Modern Steel Construction

September 2019

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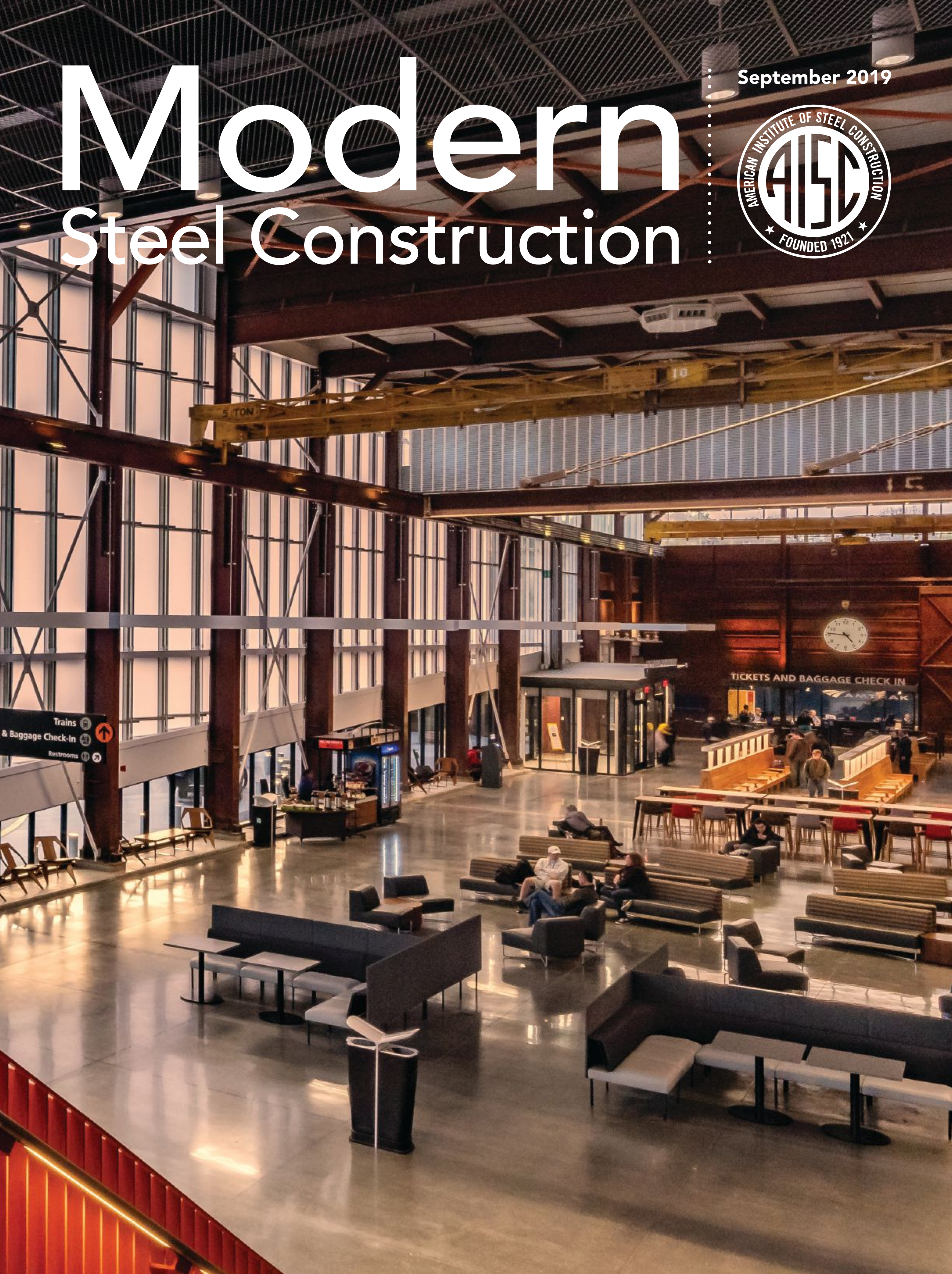

Modern
Steel Construction

September 2019


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ON THE COVER: Amtrak passengers arrive (and depart) in style at Raleigh's new Union Station, page 22. (Photo: © 2018 – Art Howard Photography)

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editor's note

I have some bad communication habits. (And before I hear from my grammarian friends, I truly mean bad, not just poor.)

Most egregious is my bad habit of using "guys," such as when I greet a group with the common sobriquet "Hey, guys." Around 20 years ago, I was at a meeting when a similar phraseology was used and my favorite reporter, *ENR*'s Nadine Post, objected. She and I have had a longstanding argument wherein I've long insisted that in English, the masculine pronoun is also used as the gender-neutral pronoun. While I'm technically correct, Nadine is truly right. This becomes painfully obvious to any observer of youth sports. Studies have shown that girls often feel like they don't belong, in part due to the use of male pronouns by coaches (even by female coaches!), and it's one of the reasons they leave organized sports as they get older.

This sense of marginalization gets even worse as young women move from the soccer field to the workplace.

Ironworkers have recognized the issue and we see a growing, but still very small, number of women in local training centers. (If you're curious about ironworker training centers, we're having a tour of one next year in Atlanta at NASCC: The Steel Conference).

And it's not just a male-female issue but also a racial and overall gender issue. You can see it at the Steel Conference, where the overwhelming majority of attendees are white and male. The trend continues at the collegiate Student Steel Bridge Competition and even at high school engineering events.

Lately, an increasing number of people have started identifying their preferred form of gender address in the signature block of their emails, such as "Pronouns: she, her, hers" or "Pronouns: Ze, Zir, Zem." While I've seen very few Baby Boomers or even Gen X-ers include it, it's certainly not uncommon among Millennials.

The case for diversity, equity, and inclusion in the workplace is strong, and the issue extends beyond the obvious moral implications. The Center for American Progress makes an economic argument that not leveraging the full range of potential employees costs American business more than $64 billion in lost opportunities. "In business terms, a diverse workforce is not something your company ought to have; it's something your company does have, or soon will have," the *Harvard Business Review* wrote way back in 1990. "Learning to manage that diversity will make you more competitive." And just last year, McKinsey & Company released a report showing that there is a direct correlation between institutional diversity and an improved bottom line.

