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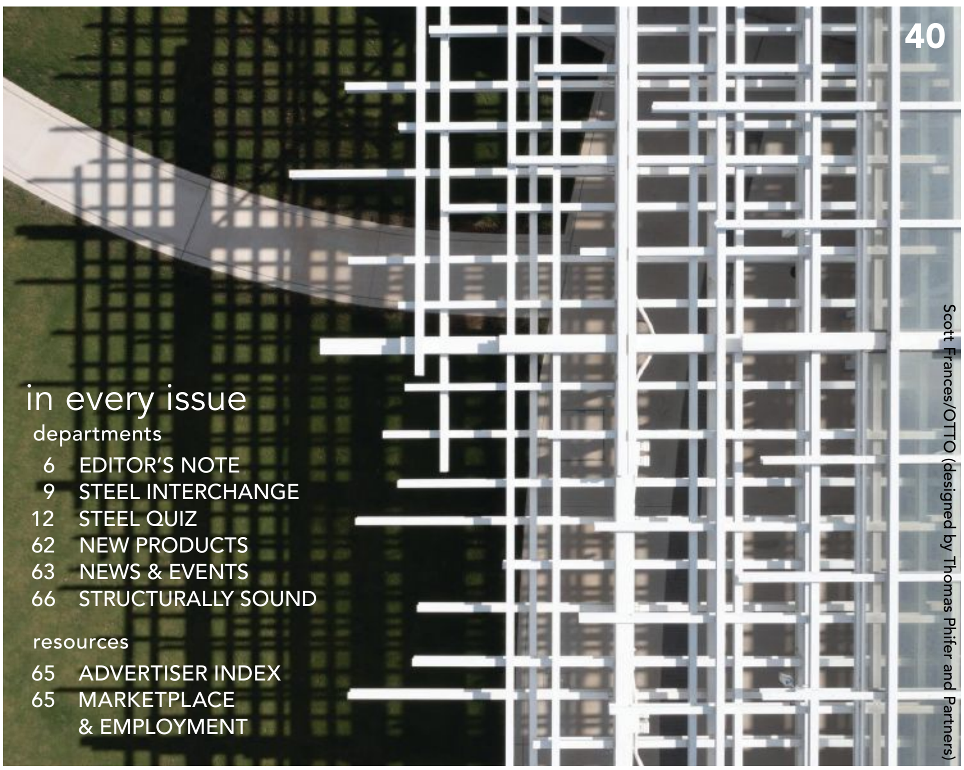
September 2022



Scott Frances/OTTO (designed by Thomas Phifer and Partners)

in every issue

features

columns

ON THE COVER: The country's oldest teaching hospital gets a brand-new addition, p. 26. (Photo by Dan Schwalm © 2021 PennFIRST)

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IRON WORKERS INTERNATIONAL SETS THE STANDARD HIGH WITH **ACCREDITED RIGGER & SIGNAL PERSON CERTIFICATION**

The National Commission for Certifying Agencies (NCCA), the accrediting body of the Institute for Credentialing Excellence, has granted accreditation to the Iron Workers International Certification Board's (I.I.C.B.) Rigging & Signalperson Certification Program.

WHY IS IT IMPORTANT?

MEET REQUIREMENTS

OSHA's Subpart CC requires signal person qualification by a third-party qualifier.

MEET DEMAND

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WHAT IS IT?

Iron Workers International Certification Board's (I.I.C.B.) Rigging & Signalperson Certification Program is accredited by the National Commission for Certifying Agencies (NCCA), the accrediting body of the Institute for Credentialing Excellence. The I.I.C.B. joins an elite group of more than 130 organizations representing over 315 programs that have obtained NCCA accreditation.

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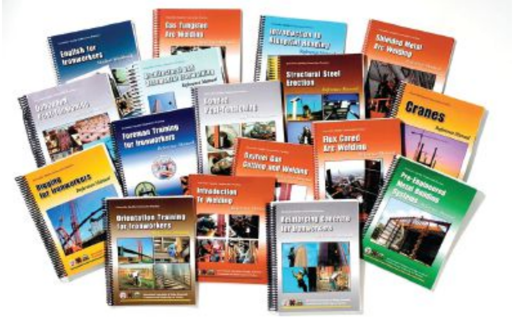

editor's note

Have you ever tried welding something? Were you any good at it?

I did. And I'm not!

My weld didn't look as much like a pile of dimes as it did a confused worm scribbled by a toddler.

To be fair, it was my first (and only, thus far) experience. But I'm glad I got to try.

On that same day, I also cut a 1-in.-thick steel plate with an oxygen-acetylene torch. That's a task I actually succeeded at. While my cut was not something that would widely be considered "beautiful" or even "competent," I did, in fact, create two distinct pieces of metal from one. If you're ever stuck in a steel box with me and I happen to have an oxy-acetylene torch, rest assured that I'll be able to get us out.

I'm apparently also not the worst crane operator. I can do a decent job positioning a hook and factoring in sway.

How did I discover all of this? I attended a SteelDay event. This was back in 2013, when I visited AISC member erector Topping Out, Inc./Davis Steel Erection in Omaha. It was fun and educational (and humbling) and it gave me—and dozens of attendees—a better appreciation for the difficult tasks that thousands of ironworkers, welders, fitters, crane operators, and others perform on a daily basis.

And that was just one SteelDay event. I've been attending them ever since AISC launched the effort back in 2009. I've visited fabrication shops and a bender-roller. I've toured an equipment manufacturing facility. I've found myself in a foundry, where I watched steel castings being made (and nearly got lulled into a trance listening to the rhythmic pounding of the forge). And I've been on several building tours from New York to Los Angeles.

Every one of these events was enlightening, and every one of them was free—and not just for me as an AISC employee but also for any and all attendees. Our goal for SteelDay is to offer events throughout the country for AEC professionals, faculty and students, and the public to see firsthand how the vibrant U.S. structural steel industry works to construct our country's buildings and bridges, as well as provide opportunities for steel fabricators to connect with AEC professionals.

While SteelDay has historically taken place in September, this year's edition is scheduled for October. It's also been extended to an entire week, October 17–21, and will include shop tours, networking opportunities, and a free national webinar. Oh, and if you'd like to have your own welding experience, several participating IMPACT training facilities will be providing that opportunity. I'm confident you'll do better than I did.

And in tandem with our annual event, AISC is hosting the Flash Steel Conference October 18–20. Now in its third year, this annual online conference comprises a series of fast-paced 30-minute sessions. You can read about it in "Back in a Flash" on page 56.

To learn more and see a list of SteelDay events, visit **aisc.org/steelday**. We hope to see you at an event in October!

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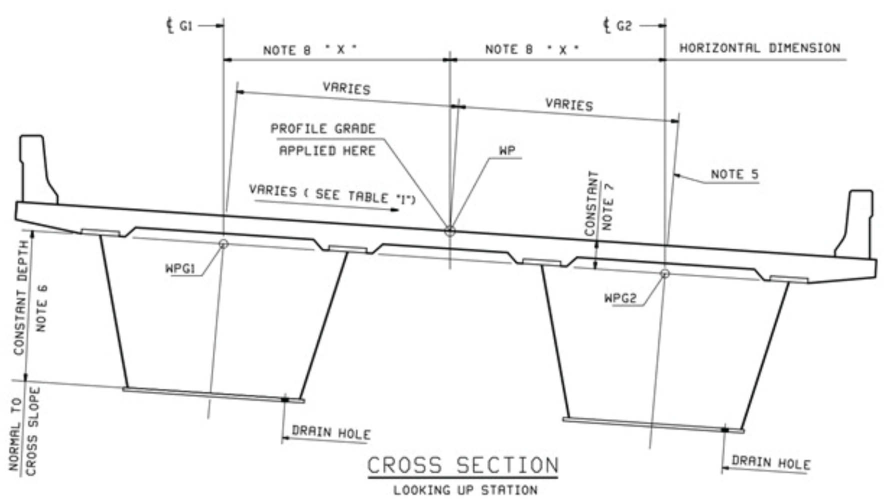
steel interchange

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

Variable Superelevation of Twin Tub Girder Bridge Decks

In the AASHTO/NSBA Steel Bridge Collaboration G1.4 – 2006: *Guideline for Design Details*, page 113 shows a cross section of the twin tub girder (see figure below). As shown in the figure, the working line connected by WPG1 and WPG2 is parallel with the deck cross slope. The depth of tubs is a constant normal to the cross slope. Note 7 has instructions to maintain a constant dimension from the top of the deck to the top of the web plate, and the deck cross-slope/superelevation rate is shown as varying.

As the deck cross-slope/superelevation rate varies along the length of the bridge and the twin tubs were detailed to rotate along with the deck cross-slope/superelevation as shown, I imagine the top and bottom flange plates and web plates of the twin tubs would be warping along the length of the bridge. How does one resolve the complication of the warping of the top and bottom flange and web plates?



The top of the deck riding surface should stay parallel to the steel tub girder's orientation. I understand your concern about the variable superelevation of the bridge deck along the length of the bridge, but let me assure you that these bridges are built regularly without much difficulty. Reviewing the fabrication/detailing methodology that is typically used may help alleviate your current concerns.

A few AISC certified member bridge fabricators I contacted confirmed that the superelevation transition (as well as the superelevation, camber, and components of the horizontal curve) is accounted for in the steel tub girder webs by being "blocked out" so that the girder is in the correct orientation—i.e., the steel tub girder is not fabricated fully and then twisted along the length to account for the superelevation, but rather the girder webs will be cut differently (one of the webs often has negative camber and the other doesn't or has a less negative camber to account for the rotation) in order for the trapezoidal box to reside as it is designed to with the superelevation, camber, horizontal curve, and vertical profile in mind. The top flange, web, and stiffeners are sub-assembled and welded to the bottom flange using internal cross frames to hold the shape. The top flange within the girder haunch (the girder build-up) also allows for setting the proper girder elevations in the field during erection.

Ultimately, I would recommend talking with the steel detailer you're working with on the project and asking them questions until you are comfortable with the process. You may also want to ensure that any detailer you work with has the tools to develop (i.e., flatten) the warped shape of the webs. While it is not overly complicated, the detailer must have the knowledge or software to do it properly.

Devin Altman, PE

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**.

Pairing F844 Washers with Anchor Rods

For a project I'm working on, the contract documents call for F844 washers to be used with anchor rods at the base plate connection. I thought F436 washers were required with ASTM F1554 anchor rods. Are F844 washers acceptable?

Yes. ASTM F1554: *Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength* (available at **www.astm.org**) lists suitable washers in Section 6.8, which states: "Unless the washer material and dimensions are otherwise specified in the inquiry and the order, washers conforming to the requirements of *Specification* F436, Type 1 shall be furnished." This indicates that the default washer listed in ASTM F1554 is F436. However, the standard does not prohibit the use of other washer types.

The June 2022 article "Are You Properly Specifying Materials?" provides some guidance on this question. It states the following for washers for anchor rods: "In base plate applications, anchor rods' hole sizes for anchor rods are usually larger than those for steel-to-steel structural bolting applications. AISC *Manual* Table 14-2 provides recommended hole sizes that correlate with anchor rod placement tolerances from ACI 117. Accordingly, washers used in such applications generally must be larger and require design considerations for proper force transfer, particularly when the anchorage is subject to tension. Table 14-2 is revised to reflect different material thicknesses for Grade 36, 55, and 105 anchor rods. Such anchor rod washers are generally made from rectangular plate or bar material."

Note that the statement regarding the revision to Table 14-2 refers to the updated table that will appear in the 16th edition AISC *Steel Construction Manual* (which is expected to be published in mid-2023). The revisions to Table 14-2 are based on research by Cozzens, Rassati, and Swanson (the related report, *Pull-Through Testing of Plate Washers for Column Anchor Rod Applications*, is available via the Research Library link at **aisc.org/research**).

I will also point out that Note 4 of Table 14-2 "Recommended Sizes for Washers and Anchor Rod Holes in Base Plates" of the 15th edition *Manual* states: "ASTM F844 washers are permitted instead of plate washers when hole clearances are limited to $^{5}/_{16}$ in. for rod diameters up to 1 in., ½ in. for rod diameters over 1 in. up to 2 in., and 1 in. for rod diameters over 2 in. This exception should not be used unless the general contractor has agreed to meet smaller tolerances for anchor rod placement than those permitted in ACI 117."

Section J9 of the 2016 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360) states: "Larger oversized holes and slotted holes are permitted in base plates when adequate bearing is provided for the nut by using ASTM F844 washers or plate washers to bridge the hole." The *Specification* requirement is consistent with the guidance provided in Table 14-2. One would need to use plate washers to bridge the recommended hole sizes shown in Table 14-2. F844 washers can be used when smaller holes meet the criteria recommended in Note 4 of Table 14-2.

Finally, a November 2014 Steel Interchange item also discusses the use of ASTM F844 washers when smaller hole sizes are used in the base plate.

Yasmin Chaudhry

Tightening Nuts on Anchor Rods

Is a minimum installation torque required for cast-in-place F1554 anchor rods (Grades 36, 55, and 105)?

It is not necessary to pretension base plate joints in the vast majority of structural steel buildings.

Section J9 of the 2016 AISC *Specification* provides requirements for anchor rods and embedments. The Specification does not explicitly address nut installation. However, guidance is available. AISC Design Guide 1: *Base Plate and Anchor Rod Design* states: "It is important in all methods that the erector tightens all of the anchor rods before removing the erection load line so that the nut and washer are tight against the base plate. This is not intended to induce any level of pretension but rather to ensure that the anchor rod assembly is firm enough to prevent column base movement during erection. If it is necessary to loosen the nuts to adjust column plumbness, care should be taken to adequately brace the column while the adjustment is made." Also, Appendix A in Design Guide 1 provides guidance on the anchor rod nut installation sequence.

Yasmin Chaudhry

Devin Altman (**altman@aisc.org**) is a bridge steel specialist at AISC and **Yasmin Chaudhry** (**chaudhry@aisc.org**) is a staff engineer in AISC's Steel Solutions Center.

STEEL SOLUTIONS CENTER

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

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

The complete collection of Steel Interchange questions and answers is available online at **www.modernsteel.com**.

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Interested contractors should submit a statement of interest and resume to **contractor@qmcauditing.com**.

This month's Steel Quiz focuses on AISC's education department and the numerous programs and resources available

As summer winds down, it's time for students of all ages to head back to school. But as we all know, learning doesn't stop when you leave school. This month's Steel Quiz focuses on AISC's education department and the numerous programs and resources available for practicing engineers, educators, students, and anyone wanting to learn or get excited about structural steel! You can find hints in the many resources on our Education page at **aisc.org/education**. And you can view the on-demand courses for free at **learning.aisc.org** (use the Advanced Search bar on the right side of the pages and select "None" under "Credit Type."

1 **True or False:** A moment connection framing into the weak axis of a wide-flange column (as opposed to the strong axis) is typically used when bi-axial bending of the column is needed.

2 A hot-rolled structural steel shape produced at an American mill contains an average of what percentage of recycled steel?
a. 80% **b.** 87% **c.** 93% **d.** 96%

3 **True or False:** Notch toughness is the ability of a material to absorb energy in the presence of a sharp notch, often when subjected to an impact load. (Hint: Watch the on-demand course "Ductility and Brittle Fracture: Another View, Part 2.)

4 Which of the following effects should be considered on the stability of a structure and its elements? (Hint: Watch the on-demand course "Structural Stability—Letting the Fundamentals Guide Your Judgement.")
a. Pertinent deformations
b. Equilibrium on the deformed shape
c. Initial geometric imperfections
d. Loss in stiffness due to partial yielding
e. Potential for variation
f. All of the above

5 **True or False:** All grades of steel are magnetically attractive.

TURN TO PAGE 14 FOR THE ANSWERS.

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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**.

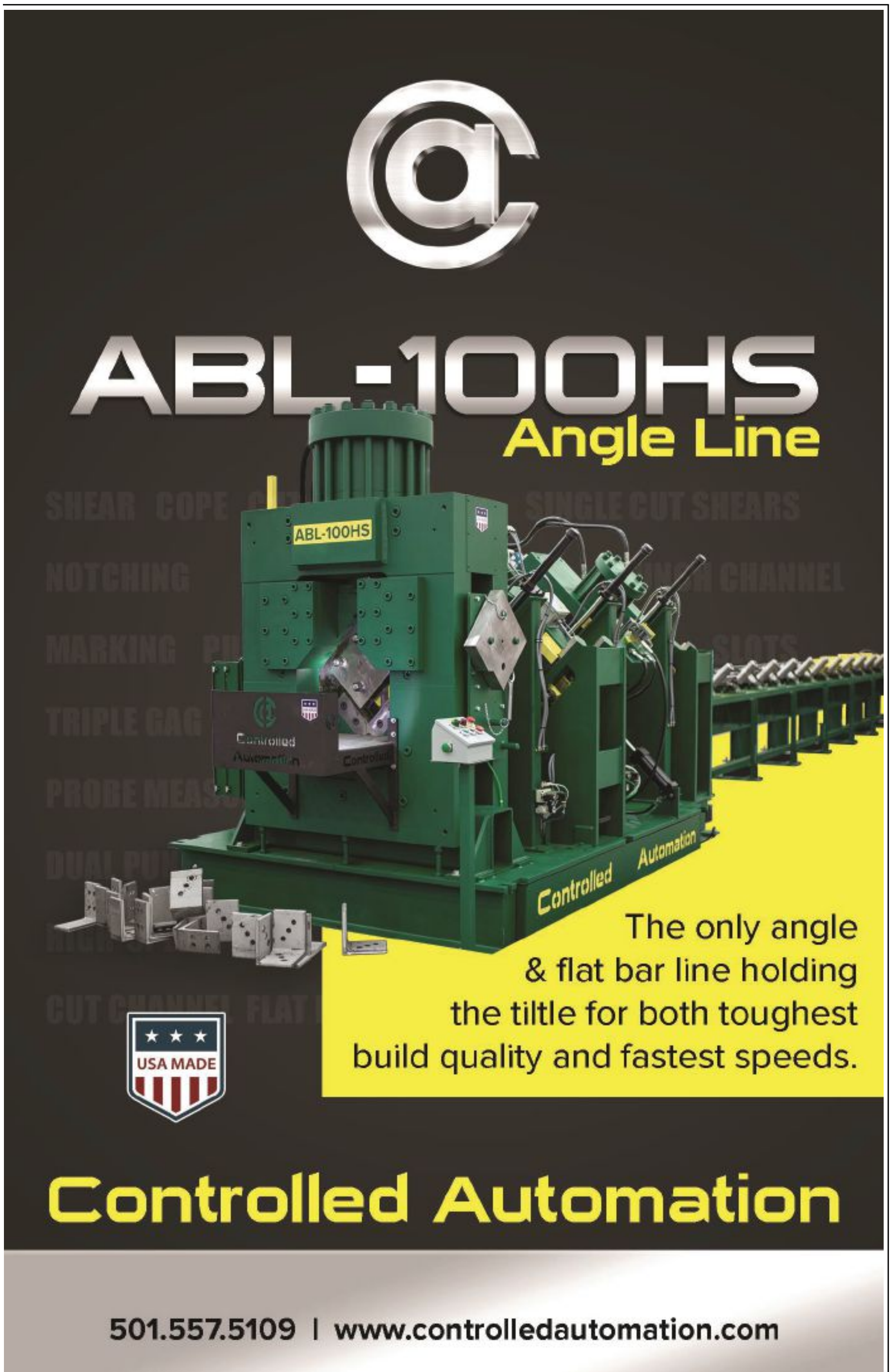
1 **True.** A moment connection framing into the weak axis of a wide-flange column is typically used when bi-axial bending of the column is needed. Connection to the weak axis may be limited by the weak axis moment capacity of the column. Moment connections to the weak axis are not nearly as common as moment connections to the strong axis of wide-flange columns. This type of connection is just one of six connections you can 3D print to help students visualize how connections are constructed using AISC's 3D-Printed Connections Teaching Aid (available at **aisc.org/education/university-programs/teaching-aids**).

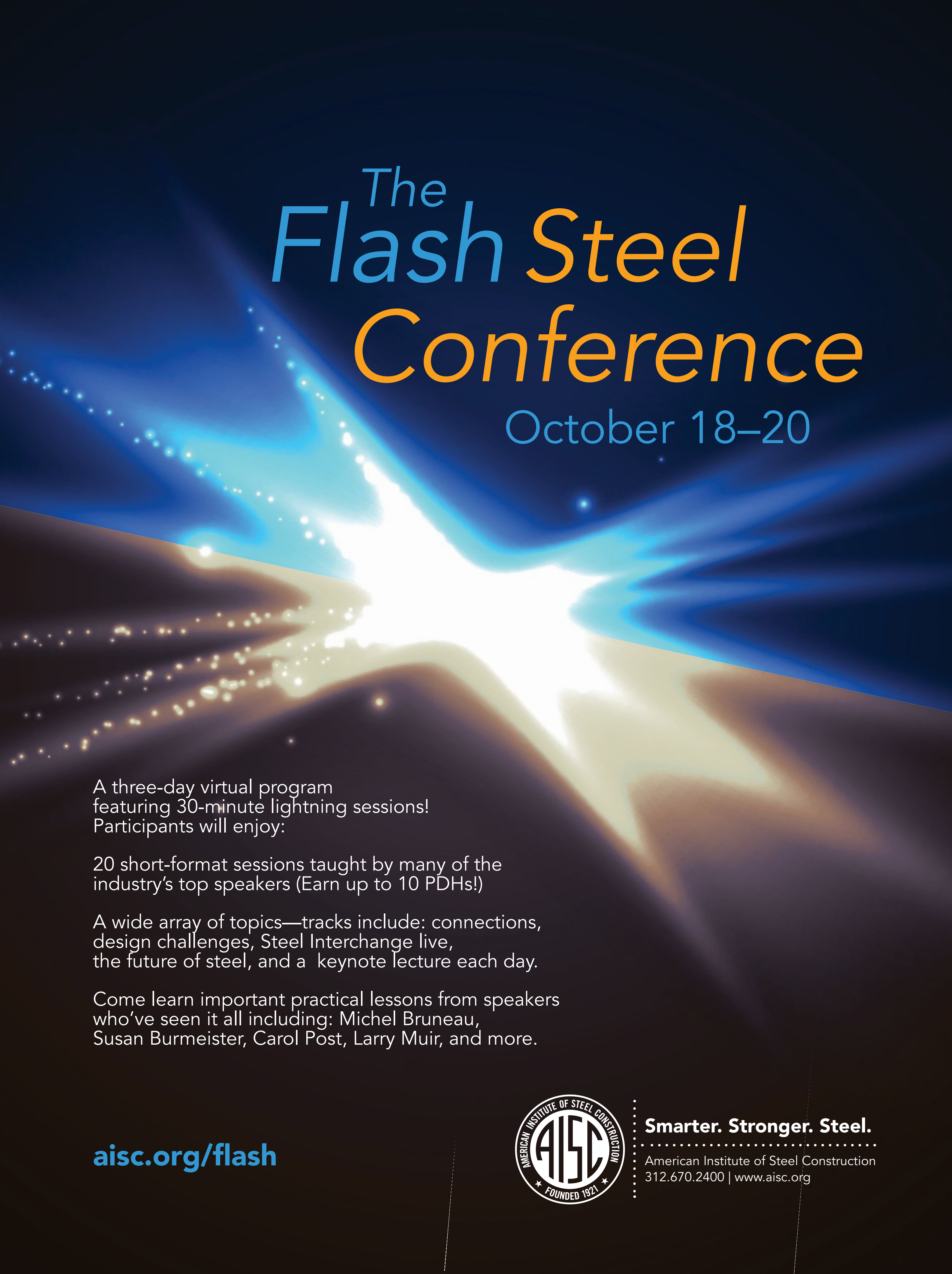
2 **c.** 93%. A hot-rolled structural steel shape produced at an American mill contains an average of 93% recycled steel scrap from cars, refrigerators, decommissioned buildings, old bridges, and other sources (learn more about the sustainability of structural steel at **aisc.org/sustainability**). In fact, steel is the most commonly recycled material on the planet. At the end of a building's life, 98% of all structural steel is recycled back into new steel products, with no loss of its physical properties. This unique quality of steel inspired the 2021 Student SteelDay Contest, where participants recreated iconic steel structures using contents from their recycling bins (**aisc.org/education/university-programs/steelday-student-competition**).

