. "They want to know that a fabricator or erector is proud of their safety records—and just as important, it means a lot to the workforce to see that their efforts are recognized by an industry leader like AISC."

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

2023 SAFETY AWARD

EDUCATION FOUNDATION

AISC Education Foundation Board Expands, Elects New Officers

The AISC Education Foundation has grown over recent years—and the Board of Directors that manages its operations has grown along with it.

Its membership now reflects additional sectors of the industry and is comprised of five steel fabricators, five engineers, and five educators.

"Looking at the growth in Foundation assets and the scope of its reach into the education and engineering design communities over a decade, I thought it was a good time to expand the size of the Board and include participation from other stakeholders in these communities," former Chair David Zalesne (Owen Steel Company) said.

The Education Foundation, a registered 501(c)(3) organization, funds programs designed to bring steel to life for the next generation of industry leaders. Scholarships are a major part of its impact, and the Foundation administers more than $200,000 annually in funding for undergraduate and master's students at U.S. colleges and universities.

The expanded Board elected new leadership at its most recent meeting. Emily Guglielmo, SE, PE (Martin/Martin Inc.) has stepped up as chair.

"Emily has embraced her role as Chair and is doing a fantastic job organizing both long-term and short-term goals for the Foundation," said Zalesne. "The new Board has been fully engaged to support her and bring fresh perspectives to the Foundation, and Maria Mnookin continues to provide expert support from the AISC staff side to manage the day-to-day work of the Foundation."

Benjamin Baer, SE, (Sheffee Lulkin & Associates, Inc.) was elected vice chair, and Glenn Tabolt (STS Steel, Inc.) was elected treasurer. Edward Seglias (Cohen Seglias Pallas Greenhall & Furman PC) serves as the Board secretary.

Other engineers on the Board include Jon Magnusson, PE, SE, Hon. AIA (Magnusson Klemencic Associates); Stephanie Slocum, PE (Engineers Rising LLC); and Jeffrey Smilow, PE (WSP).

The Board also recently welcomed educators Patricia Clayton, PhD (Wake Forest University); Gregory Michaelson, PE, PhD (Marshall University); Machel Morrison, SE, PhD (University of California, San Diego); W. M. Kim Roddis, PE, PhD (The George Washington University); and Andrea Surovek, PE, PhD (South Dakota School of Mines & Technology).

Steel fabricators on the Board include Casey Brown (Zimkor LLC), Babette Freund (Dave Steel Company, Inc.), Dan Kadrmas (TrueNorth Steel), and Glenn Tabolt (STS Steel, Inc.).

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The Eskenazi School of Art, Architecture + Design

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Back to the Future

INDIANA UNIVERSITY commemorated an AISC honor with more than a spot in a display case somewhere on campus or in an engineering firm office. The school decided that one of its newest buildings winning a 2023 AISC IDEAS² award deserved a ceremony.

The Eskenazi School of Art, Architecture + Design on the Bloomington, Ind., campus won the IDEAS² merit award for submitted projects that cost less than $15 million. The parties who made the project a reality gathered to accept their awards from AISC in that very building Oct. 6. AISC structural steel specialist Larry Flynn emceed the ceremony, which Eskenazi School dean Peg Faimon hosted.

Representatives from IU, the architect (Thomas Phifer and Partners), engineer (Skidmore, Owings & Merrill), fabricator (MAK Steel Services, LLC, an AISC member), steel producer (Steel Dynamics, Inc.), and general contractor (CDI Inc.) each accepted an award. For the fabricator, the ceremony was a rare chance to see the completed project. Fabricators see drawings and handle the steel, but often leave the jobsite before the building is completed and are onto the next job by the time it opens.

The Eskenazi School is a modern revival of a 1952 Ludwig Mies van der Rohe design of an IU fraternity house that budget cuts sideswiped before construction. Its 10,000-sq.-ft, two-story design was archived for more than five decades.

The design and construction team artfully adapted van der Rohe's clean-lined original design for modern services, such as air conditioning. Tight tolerances between long-span steel and glass had to be achieved, complex connections had to be hidden. HVAC systems and MEP lines had to be run through the few spaces where they would not be visible.

"It's amazing to see that the team was able to honor the original design that Mies had," said 2023 IDEAS² judge Anders Lasater, AIA architect and principal at Anders Lasater Architects. "You can't separate the idea of steel and the idea of that building. Steel is the only thing that could make that building work. When it's executed at that level, with that sensibility for detail and attention to the original intent of the architect, it's a magical experience to see a building come together like that."

Judging for the 2024 IDEAS² awards took place in November, and the winners will be featured in the May 2024 issue. And you can read about the 2023 winners in the May 2023 issue at **www.modernsteel.com**.