Companies such as Deloitte add to the economic argument by discussing how better reflecting the identity of potential clients strengthens your ability to better serve their needs. And Scott Page, a professor at the University of Michigan, uses mathematical modeling to demonstrate how diversity increases organizational strength and productivity.

So folks, friends, team, chums, pals, cohorts, gang, and people, let's all be more inclusive.

Scott Melnick
Editor

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

steel interchange

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

Vertical Welds in Downward Direction

A member has been attached to a support using a welded connection. The welder made the vertical welds in the downward direction. The inspector has flagged these welds as noncompliant with AWS D1.1 and recommends that the welds be removed and redone. What is the requirement in AWS D1.1 that the inspector is referring to? Is there a way to avoid having to replace these welds?

AWS prohibits vertical down weld in most instances. This is specifically addressed in Section 3.7.1 in AWS D1.1. Note that if you have questions about AWS requirements, then you may want to contact AWS directly.

Keep in mind that the inspector, while required to report problems and permitted to make recommendations, cannot make design decisions or direct work as indicated in Section 8.5.6 of the AISC *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/AISC 303), which states: "The *inspector* shall not suggest, direct or approve the *fabricator* or *erector* to deviate from the *contract documents* or the *approved approval* documents, or approve such deviation, without the written approval of the *owner's designated representatives for design* and *construction*." As the owner's designated representative for design (commonly referred to as the engineer of record/EOR), you will have to use your own engineering judgment when determining what course of action is needed.

AISC Design Guide 21: *Welded Connections—A Primer for Engineers* provides some further information and states in Section 6.3.1 Centerline Cracking, stating: "Vertical-down welding also has the tendency to generate these crack-sensitive, concave surfaces. Vertical-up welding can remedy this situation by providing a more convex bead." The problems associated with the concavity are also described: "A third mechanism that generates centerline cracks is the surface profile condition. When the surface of an individual weld bead is concave, internal shrinkage stresses will place the weld metal on the surface into tension… In addition to being crack sensitive, excessively concave fillet welds may have acceptable leg dimensions but lack the required throat dimension as shown in Figure 6-9."

From these two concerns, there would seem to be a propensity for centerline cracking and a propensity for insufficient throat. Presumably, the inspector can (and possibly has) evaluated the throat of the weld, so this issue may require no further consideration. Note that AWS does permit a slightly concave profile, stating: "The faces of fillet welds may be slightly convex, flat, or slightly concave as shown in Figure 5.4 and as allowed by Table 6.1."

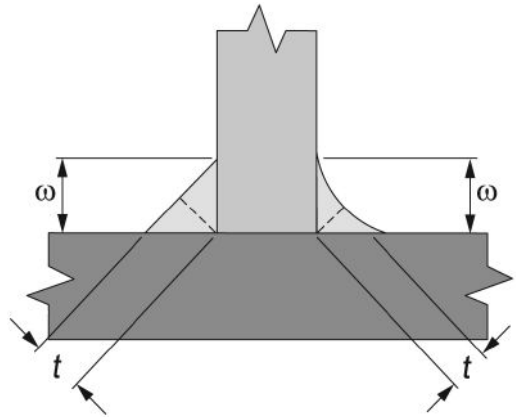


Fig. 6-9. Weld throats and surface profile.

Since the centerline cracks are described as forming at the surface due to internal shrinkage stresses, it might be prudent to apply either a more rigorous visual inspection or potentially some sort of NDT that would be suited to detecting cracks at or near the surface of the weld.

These are measures that could be taken to make you more comfortable with the existing condition.

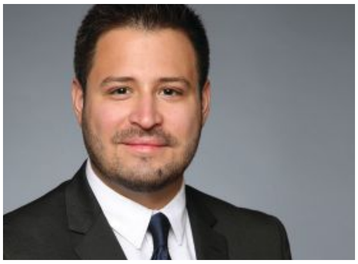
Larry Muir, PE

Proper Value for S_x

When checking the strength reduction for member with holes in the tension flange, per Section F13.1 in the AISC ***Specification for Structural Steel Buildings*** **(ANSI/AISC 360), is the elastic section modulus, S_x, based on the reduced cross-section of the wide flange shape (holes removed) or the value as provided in Table 1-1 of the 15th Edition AISC** ***Steel Construction Manual.***

No, the elastic section modulus, S_x, is equal to the gross section modulus. *Specification* equation F13-1 calculates the M_n as the elastic section modulus times a reduction factor of the ratio of the net tension flange area divided by the gross tension flange area. Example II.B-1 in the AISC Design Examples (a free download from **aisc.org/manualresources**) uses *Specification* Equation F13-1 and may be helpful.

Bo Dowswell, PE, PhD



Jonathan Tavarez (**tavarez@aisc.org**) is a staff engineer with AISC's Steel Solutions Center. **Brad Davis** of Davis Structural Engineering, LLC, **Bo Dowswell**, principal with ARC International, LLC, and **Larry Muir** are all consultants to AISC.

Section Property Changes

I am looking at the section properties for C4×4.5 and noticed that there is a difference in some section property values (r_{ts}, S_x, I_x, C_w ...etc.) from 13th to the 15th Edition AISC *Manual*. What was the basis for these changes?

While I was unable to track down the specific documentation tied to these updates, I suspect that the updates were a result of two separate modifications. Note that ASTM A6 provides certain cross-sectional properties for shapes that our manual tables copy from directly. ASTM A6-05a lists a flange width of 1.58 in.. The ASTM A6 standard more recently revised the flange width from 1.58 in. to 1.50 in. This change likely accounts for the slight variation in the calculated section property values between what was listed in the 13th Edition and what is currently listed in the 15th Edition.