3 **True.** Notch toughness is the ability of a material to absorb energy in the presence of a sharp notch, often when subjected to an impact load. Notch toughness is defined in the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, available at **aisc.org/specifications**) as the energy absorbed at a specified temperature as measured in the Charpy V-notch impact test. In addition to material properties such as yield strength, modulus of elasticity, and tensile strength, another critical material property related to structure behavior is notch toughness. To learn about notch toughness and brittle fractures, you can view the entire on-demand course.

4 **f.** All of the above. Chapter C of the AISC *Specification* lists five factors that should be considered for the stability of a structure and its elements. These are dubbed the AISC Chapter C "Big 5" in the on-demand course. Brush up on your understanding of structural stability and earn 1.5 PDHs now!

5 **False.** Some grades of steel are not magnetically attractive. Many stainless steels are not magnetically attractive. This is particularly important for the AISC Student Steel Bridge Competition (SSBC) because the steel used in the competition is required to be magnetically attractive per Section 8.1 of the 2022 rules. (The SSBC is an annual competition that challenges student teams to develop and test a scale-model steel bridge. Learn more at **aisc.org/ssbc** and read a recap of this year's National Finals in the August 2022 article "Building Bridges in Blacksburg," available at **www.modernsteel.com**.)

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Stainless by Design

BY FRANCISCO MEZA AND NANCY BADDOO

AISC's updated Design Guide on structural stainless steel provides engineers and others with examples, tips, and advice on creating projects that shine.

The structural stainless steel entrance framing for New York's South Ferry Subway Station.

Courtesy: di Domenico + Partners, Architects

THE STRUCTURAL STAINLESS STEEL TRILOGY is now complete.

AISC's *Specification for Structural Stainless Steel Buildings* (ANSI/AISC 370) and its accompanying *Code of Standard Practice for Structural Stainless Steel Buildings* (AISC 313) were both released in 2021. And with the recent publication of the second edition of Design Guide 27: *Structural Stainless Steel*, engineers, and others now have a trifecta of publications to reference when designing projects involving structural stainless steel.

The first edition of Design Guide 27 was published in 2013, at a time when no provisions in accordance with U.S. practice were available for designing welded or hot-rolled stainless steel members. The rules in the first edition were used as a basis for the development of the *Structural Stainless Steel Specification*, and the second edition has subsequently been extensively revised to function more as a structural stainless steel "manual" focused on providing practical guidance on the design of structural stainless steel structures. Here are a few highlights from the updated Design Guide.

Chapter 1 whets readers' appetites with an introduction to the varied applications of structural stainless steel—large and small, aesthetic and utilitarian—in different sectors of the construction industry. Typical applications range from entrance structures to commercial buildings or subway stations to platforms and equipment supports in the water, nuclear, and pharmaceutical industries.

Chapter 3 covers the selection of alloys and durability issues and presents guidance on the performance of stainless steel alloys in different environments, including air, soil, and seawater, providing practical advice on how to ensure the corrosion resistance of welds is sufficient and detailing tips to control corrosion.

Chapter 5 provides an overview of the differences between designing with structural stainless steel using the *Structural Stainless Steel Specification* and carbon steel using the *Specification for Structural Steel Buildings* (ANSI/AISC 360).

Section property and member strength tables are given for a range of structural stainless steel sections and bolted connections. Because there are currently no ASTM specifications that designate standard shape profile sizes for stainless steel structural sections, many domestic steel service centers and manufacturers were contacted to establish the most popular sizes for various section shapes. Note that some of the shapes listed in the tables are not commonly produced or stocked; these may only be produced to order and may be subject to minimum order quantities.

All the design tables comply with the requirements of the *Structural Stainless Steel Specification*, and the layout and contents of the tables closely resemble those for equivalent carbon steel structural sections and bolts in the 15th edition AISC *Steel Construction Manual*. The member design tables cover two yield strength levels—30 ksi, which corresponds to the strength of austenitic stainless steels, and 65 ksi, which corresponds to duplex stainless steels. Note that sections are far more widely available in austenitic stainless steel than duplex stainless steel.

In addition, the Design Guide provides ten design examples to get you up to speed with the design of structural stainless steel structures, demonstrating the application of the provisions in the *Structural Stainless Steel Specification*.

Types and Designations

Stainless steel structural shapes are typically fabricated in sizes that match the well-known hot-rolled carbon steel shapes. Therefore, in many instances, the same designation is used to that of the equivalent carbon steel shape of the same nominal width and depth.

Design Guide 27 includes section property tables for hot-rolled and welded I-shaped members (W- and S-shapes), channels (C and MC-shapes), equal-leg angles (L-shapes), round, square, and rectangular hollow structural sections (HSS), and pipe sections.

For hot-rolled stainless steel structural shapes, the nominal cross-sectional dimensions are identical to those of the equivalent carbon steel shape. However, for welded structural stainless steel shapes, the cross-sectional dimensions will slightly differ from those of a hot-rolled carbon steel shape of the same designation because the welded sections do not have radii or fillets. Rather, they are made from commonly available plate thicknesses, and they do not have tapered flanges as some hot-rolled shapes have.

Because some of the stainless steel product standards give different geometric tolerances to those in the carbon steel product standards, a different value for design thickness applies, as detailed in Section B4.2 of the *Structural Stainless Steel Specification*. These values were used for calculating the cross-sectional properties of the structural sections in the tables:

- For hot-rolled and welded sections, when the nominal thickness of the element is less than or equal to $^3/_{16}$ in., the design thickness is 0.95 times the nominal thickness
- For all HSS and pipes, the design wall thickness is 0.95 times the nominal wall thickness
- For all other sections, the design thickness is taken as the nominal thickness

For the reasons given above, the cross-sectional properties of a structural stainless steel shape may differ from those of a carbon steel shape of the same designation. Remember: All the cross-sectional properties listed in Design Guide 27 were specifically derived for stainless steel structural shapes and are not to be used for carbon steel shapes. Do not use the cross-sectional properties for carbon steel shapes!

Compression Members

The strength of austenitic and duplex stainless steel columns is determined in the *Structural Stainless Steel Specification* by one of three buckling curves, depending on the type of cross section and axis of buckling. The reason for specifying three buckling curves for stainless steel columns (see Figure 1), as opposed to one (as for carbon steel columns), is the higher cost of stainless steel, which justifies the adoption of more tailored—and, therefore, more efficient—design rules. Another important characteristic differentiating the buckling curves for stainless steel columns from the one for carbon steel columns is that all the stainless steel buckling curves include a yield plateau for short slenderness to recognize the high strength exhibited by stainless steel columns at short slenderness as a result of strain hardening.

Design Guide 27 tabulates available strength in axial compression for austenitic and duplex W-shapes, equal-leg angles, and HSS as a function of the column effective slenderness ratio (see Figure 2 on the next page). For equal-leg angles, only non-slender cross sections are covered, which is consistent with the scope of the *Structural Stainless Steel Specification*. For W-shapes, the tables also include parameters for determining the strength of the column to resist concentrated forces normal to the flange(s).

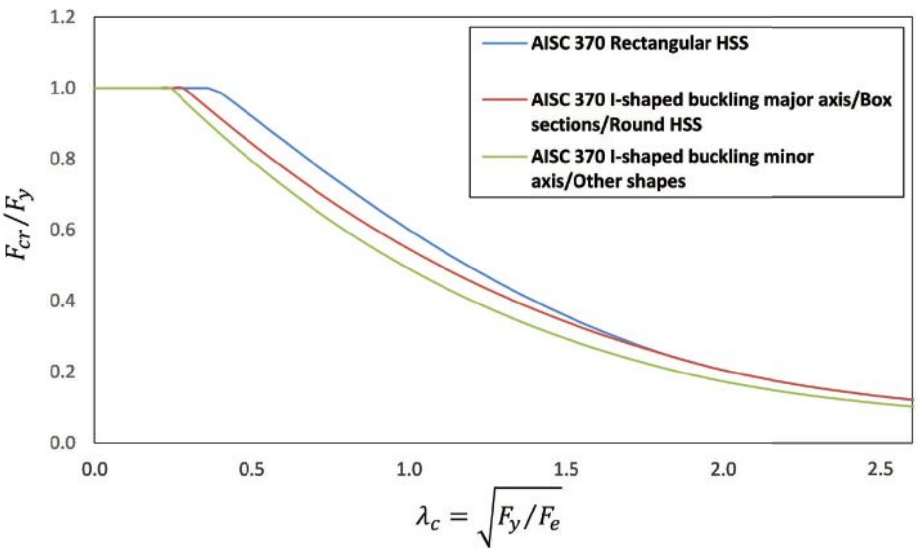
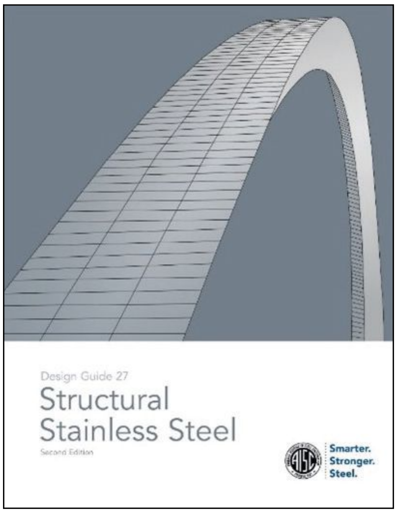


Fig. 1. Multiple buckling curves for stainless steel columns are used to allow for a more efficient design. The curves also include a plateau at short slenderness at which the strength is not affected by global buckling.



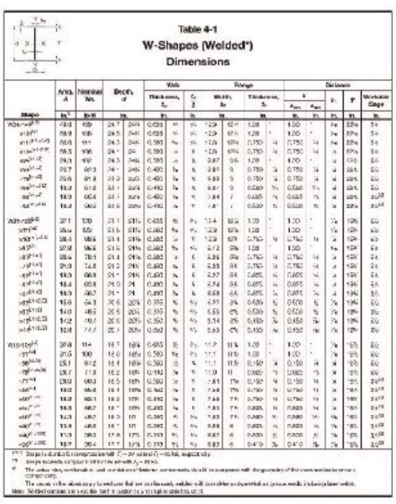


Table 4-1
W-Shapes (Welded*)
Dimensions

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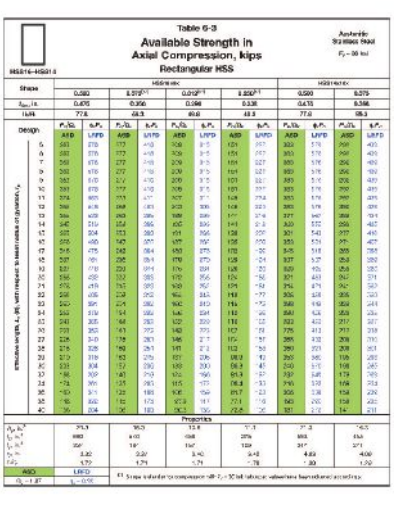
Table 6-3
Available Strength in
Axial Compression, kips
Rectangular HSS

132 / STRUCTURAL STAINLESS STEEL / AISC DESIGN GUIDE 27

Fig. 2. Examples of the structural stainless steel tables in Design Guide 27.

Flexural Members

Design Guide 27 provides tables that can be used to determine the available flexural strength and shear strength of flexural members subject to uniaxial flexure without axial forces or torsion. The flexural strength is calculated considering the limit states of yielding, local buckling, and lateral-torsional buckling as appropriate for the type of structural section, while the shear strength is calculated considering the limit states of shear yielding and shear buckling. In the tables for W-shapes, the sections are sorted in descending order by strong-axis or weak-axis flexural strength and then grouped in ascending order by weight, with the lightest W-shape in each range in bold.

There are also tables giving the total maximum uniform load that can be resisted by simply supported laterally braced (i.e., not susceptible to lateral-torsional buckling) beams with W-, S-, C-, and MC-shaped cross sections bent about the strong-axis against the beam span. These tables can also be used for braced single-span beams subject to other loading conditions.

Continuous Strength Method

The continuous strength method (CSM) is a new design method that can be used for calculating the cross-sectional strength of structural stainless steel members. By adopting a deformation-based design approach, this method is able to account for the beneficial effect of the spread of plasticity, strain hardening, and element interaction. The critical components of the CSM are (1) a "base curve" that permits determining the maximum strain a member is able to sustain before failing as a result of local buckling and (2) a constitutive material model which considers the strain hardening of the material.

The CSM may be used in the design of stainless steel structures in accordance with the *Structural Stainless Steel Specification* in three ways:

- As a less conservative way of determining the cross-sectional strength of members that are not susceptible to global buckling to the traditional methods in Chapters D, E, F, and H of the *Structural Stainless Steel Specification*
- To perform cross-section checks as part of a design by second-order elastic analysis in accordance with Appendix 1 of the *Structural Stainless Steel Specification*
- In design by second-order inelastic analysis in accordance with Appendix 1 of the *Structural Stainless Steel Specification*

The increase in strength from strain hardening is most significant for compact cross sections and for austenitic stainless steels (which exhibit a higher level of strain hardening than duplex stainless steels). To help designers become familiar with the CSM, Design Guide 27 outlines the list of steps that need to be followed when the CSM is used in any of the three ways mentioned above, and one of the design examples shows the benefit which can be obtained through its use.

Connections

Design Guide 27 gives practical guidelines for designing stainless steel bolted and welded connections, including the design of connections between stainless steel and other metals (see Figure 3 for an example detail). It's important to remember that the corrosion resistance of the bolts should always be at least as good as the most corrosion-resistant of the materials being joined; galvanized bolts should not be used to join stainless steel components. Information is also given on welding procedures, including a list of prequalified filler metals for welding the most common austenitic stainless steels (i.e., S30400/S30403 and S31600/S31603). The greater distortion associated with welding stainless steel makes fixturing and weld sequence planning necessary, and appropriate measures are discussed in the Design Guide.

Appendix A of the Design Guide outlines a bolt tightening qualification procedure for slip-critical bolted connections, which can be used for developing installation parameters as part of a preinstallation verification to ensure the suitability of the provisions in the *Structural Stainless Steel Specification*. A testing method for determining the slip coefficient in slip-critical bolted connections with different faying surfaces from those given in the *Structural Stainless Steel Specification* is also provided.

The bolt design tables set out the available shear and tensile strength for a range of austenitic, duplex, and precipitation hardening stainless steel bolts and the available bearing and tear-out strength at bolt holes based on the bolt spacing and edge distance.

With this newly released edition of Design Guide 27 and its associated specification and code, designers have an updated wealth of information and guidance for designing structural stainless steel projects. ■

All publications mentioned in this article can be found at ***aisc.org/publications***.

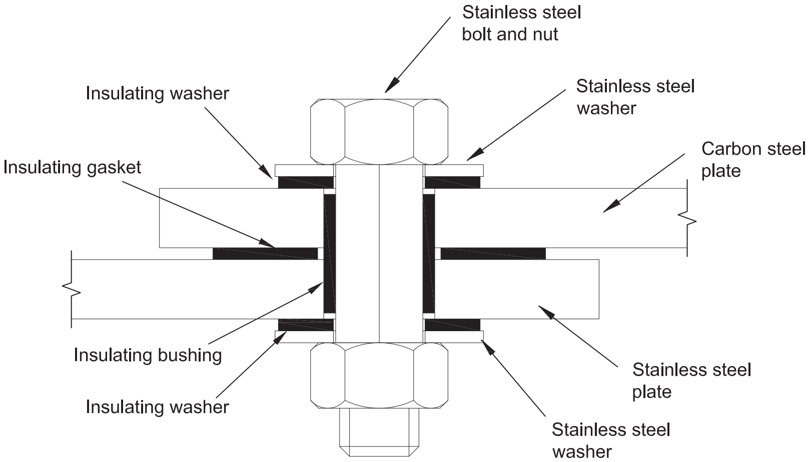

Fig. 3. A typical detail for connecting dissimilar materials to avoid galvanic corrosion for bolts installed in the snug-tight condition in a water-shedding service environment.

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We're All in this Together

BY JOE DARDIS

When it comes to the ups and downs of the construction market, remember: No material is an island.

Fig. 1.
Cost Index for Structural Materials

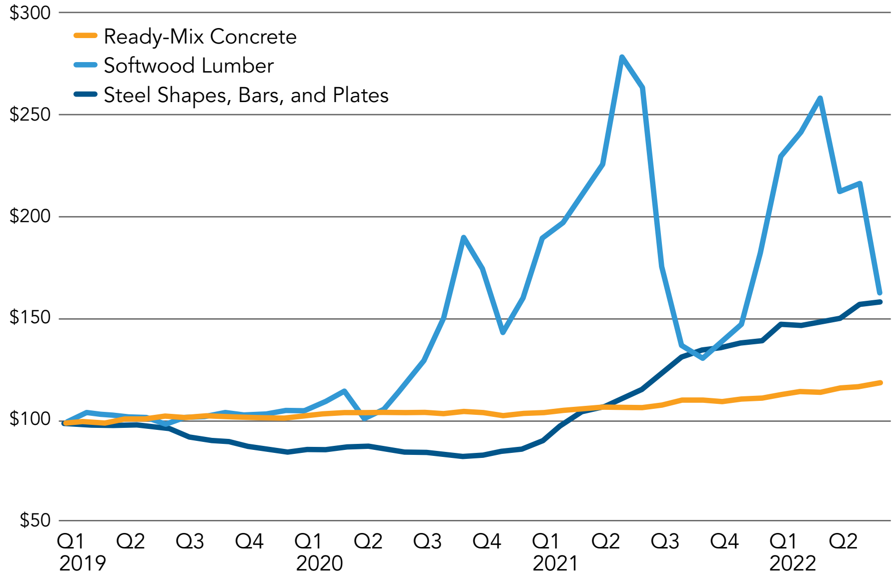
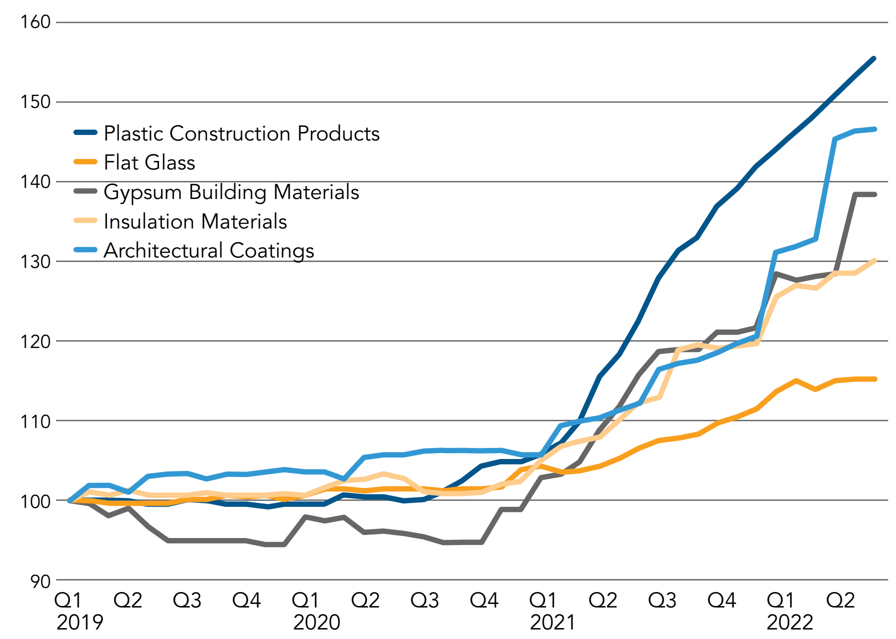


Fig. 2.
Cost Index for Common Building Materials



AS WE ROUND SECOND BASE for 2022 in terms of analyzing quarterly fiscal data, we are still seeing rising project costs due to supply chain problems and material price escalations.

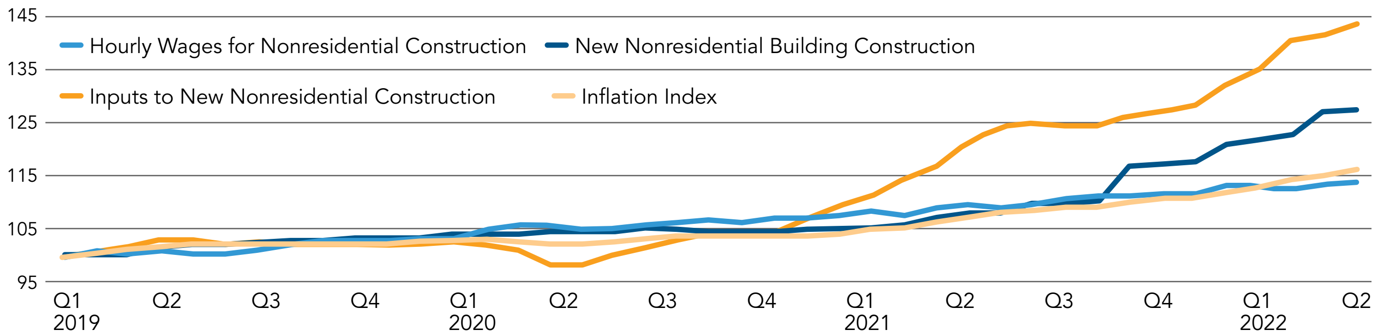
The prices for wood, steel, and concrete have risen significantly since the start of the pandemic (Figure 1), which is leaving many structural engineers and fabricators in a tough position when trying to design a budget-friendly frame or bid a project months before breaking ground.

However, we aren't the only ones shaking our heads. Supply chain problems and material price escalations are causing fits for every trade and subcontractor on the job site. Items such as construction plastics, glass, drywall, and paint (see "No Paint? No Problem" in the August issue, available in the Archives section at **www.modernsteel.com** for an article on paint availability) have increased between 15% and 50% since the start of the pandemic (Figure 2).

Further, Figure 3 shows an aggregate index of all construction inputs, which have risen roughly 45% since 2019. More importantly, however, is that Figure 3 shows a discrepancy between the cost of inputs and the cost of new nonresidential building projects. While the cost of inputs has, again, risen 45%, the cost of the projects that use those inputs has only increased roughly 28% since 2019. Moreover, Figure 3 also shows that the price increases of both inputs and new projects have greatly outpaced inflation.

What's causing this discrepancy? The answer is twofold. The two main costs of a project are materials and labor, and the first reason is that labor wages for nonresidential construction projects have only grown modestly and have been on pace with inflation. The second reason is that contractors are often absorbing some of the material price increases. If material prices go up

Fig. 3.
Cost Index of Construction Inputs, New Projects, and Wages



after a contractor has been awarded a contract, they are often left to make up the difference if an escalation clause is not written into the contract.