Jonathan Tavarez, PE

Headed Stud Anchors

I noticed that steel headed stud anchors have been removed from Table 2-6 in the 15th edition AISC *Manual* and the reference to ASTM A108 has been removed from the material discussion in Part 2. We typically reference ASTM A108 on our drawings when specifying steel headed stud anchors. Should we be referencing a different ASTM standard?

Headed stud anchors are sort of an odd case. For various reasons the headed stud anchor manufacturers developed a path into the codes through AWS rather than through ASTM. The April 2018 *Modern Steel Construction* article "Are You Properly Specifying Materials" states: "Shear studs are specified as given in AWS D1.1 Clause 7, with material as required in Clause 7.2.6. Type B is usual and the corresponding mechanical requirements are stated in AWS D1.1 Table 7.1 (F_y = 51 ksi, F_u = 65 ksi)."

Though various documents (including the *Manual*) have attempted to use various ASTM standards to define/specify headed stud anchors, a reference to AWS D1.1 Clause 7 is likely the most complete means—as odd as this may seem.

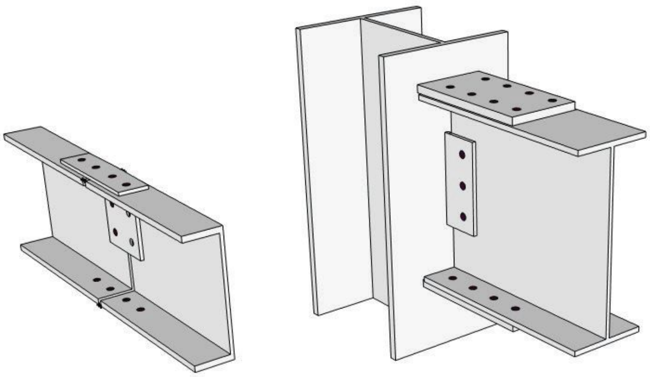
Larry Muir, PE

Moment Connected Channel Shapes

Is it possible to use a bolted flange plate moment connection to splice two channel shapes together? I have never seen it done before.

Yes, it is possible. I would approach the design in a manner similar to that shown in AISC Design Example II.B-1 (**aisc.org/manualresources**). That example is for a beam-to-column connection, but many of the same limit states apply. Of course, you would only have one row of bolts instead of two shown in the example.

Brad Davis, SE, PhD



Channel splice (left) and Design Example II.B-1 (right).

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

steel quiz

This month's Steel Quiz focuses on AISC's education and research departments and their impact on the structural steel industry. The answers can be found in the many resources located on our website on the Education (**aisc.org/education**), Research (**aisc.org/research**), and SpeedCore (**aisc.org/speedcore**) pages.

1 **True or False:** For the AISC Student Steel Bridge Competition (SSBC), teams are allowed to use any grade of steel in the fabrication of a 1:10 scale steel bridge capable of resisting a lateral load and a larger vertical load.

2 What program does AISC offer that helps steel fabricators connect with local universities?

3 The bolt holes for a connection were fabricated slightly off, as shown in the figure below. Which of the following is **not** an acceptable fix? (Hint: View Duane Miller's 2019 NASCC: The Steel Conference session "What I Didn't Have Time to Say in Baltimore," which you can find at **aisc.org/2019nascconline**.

a. Drill new holes and install new bolts, carefully checking the net section.

b. Fill the holes with a buttered plug weld on both sides.

c. Drill oversized holes and install larger bolts.

d. Convert holes into slots and install bolt.

4 **True or False:** The hope for the upcoming fire tests for the SpeedCore (coupled composite concrete-filled steel plate shear wall) system is to confirm the need for sprayed-on fire resistance on the outer surface only.

5 What are the tasks involved in each of the main thrust areas of the "Steel Diaphragm Innovation Initiative: Innovation and Practice, Experiments, and Modeling?" (Hint: Find this in a research update that was published in the second quarter 2019 issue of *Engineering Journal*, available at **aisc.org/ej**.)

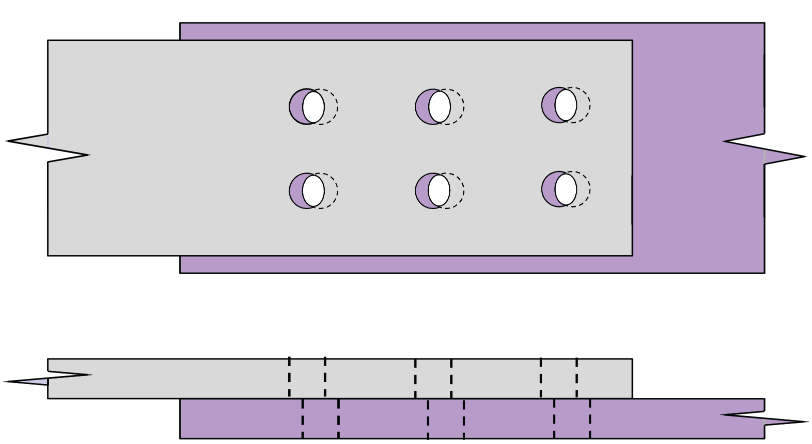


Figure for Question 3 (courtesy of Lincoln Electric).

6 AISC actively funds and supports research related to structural steel design and construction. Which of the following would not be a topic that AISC may consider funding with respect to developing next-generation structural steel systems for enhanced performance, safety, sustainability, and economy?

a. Performance-based design/analysis criteria and procedures to achieve steel structures with targeted performance objectives.

b. Connections and fastening systems using innovative configurations, components, and materials.

c. Models for analytical simulation of steel response over the entire range of behavior up to failure.

d. The development of a proprietary base isolation systems to be used in steel buildings in high-seismic regions

e. Develop scientific support for the use of structural steel in sustainable construction.

7 The strongback braced frame system is a recent innovation developed with the support of AISC's research initiatives, and was highlighted in a session during the 2018 Steel Conference as well as an April 2018 *Modern Steel Construction* article. **True or False:** The hybrid characteristics of the strongback braced frame, consisting of a conventional inelastic system and an essentially elastic truss, provide supplemental lateral strength.

TURN TO PAGE 14 FOR THE ANSWERS

steel quiz ANSWERS

1 **False.** The steel used in the competition is required to be magnetically attractive per Section 8.1 of the 2019 rules.

2 The AISC Adopt-a-School Program connects steel fabricators with local schools in order to develop long-term relationships and improve students' learning experience. Fabricators can contribute by providing tours of their shop, sponsoring an SSBC team, providing guest lecturers, connecting classes with local construction projects, and arranging site visits. More information on can be found at **aisc.org/education/university-programs**.

3 **b.** Buttered or "goobered" welds are not prequalified and are not recommended. A correct method would be to place a cylindrical plug inside the hole, gouge a canoe-shaped cavity on one side, and fill it in with weld metal, then flip the plate over and do the same process again. The weld can then be ground flat, allowing for the re-drilling of holes. This is discussed and visualized in Duane Miller's session. The discussion on this particular topic begins around the 26-minute mark.

4 **False.** The performance-based structural fire tests on the SpeedCore system, developed by Magnusson Klemencic and Associates, are expected to provide physical proof of the system's fire resistance, and may eliminate the need for applied fire resistance altogether. The goal is to develop code change proposals for Appendix 4 of the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, **aisc.org/specifications**) containing structural performance-based design methodologies and standard fire ratings for the core walls and floor-to-wall connections. More information on this can be found in the April 23, 2018 *Engineering News-Record* article "Fire Tests Coming for Core Module" in the "In the News" column at **aisc.org/speedcore**.

5 Innovation and Practice tasks range from evaluation of existing design methods and technologies to seismic standards work to development and validation of new designs and technologies. The Experiments tasks include developing databases of available steel diaphragm testing and conducting new experiments to fill knowledge gaps. Modeling tasks include modeling to support the experiments as well as development of high-fidelity diaphragm models and whole-building models for exploration of various factors for diaphragm and whole-building performance.

6 **d.** AISC has continuously remained involved with research related to seismic design. However, AISC does not fund research tied to the development of a proprietary product. More information on AISC funded research can be found here: **aisc.org/technical-resources/research**.

7 **False.** The strongback spine actually pivots about its base and is not intended to provide supplemental lateral strength. The pivoting action distributes inelastic demands in an imposed first mode shape to designated elements that are designed and detailed to yield. Inelastic demand is averaged through the use of the stiffer elastic spine, and story mechanisms are prevented in seismic events.

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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**.


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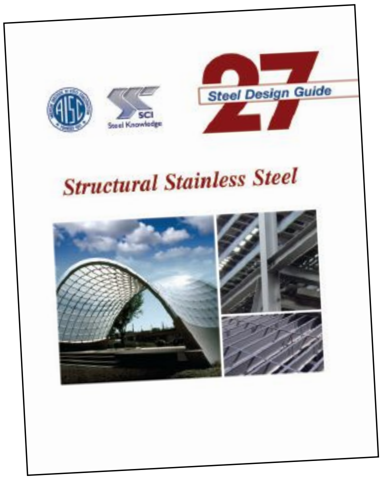
DESIGN WITH A SHINE

BY NANCY BADDOO

There are plenty of resources for designing structural projects with stainless steel—and more are coming soon.

Nancy Baddoo (**n.baddoo@steel-sci.com**) is an associate director at the Steel Construction Institute in the United Kingdom and the author of AISC Design Guide 27.



THERE IS A GROWING NEED for specialty high-performance materials in the built environment that offer improved durability, strength, resilience, and lifespan—and stainless steels check all of these boxes.

However, stainless steel can cost as much as 400% more than carbon steel, and it emits hexavalent chromium when heated, requiring safety precautions when welding. Fabricators must isolate stainless steel fabrication in their shops to avoid contaminating the surface of the stainless steel with particles from carbon steel fabrication. Taking all of this into account, for critical structures in aggressive environments, the greater cost of stainless steels can often be justified in return for longer maintenance-free periods.

Stainless Properties and Benefits

The two common families of stainless steel used in construction are austenitic and duplex stainless steels. Austenitic stainless steels are the family most widely used for structural applications, though the use of duplex stainless steels is increasing where it is possible to exploit their higher strength (around 65 ksi). Both types are inherently corrosion-resistant due to the tightly adherent protective layer of chromium oxide that spontaneously forms on the surface in the presence of oxygen.

Thanks to this corrosion resistance, stainless steels are suitable for structures in aggressive environments—e.g., those that are close to saltwater, exposed to de-icing salts, or in heavily polluted locations—and without the need for protective coatings. They are well suited for many infrastructure applications that require durability combined with long service life, particularly where maintenance closures are very costly, such as bridges. (Resources on the use of stainless steel in bridges and highway structures, including a recorded webinar, are available at **www.steel-stainless.org/bridges**.)

Stainless steels are also widely used for industrial structures in the water treatment, nuclear, petrochemical, and food and beverage sectors. Building canopies, entrance structures, and tension bar systems are often built from stainless steel, as are many unseen structural components, such as support and restraint systems for curtain walling, masonry, and tunnel linings, and for shear and tension bars for balconies. Security barriers, hand railings, and street furniture are also often made from stainless steels.

Let's take a look at some of the technical aspects of structural stainless steels. Table 1 provides mechanical properties for common carbon steels and stainless steels, and Figure 1 shows stress-strain characteristics at high strains, comparing stainless steels against carbon steel and a structural grade of aluminum. The distinctive mechanical properties—considerable strain-hardening and ductility—make

Table 1: **Minimum Mechanical Properties: Strength, Stiffness, and Elongation**

	Yield Strength ksi	Tensile Strength ksi	Tensile-to-yield Strength Ratio	Elongation in 2 in. %	Initial Modulus of Elasticity ksi
A36 Carbon Steel	36	58	1.60	23	29,000
ASTM A992 Carbon Steel	50	65	1.30	21	29,000
Austenitic Stainless Steel	30	75	2.51	40	28,000
Duplex Stainless Steel	65	95	1.46	25	29,000
6061 T6 Aluminum	35	38	1.09	10	10,000

Stainless steel data from AISC Design Guide 27.