Ultimately, project stakeholders should understand the underlying issues behind rising project costs and realize there are several drivers. While phrases like "rising steel prices are increasing building costs" make for dramatic headlines, they only tell a small part of the story and don't provide context. The rising costs of *all materials* (*not just steel* and *not just framing materials*) are increasing building costs. Further, a steel building frame typically represents less than 20% of the overall cost of the building, and the majority of that cost is due to labor, not material. Therefore, a 50% rise in steel prices would not indicate a 50% rise in the price of a steel package.

As the steel industry continues to battle these challenges and skewed messaging, just remember we are not alone. There is no trade or material that has not been significantly affected by price escalation, and steel by itself does not hold the responsibility for rising project costs. And keep in mind that there are ways to make a steel project more economical in any market climate, such as engaging a steel fabricator early in the design process. ■

Joe Dardis (**dardis@aisc.org**) is AISC's senior structural steel specialist for the Chicago market.

Engineer, Pioneer

INTERVIEW BY GEOFF WEISENBERGER

Remember when computers weren't ubiquitous in engineering offices? Allen Adams does. And it led him to help create design software with the ultimate goal of letting engineers be engineers.

IF YOU'VE EVER DESIGNED a structural steel project (and I'm really hoping many of you have), there's a good chance Allen Adams helped you bring it together—if perhaps not directly or obviously.

Allen is one of the creators of the RAM Structural System engineering software package, which was born from a simple "What if?" question combined with engineering know-how and the desire to fill a void of sorts and make structural design more efficient.

Now the chief structural engineer at Bentley Systems, Inc., and the company's senior product manager for RAM Structural System, Allen was also one of this year's AISC Lifetime Achievement Award winners, being recognized for his contribution to RAM, his drive to improve the accuracy and speed at which steel buildings can be designed, and his service on the following AISC committees: Committee on Specifications, Committee on Manuals, Task Committee TC3: Loads, Analysis and Stability, and Manual Subcommittee M3: Seismic Design Considerations..

I caught up with Allen at this year's NASCC: The Steel Conference in Denver, where he and the rest of the 2022 AISC award winners were recognized. There, we discussed the genesis of RAM (including how it got its name), his love of NASCC, the most satisfying thing about his job, and his thoughts on fish tacos.

Since we're at NASCC, I have to ask, how many steel conferences have you been to?

I've lost track, but I think it's probably in the range of 25.

That's quite a few! Do any of them stick out in particular, or do they all sort of bleed together at this point?

They all kind of bleed together but over time, they have just gotten better and better, and I really enjoy being at them. They're so much fun, there's so much to learn, and there's so much to see. I like the connections that I've made over the years, and then I get to see those connections over and over again at other trade shows too. But I have to admit that for me, this one is the most satisfying.

That's great to hear! Let's talk a little bit about RAM. Can you talk about how you got into developing the program? Did you start as a structural engineer, or did you have a software background?

I started work for an engineering company called Culp and Tanner in Northern California. And while I was there, I worked as a structural engineer. We did a lot of parking garages, hotels, casinos, and office buildings. Back then, engineering software was very rudimentary, and a lot of what we did was by hand. But I was fortunate that the company was forward-thinking enough that they actually had a computer in-house called a minicomputer. And it was called a minicomputer because it didn't fill up a whole room like a regular mainframe. It was roughly the size of a large filing cabinet. There was no graphical user interface, so we wrote some rudimentary programs. But we were always talking about how nice it would be if we had a program that did all the

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**.

bookkeeping, all the number crunching, all the stuff that requires an engineer to know how to do it. That tool could do all the number-crunching stuff and free the engineer up to be an engineer and make their projects better by using their engineering skills. The more we talked about it, we decided that there was nothing out there. But what if we came up with something ourselves?

We had a programmer that had gone on to another company, but we brought him back. I was given the assignment to work with him to create what we now know as RAM Structural System. This was in 1988, when I had about five years of engineering experience. I started working with Mike, the programmer, and I would tell him, "This is what we need in the program," and he would go off and work on the program. I'd go back to my projects, designing buildings, and if he needed something, I'd go back and work with him. I had enough programming experience that sometimes, it was just easier for me to program engineering equations than it was to tell him what to do. So I actually contributed to the programming part of it too. And for the next two years, it was the two of us working mostly with a couple of his friends that were programmers that helped with some components.

In 1990, we released the first version, which we called RAMSTEEL. And all it did was gravity beams. And then a couple of months later, we released the column design module. Along the way, we implemented frame analysis so you could do wind and seismic, not just gravity, and also added foundations. And in 2005, Bentley Systems came along and acquired the company. So RAM became part of Bentley, and they retained the RAM name on the products because we were so well known. And we're now part of the family. Bentley has a wide range of software products—anything to do with infrastructure, construction management, project management, water, sewers, roads, bridges, buildings, geotechnical, the whole gamut of infrastructure projects. It's fun being part of a big international company where we have more of a reach with our products.

Speaking of the name (RAM), how did you come up with it?

That's an interesting story. I think it was Mike, the programmer, that came up with the idea of a ram being this powerful animal, and the thought of a ram's head with the horns and stuff like that, you know, that we thought would make for good imagery. We never ended up going with that idea, but Rory Rottschalk, the vice president of the company that pushed for devoting resources to writing RAM and undertaking it as a commercial venture, pointed out that his initials were RR. And that Mike's initials were MM. I could see where this was going since I'm Allen Adams. And there you have it. That wasn't our original intent. It was just sort of this natural fit that worked out really well.

That's a neat bit of history! On the flip side, is there anything new with the software?

We're continually upgrading the software. That never stops. Recessions come and go, the pandemic ebbs and flows, but we just we never slow down. There's always something to do in the software to make it better. And codes always change. For example, right now we're working on an update involving the Canadian steel code. We're also looking at things like bringing in cloud computing, and we've introduced some cloud capabilities with our most recent version, and those will continue to improve. And I'm excited about that because all of Bentley's software packages can share capabilities with each other. What I actually enjoy the most is coming up with simple features like creating commands that can save the engineer a few seconds. But it's a few seconds of repetitive work, and that adds up. Those are the changes that are the most fun because they make the engineer have a more delightful experience with the software.

When I was a structural engineer actually doing projects, I used to love to go out on the job site and see if the project looked like it did on the drawing. It was so satisfying to visit a project and say, "I did that!" I don't get to do that anymore, and that's what I miss most about structural engineering. But what I have now is the knowledge that I've had an impact, that I've helped engineers across the country and all over the world with the buildings that they're designing. And when I drive by buildings, I wonder whether it was designed with RAM. And even more satisfying is when engineers tell me how much they love RAM or how much they appreciate it because of how it's helping them work more effectively and more productively. And to be honest, I love this conference because I get to meet so many of these engineers who have used our software on their projects.

That has to be very satisfying. Switching gears, I want to talk briefly about where you live. You're in Oceanside, Calif., near San Diego. I always like to ask people about their favorite things about where they live. For you, I'm just going to guess the beach. Or maybe the weather.

Ha! Yeah, the two kind of go hand-in-hand.

Being near San Diego, are you a fish taco fan?

I love fish tacos.

Do you have a personal favorite that you're willing to tell people about?

It's actually a chain called Rubio's. It's really good. They sort of invented the whole market for fish tacos in Southern California. ■

*This column was excerpted from my conversation with Allen. To hear more from him, check out the September Field Notes podcast at **modernsteel.com/podcasts**. Allen was one of several award winners that I interviewed at this year's Steel Conference in Denver. We'll post videos of all the interviews later this year on AISC's YouTube channel at **youtube.com/AISCSteelTV**. And you can also read an interview with another winner, Gian Rassati, in "Intercontinental Connection" in the June issue, available in the Archives section at **www.modernsteel.com**. Also, in addition to Rubio's, this editor also highly recommends **Juanita's Taco Shop** in Encinitas, Calif., for excellent fish tacos.*

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

Creating a Creative Environment

BY SUSAN ROBERTSON

If you follow the "rules," you can achieve brainstorming success in any environment.

IS ONLINE OR IN-PERSON a more creative environment?

The short answer: Both. Or neither.

It's solely dependent on how the meeting is structured and managed.

A recent study found that online interactions result in less creativity than those that take place face-to-face. The reason: When online, people mostly stare at the screen rather than letting their eyes wander around, which sparks more divergent thoughts.

But the flaw with this study and others that come to the same conclusion is that the conditions that actually result in creative thinking were never set—in either the online or the in-person experiments. So while the in-person interactions were seen as slightly more creative, neither type was very creative at all, in the absolute.

While an "anything goes" approach might seem intuitive at first when it comes to creative thinking, truly effective creative thinking requires adherence to specific guidelines. If done casually, without guidelines, it won't be effective regardless of the format. But don't worry: The guidelines are anything but limiting. Here are ten "rules" to adopt when encouraging creative thinking in your next work meeting, whether online or in-person.

Free them from fear. It's very difficult for people to share ideas if they're concerned about negative consequences. A climate that helps people get past their fear is critical. One key principle is to prohibit any evaluation (even positive evaluation) during the idea generation phase. All evaluation should only occur *after* idea generation is complete.

Use the power of the group. Build, combine, and create new ideas in the moment. Don't just collect ideas that people have already had. *The building and combining are where the magic happens.* Break up into pairs or small groups to encourage even more building and combining.

Get outside stimulus. Asking the same people to sit in the same place and review the same information won't result in exciting, new ideas. Talk to your customers, talk to other experts, and explore what other industries are doing. Have the in-person meeting in a park or museum. If online, mail everyone some dollar-store toys in advance or play music or show (appropriately) unusual pictures.

Encourage the crazy. Something often heard at the beginning of a brainstorming session: "Every idea is a good idea." This is often followed by a collective eye roll because no one believes it. While it's not true that *every* idea is a practical idea, it is true that every idea can offer useful stimulus for additional ideas. Sometimes, ideas thrown in as jokes can be the spark that leads to a new direction and a winning idea. So allow, encourage, and use every idea, even if only for creative fodder.

It's a numbers game. The more "at bats" you have, the more likely you are to hit a home run. Drive for quantity. Ensure the session is long enough to generate lots of ideas. If you only spend ten minutes on this exercise, don't expect great results.

Laugh a lot. Humor stimulates creativity, so let it happen. One easy way: Have everyone introduce themselves by answering a fun or silly question. Here's one I used in a session in December: "What's something you *don't* need more of for the holidays?" The resulting answers were hilarious, and some even started sparking real ideas!

Homework is required. Both individual and group efforts are critical for success. Insist on individual preparation. Ensure everyone knows the goal and ask them to do some homework in advance if you think it will benefit the process (and it almost certainly will).

It's not casual. Effective brainstorming requires skillful facilitation, which is a different set of skills from managing other types of meetings. There must be a designated facilitator, someone who is *not* the primary problem owner. The role of the facilitator is to objectively manage *the process*. Ideally, the facilitator should be someone who has no stake in the outcome and can remain neutral to all content. Designate a facilitator far enough in advance that the person has time to fully plan the session and potentially study up on how to do it well.

If it looks like a duck but doesn't act like a duck, it's not a duck. If you can't, or don't intend to, follow the guidelines for successful brainstorming, then don't call it brainstorming. For example, a meeting that just becomes a stage for one person to spout their opinions isn't useful. And if a brainstorming meeting is not organized and structured appropriately, everyone will feel how ineffective it is—and they'll be sure to skip your next session. So either set up for success or don't bother.

You're not done until you decide. Everyone has been in this situation: It's the end of a brainstorming session, a long list of ideas has been created, and someone volunteers to type up the list. And... that's it. There's no action, or at least none that we're aware of. It's demotivating to spend time and energy generating ideas only to feel they went nowhere. Plan time for selecting and prioritizing the ideas *during the session*. Spend at least an equal amount of time on converging as you do on diverging. Yes, you read that right. If you generate ideas for an hour, also spend at least an hour on selecting, clarifying, and planning. If you leave with a huge list of nebulous, potential ideas, that's not success. The outcome should be a short list of clear ideas and a plan for action.

Whether in-person or online, creativity happens when the correct conditions are set. If you're doing it casually, without guidelines and without skillful facilitation, it may not be tremendously effective. However, with appropriate focus on the process and environment, and by considering these ten rules, you can effectively generate creative solutions in any setting. ■

Susan Robertson empowers individuals, teams, and organizations to more nimbly adapt to change by transforming thinking from "Why we can't" to "How might we?" She is a creative thinking expert with over 20 years of experience speaking to and coaching employees of Fortune 500 companies. As an instructor on applied creativity at Harvard University, Susan brings a scientific foundation to enhancing human creativity. To learn more, please go to **www.susanrobertsonspeaker.com**.

Teaming Up

BY MATTHEW FAHRENBACH, PE

An integrated team approach
was the right prescription for an expansion to the
country's first teaching hospital.

The Pavilion at the Hospital of the University of Pennsylvania is a $1.6 billion, 17-story, 1.5-million-sq.-ft addition to the nation's first teaching hospital.


Photo courtesy of HDR © 2018 James Lane/HDR

AS THE HOME of the nation's first teaching hospital, Penn Medicine—short for the Perelman School of Medicine and the University of Pennsylvania Health System—is a pioneer in health care.

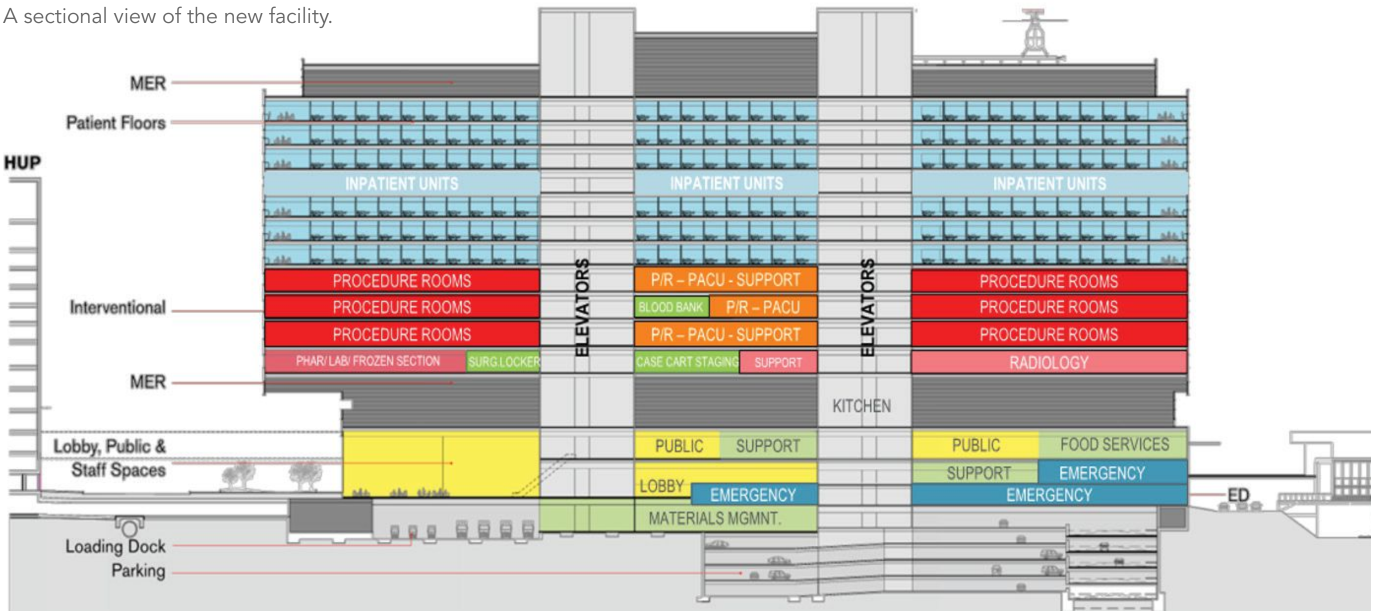
In 2008, the system's Penn Tower—which began life in the 1970s as a hotel—was emptied as the outpatient hub was moved to a new facility, freeing up valuable real estate for Penn Medicine to undertake its largest project ever. The result is the Pavilion at the Hospital of the University of Pennsylvania, a $1.6 billion, 17-story, 1.5-million-sq.-ft state-of-the-art hospital with 504 new private patient rooms and 47 operating/interventional rooms that sits atop a 690-stall subterranean parking garage. The building also houses inpatient care for the Abramson Cancer Center, heart and vascular medicine and surgery, neurology and neurosurgery, and an emergency department. The new steel-framed facility, which opened in the fall of 2021, is a beacon of hope for patients and an exemplar for the future of hospital design.

Occupying a highly visible spot in West Philadelphia, the Pavilion links the Hospital of the University of Pennsylvania to the neighboring Penn campus and the adjacent Perelman Center for Advanced Medicine. Continuing Philadelphia's civic tradition, the design weaves together several existing public spaces by providing a new promenade, plaza, and garden spaces that connect with the adjacent Penn Museum of Archaeology and Anthropology and SEPTA, Philadelphia's regional train system. In order to enhance the building's connectivity with the medical campus, three enclosed elevated steel pedestrian bridges were used to link the adjacent buildings, and another open-air bridge links the exterior green space to the regional rail system across the street. The enclosed pedestrian bridges span between 100 ft and 150 ft and are comprised of Vierendeel trusses, maximizing views through the curtain wall system.

NEED FOR SPEED

AISC's Need for Speed initiative recognizes technologies and practices that make steel projects come together faster. Check out **aisc.org/needforspeed** for more.

A sectional view of the new facility.



A PennFIRST Approach

Tackling a project as large and complex as the Pavilion is difficult enough on its own. Doing so while meeting a hyper-fast-track schedule required an incredible amount of communication and teamwork between the owner, designer, and contractor to complete the structural design in less than a year and construction of the building in less than five years. To facilitate collaboration and innovation while meeting the aggressive schedule, Penn Medicine chose an integrated project delivery (IPD) delivery method and, in 2014, formed the PennFIRST team, which included players from the planning, design, and construction areas of the project. The name is a nod to Penn Medicine's Hospital of the University of Pennsylvania, which was established in 1874 as the nation's first teaching hospital and symbolizes the organization's focus on the future. This unique project team incorporated the input of Penn nurses and other caregivers and staff into the design, giving them the opportunity to meet with engineers, architects, and constructors to talk through issues and preferences. This included the team creating a 30,000-sq.-ft model of the hospital, with movable walls and tape on the floor, for nurses and other hospital staff to "test" different spaces.

The PennFIRST team conducted several studies early in the design phase to determine the structural system that could provide the flexibility and form that the design architects and client desired while also meeting the aggressive project schedule. They divided the building into two main structural areas: the below-grade concrete parking structure and the above-grade superstructure. For the latter portion, the project team studied several different gravity and lateral systems, including an all-concrete building, a structural steel building with a precast concrete plinth, a structural steel building with two concrete cores, a structural steel building with concrete-filled composite steel plate shear walls, and a structural steel building with steel moment frames and braced frames. Ultimately, the team found that erecting a steel superstructure combined with moment frames and braced frames was the fastest, most cost-effective system. In total, 16,800 tons of structural steel comprise the project.

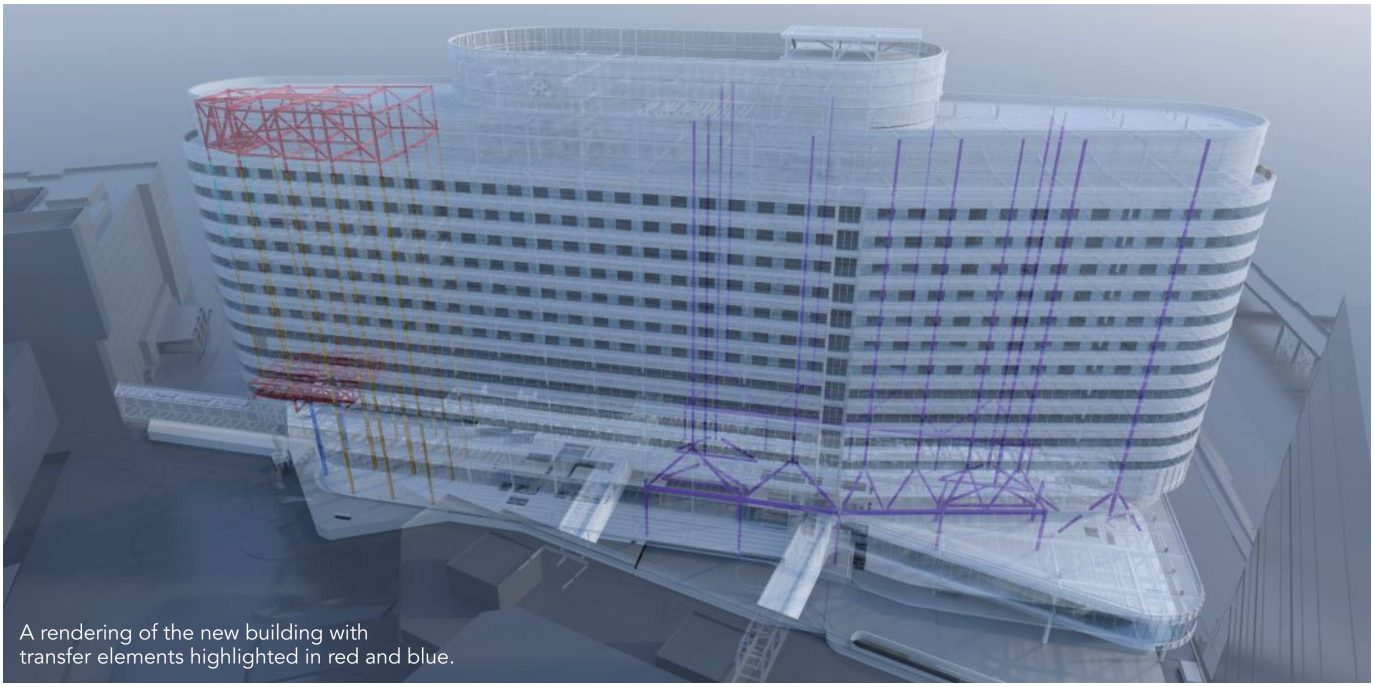
The steel erector divided the floor plate in half, placing a tower crane within an elevator shaft on both sides, which allowed two crews to work simultaneously, each erecting half of the building. Choosing an all-steel superstructure allowed the erector to complete approximately 14,000 sq. ft of area every week or so over the 20-month erection operation. In addition to the schedule benefits, the IPD team selected structural steel because it provided the most flexibility to solve the project's unique challenges, including building on a tight urban site, creating an expressive building that seemingly floats above the landscape, and the need for column locations to transfer and change as they travel vertically up the structure to optimize the building functions.

Tight Parameters

On the land-locked urban campus, the irregularly shaped, narrow site made it challenging to create a functional, aesthetically pleasing structure, and the project team developed complex structural solutions in response to the architectural demands. For example, when it came to addressing an unobstructed loading dock beneath an occupiable pedestrian plaza, the team responded by designing one of the East Coast's largest steel plate girders, which stands more than 10 ft deep and weighs 65.5 tons. The plate girder, comprised of 5-in.-thick steel plate web and flanges, allowed the column loads to transfer from the tower above to the mat foundation below, creating the open space for the dock. Further, to accommodate a car exit ramp, the team used ASTM A572 grade-65 steel, which reduced the depth of the large plate girders over the loading dock, as well as overall tonnage.

Another site-driven challenge was the need for a large on-site parking structure to accommodate the building's large number of patients and visitors. The parking structure was placed below grade to preserve grade-level hospital functions, and it was constructed out of precast concrete. The precast garage required a 63-ft grid module, which didn't match the patient tower's 31.5-ft grid module above. This resulted in 19 column transfers to the larger grid spacing. These column transfers were addressed with one- and two-story steel transfer trusses. The exterior

A site plan showing the new building's (middle) location in relation to other buildings on the Penn Medicine campus.