Carbon steel and aluminum data taken from the applicable ASTM specification.

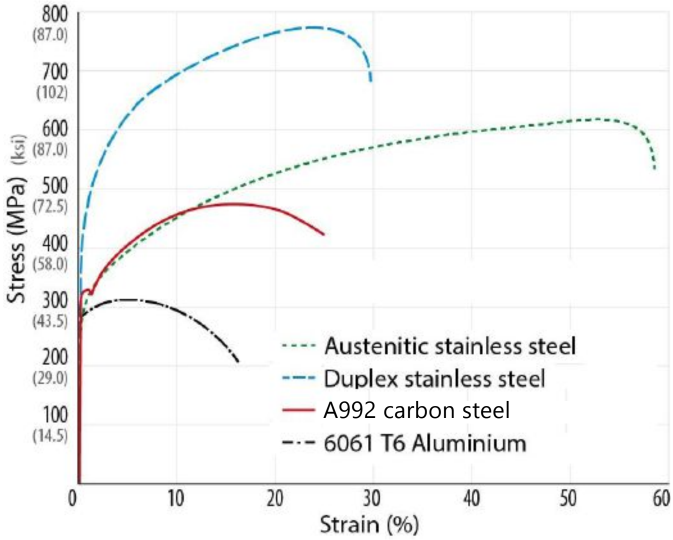


Fig. 1. Comparison of stress-strain characteristics of stainless steel with carbon steel.

above: Duplex stainless steel S31803 tubular sections used for the railing on Harbor Drive Bridge in San Diego.

left: A stainless steel skid for a regasification plant.

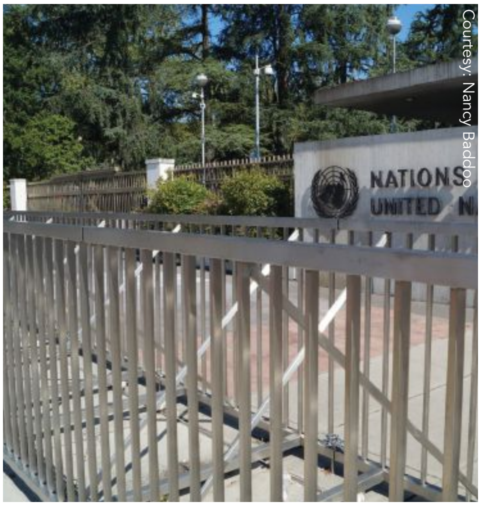
austenitic and duplex stainless steel particularly well suited for structures required to withstand accidental loading due to their high energy absorption characteristics.

Guide and Tables

To assist with designing with stainless steel, AISC released Design Guide 27: *Structural Stainless Steel* (**aisc.org/dg**) in 2013 to provide design rules for hot-rolled and welded structural stainless steel wide-flange sections and hollow structural sections (HSS). Guidance on material properties, grade selection, specification, durability, connections, and fabrication are also given in the Design Guide, which is aligned with the design provisions in the 2010 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-10, **aisc.org/specifications**).

At present, there is no U.S. specification giving a standard library of sizes of stainless steel sections for structural applications. Consequently, a wide variety of sizes and shapes are used in practice. In order to provide practical design information, a large number of stakeholders, fabricators, and manufacturers in the U.S. were contacted in order to establish the most commonly used sizes for various section shapes. Based on the collected information, ranges of sizes for stainless steel sections were established according to practical sizes in typical use, structural economy, and effective use of material.

From this collected data, the United Kingdom's Steel Construction Institute has recently developed design tables in accordance with Design Guide 27. (These are accessible at **aisc.org/technical-resources** under the "Stainless Steel" link). The layout and contents



Courtesy: Nancy Baddoo

above: A stainless steel security barrier at the United Nations Office in Geneva, Switzerland.

of the tables closely resemble those given for equivalent carbon steel structural sections in the 15th Edition AISC *Steel Construction Manual* (**aisc.org/manual**) and examples of the tables are provided in Figure 2. However, it should be noted that some of the shapes listed in the tables are not commonly produced or stocked. They will only be produced to order and may be subject to minimum order quantities. Also note that sections are far more widely available in austenitic stainless steels than duplex stainless steels.

The tables cover the following structural sections:

- W- and S-shapes
- C- and MC-shapes
- Equal angles
- Rectangular, square, and round HSS

Two strength levels are covered: 30 ksi, which corresponds to austenitic stainless steels, and 65 ksi, which corresponds to duplex stainless steels.

The tables are divided into five parts:

- Part 1: Dimensions and Properties
- Part 2: Design of flexural members (F_y = 30 ksi)
- Part 3: Design of flexural members (F_y = 65 ksi)
- Part 4: Design of compression members (F_y = 30 ksi)
- Part 5: Design of compression members (F_y = 65 ksi)

The tables for flexural members give the maximum total uniform load for all the shapes except for angles, which are rarely used in bending. The tables for compression give the available strength in axial compression for all the shapes except for S-, C-, and MC-shapes, which are rarely used as compression members.

below: Fig. 2. Examples of the structural stainless steel tables developed by the Steel Construction Institute.