A rendering of the new building with transfer elements highlighted in red and blue.

Photo courtesy of HDR © 2018 James Lane/HDR

A view of the addition under construction with Philadelphia's Central Business District in the background.


Photo courtesy of HDR © 2017 James Lane/HDR

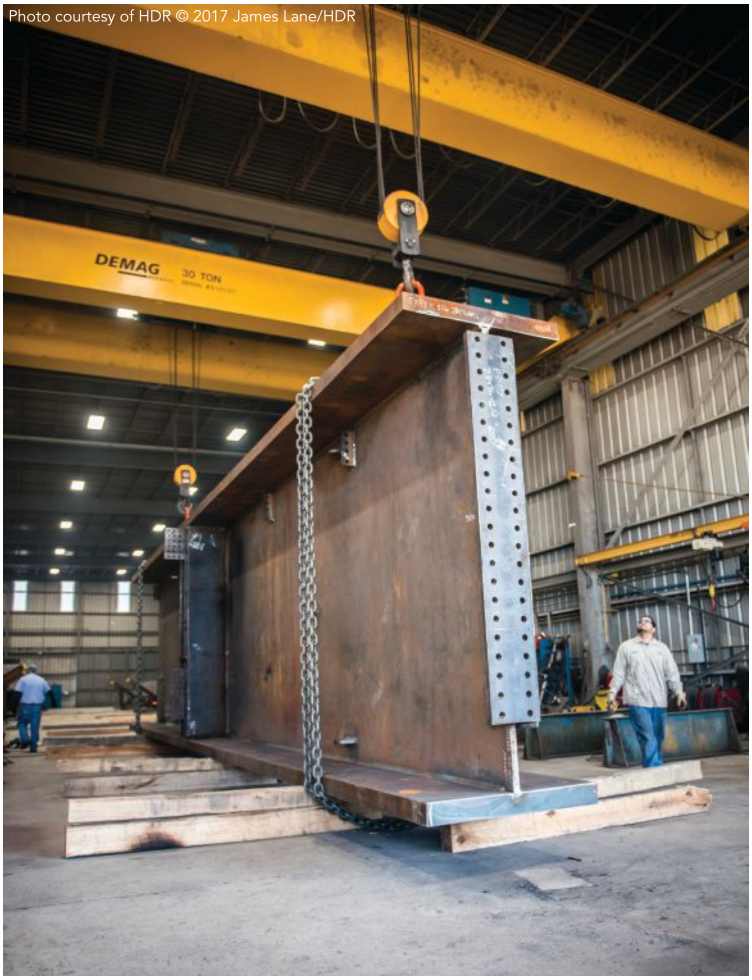


Photo courtesy of HDR © 2017 James Lane/HDR

above: Welding a plate girder in one of the three SteelFab facilities that fabricated steel for the project.

left: A completed plate girder. The largest girder used in the project is more than 10 ft deep and weighs 65.5 tons.

columns transfer within the mid-level, double-height mechanical space using heavy W14 column shapes, and interior column transfers were placed in the public level below the mechanical room, which has an 18-ft floor-to-floor height. The shallower transfer trusses consisted of cover-plated W14×730 diagonal members and W14×605 bottom chords, and the diagonal members are braced in their weak axis with double angles to reduce their unbraced length.

Floors three through 17 form a "boomerang"-shaped tower, cantilever 50 ft above the public green space, and benefit from open views of the adjacent University of Pennsylvania Museum of Archaeology and Anthropology. The cantilever's structural support is divided into two vertical regions: Floors three through nine are supported by two 11-ft-deep transfer trusses located below the third-floor mechanical room, which is hidden within the building overhang's soffit, and floors ten through the roof hang from a 27-ft-deep truss concealed within the upper mechanical room. The two support systems come together between floors nine and ten and are linked by two steel columns, which allows the vertical assembly to move as one unit under transient loads. A "W"-shaped transfer truss brings the column loads along the building's short sides down onto two "super columns," custom-plated composite steel columns encased in 10-ksi concrete. The steel in these columns weighs more than 1,000 lb per ft and the composite section supports over 10,000 kips of load.

When it came to building the cantilever, the design team proposed an initial construction sequence, and the construction team modified it as needed to meet the project's schedule requirements. To begin, the contractor placed temporary shoring towers underneath the lower 11-ft transfer trusses, more than 90 ft above the mat foundation, to help maintain truss stability during erection until all braces could be installed. Once stable, the erector installed steel up to level nine, and the contractor poured the composite slabs. The team cambered the lower truss 1¾ in. to account for the deflection under the weight of the steel and concrete. When construction reached level 9, the lower truss was roughly level.

The lower trusses support the weight of the steel beams and columns on the cantilever from level ten up to the roof, providing a base for the erector to construct the upper transfer trusses. After the erector set and bolted the upper transfer trusses, the connection between the ninth and tenth floor

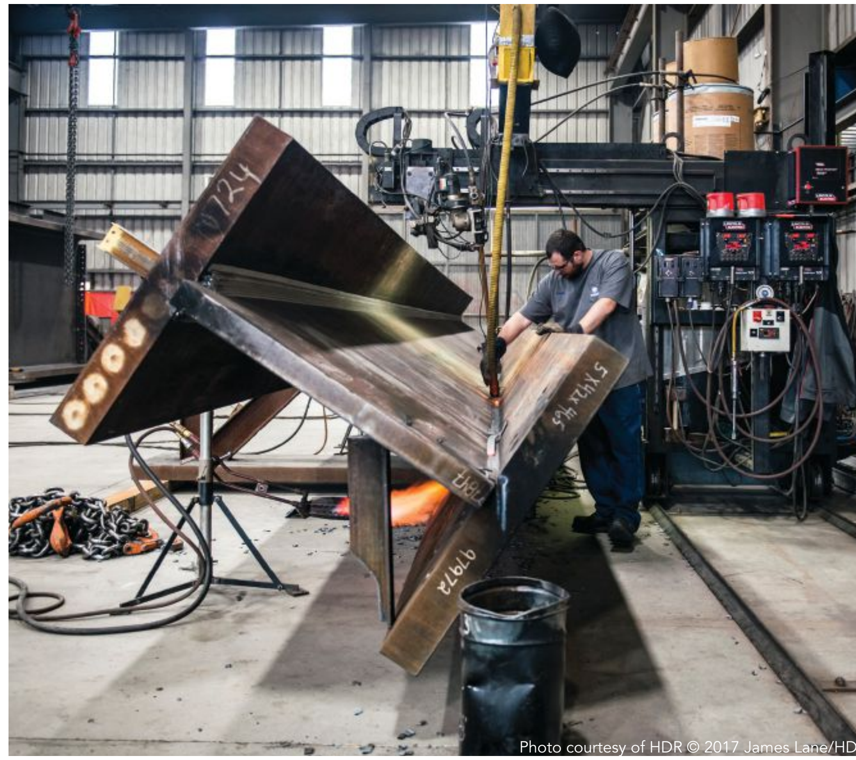


Photo courtesy of HDR © 2017 James Lane/HDR

above: The project includes nearly 17,000 tons of structural steel.

below: A "W"-shaped transfer truss brings the column loads along the building's short sides down onto two custom-plated composite steel columns encased in 10-ksi concrete.

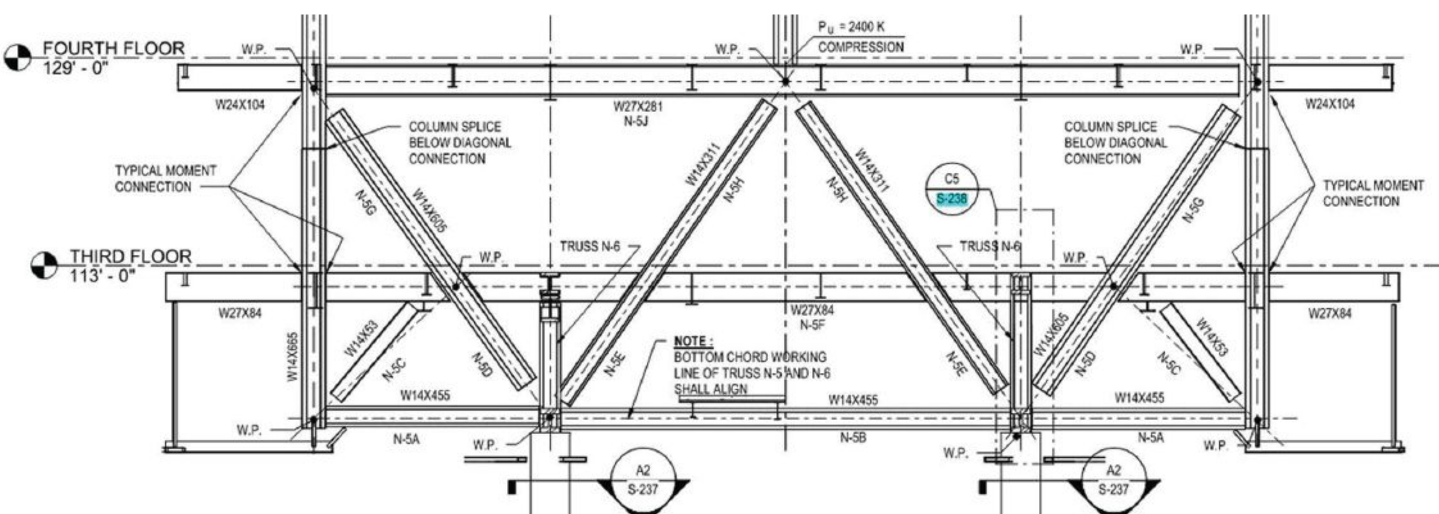


Photo courtesy of HDR © 2018 James Lane/HDR columns was split to allow the trusses to support their floors independently while the contractor poured the upper slabs. After pouring the tenth floor through roof slabs, the columns between the ninth and tenth floors were rejoined, allowing the combined cantilevered structure to move as one unit for transient loading as well as to comply with the column splice tension requirements for high-rise construction.

The construction schedule dictated that the façade erection would need to start before completing the cantilevered steel tower, and the façade subcontractor had to know how much the cantilever would deflect at different stages of construction. The team estimated cantilever deflections to help the contractor sequence and plan the work, then surveyed the floors at different times to verify the building was deflecting as anticipated.

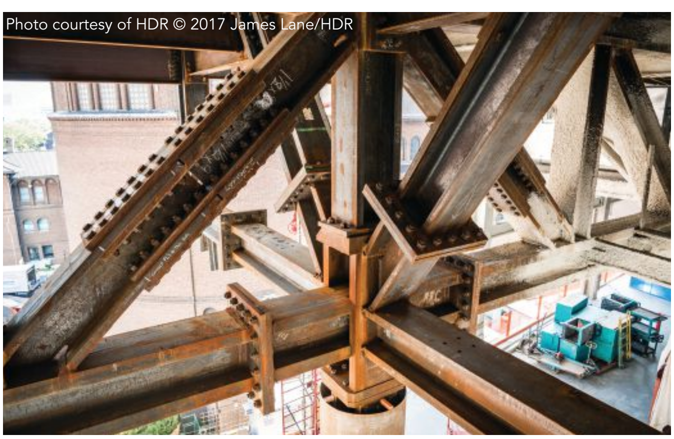
The interface between the below-grade precast parking structure and the steel superstructure above also took careful planning and coordination between the engineering teams. The precast parking garage, located below half of the building's footprint, contains one of the tower's two main steel braced frame cores. The team extensively studied the options for transferring the lateral loads from the tower above to the precast structure below and ended up settling on a hybrid approach.

Early Involvement

Early in the design phase, the IPD team brought the steel fabricator, SteelFab, and detailer on board as key trade subcontractors. This arrangement allowed SteelFab to share in the risk and reward of the contractual arrangement and integrate it into the core project team. SteelFab's early involvement was key in shaping the eventual solutions to the many unique structural challenges of the project.

When the project team analyzed the dock column load transfers, SteelFab assisted the design team by providing real-time access to plate sizes and thicknesses, confirming 65-ksi steel availability, determining the maximum girder lengths, and verifying that the large sections could be delivered from SteelFab's Charlotte, N.C., facility to the project site more than 500 miles away. As several of the plate girders exceeded the capacity of the on-site tower cranes, the contractor brought in special mobile cranes to erect the heavy members.

The project also included several transfer and cantilever trusses with complex geometry and complicated connection details. The design team worked collaboratively with the steel detailer to develop cost-effective connection details that allowed the large members and their connections to be safely erected. One complicated condition was the truss joint where the "W"-shaped transfer truss meets the lower transfer truss and the custom-plated composite concrete encased steel columns. After many design iterations, the team's collaboration led to a shop-fabricated node consisting of large column shapes welded together and fitted with doubler plates. To verify proper fit up in the field, SteelFab assembled the major steel trusses in its shop before shipping them to the construction site, where it was erected and field bolted to the connecting truss members. This averted expensive field fixes, especially as the trusses were located far above the ground.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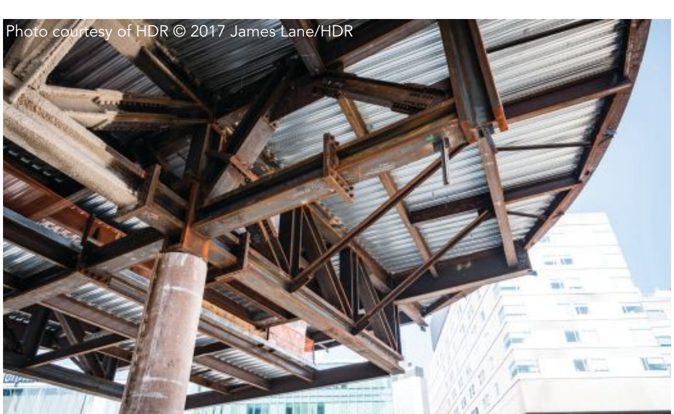
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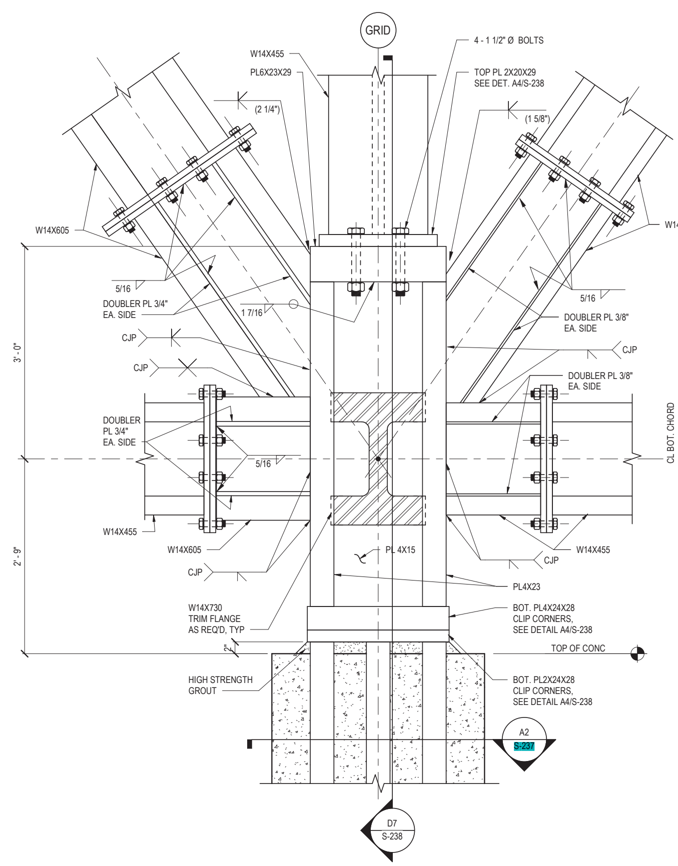

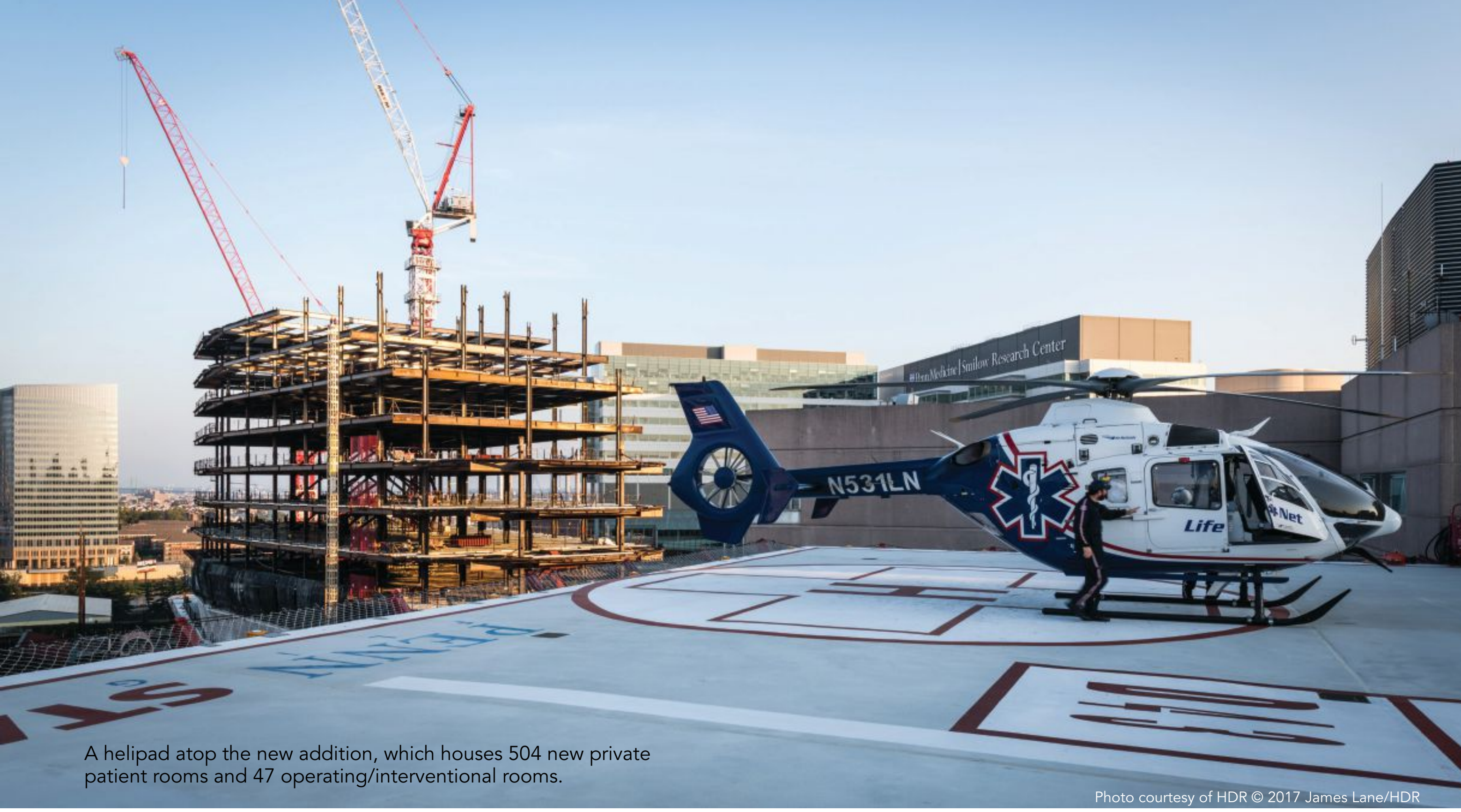

A helipad atop the new addition, which houses 504 new private patient rooms and 47 operating/interventional rooms.

Photo courtesy of HDR © 2017 James Lane/HDR

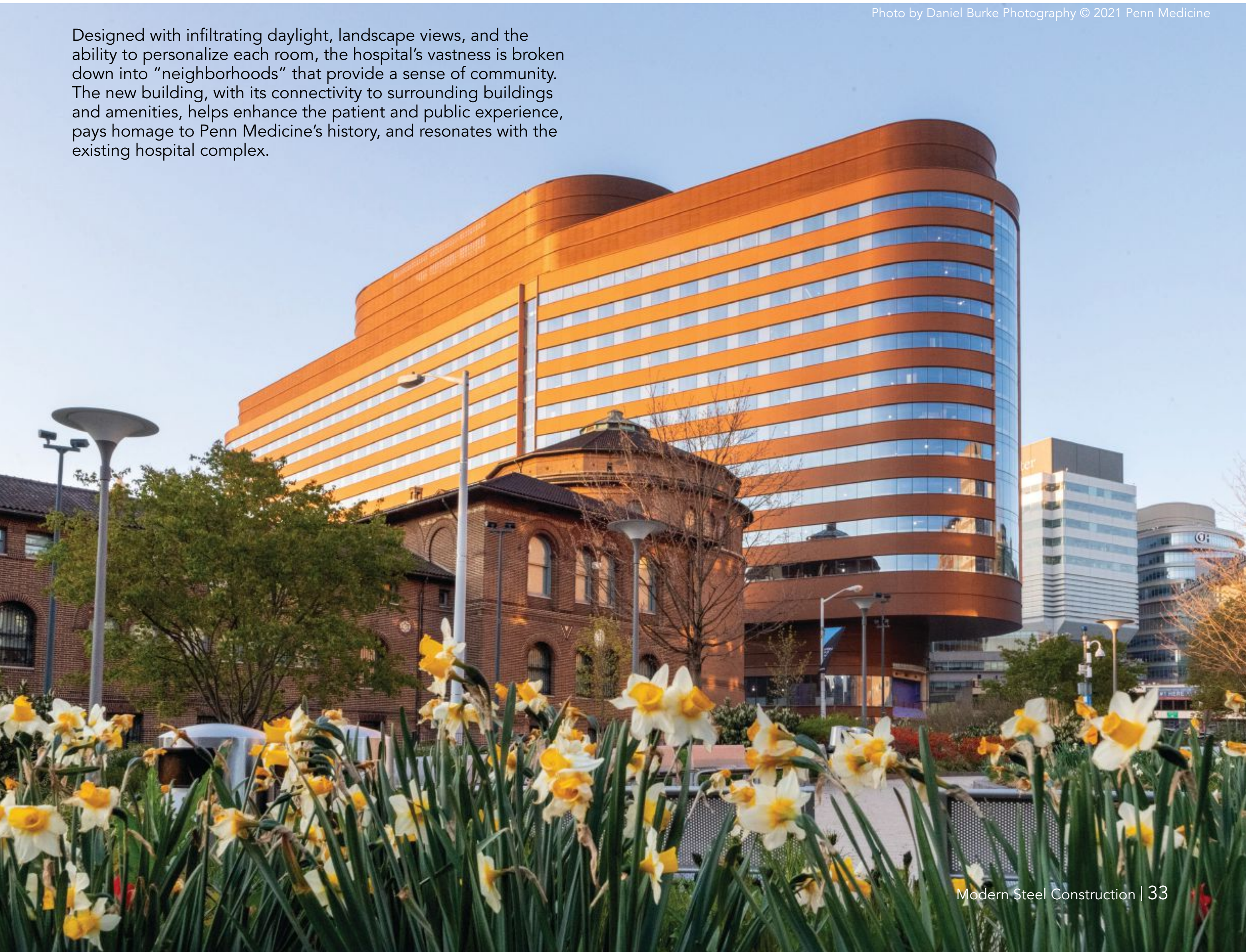

Photo by Daniel Burke Photography © 2021 Penn Medicine

Designed with infiltrating daylight, landscape views, and the ability to personalize each room, the hospital's vastness is broken down into "neighborhoods" that provide a sense of community. The new building, with its connectivity to surrounding buildings and amenities, helps enhance the patient and public experience, pays homage to Penn Medicine's history, and resonates with the existing hospital complex.

It wasn't feasible to transfer the axial loads from the steel columns into a precast column, given the magnitude of the overturning forces and the space constraints around the elevators, so the design team threaded the steel columns through the precast garage structure, bearing directly on the mat foundation. This provided a direct load path for compression and tension forces from the tower's braced frames. Lateral loads transfer from the steel braces to precast shear walls through embed plates and welded strut angles, and a heavily reinforced concrete encasement was implemented to link the precast shear walls and steel columns. The team covered the garage with a reinforced topping slab to help with lateral load redistribution between floors and to resist soil forces from the basement walls.

Staying Up to Date

In addition to increased collaboration, the project team's approach also provided up-to-date models in real time. In a "typical" project, where teams share models weekly or every other week, the information becomes outdated as soon as someone makes an update, which may not be shared until weeks later. The

Photo by Dan Schwalm © 2021 PennFIRST

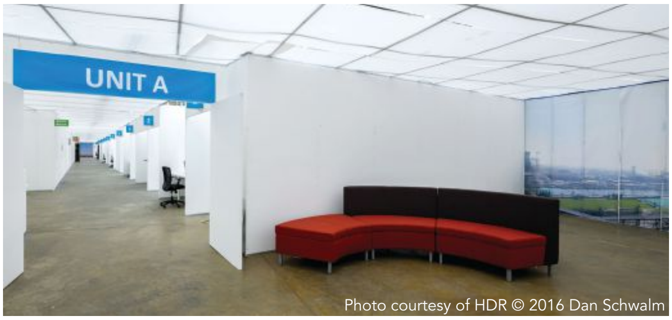

Photo courtesy of HDR © 2016 Dan Schwalm

above: The team created a 30,000-sq.-ft model of the hospital for nurses and other hospital staff to "test" different spaces.

left and below: The new steel-framed facility, which opened in the fall of 2021, is a beacon of hope for patients and an exemplar for the future of hospital design.


Rendering © PennFIRST

Grading on the Curve

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Cottrell Hall,
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4	Flat Bar The Easy Way	INSIDE DIA.	36" x 12" Flat
5	Square Bar	INSIDE DIA.	18" Square
6	Beam The Easy Way (Y-Y Axis)	MEAN DIA.	44" x 335#, 36" x 925#
7	Beam The Hard Way (X-X Axis)	INSIDE DIA.	44" x 285#
8	Channel Flanges In	OUTSIDE DIA.	All Sizes
9	Channel Flanges Out	INSIDE DIA.	All Sizes
10	Channel The Hard Way (X-X Axis)	INSIDE DIA.	All Sizes
11	Tee Stem In	OUTSIDE DIA.	22" x $142^{1}/_{2}$# Tee
12	Tee Stem Out	INSIDE DIA.	22" x $142^{1}/_{2}$# Tee
13	Tee Stem Up	MEAN DIA.	22" x $142^{1}/_{2}$# Tee
14	Angle Heel In	INSIDE DIA.	8" x 8" x 1" Angle
15	Angle Heel Out	OUTSIDE DIA.	8" x 8" x 1" Angle
16	Angle Heel Up	MEAN DIA.	8" x 8"x1" Angle
17	Square Tube	INSIDE DIA.	24" x $^{1}/_{2}$" Tube
18	Rectangular Tube The Easy Way (Y-Y Axis)	INSIDE DIA.	20" x 12" x $^{5}/_{8}$" Tube
19	Rectangular Tube The Hard Way (X-X Axis)	INSIDE DIA.	20" x 12" x $^{5}/_{8}$" Tube
20	Square Tube Diagonally	MEAN DIA.	12" x $^{5}/_{8}$" Square Tube
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PennFIRST integrated approach included architect, structural engineer, steel team, mechanical, electrical, plumbing, and site/civil representation. Using a cloud-based virtual desktop interface to host models and project-related files allowed the core team to share information in real time with live modeling.

The cloud environment also hosted the steel detailer's model, giving all construction trades access to detailing and coordination. This led to a finer granularity of coordination earlier in the construction process, where a typically less-detailed structural model is used. It also avoided coordination pitfalls, including clashes between MEP components and gusset plates, secondary members, and large connections. Having the detailing model available for trade coordination also helped locate and optimize beam web penetrations. In total, the structural and MEP teams located and coordinated more than 400 beam web penetrations, which led to a more efficient MEP system layout. ■

Owner
Penn Medicine, Philadelphia

Construction Manager
Driscoll/Balfour Beatty, JV
(L.F. Driscoll, Bala Cynwyd, Pa./
Balfour Beatty, Dallas)

Architect and Structural Engineer
HDR, Philadelphia and
Pennington, N.J.

Connection Design
McGill Engineering, Inc., Tampa, Fla.

Steel Team

Fabricator
SteelFab, Inc. AISC CERTIFIED FABRICATOR, Norcross, Ga.

Erector
Berlin Steel Construction Company AISC CERTIFIED ERECTOR, Kensington, Conn.

Matthew Fahrenbach
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A new addition to Denver Health's urban medical campus brings together more than 20 specialty clinics under one roof, employing a first-of-its-kind steel solution for Colorado.

Laura Prendergast

Come Together

BY LAURA PRENDERGAST

DENVER HEALTH'S NEW Outpatient Medical Center brings it all together.

The new seven-story, 290,000-sq.-ft hospital, located in the heart of the Denver Health Medical Center campus on the outskirts of the Mile High City's downtown area, combines approximately 26 formerly disparate specialty clinics and services—including an ambulatory surgery center with eight operating rooms—in one location. The steel-framed project was delivered under an integrated project delivery (IPD) "lite" contract in which the design team, general contractor, and key trade partners were all on-boarded at and worked collaboratively from the start of schematic design. In this scenario, general contractor Turner issued a request for proposal (RFP) for a "design-assist/target value design" while providing a square-foot summary, structural basis of design narrative, and milestone schedule. Steel fabricator Drake-Williams Steel proposed an experienced project team, a conceptual budget narrative, early involvement preconstruction services, and a transparent approach to pricing and communication.


Marisa Whitson


Laura Prendergast

opposite page: The Denver Health project was delivered under a contract in which the design team, general contractor, and key trade partners worked collaboratively from the start of schematic design.

above, right, and below: The new hospital, located on the outskirts of Denver's downtown area, combines approximately 26 formerly disparate specialty clinics and services in one location.


Laura Prendergast

The original design intent was to implement a structural steel braced frame with concrete cores and shear walls, and several different systems were evaluated for lateral bracing, including cast-in-place concrete cores and shear walls, precast cores, a traditional welded moment frame, and a fully field-bolted moment frame. The team was intrigued with the latter idea, which hadn't yet been attempted in Colorado and seemed better suited for high-seismic regions. However, the team noted this solution could speed up the construction schedule as well as offer the benefit of eliminating temperature concerns in terms of both concrete and field welding. On top of that, Denver Health was also seeking future flexibility for potential renovation and expansion over the life of the building, a situation for which a bolted steel frame would be ideal.

NEED FOR SPEED

AISC's Need for Speed initiative recognizes technologies and practices that make steel projects come together faster. Check out **aisc.org/needforspeed** for more.

During the early stages of design, the structural team—consisting of structural engineer S.A. Miro, Turner, HKS Architects, Drake-Williams, and steel erector LPR Construction—evaluated multiple framing options for cost, schedule, design implications, future flexibility, and any other pertinent information. Through this process, the team decided to design the structure using a SidePlate fully bolted moment frame system, a first for Colorado. The connection incorporates parallel full-depth steel plates to join the beam to the column. It requires no field welding and has already proven to be a success in low-seismic areas, where contractors and erectors can save time in the field because the connection can be quickly assembled. By eliminating all concrete cores and shear walls, structural steel erection was able to commence immediately following completion of the foundations, eliminating the typical lag and overlap for core wall work. In all, implementing the all-bolted system shortened the schedule by six weeks and resulted in approximately $500,000 in savings. In addition, designing an all-steel structure also allowed for the steel stair assemblies to be erected along with the structure, eliminating the need for temporary stair towers. In fact, Denver Health wanted to feature the stairs as largely glass-enclosed and positioned on the building's exterior. Implementing the SidePlate system versus using traditional concrete-enclosed cores allowed the design team to accommodate that wish.

The system also coordinated with the rest of the steel framing, which used a variety of typical gravity column sizes—e.g., W10×45, W12×79, and W12×96. Typical SidePlate moment frame columns used were W12×230, W24×176, and W24×370, and typical beam sizes were W24×68, W27×84, W33×116. Plate girder webs were 1¼ in. by 8 ft, 9 in., with the bottom plates being 1½ in. by 2 ft, 6 in. and the top plate being 1½ by 2 ft, 6 in., and used a single bolted splice at 42 ft, 9 in. The building uses nearly 2,400 tons of structural steel in all.

The project site is a long, linear strip of property with a street (7th Avenue) running through it. Levels 3 through 7 span over the roadway, requiring a clear span of about 85 ft. The team evaluated using steel trusses or plate girders to achieve this span, ultimately choosing 9-tall plate girders due to more efficient coordination with the SidePlate system, as well as to support the bridge's envelope from the girders rather than trying to detail this element off of traditional trusses. Due to all of the utilities routed below, the bridge structure also needed to clear the roadway by 25 ft (hence why the span begins at the third floor).

SidePlate

above: The project includes nearly 2,400 tons of structural steel in all.

below: Topping out!

Colton Mailes

above: The structure employs a SidePlate fully bolted moment frame system, a first for Colorado.

below: The project site is a long, linear strip of property with a street (7th Avenue) running through it. Levels 3 through 7 span over the roadway, requiring a clear span of about 85 ft.

The exterior envelope consists of prefabricated exterior wall backup panels and a unitized curtain wall. The team developed a plan to shop-install all exterior wall attachments onto the plate girders in an effort to mitigate the on-site safety risks of working over the slab edge, increase quality control when it came to installation, and enhance the level of coordination between envelope and steel trade partners (which could prove beneficial on future projects) by working together to model all attachments; light-gauge Drift-Trak slide tracks and J-hook steel clips to attach the envelope panels were delivered to the steel fabricator's shop for attachment to the plate framing. This method proved successful, and the project benefited from the associated (and expected) safety, quality, and schedule gains. And the collaborative effort used for the envelope system was a microcosm of the building as a whole—not just in terms of its design and construction but also in how it (safely, efficiently, and quickly) brought together multiple medical practices under one roof. ■

Owner
Denver Health and Hospital Authority

General Contractor
Turner Construction Company, Denver

Architect
HKS Architects, Denver

Structural Engineer
S.A. Miro, Inc., Denver

Steel Team

Fabricator
Drake-Williams Steel, Inc. (AISC Certified Fabricator), Aurora, Colo.

Erector
LPR Construction (AISC Associate), Loveland, Colo.

Detailer
Anatomic Iron Steel Detailing (AISC Detailer), North Vancouver, B.C., Canada

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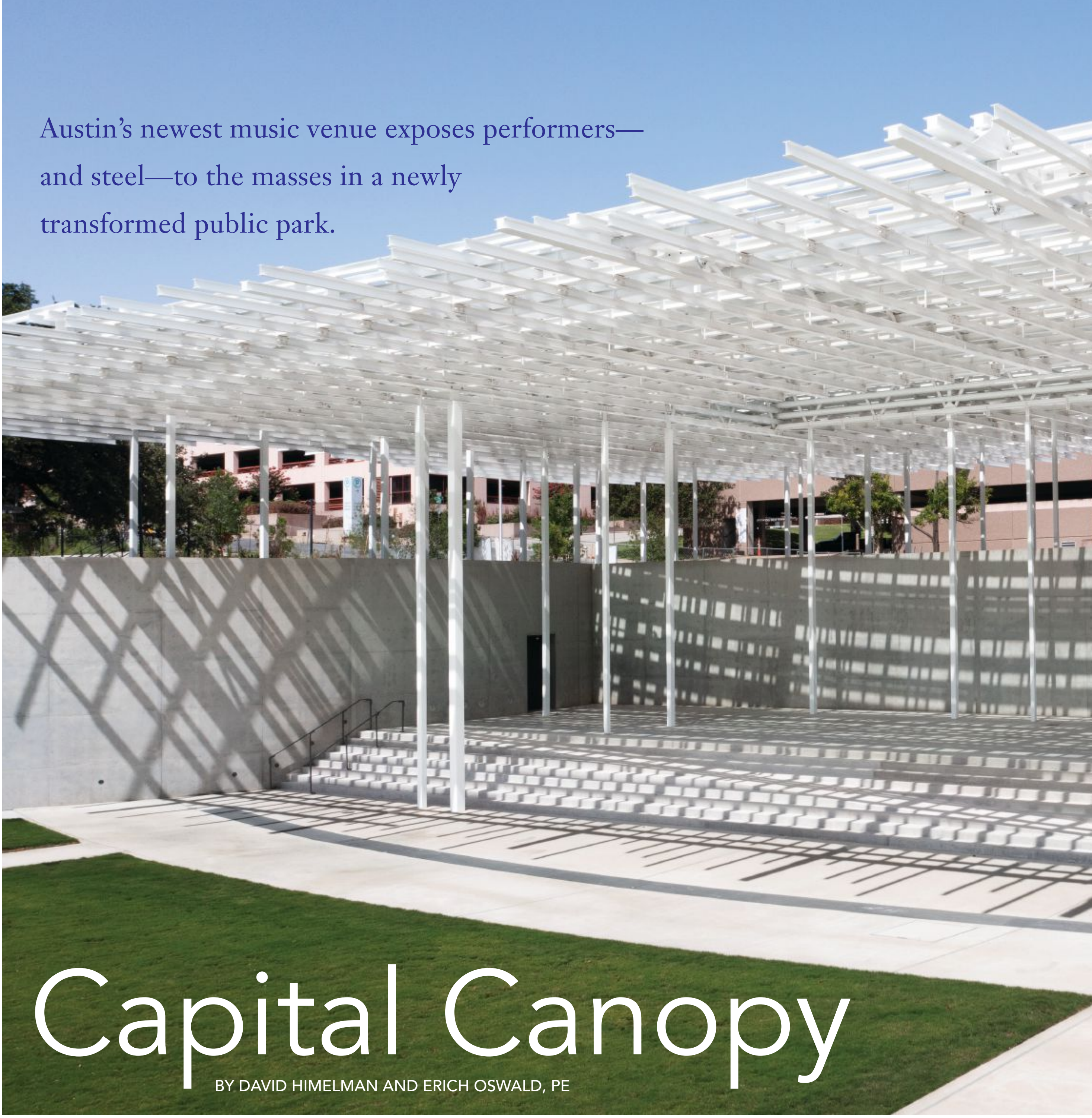


Austin's newest music venue exposes performers—and steel—to the masses in a newly transformed public park.

Capital Canopy

BY DAVID HIMELMAN AND ERICH OSWALD, PE

AUSTIN, TEXAS, long known as the "Live Music Capital of the World," has added another musical feather to its cap.

Moody Amphitheater, a new outdoor music and performing arts venue, recently opened in the heart of the city, a stone's throw away from the Texas State Capitol. Carefully integrated with the landscape of Waterloo Park, which was recently reconfigured to be part of a 35-acre greenway along Waller Creek, the amphitheater serves a dual function as a recreational space and a ticketed concert venue. The amphitheater's focal point is a 21,250-sq.-ft, 358-ton steel canopy composed of alternating layers of stacked wide-flange beams arranged in a denser pattern over the stage and feathering out at the edges. The canopy shelters a cast-in-place concrete stage and support facility that houses concessions, back-of-house functions, and VIP areas.

Lots of Load

The canopy's structural scheme satisfies the stage's high loading requirements without reducing the sculptural quality envisioned by architect Thomas Phifer and Partners (TPP). The primary canopy structure is organized on a 20-ft by 20-ft grid, with five bays in the east-west direction and eight bays in the north-south direction. The free-form plan geometry of the canopy requires the primary structure to extend past the boundaries of the primary grid along the perimeter of the structure, in some locations up to 20 ft. In elevation, the vertical depth of the canopy structure is organized as a series of 15 built-up layers, each 6½ in. deep, which "stack" upon one another to create a structural envelope with a maximum depth of 8 ft, 1½ in. and that tapers to just 6 in. deep at its outer edges.

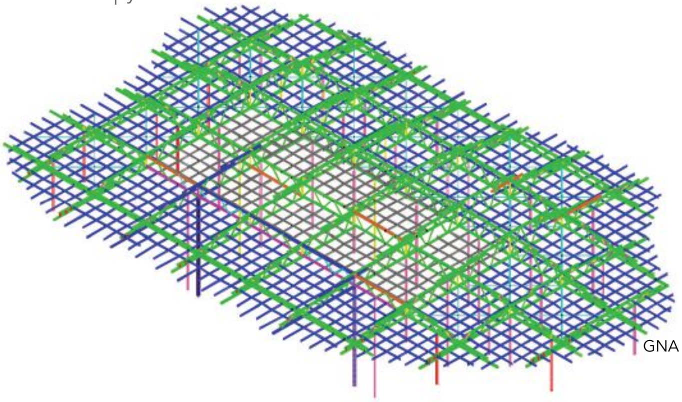
Scott Frances/OTTO (designed by Thomas Phifer and Partners)

Scott Frances/OTTO (designed by Thomas Phifer and Partners)

left: Moody Amphitheater, a new outdoor music and performing arts venue, recently opened in Austin near the Texas State Capitol.

above: The venue is defined by its exposed steel canopy.

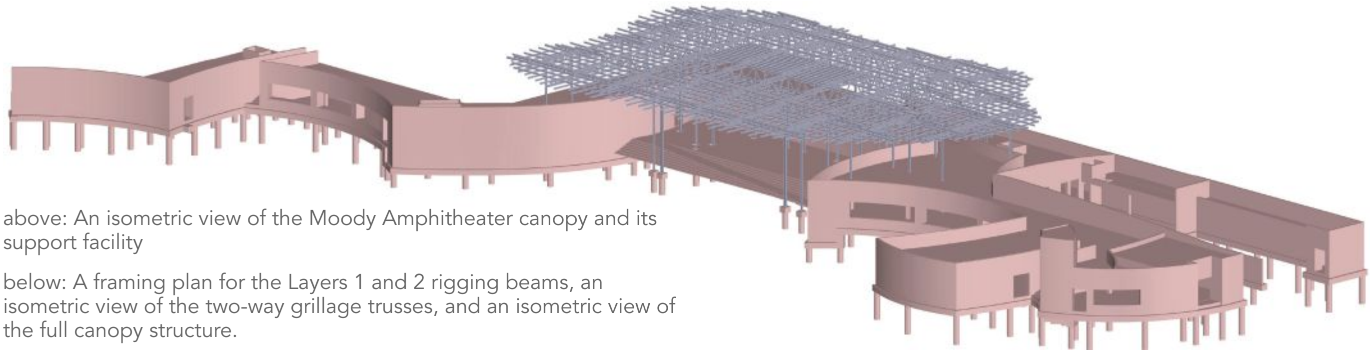
below: An isometric view of an analytical structural framing model of the canopy.



GNA

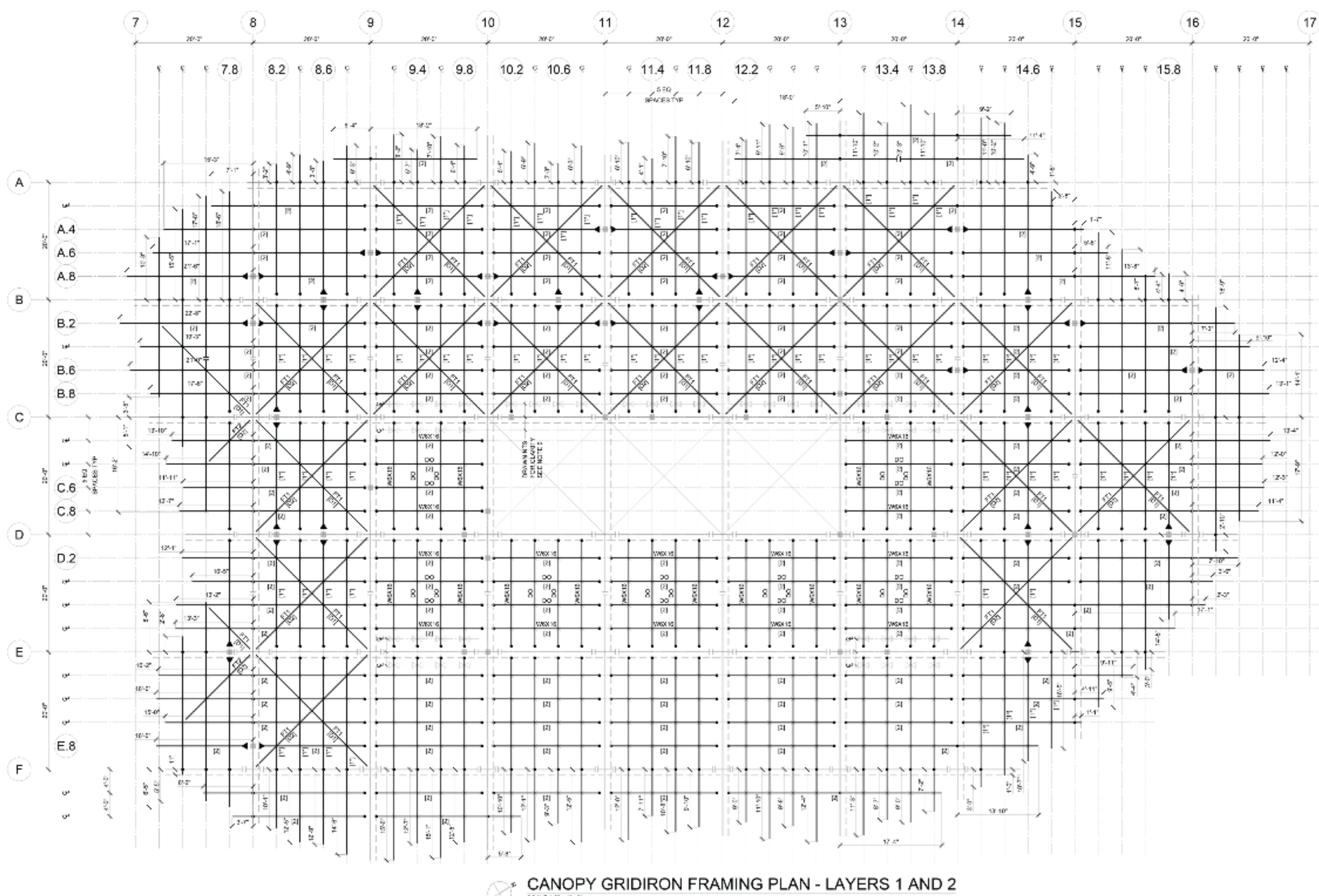
Nine primary canopy trusses spaced at 20 ft center-to-center act as the primary structure in the east-west direction, extend up to 120 ft in length, and are connected in the north-south direction by moment-connected infill trusses located at each transverse 20-ft gridline. Together, these primary and infill trusses create a two-way "grillage" of steel framing. The truss geometry of offset diagonals and uniform member dimensions was designed and detailed to be fully integrated within the architectural language of the overall canopy, adaptable enough to accommodate demanding staging, rigging, audience sightline, and irregular column placement requirements, and able to be fabricated and installed in an efficient, systematic manner.