Table 1-5B
Equal Angles (Hot Rolled)
Properties

Shape	k	Wt.	Area, A	Axis X-X: I	S	r	y	Z	y_p	Flexural-Torsional Properties: J	C_w	$\bar{r}_o$
	in.	lb/ft	in.²	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.⁶	in.
[illegible]	1	[illegible]	5.77	[illegible]	4.50	[illegible]	[illegible]	[illegible]	[illegible]	0.50	[illegible]	3.31
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[illegible]	[illegible]	[illegible]	1.44	[illegible]	0.586	0.928	[illegible]	[illegible]	0.240	[illegible]	[illegible]	1.65
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.558	0.749	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.205	0.771	0.687	[illegible]	[illegible]	[illegible]	0.005	[illegible]
[illegible]	[illegible]	4.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.05
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[illegible]	[illegible]	2.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]
Note 1: [illegible]
Note 2: [illegible]

Table 4-2 (continued)
Available Strength in Axial Compression, kips
Rectangular HSS (Roll Formed)

F_y = 30 ksi

HSS5

Shape	HSS5×4× 0.312		HSS5×4× 0.250		HSS5×4× 0.180		HSS5×4× 0.120 [c]		HSS5×3× 0.500		HSS5×3× 0.375	
t_{design}, in.	0.312		0.250		0.180		0.120		0.500		0.375	
lb/ft	17.0		14.2		10.5		7.18		21.4		17.6	
Design	P_n/Ω_c ASD	$\varphi_c P_n$ LRFD	P_n/Ω_c ASD	$\varphi_c P_n$ LRFD	P_n/Ω_c ASD	$\varphi_c P_n$ LRFD	P_n/Ω_c ASD	$\varphi_c P_n$ LRFD	P_n/Ω_c ASD	$\varphi_c P_n$ LRFD	P_n/Ω_c ASD	$\varphi_c P_n$ LRFD
Effective length, KL (ft), with respect to least radius of gyration, r_y: 0	88.2	133	73.5	110	54.3	81.5	37.1	55.8	111	167	91.3	137
1	87.8	132	73.1	110	54.0	81.2	37.0	55.6	110	165	90.5	136
2	86.6	130	72.2	108	53.3	80.2	36.6	55.0	107	161	88.2	133
3	84.6	127	70.6	106	52.2	78.5	35.8	53.9	102	153	84.5	127
4	81.8	123	68.4	103	50.7	76.1	34.8	52.3	95.1	143	79.7	120
5	78.4	118	65.7	98.8	48.7	73.3	33.5	50.4	87.2	131	73.8	111
6	74.5	112	62.6	94.1	46.5	69.9	32.0	48.2	78.5	118	67.2	101
7	70.1	105	59.1	88.8	44.0	66.1	30.4	45.7	69.2	104	60.2	90.5
8	65.3	98.2	55.3	83.0	41.2	62.0	28.6	42.9	59.9	90.0	53.0	79.7
9	60.3	90.7	51.2	77.0	38.3	57.6	26.6	40.0	50.8	76.4	45.9	69.0
10	55.2	82.9	47.1	70.7	35.3	53.1	24.6	37.0	42.3	63.6	39.1	58.7
11	50.0	75.2	42.9	64.4	32.3	48.5	22.6	33.9	35.0	52.6	32.7	49.2
12	44.9	67.5	38.7	58.2	29.3	44.0	20.5	30.8	29.4	44.2	27.5	41.3
13	39.9	60.0	34.6	52.0	26.3	39.5	18.5	27.8	25.1	37.7	23.4	35.2
14	35.2	52.9	30.7	46.1	23.4	35.2	16.6	24.9	21.6	32.5	20.2	30.4
15	30.8	46.2	27.0	40.6	20.7	31.1	14.7	22.1	18.8	28.3	17.6	26.4
16	27.0	40.6	23.7	35.7	18.2	27.4	12.9	19.5	16.6	24.9	15.5	23.2
17	24.0	36.0	21.0	31.6	16.1	24.2	11.5	17.2	14.7	22.0	13.7	20.6
18	21.4	32.1	18.7	28.2	14.4	21.6	10.2	15.4			12.2	18.4
19	19.2	28.8	16.8	25.3	12.9	19.4	9.18	13.8				
20	17.3	26.0	15.2	22.8	11.6	17.5	8.29	12.5				
21	15.7	23.6	13.8	20.7	10.6	15.9	7.52	11.3				
22	14.3	21.5	12.5	18.9	9.63	14.5	6.85	10.3				
23	13.1	19.7	11.5	17.3	8.81	13.2	6.27	9.42				
24	12.0	18.1	10.5	15.8	8.09	12.2	5.76	8.65				
25	11.1	16.6	9.72	14.6	7.45	11.2	5.30	7.97				
26					6.89	10.4	4.90	7.37				
27												
28												
29												
30												
Properties												
A_g, in.²	4.91		4.09		3.02		2.07		6.18		5.08	
I_x, in.⁴	16.2		14.1		10.8		7.67		15.8		14.7	
I_y, in.⁴	11.4		9.98		7.68		5.45		6.95		6.48	
r_y, in.	1.52		1.56		1.59		1.62		1.06		1.13	
r_x/r_y	1.20		1.19		1.19		1.19		1.51		1.50	

ASD	LRFD
Ω_c = 1.67	φ_c = 0.90

[c] Shape is slender for compression with F_y = 30 ksi.
Note: Heavy line indicates KL/r_y equal to or greater than 200.

A New Stainless Spec

As a continuation of the work done to produce Design Guide 27 and the design tables, AISC has begun work on a new specification covering the design, fabrication, erection, and quality of structural stainless steel (excluding cold-formed stainless steel). A committee has been established consisting of consultants, industry representatives, and educators, and it is expected that the specification will be available in 2021. The specification will include the rules in the design guide as a starting point and will align with the provisions in the 2016 AISC *Specification* as much as possible. The specification will extend the scope of the design guide to cover a greater range of structural sections and loading scenarios. At the same time, ASCE 8-02: *Specification for the Design of Cold-Formed Stainless Steel Structural Members* is also being revised—and is also expected to be published in 2021.