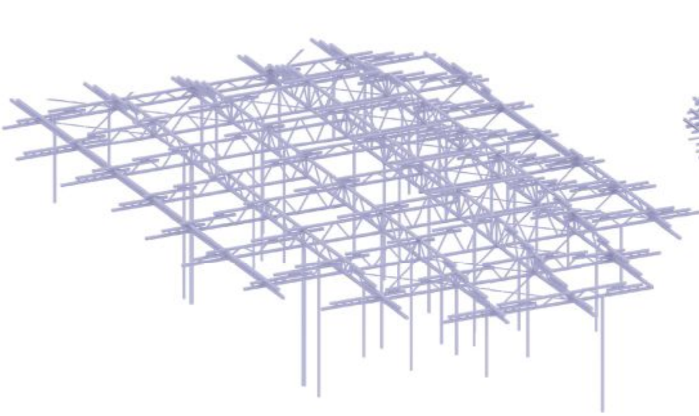
The primary canopy trusses have continuous bottom chords and discontinuous stepped top chords that follow the profile of the canopy. These chord members are fabricated sections consisting of an HSS5×5×3⁄8 or 5×5×½ "core" plus welded top and bottom horizontal flange plates of ½ in. thick by 9 in. wide (using A572 Gr 50 steel) that are intended to increase the bending stiffness of the composite profile and to bring the square hollow structural sections (HSS) within the visual language of stacked wide-flange sections. The discontinuous stepped top chords overlap one another in plan by varying lengths as required to maintain structural continuity and truss performance. Above the 20-ft by 60-ft stage area, the bottom chords of the trusses step up to Layer 9 to provide required clearance above the stage while still keeping the overall canopy profile below the city's Capitol View Corridor, a code restriction designed to keep new constructions in Greater Austin from obstructing views of the State Capitol dome.

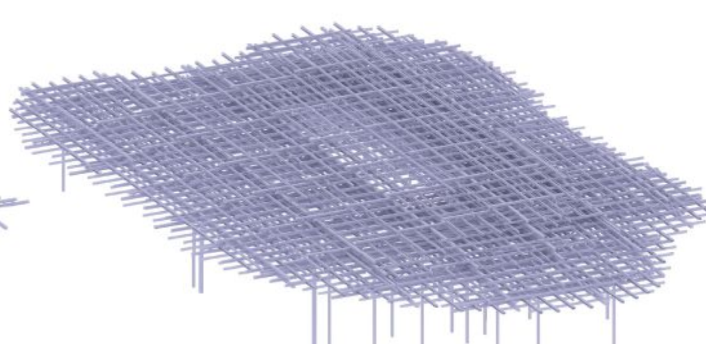


above: An isometric view of the Moody Amphitheater canopy and its support facility

below: A framing plan for the Layers 1 and 2 rigging beams, an isometric view of the two-way grillage trusses, and an isometric view of the full canopy structure.







Images this page: GNA

Vertical truss members were designed as square HSS5×5 members and were located only at primary gridline intersections. Diagonal members within the plane of each primary truss were designed as square HSS4×4 members. At locations of particularly high concentrated forces, built-up steel plate box sections and solid steel plate sections were used for the truss vertical posts and diagonals, respectively, and multiple overlapping top chord members and/or intersecting truss members often intersect these vertical and diagonal members. Design and detailing were conducted primarily using a series of analytical structural models developed in SAP2000 using initial base geometry from a Rhinoceros 3D digital model created by structural engineer Guy Nordenson and Associates (GNA) in close collaboration with TPP.

Because the intersection and connection of the primary trusses to the perpendicular infill trusses are critical to the canopy's overall structural performance, particular care was taken to detail these connections in a way that would limit the scope and complexity of required field welds and minimize the potential of field fit-up complications during erection. Each of the nine primary trusses was therefore designed with cantilevered "outrigger stubs" at the location of every intersecting transverse infill truss. These outrigger stubs vary in length from 1 ft, 6 in. to 3 ft and are typically symmetric about the vertical axis of the primary truss, extending out to each side of the truss.

The outrigger sections are built-up steel plate box sections with 9-in.-wide top and bottom flanges of 1-in. to 1¼-in.-thick A572 Gr 50 plate and double 1-in. web plates, each inset 2 in. from the outer edges of the flanges. These outrigger sections are typically 6 in. deep at the splice locations but increase in depth by the dimension of the flange thickness at the truss intersection to allow for full and direct transfer of bending forces through the connection and are aligned with the flanges of the overlapping and intersecting members at the layer above and below. The outrigger stubs were designed to be shop fabricated integrally with the primary truss steel, allowing the field splice locations of the connecting infill trusses to be offset by up to 3 ft from the primary truss centerline at locations with lower load demand and less geometrical complexity than at the nodes of the truss intersections themselves.

above: Carefully integrated with the landscape of Waterloo Park, which was recently reconfigured to be part of a 35-acre greenway along Waller Creek, the amphitheater serves a dual function as a recreational space and a ticketed concert venue.

left and right: Solid bar columns and hollow box columns in the fabrication shop.

Images this spread: GNA

Making (Many) Connections

In addition to the outrigger sections, each primary and infill truss connection was explicitly detailed and documented by GNA in a 200-plus-sheet detail booklet that accompanied the contract document structural drawings. While many of the connection details were somewhat repetitive, varying only slightly in geometry or configuration, GNA, general contractor DPR, and steel fabricator and erector Patriot Erectors recognized that sufficient complexity existed across the range of connection types such that it would be beneficial to all involved for GNA to draw each detail and reference them in key framing elevations of each primary and infill truss.

The amphitheater canopy roof structure is supported on a series of 45 built-up steel plate box columns, located along primary gridlines but typically offset in intervals of 4 ft from gridline intersections, and serve as both the primary gravity and lateral load resisting system. Columns were connected to the bottom of the truss chords at either Layer 1 or Layer 2 and range in height from 17 ft, 4 in. where they're supported at the support facility roof level to 27 ft, 4 in. where they extend down to the stage and park level. These column locations were carefully coordinated with a challenging set of competing design constraints, including placement limitations due to staging and audience sightlines, lateral load-resisting column locations limited to "short" columns located above the support facility, the need to accommodate significant axial and bending force demands generated by truss spans of up to 170 ft, and maximizing column slenderness and perceived "irregularity" of placement to maintain architectural design intent.

GNA developed four column profiles in response to these constraints. Column Type SC1, the smallest profile, is 4½ in. by 4½ in. made from solid ASTM A572 Gr. 50 plate stock, Column Type SC2 is a 6-in. by 6-in. hollow box section fabricated from of 1-in.-thick plate, Column Type SC3 is a 6-in. by 6-in. square box section cut from solid A572 plate, and Column Type SC4 is a 9-in. by 9-in. square hollow box section, also fabricated from 1-in. thick plate stock. These dimensions follow a proportional sequence of 3, 4, and 6.

Gravity columns are connected to the truss cords with slender steel "column plates," typically 1 in. by 4 in. by 12 in., each oriented to be co-planar with the longitudinal axis of the truss to which it is connected. Lateral columns are connected to the truss cords with "column stubs," which are solid 6-in. by 6-in. square profiles similar to Column Type SC3. Similar to the infill truss outriggers, these column stubs were shop fabricated integrally with the primary trusses and infill trusses, allowing the field welded connections of the lateral columns to canopy structure to occur downset from the canopy truss bottom chords.

above: Custom truss chord fabrication.

right: Truss outrigger section fabrication.

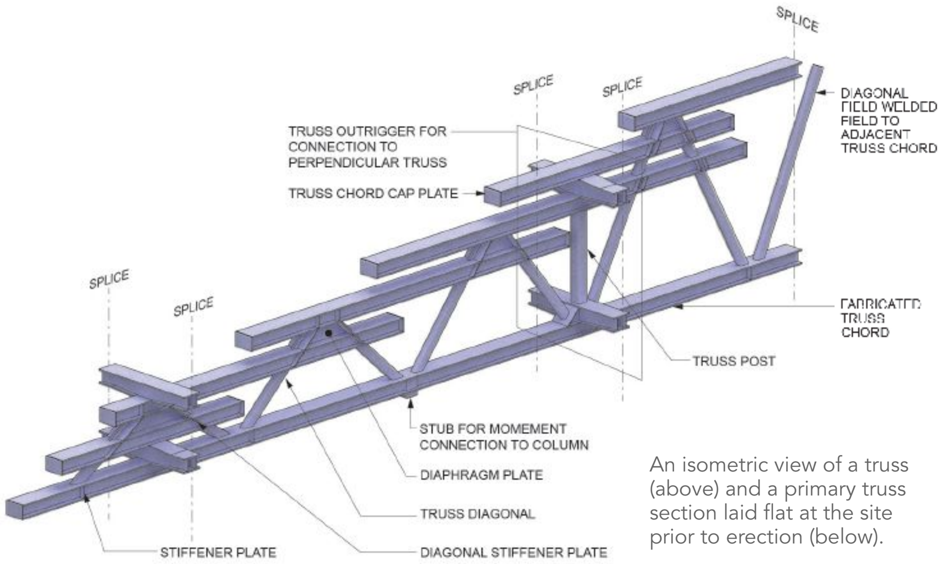
below: Fabricating a diagonal member with multiple overlapping truss members.

While not specifically designated as architecturally exposed structural steel (AESS), the entire frame is exposed and GNA included finish requirements in its specifications that would place the steel on par with AESS requirements—e.g., the columns were all designed with corner radii of only ⅛ in. maximum. (For details on the various AESS levels and requirements, see "Maximum Exposure" in the November 2017 issue, available in the Archives section at **www.modernsteel.com**.) The columns are integrated with the architecture and landscape in such a way that park visitors and concertgoers can move in between and around them, and their slenderness and irregularity of placement helps impart a sense of lightness to the cloud-like canopy mass supported above.

The steel and aluminum wide flange sections, which populate the body of the canopy structure within the truss grid, were designated as either "rigging beams" or "architectural infill members." These members are organized along a 4-ft by 4-ft sub-grid and maintain the same stacked "grain" as the 15-layer build-up. The beams in Layers 1 and 2 are designated as rigging beams and were designed as AESS W6×12 members. Above the stage area, the rigging beams occur at Layers 9 and 10, based on the raised bottom chord profile of the trusses at that location.

These rigging beams are typically connected to the truss chords at both ends, except at the perimeter of the canopy, where beam cantilevers of varying lengths produce the feathered edge appearance. These beams provide flexible attachment points for live performance equipment, including speakers, lighting, and display signage. The Layer 1 and Layer 2 steel framing also includes a series of diagonal WT sections within the plane of the roof canopy. These diagonal sections were arranged as X-braces within each column-supported bay, creating a continuous network of diagonalized diaphragm bracing around three sides of the canopy with lateral columns below. The diagonal bracing does not extend over the canopy area between the stage and the audience lawn, as only slender gravity columns support the canopy framing in that zone. The rigging steel and bracing details were designed primarily as bolted-only connections and incorporated long-slotted slip critical bolts and shim space to accommodate horizontal and vertical tolerances, respectively.

The architectural infill members make up Layers 3 through 15 and were designed as W6 profile aluminum sections and support the glass skylight sections that are integrated into the canopy framing above the stage area. The layered build-up of more than 2,000 steel and aluminum W6 beams within the canopy structure provides significant shading below the deeper areas, feathering out to less uniform shading and more dramatic shadows around the shallower perimeter areas.



An isometric view of a truss (above) and a primary truss section laid flat at the site prior to erection (below).

Images this page: GNA

Putting it Together

Erection engineering services were provided by Walter P Moore (WPM) and included a detailed erection sequence for installing the amphitheater steel framing. First, all structural columns and base plates were installed, plumbed, secured, surveyed, and temporarily braced. Next, multiple shoring towers set to the elevation of the bottom truss chord bottom of steel were installed at the locations of the nine primary trusses. Primary truss sections were then trucked to the site after being fabricated at Patriot Erectors' facility and then coated with bright white paint supplied by Tnemec (the coating system consisted of SP-10 blast, zinc primer at 3 mils, and an epoxy primer intermediate coat at 4 mils DFT and was finished with an aliphatic acrylic polyurethane semi-gloss at 3 mils DFT). After arriving on site and being staged flat, primary truss sections were field welded on the ground at their designed splice locations. Each of the nine primary trusses was then lifted by crane, placed in its correct location atop the shoring platforms, and secured in place temporarily via a series of connection details designed by WPM. After all nine primary trusses were installed and temporarily secured, Patriot began erecting the infill truss segments from south to north, completing all infill trusses between adjacent primary trusses before moving north to the next bay.

Following completion of the truss erection, the tops of the columns were then welded to the underside of the canopy at their designated

left and below: The 21,250-sq.-ft, 358-ton steel canopy is composed of alternating layers of stacked wide-flange beams arranged in a denser pattern over the stage and feathering out at the edges.

locations. The temporary shoring towers and bracing were removed, and then rigging steel and architectural infill member installation was able to begin. The installation of glass skylight sections took place interspersed with the rigging steel and architectural infill installation because, once the tight 4-ft by 4-ft grid of members was in place, the layer became inaccessible.

The challenges of the canopy's architectural concept, the structure's exposure to the elements, and supporting the venue's functional requirements required and were addressed by innovative and unusual structural solutions at multiple scales, from the stepped, two-way grillage of trusses to individual connection details. These challenges also promoted early close collaboration between TPP and GNA—which have collaborated on projects for three decades—to develop a viable structural design that did not impede the architectural concept predicated on an appearance of randomness. To ensure the canopy was constructable, GNA consulted with several steel fabricators during the design phases and developed detailed connection design books for Patriot Steel during construction. These collaborative efforts and development of pragmatic structural approaches helped ensure the Moody Amphitheater's full realization and have given a city known for live entertainment a beautiful new outdoor venue. ■

Owner
Waterloo Greenway Conservancy

General Contractor
DPR Construction

Architect
Thomas Phifer and Partners

Structural Engineer
Guy Nordenson and Associates

Erection Engineering
Walter P Moore

Steel Team

Fabricator and Erector
Patriot Erectors, LLC (AISC CERTIFIED FABRICATOR & ERECTOR), Dripping Springs, Texas

Detailers
Patriot Erectors
Guy Nordenson and Associates

Erich Oswald was an associate partner with Guy Nordenson and Associates until 2021 and is currently a product regional engineer with Boise Cascade. **David Himelman** is an associate with Guy Nordenson and Associates.

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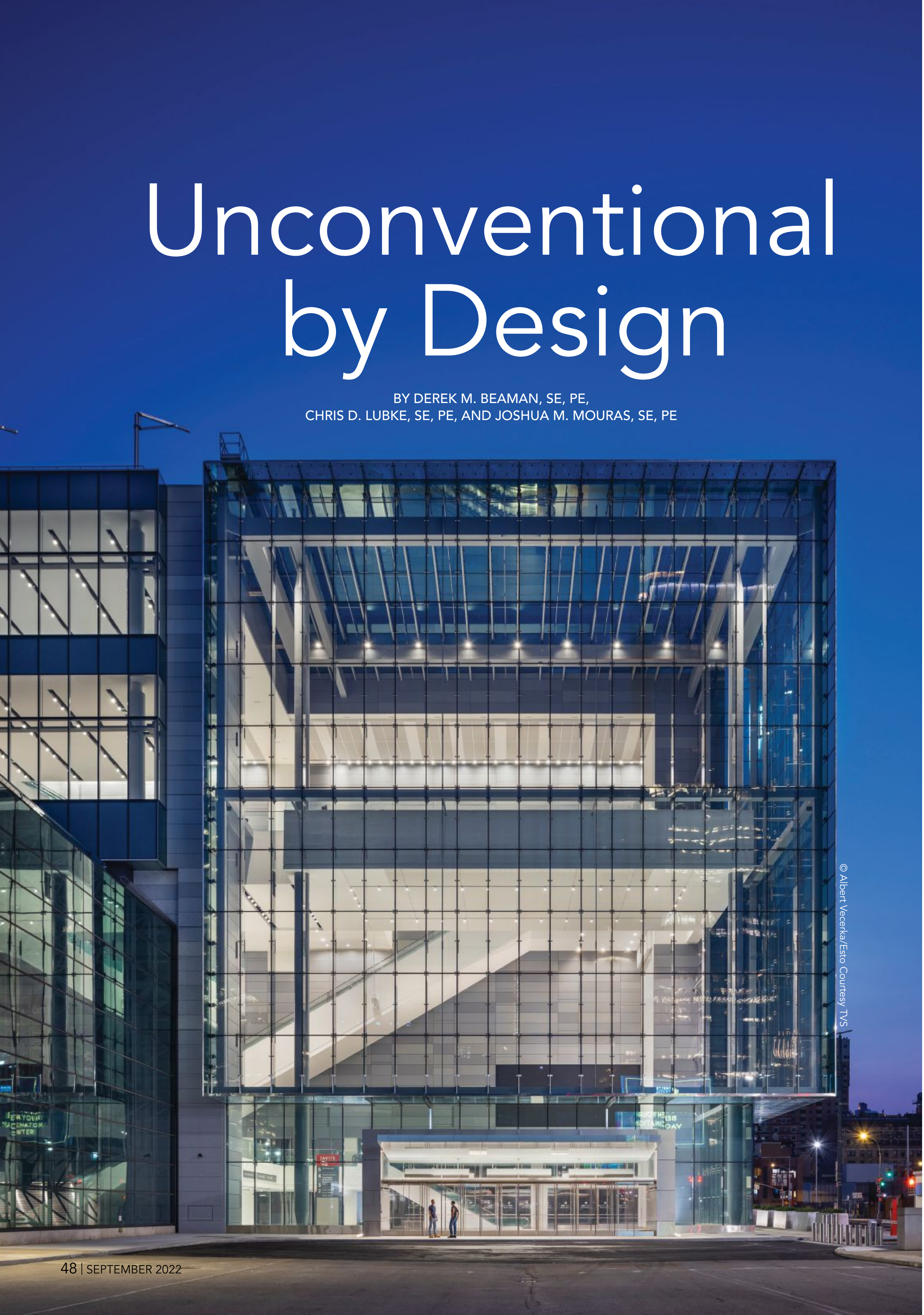
Unconventional by Design

BY DEREK M. BEAMAN, SE, PE, CHRIS D. LUBKE, SE, PE, AND JOSHUA M. MOURAS, SE, PE



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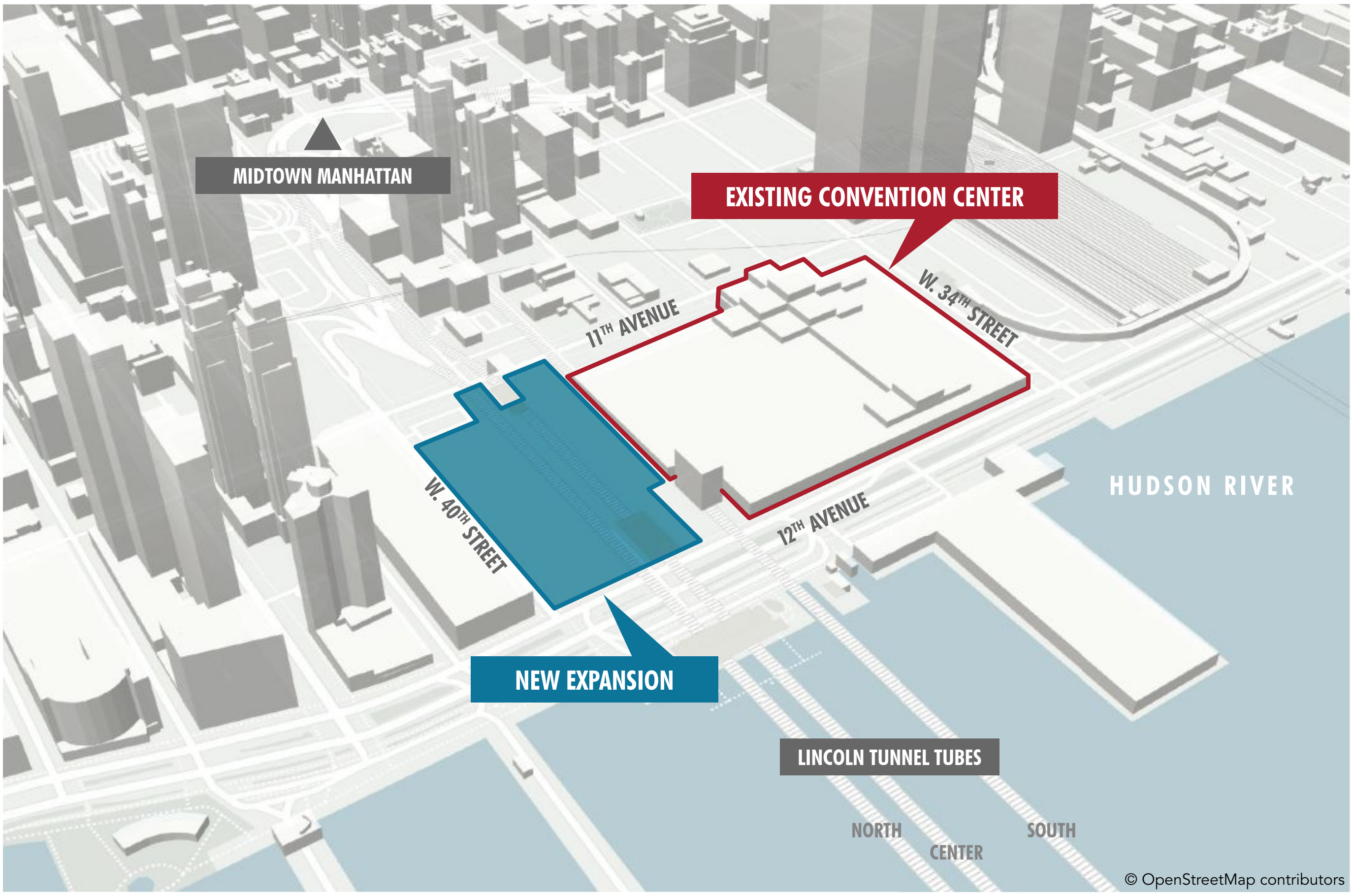
The Jacob K. Javits Convention Center's 1.2-million-sq.-ft expansion navigates Big Apple construction challenges with innovative structural engineering and a fresh take on steel design.



MANHATTAN'S JACOB K. JAVITS Convention Center has always been big and busy.

Designed by I. M. Pei and opened in 1986, its 2.1 million sq. ft made it one of the largest and most sought-out venues in America, often hosting events for more than 330 days per year.

Over the years, however, more than a dozen domestic convention centers were constructed or expanded in the United States that surpassed the Javits Center in size, making it increasingly difficult to secure the most sought-after events that were, themselves, ever-expanding. If the venue were to remain a viable New York City convention option that continued to draw visitors and generate revenue, it would need to increase its program space and elevate its place in the competitive convention center market.

opposite page: The jewel box lobby of the 1.2-million-sq.-ft expansion to New York's Javits Center.

above: A layout of the Javits Center showing the existing facility and the new addition.

In 2016, the State Legislature enacted legislation and appropriated funds to expand the Javits Center, thus starting the process of selecting a design-build team to deliver on the program aspirations, which included:

- A 90,000-sq.-ft expansion of the existing exhibition hall (bringing the combined area to the industry-coveted 500,000 sq. ft)
- An additional 45,000 sq. ft of flexible meeting room space configurable to meet each client's needs
- An awe-inspiring 55,000 sq. ft of column-free ballroom space offering Hudson River views and a nearly 50-ft ceiling height
- A signature rooftop special events pavilion with room for up to 1,500 guests that allows events to flow freely from inside to outside, a space the facility previously lacked

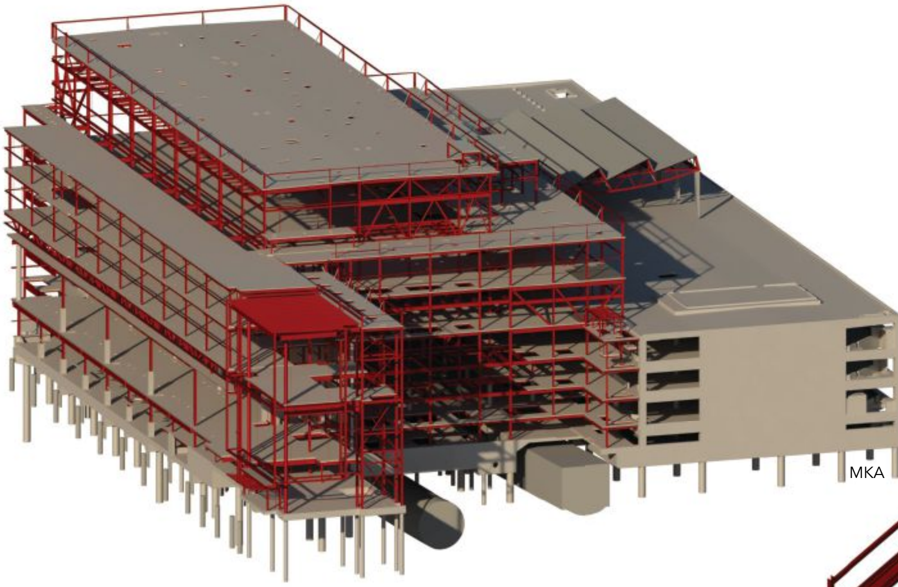
The expansion also incorporates a new four-level, 480,000-sq.-ft Truck Marshaling Building—to the authors' knowledge, the first-ever feature of this type for a convention center—with space for more than 225 trucks. The building alleviates traffic congestion by removing more than 20,000 event-related trucks annually from local streets. It also creates 20 new event days thanks to a 30%

The truck building includes steel elements on the roof in the form of trellises in the outdoor portion of the pavilion and a steel-framed indoor gathering space.

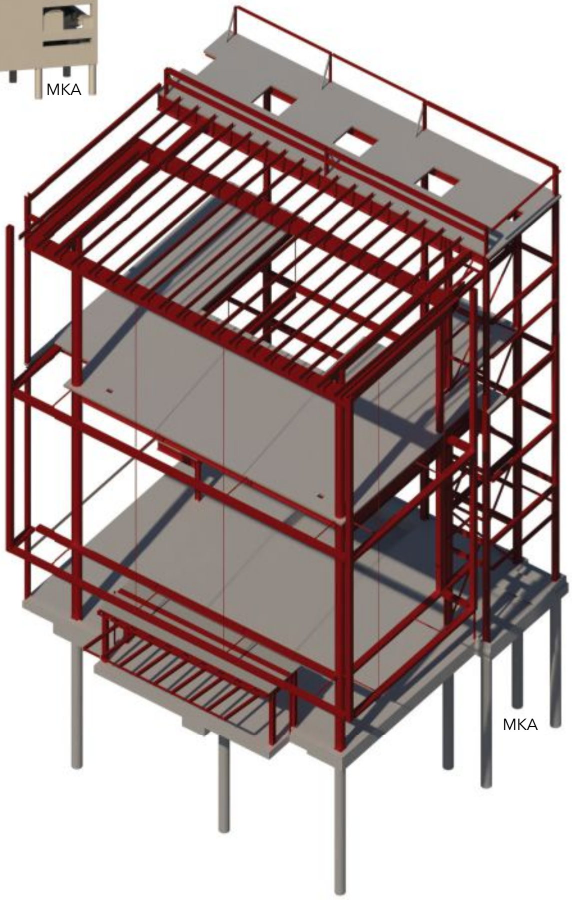
TVS

© Javits Center, Courtesy TVS

A portion of the expansion's roof includes a one-acre farm, a 10,000-sq.-ft apple and pear orchard, and a greenhouse for microgreens and vegetables. The farm operator planted 50 different crops in the first year of operation, producing 40,000 lb of fruits and vegetables for the facility's kitchen.



left and below: Revit models of the entire expansion and the jewel box lobby.



improvement in move-in/move-out efficiencies. In addition, by getting the trucks off the streets and parked rather than idling, it curbs pollution and creates a safer neighborhood environment for pedestrians and drivers alike. The truck building's roof houses the special events pavilion as well as another industry-first program element: an urban agriculture outlet in the form of a one-acre farm, 10,000-sq.-ft apple and pear orchard, and a greenhouse for microgreens and vegetables. The farm operator planted 50 different crops in the first year of operation, producing 40,000 lb of fruits and vegetables for its kitchen and cutting the use of fossil fuels and carbon emissions normally associated with produce deliveries. While this portion of the project is concrete-framed, it includes steel elements on the roof in the form of trellises in the outdoor terrace space and a steel-framed indoor gathering space (the pavilion).

With only 42 months to design and construct the $1.5-billion, 1.2-million-sq.-ft predominantly steel-framed expansion (incorporating nearly 14,000 tons of structural steel), the team needed to work collaboratively to find creative solutions to challenges surrounding the project's site, programming, schedule, and construction.

A Challenging Trifecta

Three significant challenges had to be addressed at and below grade level before the superstructure systems could be optimized based on cost, schedule, and constructability considerations.

A fickle foundation. Most of the expansion site is outboard of the Manhattan shoreline that was present in 1836 and is located on land reclaimed via the placement of fill between then and the early 1900s. Bedrock elevations vary severely, dropping 60 ft from east to west. The design of the rock-socketed drilled caisson foundation system required careful coordination between the structural and geotechnical engineers to evaluate soil-structure interaction issues and ensure deformation compatibility. Based on the data from 155 borings, engineers performed an iterative 3D finite element analysis to determine vertical and lateral head stiffnesses for all 166 caissons.

Tunnel vision. Two of the Lincoln Tunnel's three tubes connecting New York and New Jersey pass beneath the expansion. The design team had to carefully coordinate the elevation and structural depth of the lowest floor to ensure the new structure cleared the tunnel structure, most significantly on the east side where the north tube daylights less than 200 ft east of the site. The layout of the caissons had to avoid the tubes, which often required grade beams to support eccentric column loads. In addition, the depth of the rock sockets had to put the bearing elevation of each caisson below the 1:1 influence line prescribed by the Port Authority to avoid lateral loads on the almost 100-year-old tunnel structures.

Flood factors. Completing the trifecta of site and foundation challenges was the design flood elevation, which has been at the forefront of many minds since Hurricane Sandy in 2012. Within a FEMA non-coastal flood zone, the design flood elevation is more than 17 ft above the lowest occupied space, a condition that imposed hydrostatic loads of more than 1,000 lb per sq. ft (psf) on the below-grade structure. The design incorporated a mild-reinforced, variable-thickness concrete pressure slab foundation system spanning up to 60 ft to combat the hydrostatic uplift pressures and support the heavy live loads.

Steel Rises to the Challenge

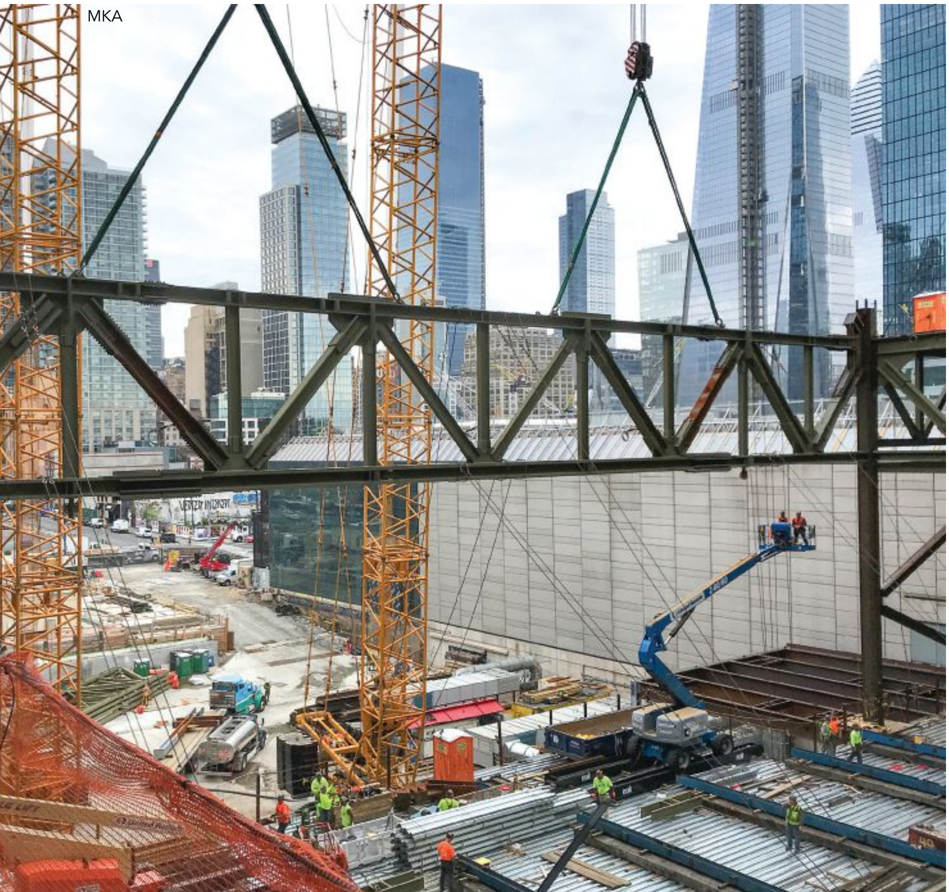
To actualize the Expo Building's stacked program of ballroom, meeting room, exhibition hall, and loading dock spaces, the team implemented a variety of custom-tailored steel solutions that met strict vibration criteria and efficiently supported long spans and heavy loads.

Two critical superstructure components underpinned the Expo Building's successful completion. The first was the floor structure for the exhibition hall, located above the loading dock. The engineers selected a composite floor structure comprised of concrete slab on steel deck, W36 steel beams, and 10-ft-deep built-up steel-plate girders spaced 45 ft apart. This framing system supports the exhibition hall's live load of 350 psf, spans up to 110 ft between columns (to allow truck maneuvering in the loading dock), and meets the strict depth limitations dictated by truck clearances below. Given the limited depth available, plate girders proved more capable of providing the necessary strength and stiffness than traditional open-web steel trusses and did so in a less fabrication-intensive and more economical manner.

The second critical component was selecting the optimal structural system to support the meeting room and ballroom levels hovering above the exhibition hall. The need to control floor vibrations during ballroom events far surpassed the challenge associated with supporting the 250-psf and 125-psf live loads for the two spaces. Rather than implement a traditional floor-by-floor framing system, an innovative interstitial steel truss system was developed. Trusses spaced 90 ft apart house the meeting room level within their depth, with a hyper-efficient truss depth of 45 ft being naturally defined by the secondary floor framing at each level in combination with the required programmatic clear height for the meeting room program. Not only did this solution deliver on the strength and vibration control, but it also afforded a span of 150 ft over the exhibition hall, vastly exceeding the owner's desires for a 90-ft-by-90-ft column spacing in that area. The structural engineer followed the acceleration criteria defined in AISC Design Guide 11: *Vibrations of Steel-Framed Structural Systems Due to Human Activity* (available at **aisc.org/dg**) and performed a 3D dynamic analysis to simulate dancing events in the ballroom and ensure that accelerations both within and outside the dance floor (and at the meeting room below) satisfied these criteria.

above and below: The two columns visible within the lobby space that support the halo beams above were designed to go above and beyond the call of duty. These 30-in.-diameter round HSS columns soar to heights of nearly 120 ft while simultaneously supporting the roof loads, eccentric façade loads, and wind loads. Custom tapered steel castings from Cast Connex were used at the top and bottom of each column.

MKA



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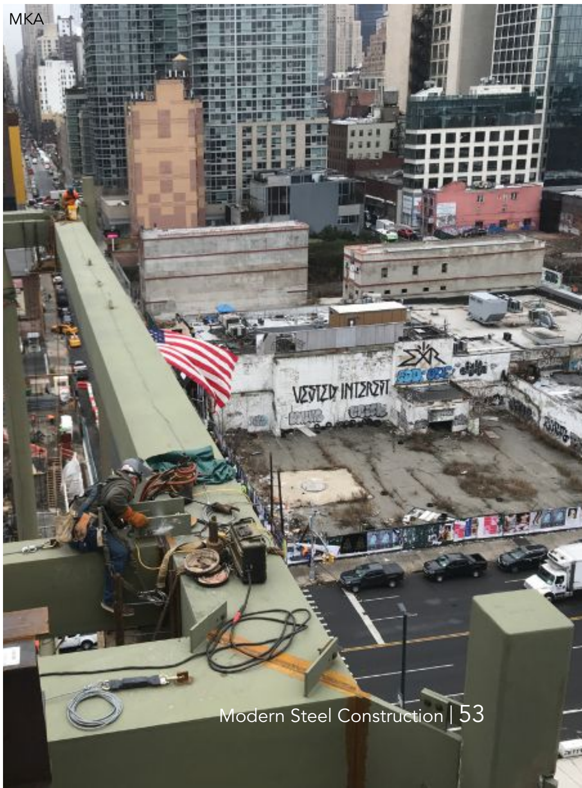
The predominantly steel-framed expansion incorporates nearly 14,000 tons of structural steel, including an interstitial steel truss system.



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A Jewel Box Lobby

The Expo Building's signature spaces warranted a grand entrance along 11th Avenue, the public entrance side for the overall building. This entrance space is wrapped in glass on three sides with interior clear heights up to 120 ft, and the design team looked to architecturally exposed structural steel (AESS) to deliver the desired look. The building was designed/specified as the current AESS categories were being refined, so the engineer custom-specified the criteria based on input from the owner. The specification most closely aligns with a current designation of AESS 3: Feature Elements in Close View for the steel spanning the ceiling of the exhibit hall and AESS 2: Feature Elements not in Close View for other steel designated AESS (steel in public lobby and pre-function spaces, etc.). (For more details on the various AESS categories, see "Maximum Exposure" in the November 2017 issue, available in the Archives section at **www.modernsteel.com**.) PPG Coraflon ADS Intermix was used as the topcoat for the UV-exposed steel in the lobby, and Sherwin-Williams Pro-Industrial DTM was used for the non-UV exposed steel (e.g., in the exhibit hall).

Hollow structural section (HSS) purlins support the skylight system at the roof level, and the skylight contractor installed the HSS framing to meet the strict AESS erection tolerances. The purlins and the façade's backup steel below are supported by four 36-in. square built-up HSS beams. Despite the rectangular configuration of these beams, this feature is known affectionately as the "halo" because of its elegant and dramatic presence.

To properly support the façade system measuring over 100 ft tall, deflection control was the name of the game for the roof's framing design. The halo beams, with spans up to 90 ft, were cambered to account for self-weight and dead loads imposed by the skylight and façade systems. To minimize deflection during construction as the loads were applied, vertical prestressing cables pre-loaded the halo beams downward to their predicted final elevations. As the skylight and façade loads were applied, the prestressing was reduced so that the beams always maintained their final position. This construction approach allowed the skylight and façade systems to be detailed to accommodate only the live load deflections, yielding smaller and more architecturally pleasing joint dimensions.

The two columns visible within the lobby space that support the halo beams above were designed to go above and beyond the call of duty. These 30-in.-diameter round HSS columns soar to heights of nearly 120 ft while simultaneously supporting the roof loads, eccentric façade loads, and wind loads. To maximize the aesthetic impact of these two key exposed elements, custom tapered steel castings (made by Cast Connex) with machined reveals were used at the top and bottom of each column.

When it came to erecting the steel, the most significant challenge was the heavy pick weights (requiring multiple mobile cranes) and the very tight site. The engineering team designed the foundation system (caisson-supported pressure slab) to be constructed before steel erection and to support the weight of steel layout and crane operations. Careful coordination was also required to erect steel immediately adjacent to the existing building (with operations ongoing inside) and cantilever the new structure over the existing structure.


MKA

above: Steel framing for the rooftop pavilion.

opposite page: The Expo Building's signature spaces warranted a grand entrance along 11th Avenue, the public entrance side for the overall building. This entrance is wrapped in glass on three sides with interior clear heights up to 120 ft, and the design team looked to AESS to deliver the desired look.

Perfect Timing

When New York City officials celebrated the updated Javits Center's grand opening in 2021, they opened the doors to a project that increased the size of the building by more than 50% and ensured its position as one of America's premier convention centers for years to come. The project presented to the market a newly expanded building with the right mix of program spaces, vastly improved operational efficiency, and fewer event-related trucks on the already-congested streets of Manhattan—not to mention the unprecedented decision to turn an urban rooftop into an unconventional farm and orchard space in the heart of the city.

To achieve these goals, the team had to find innovative solutions to a host of site- and structure-related challenges. Their tireless efforts during construction, much of which was accomplished in an environment of ever-changing COVID-19 safety protocols, coupled with the collaborative way countless obstacles were overcome during the design phase using structural steel ensured that the building opened at the perfect time—just as everyone was ready to gather again at conventions and trade shows. ■

Owner
New York Convention Center Development Corporation

Design Builder
Lendlease Turner, A Joint Venture (LLT)

Architects
TVS (prime)
Moody Nolan (associate)
WXY (associate)

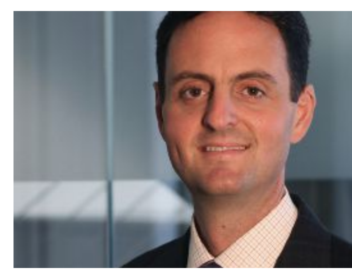
Structural Engineers
Magnusson Klemencic Associates (MKA) (prime)
Casco Bay Engineering (associate)

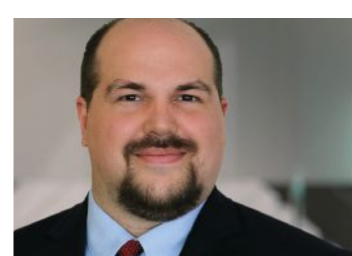
Steel Team

Fabricators
Banker Steel (AISC Certified Fabricator)
Lynchburg, Va. (main)
Cody Builders Supply (AISC Certified Fabricator)
Austin (rooftop trellis)
Berlin Steel Construction (AISC Certified Fabricator)
Kensington, Conn. (rooftop pavilion)

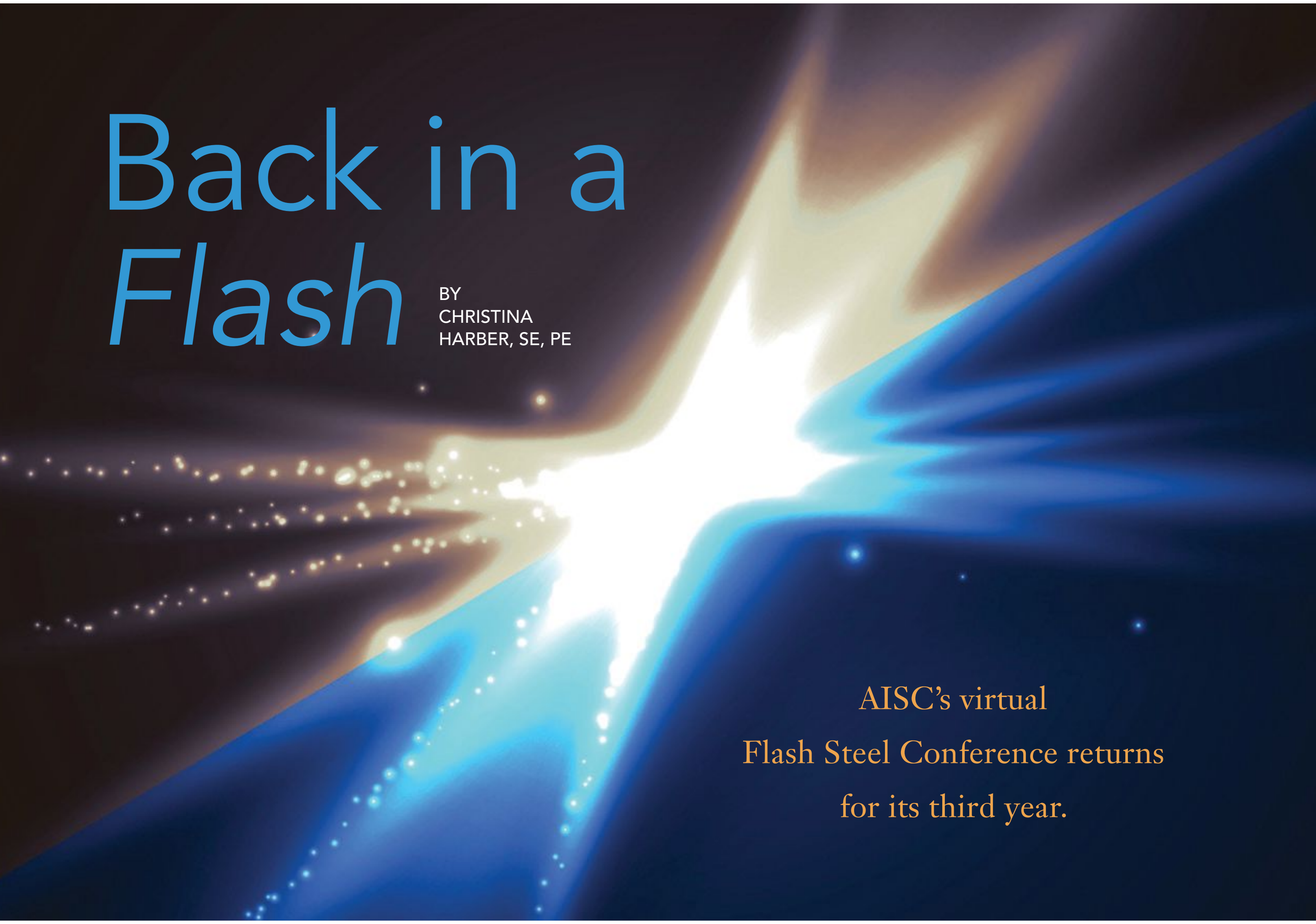
Erector
NYC Constructors, LLC (AISC Associate, AISC Certified Erector)
A Banker Steel Company, New York

Detailer
Banker Steel





Derek M. Beaman is a senior principal, **Chris D. Lubke** is a principal, and **Joshua M. Mouras** is a senior associate, all with Magnusson Klemencic Associates.



Back in a *Flash*

BY CHRISTINA HARBER, SE, PE

AISC's virtual Flash Steel Conference returns for its third year.

WANT TO LEARN a lot about steel design and construction quickly?

Then the Flash Steel Conference is for you! Taking place virtually October 18-20, the three-day online conference, now in its third year, packs a ton of education into a short time period.

What sets the Flash Conference apart from other virtual conferences and AISC programs? The fast-paced 30-minute lightning sessions, of course! For our typical online programs, 90 minutes is the perfect duration because that's how long it can take to really delve into a topic in a meaningful way. In fact, some topics require several 90-minute sessions and will form an entire webinar series—and still others warrant an entire Night School course of eight 90-minute sessions.

The Flash Conference is just the opposite. It's more like a bountiful buffet for people who just want a sample of this and a bite of that, and the 30-minute time frame is perfect for getting an audience thinking about a grand new idea. It's also perfect for highlighting lessons from a project or explaining one or two important concepts. With 15 minutes in between sessions, that's enough time to stretch, check email, use the restroom, refill your coffee cup, and feel refreshed for the next session.