Stainless steel will see increased use as owners of critical infrastructure acknowledge the need for high performance materials that offer extended service life coupled with lower maintenance requirements. Eliminating corrosion extends useful service life, saves money and natural resources, improves public safety, and protects the environment. ■

Courtesy: di Domenico + Partners, Architects

Resistant to Flooding—and Corrosion

In 2012, Hurricane Sandy led to extensive flooding of the South Ferry subway station with saltwater and sewage. The station, which had been refurbished just two years earlier, was flooded from the tracks to the mezzanine, and all of the electrical and mechanical systems were destroyed. In order to repair the station and prevent flooding from occurring again, new surface entrance structures have been installed. The structures are made from duplex stainless steel S32205 channels and I-sections and ensure the entrance can now be sealed off to prevent the ingress of floodwaters.

business issues

VITAL VISION

BY THOMAS Z. SCARANGELLO, PE

Want your business to stand out as forward-thinking? Start by creating an environment where new ideas can be shared more easily—and keep vitality in mind.

Thomas Z. Scarangello is the chairman and CEO of Thornton Tomasetti.

BACK IN 2017, when we flipped through *Fortune* magazine's Future 50—a list of organizations that demonstrate both steady execution and a forward-looking strategic nimbleness, the qualities of vital organizations—we discovered a troubling fact: not one AEC organization had made the list.

So last year we engaged Boston Consulting Group (BCG), whose work had served as a basis for the list, to help give us some insights into how we could change that.

Vitality has been defined as the capacity for future growth and reinvention, and we believe those who maintain vitality can thrive, while those who do not will fail. We wanted to learn how an AEC firm can ensure that they fall on the right side of this process.

Martin Reeves of BCG has noted that while traditional metrics—such as revenue growth, market share, profitability and financial returns—are useful, they share a common limitation in that they are backward-looking.

That can be downright dangerous, since past performance doesn't predict future success. In the mid-20th century, Reeves noted that 77% of industry-leading companies were still among the top firms five years later, but today that number has fallen to 44%.

In our 2018/2019 annual report, we mapped out a new set of objectives developed by BCG that can help our industry maintain vitality by looking to the future instead of the past (see figure at right). The figure shows that vitality is predicated on three broad areas: laying the groundwork for new ideas to flourish, identifying and generating new ideas, and having a sufficient portfolio of bets. For those three categories, there are 11 subcategories, each with its own set of metrics to measure progress toward defined goals.

By following this approach, we believe the AEC industry can narrow the gap between AEC and the tech and tech-enabled companies that typically lead the pack on the Future 50.

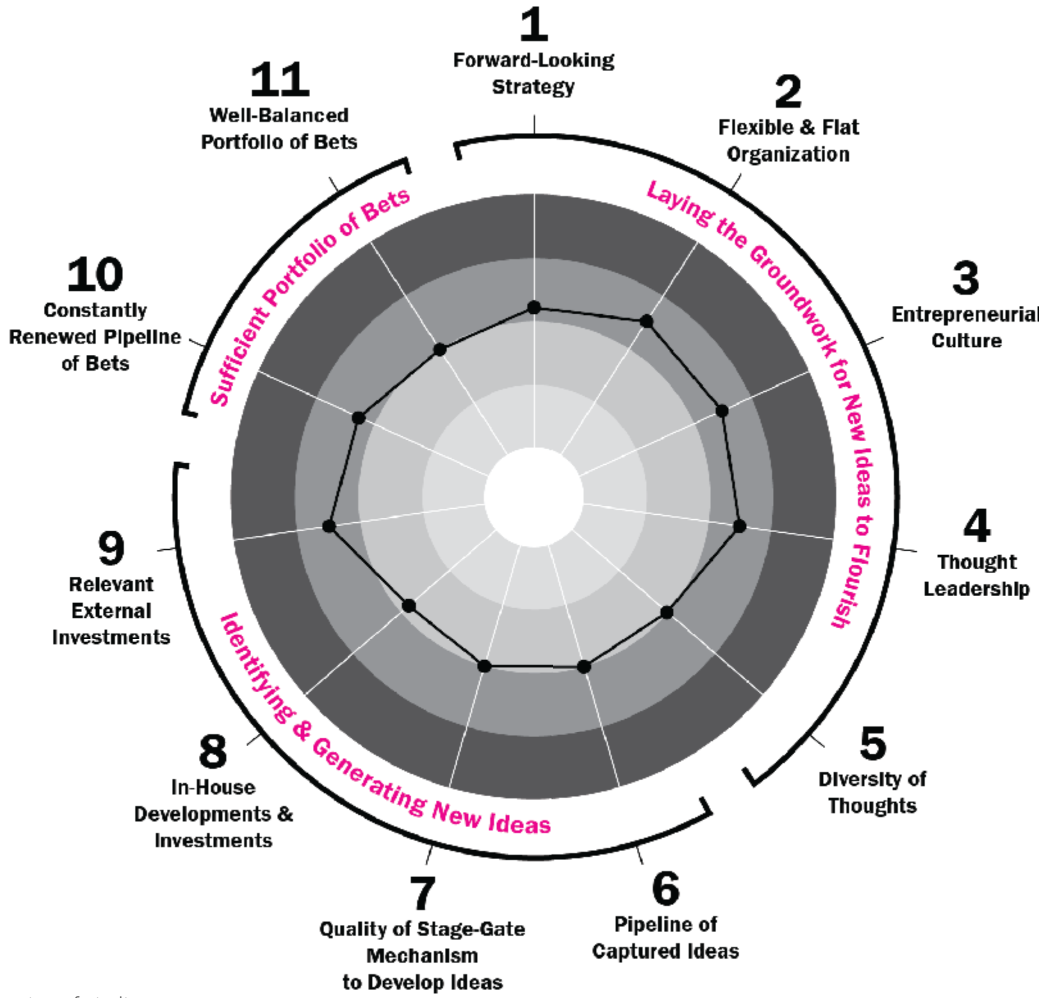
As Reeves noted, achieving performance along with vitality is no easy task, as businesses often fall on old habits, requiring leaders to "apply different strategic approaches throughout the business simultaneously, and to think on multiple time horizons, balancing short-term considerations with long-term competitiveness."

"The current business model can easily dominate resources, talent and strategy, especially for established, incumbent organizations," Reeves added. "To balance performance and vitality appropriately, companies must achieve ambidexterity, the ability to run the business and reinvent it at the same time." This key enabling skill, ambidexterity, is the mindset of optimizing present performance while also developing the potential for sustained future growth.