The conference sessions are organized into tracks. This year's tracks include practical topics as well as those that preview what's ahead for steel. And for those looking for continuing education units (CEUs), the conference offers a certificate with your cumulative hours for up to ten professional development hours (PDHs).

Engaging keynote speakers. Like any useful conference, the Flash Steel Conference includes thought-provoking keynote sessions. In one of them, Robert Otani of Thornton Tomasetti will discuss the concept of artificial intelligence (AI) and what role it will play (and is already playing!) in design and construction. In another, Michel Bruneau of the University at Buffalo will speak about designing for resilience and how structural steel can contribute to meeting our future needs. And in the third keynote, Carol Post, who recently retired as a structural engineer at some of the world's top firms, will share her revolutionary vision for attracting and developing top talent into what she considers the most exciting profession.

Steel Interchange jumps off the page. Are you a regular reader of our monthly Steel Interchange section? The Flash Steel Conference will essentially feature the audiobook version, with AISC's Steel Solutions Center (SSC) advisors and consultants presenting some of the most intriguing and useful questions and answers from recent years on a variety of topics. Will you already know the answers, or will you learn something new? There's only one way to find out.

The future is now. The Future of Steel track contains sessions that look forward to areas of increasing importance. For

SteelDay is the annual celebration of the structural steel industry, sponsored by AISC and hosted by its members and partners. SteelDay is an opportunity for steel fabricators to connect with AEC professionals.

SteelDay offers events throughout the country for AEC professionals, faculty and students, and the public to see firsthand how the vibrant U.S. structural steel industry works to build our country's buildings and bridges.

You'll learn about the industry's latest technologies (ranging from improvements in the properties of steel to better equipment and new communication and design tools), see what's going on today with structural steel, and network with people advancing the design and construction industry.

SteelDay 2022 takes place Friday, October 21, with related events leading up to it all week. To learn more about it or to host or attend an event, visit **aisc.org/steelday**.

example, everyone's talking about sustainability, and we don't want you to be left behind. For those that need to catch up, we'll start by introducing the basics of sustainability and what role the steel industry can play, and two steel educators will share their latest research. Adam Phillips of Washington State University will present his findings on steel building performance, cost, and sustainability compared to other materials. Patricia Clayton of Wake Forest University will present her Milek Fellowship research on a new seismically resilient connection. And Devin Huber, AISC's director of research, will present an update on AISC's Need for Speed initiative (**aisc.org/needforspeed**) that he introduced at last year's Flash Steel Conference.

Winning ideas. The Design and Construction Challenges track showcases four recent IDEAS^2 (Innovation Design in Engineering and Architecture with Structural Steel) Award-winning projects and examines the innovative solutions that engineers, fabricators, erectors, and others used to overcome specific challenges. One such winning project is the 2Life Communities Administrative Offices, a vertical building addition that could not be supported by any structure within the existing building. How did the structural engineer support the additional floors? David Odeh of Odeh Engineers will explain! (See **aisc.org/ideas2** for more information on the program and the May 2022 issue, available in the Archives section at **www.modernsteel.com**, for write-ups and images on this year's winners.)

Making Connections. If you crave practical connection tips and tricks, you should check out our Connection Design track. From delegated connection design to seismic connections and reinforcing existing connections, we'll have lessons for everyone.

If the bountiful buffet sounds irresistible, consider joining us for this week-long celebration of steel. Sessions run from 10:00 a.m. to 3:45 p.m. Central each day. There are multiple registration options for individuals and companies, as well as discounts for educators, students, and government employees. For more information and to register, visit **aisc.org/flash**. We hope to see you then! ■

Christina Harber (**harber@aisc.org**), is AISC's senior director of education.

Crossings Create Connections

BY JASON LLOYD, PE, PhD

All photos: Envision Rwanda/NSBA

This year's Bridges to Prosperity project created a safe crossing over a treacherous Rwanda river, replacing a series of timber structures that would routinely wash out.

IN 1963, during what has become known as the "I Have a Dream" Speech, Dr. Martin Luther King, Jr. said, "Let's build bridges, not walls."

His was a vision to build bridges of trust and mutual respect for all humans, of hope and opportunity for all people.

This analogy translates intuitively to actual bridges. Bridges create connections: connections to healthcare, to markets, to education, and between communities. In other words, they create connections to opportunity.

Established in 2001, Bridges to Prosperity (B2P) has made it its mission to build bridges that better lives in rural communities by solving the poverty caused by isolation with the connections created by trail bridges. The organization reports that more than one billion people across the globe are separated from critical resources by an impassible river. A study conducted by economists at the University of Notre Dame evaluated the effect of rural trail bridges in Nicaragua and found that farm profits increased by 75% and labor market income increased by 30% when usable bridges are in place! In addition, they found that when a community has safe access across a river, school enrollment increases by 12% more children.

Every year, the National Steel Bridge Alliance (NSBA) teams up with B2P to recruit a team of volunteers from among the many U.S.-based steel bridge fabricators, design consultants, steel producers, and departments of transportation (DOTs) to travel somewhere in the world and create multi-generational opportunities for an underprivileged community. How? By building steel pedestrian bridges. For this year's project, the build team was sent to a remote western province of Rwanda.

opposite page: The author and Troy McWaid of Washington preparing a rigging system to launch the decking units.

above: Local community members and the NSBA build team join hands to pull the heavy suspension cables into place.

below: Munini I Bridge build team volunteers hiking through the hills to the construction site.

The bridge construction site was set in a valley between the hills at the Kaganda River, and the project took place in February. Every morning for ten days, the team meandered the roughly one-mile trail among the rolling hills of Rwanda's Karongi District on their way to the Munini I bridge construction site. The quilt-like hills resembled a tapestry of varying subsistence and cash crops tended by local farmers, each patch carefully hand-sown and harvested. The team soon learned that most things in Rwanda are done by hand, giving Rwandans a unique connection to each other and to their land. The bridge team volunteers would meet up each morning with 20 local community members hired by B2P to work together to build the bridge, a 206-ft steel suspension bridge. Nine volunteers comprised the U.S.-based bridge team, with members from the states of Texas, Washington, the Delaware DOT, the Tennessee DOT, Alliance for American Manufacturing, Modjeski and Masters, HDR, Hoyle Tanner, and AISC member producer Nucor. In addition to the volunteers, several organizations provided financial support for the build, including NSBA, HDR, Modjeski and Masters, Nucor, and AISC member fabricators High Steel, W&W|AFCO Steel, and Fought and Company.

Two young boys from the local community pose on the temporary timber bridge, with the new bridge in the background. These timber crossings are often built by the community and are frequently washed out by rainstorms during the rainy season.

Construction of these bridges is performed by hand, so it's no vacation—or maybe it could be categorized as a working vacation. However, the work is incredibly rewarding. All of the materials were hauled in by hand to the build site by local laborers—no small task! This includes the steel tower components, 300-ft-long steel suspension cables, steel grid decking, rebar, cement mix, tools, and other necessary items for building a bridge. And this was done carrying *every single component* along the one-mile trail that descended 600 ft into the valley.

After all of the materials were carried in, the volunteer erection team showed up, and from there it was simply a matter of assembling the pieces. First, the towers were assembled on the ground and painted to resemble the Rwandan flag, and then they were hoisted into position using large jacks and scaffolding. Next, the team dragged the four 1¼-in.-diameter main cables into position and set the correct sag. Hangers and cross beams that support the walking surface (decking) were assembled and launched using hand-pulled cables, then the decking itself was installed. Safety fencing along the length of the bridge provided the final touch, and then the bridge was ready for its inauguration.

The new bridge marked a significant improvement over its predecessor route. Prior to its completion, the community relied on small, unstable timber bridges constructed from the local supply of eucalyptus trees. Community members explained that these bridges were inadequate and would routinely wash out during large rainstorms, putting users in danger and requiring frequent and frustrating rebuilds. The economic impact to local farmers who needed to cross the river to sell their cash crops was catastrophic. Imagine your livelihood, not to mention access to a clinic in an emergency, threatened by every rainstorm! And can any parent conceive of sending their children to school knowing they could be risking their lives to cross the river if a rainstorm came during the school day? These scenarios are not hypothetical either. In the last three years alone, five community members' lives were taken while attempting to cross the Kaganda River at high water levels.

Needless to say, the community was extremely excited to have the bridge built! In the grand scheme of things, this bridge may

above: The completed Munini I Bridge just prior to inauguration, outfitted with balloons for the celebration with local community members.

below: The U.S.-based volunteers pose for an inauguration photo at midspan of the new bridge.

above: Community members cross the bridge for the first time.

below: Following the first crossing by the community, locals and the build team enjoyed traditional music and dancing, speeches by the build team and political leadership, and stories from the community of hardships faced crossing the Kaganda River.

have made a small difference in the world, but it will make a world of difference to those communities it now connects.

After ten days, the bridge was completed. Despite the language barriers between the locals and the build team, there was much laughter and hard work shared throughout the build. In addition, the volunteer team made new personal connections among its members as well as with the local residents. In many ways, the bridge became a symbol of a deeper connection among people separated previously by culture, language, and 8,000 miles.

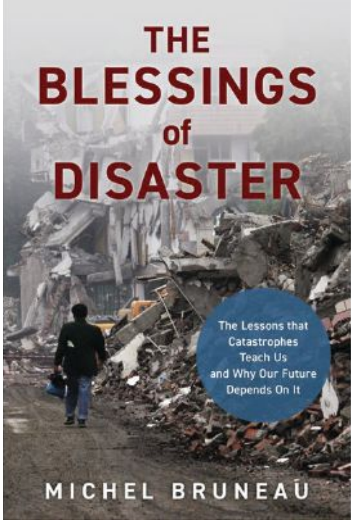
Following the first crossing by the community, locals and the build team enjoyed traditional music and dancing, speeches by the build team and local political leadership, and stories from the community of hardships faced crossing the Kaganda River. We enjoyed watching the local communities finally running, walking, or jumping their way across the bridge for the first time. I specifically recall watching an elderly man run back and forth across the bridge multiple times, as if he were a child again. His face spoke volumes of the hardships he had faced in his life and of the gratitude he felt to have this new connection between his communities—a safe passage for people he knew and loved and for himself too. I think these words from my inauguration speech sum up my feelings well: "This bridge is a beautiful structure that we have labored side by side to build. We hope it will continue to serve your community safely for many years. We hope it will inspire creativity and ingenuity in your children. This bridge spans the river to connect your communities. And whereas two weeks ago we came together as strangers to build this bridge, today we are connected by this experience as brothers and sisters forevermore."

My fellow bridge teammates and I will never forget this experience—of that, I'm certain. Personally, it has built a connection between me and Rwanda that will last a lifetime. ■

Jason Lloyd (Jason.Lloyd@nucor.com), formerly with NSBA, is the manager of bridge and infrastructure solutions with Nucor.

new products

Instead of focusing on tools, equipment, and software, this installment focuses on recently published books—two for young kids and one for grown-ups—authored by an AISC board member and fabricator, a structural engineering professor, and a welder and artist.



The Blessings of Disaster by Michel Bruneau

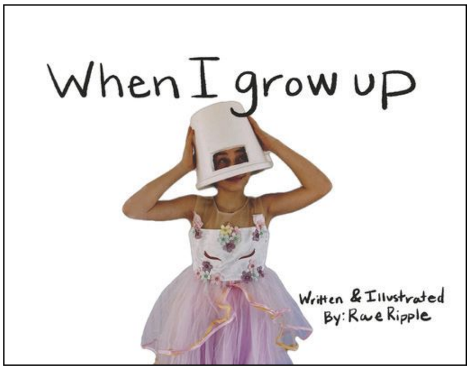
Are we doomed? As individuals, certainly, eventually, inevitably. But as a species? As a civilization? Leading catastrophe engineer Michel Bruneau thinks perhaps not. *The Blessings of Disaster* draws on knowledge from multiple disciplines to illustrate how our civilization's future successes and failures in dealing with societal threats—be they pandemics, climate change, overpopulation, monetary collapse, or nuclear holocaust—can be predicted by observing how we currently cope with and react to natural and technological disasters. Maybe most importantly, this entertaining and often counterintuitive book shows how we can think in better ways about disasters, to strengthen and extend our existence as both individuals and as a species.

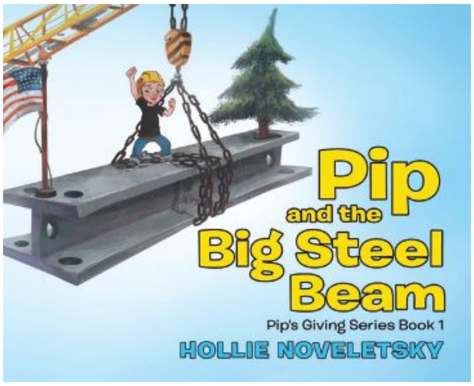
Michel Bruneau, a professor in the Department of Civil, Structural and Environmental Engineering at the University at Buffalo, is recognized nationally and internationally for the impact of his research contributions to the design and behavior of steel structures subjected to extreme events, particularly earthquakes. He has been honored with multiple AISC awards, including the T.R. Higgins Award in 2012, the Lifetime Achievement Award in 2019, and a Special Achievement Award in 2020 for his groundbreaking work in developing SpeedCore. You can learn more about him in the February 2012 People to Know article "The Engineer as Writer."

When I Grow Up by Rae Ripple

When I Grow Up showcases Olivia, a young, elementary school-age girl in search of what she wants to do in her career someday. She takes a trip to the library with her mother and when she arrives, she notices someone welding a sculpture outside—and is surprised to see that the welder is a woman. She asks her mother if she can become a welder too, then rushes inside to find the books that will help her achieve her new dream.

Rae Ripple is a world-renowned metal artist, television personality, stunt rider, and now author. Her work has been featured in magazines, television shows, and documentary films, and she was a contestant on the Netflix series *Metal Masters*. You can learn more about her in the August 2022 Field Notes article "Master of Metal."





Pip and the Big Steel Beam by Hollie Noveletsky

Pip and the Big Steel Beam is the first book in the Pip's Giving series. Each book is written about the author's grandson, Pip (whose real name is JR; Pip is short for his nickname, Pipsqueak), and a special person in his life, and a portion of the proceeds from each book will be given to a charity that is important to that person. In the first installment, Pip and his dad share an exciting day in the latter's steel fabrication shop. Read along as the big steel beams are made, then join the pair on an exciting adventure to see where those big steel beams end up.

Hollie is an AISC board member and the CEO of AISC member fabricator Novel Iron Works in Greenland, N.H., which her father started. You can learn more about her in the August 2022 Structurally Sound article "Steel Storytime" and the August 2020 Field Notes article "Lifetime Advocate."

You can find all mentioned articles in the Archives section at **www.modernsteel.com**. And you can order all three books at **www.amazon.com**.

GOVERNMENT RELATIONS

New Hampshire's Buy America Law Keeps Taxpayer Money, Jobs in the U.S.

New Hampshire Governor Chris Sununu today signed Buy American legislation into law during a visit to AISC member Capone Iron Corporation North Woods, Inc.'s fabrication facility in Berlin, N.H. The new regulations require the use of American contractors and products on state-funded construction projects.

"New Hampshire's Buy American law is a win for steel fabricators who have too long suffered from unfair foreign competition," said American Institute of Steel Construction Director of Government Relations and Sustainability Max Puchtel. "And beyond New England, the law signals a movement among our elected leaders to commit to spending tax dollars domestically. The American structural steel industry is ready and capable of delivering for our great steel bridges, critical infrastructure projects, and iconic skylines."

More than two dozen states have now taken action to keep American taxpayer money in America's own economy instead of sending it overseas.

AISC urges other states to follow suit.

Domestic procurement for public infrastructure projects keeps taxpayer money in the American economy, employing skilled American workers who invest in their own communities to multiply the economic benefits. The domestic structural steel industry has enough capacity to meet all of the country's needs today, and it continues to grow to ensure it meets tomorrow's needs, as well.

Domestic procurement is also the responsible choice for sustainable design and construction. American-made structural steel beams are 93% recycled, 100% recyclable, and are made with pure electricity. Foreign steel can have as much as three times the global warming impact. Visit **aisc.org/sustainability** to learn more.

TECHNOLOGY

AEM Identifies Ten Trends Changing How Construction Companies Operate

According to a recent whitepaper from the Association of Equipment Manufacturers (AEM), technology is changing the way buildings are designed, construction equipment operates, and organizations function. Renewable energies are being leveraged more often and in different ways, and a generational shift in the workforce is already underway. The whitepaper identifies ten trends that will impact the future of building over the next decade. The trends are as follows:

1. Increased regulation of carbon-based fuels spurs adoption of alternative power solutions
2. Renewable energy production booms
3. Compact equipment trends toward electric
4. Connectivity leads to job-site transformation
5. Pathway toward autonomous machinery
6. Sensors improve efficiency and safety
7. Fewer workers, different skillsets
8. Business models shift toward subscriptions
9. Construction data will reveal its value
10. Cybersecurity becomes central to corporate strategy

To read the full white paper, visit **aem.org/future-of-building**.

Corrections

In the July 2022 Prize Bridge Awards feature, the steel detailer for the Dublin Link Pedestrian Bridge was inadvertently omitted. AISC member Tensor Engineering served as the detailer for that project.

And in the February 2022 article "Tied with a Ribbon," which featured the Las Vegas Convention Center expansion project, the bender-roller was omitted. AISC member WhiteFab provided steel curving services for that project.

People & Companies

The **American Welding Society (AWS)** recently authorized free electronic distribution of the current **ANSI Z49.1: *Safety in Welding, Cutting, and Allied Processes***, with the idea that this voluntary welding safety and health standards document should receive the widest distribution possible. You can download it at **aws.org/standards/page/ansi-z491**.

Integrated design firm **SmithGroup** has opened its first office in the southeastern U.S. Located in Atlanta's Midtown neighborhood, the office is the firm's 19th location worldwide, expanding an already extensive footprint in the higher education and healthcare markets. The Atlanta office is led by **Robert Bull**, who also serves as the director of the firm's Washington, DC location.

Walter P Moore has promoted **Scott Martin** as its design-build market leader. A principal in the firm's Tampa office, Martin has led several critical design-build projects in his career.

Steel Dynamics, Inc. (SDI), an AISC member producer, has announced the creation of a strategic joint venture with **Aymium**, a producer of renewable biocarbon products. The entity will operate under the name **SDI Biocarbon Solutions, LLC**. Initial plans for the joint venture include the construction and operation of a biocarbon production facility to supply SDI's electric arc furnace steel mills with a renewable alternative to fossil fuel carbon using Aymium's patented technology. The initial facility's production capacity is expected to be more than 160,000 metric tons per year, for an estimated capital investment of $125 million to $150 million. The facility is planned to begin operations in late 2023.

AWARDS

AISC's IDEAS² Awards Program Accepting Entries until September 30

Max Touhey

AISC's flagship competition for buildings is still accepting entries for the 2023 IDEAS² Awards.

The Innovative Design in Engineering and Architecture with Structural Steel (IDEAS²) Awards recognize outstanding projects that illustrate the exciting possibilities of structural steel.

The winners will get a prime-time spotlight at NASCC: The Steel Conference in Charlotte, N.C., next April, and the May 2023 issue of *Modern Steel Construction* magazine will feature them. In addition to substantial press support and publicity through AISC's own print and online media, winning teams have the unique opportunity to present their projects to the AEC community during special webinars or live events throughout the year. If possible, AISC will conduct an on-site award presentation at some point in 2023.

Entries are due by September 30, 2022, and AISC will announce the winners in early 2023. Visit **aisc.org/ideas2** for more information, eligibility requirements, and to enter.

You can read all about this year's winners in the May 2022 issue, available in the Archives section at **www.modernsteel.com**.

BRIDGES

AASHTO/NSBA Steel Bridge Collaboration Approves New Documents at Recent Meeting

The AASHTO/NSBA Steel Bridge Collaboration has brought forward two documents for consideration and balloting by the AASHTO Committee on Bridges and Structures, which met recently in Pittsburgh.

The first document is the new guide specification S8.3: *Hot Dip Galvanizing Specification*. This document represents best practices for design and fabrication as well as provides information on properties of hot-dip galvanizing, types of materials suitable for hot-dip galvanizing, welding procedures, venting and draining, distortion control, and more. The second document is an update to the existing G9.1: *Steel Bridge Bearing Guidelines*, which focuses on cost-effective detailing for steel bridge bearings with design guidance on the connection of the bearing to the girders. In addition to the updates, it also contains several new sections. It is intended to supplement the design requirements in the AASHTO *LRFD Bridge Design Specifications*. Both documents were successfully balloted and will be available later this year.

The Collaboration also just posted the new G14.1: *Addressing Fatigue Cracking and Details at Risk of Constraint-Induced Fracture*. This publication provides maintenance guidelines for addressing fatigue cracking, as well as details that are at risk of constraint-induced fracture (CIF) in steel bridges. Intended to be a practical reference text for a wide range of audiences—including maintenance contractors, asset managers, and design engineers—this publication provides detailed descriptions of the driving causes of fatigue cracking and CIF in steel bridges and accepted methods for repair or retrofit.

All AASHTO/NSBA Collaboration documents are available for free on the NSBA (**aisc.org/nsba**) and AASHTO Store (**store.transportation.org**) pages.

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Peddinghaus HSFDB 2500/B Plate Processor, 3" Plate, 96" Maximum Plate Width, HPR400XD Plasma, Drill, Oxy, 2015, #31660
Voortman V630/1000 CNC Drill Line, (3) Drill Units, ATC, VB1050 20" x 44" Saw, Conveyor & Transfers, 2006, #31801
Ficep HP 20 T6 Angle Punch & Shear Line, 8" x 8" x 1", 65' Infeed, 505 Ton Shear, Ficep Pegaso CNC, 2018, #32110
Peddinghaus PCD-1100 Drill & Saw Line, 44" x 18" Capacity, (3) Spindle, Meba 1140/510 Saw, Siemens CNC, In/Out Conveyor, 2006, #31842
Peddinghaus ABCM-1250A Beam Coping Line, 50" x 24" Maximum Profile, Fagor 8055 Retrofit, #31655

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UDOT

A Bridge with a View

THE UTAH VALLEY UNIVERSITY (UVU) Pedestrian Bridge was built to mimic mountains—specifically, those that are visible from every step of the way across the nearly 1,000-ft-long steel crossing.

Designed by WSP USA and fabricated by AISC member and certified fabricator Utah Pacific Bridge and Steel, the new bridge provides a key pedestrian connection over Interstate 15 in Orem, Utah, between the Orem Intermodal Center and the main UVU campus. The bridge reduces congestion at the University Parkway interchange by eliminating vehicular trips between the intermodal center and campus, improves connectivity for FrontRunner commuter rail users, further reduces congestion on I-15, and reduces vehicular traffic and parking demand on the UVU campus. A slightly curved design accommodates the north-south offset between the eastern and western terminus points.

As part of UVU, the bridge's look needed to complement campus architecture and provide a pleasing appearance. The custom peaked roofline—which pays homage to the nearby Wasatch Mountains—controllable lighting, delta pier supports, and sleek superstructure were all designed to provide a distinctive-looking bridge the community could be proud of.

The UVU Pedestrian Bridge is the subject of one of several bridge-related articles that will be featured in next month's issue. ■

CALLING ALL INNOVATORS!

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2023 IDEAS² AWARDS

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Casey Dunn

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aisc.org/steelday

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