Our goal at Thornton Tomasetti is to strive for this balance, and we've implemented metrics to help track our progress on the 11 dimensions. As a result, we developed our Freshness Index, through which each of our projects is assessed and assigned a freshness score that measures the forward-thinking innovation we bring to each client's project.

We had put many of the categories and premises outlined by BCG to work in the past. But more importantly, we intend to actively incorporate the categories they've mapped out into our business model far into the future, and we believe the broader AEC industry would be well-served to do so as well.

One important area of focus at our firm has been the Diversity of Thoughts category, which is achieved by promoting diversity of people and creating an environment that



The 11 subcategories of vitality.

allows new ideas to be shared more easily. In turn, this attracts a more diverse workforce, which leads to more creative solutions in which our clients will find value.

We've seen this at play within our protective design and security team, through which we've attracted a diverse roster of security design and consulting professionals, such as ex-military, law-enforcement, and intelligence specialists, whose experience serves as a supplement to the traditional AEC mindset that is prevalent in our culture.

We've doubled down on creating a Diversity of Thoughts by maintaining a Well-Balanced Portfolio of Bets, another key category outlined in the BCG research. When it comes to acquisitions, we've made our bets only to add complementary expertise, and not just for the sake of growing larger.

For example, our acquisition in 2018 of MFD expanded the capabilities and reach of our security design and consulting team, while that of MMI Engineering brings to our clients a range of scientific and engineering backgrounds and an expanded footprint in the energy sector, with offices across the UK and in the U.S. and Australia.

Technology is another key area that must be addressed in any discussion on vitality, since it both enables and is enabled by disruption. For example, a structural framing system might typically take a project team upwards of three weeks to develop. Our CORE studio has developed an artificial intelligence approach that can rough out a building structure to a concept level in under a minute. The impact of such speed will influence the entire project development process, from concept iteration to project budgeting and scheduling to fabrication though construction.

Increasing vitality across the AEC industry will help attract the brightest people to spearhead technological innovation that not only saves time and money, but also help make the AEC industry a regular presence on the Future 50 list.

We hope that the spotlight we've shined on BCG's work will help give fellow design firms and others in the AEC industry a renewed focus on vitality, making us all think twice about solely relying on backward-looking metrics and outdated business models. By approaching vitality head-on, we believe we can become more dynamic, innovative, and profitable as our AEC leaders redefine and revitalize the future of our industry. ■

Structural steel transforms a former industrial building into a modern train station in the rapidly growing city of Raleigh.

All Aboard!

BY MICHAEL STONE, PE, AND DENNIS PILARCZYK, PE

© 2018 – Art Howard Photography

THE U.S. NEWS AND WORLD REPORT recently ranked Raleigh, NC as one of the top 10 places to live in the U.S.

With three major universities located within 25 miles of the state capital and nearly 22,000 new residents moving to Wake County every year, it is no wonder that Raleigh is catching the eye of business owners from across the country.

But as a region grows, so does traffic, and the city's disjointed transit system was in desperate need of an overhaul. The outdated Amtrak station located downtown served more than 160,000 passengers yearly, making it one of the busiest in the Southeast. Due to the station's limited footprint, it needed to be replaced to keep up with growing demand, incorporation of bus lines, and a proposed light rail line. Luckily, the solution could be found nearby, in an existing building surrounded by rail lines in the historic Depot District.

Uniting a City

The North Carolina Department of Transportation and the City of Raleigh wanted a site that was easily accessible to downtown Raleigh and could accommodate a large station with room for future expansion. An old industrial site with the existing 26,000-sq.-ft Viaduct Building, located near the intersection of two major railroads just south of the existing Amtrak station, was chosen. Originally constructed in 1965 and vacant since 2005, the Viaduct Building would be updated to become Raleigh Union Station.

Open since mid-2018, the station is now a full-service focal point of the Depot Historic District in the heart of downtown Raleigh. The entire Viaduct Building renovation, rail terminal, and plaza canopy were built in just over 24 months at a total project cost of $85 million. Primary steel fabricator SteelFab, Inc., provided the structural steel elements for the Viaduct Building renovation as well as the passenger platform and canopy, with the latter being required to match the radius of the rail line and slope grade with galvanized steel. A second fabricator, North State Steel, provided the structural steel for the station's galvanized plaza canopy.

Uniting Old and New

As can be expected with a building renovation, combining the new structural steel framing to the existing building posed many challenges, including deteriorated roof steel, unusable roof deck, unsuitable soils uncovered during geotechnical investigation, warped asymmetrical steel, and even buried concrete structures that were not on any plot plans. Nevertheless, the team found solutions to every hurdle, in short order.

Starting with the Viaduct Building structure, a combination of existing steel moment frames and unreinforced perimeter brick walls on shallow foundations were unable to fully meet the demands of the future design. To support the new loading conditions, the design team of structural engineer Lysaght and Associates and architect Clearscapes, along with Axiom Foundation Solutions of Raleigh, incorporated grout-filled micro-piles to be installed through the shallow block foundations. With only minimal deteriorated roof steel located at

above: The new Raleigh Union Station replaces an outdated Amtrak station that served more than 160,000 passengers per year.

opposite page: A rooftop garden provides a habitat for indigenous pollinator species, and grasses and flowers were chosen for their ability to absorb potential air contamination from the new transit vehicles.

Michael Stone is a principal with Lysaght and Associates and **Dennis Pilarczyk** (pilarczyk@aisc.org) is AISC's structural steel specialist for the Raleigh and Charlotte markets. **Steve Schuster, FAIA**, principal with Clearscapes, also contributed to this article.

above: Much of the original building's 36-ksi steel blended well with today's A992 50-ksi steel.

left: The preexisting Viaduct Building prior to its redevelopment into Raleigh Union Station.

Each canopy column was comprised of four W27×194 sections, with ripped-down flanges, and welded into a cruciform shape with over 500 lb of weld material per column.

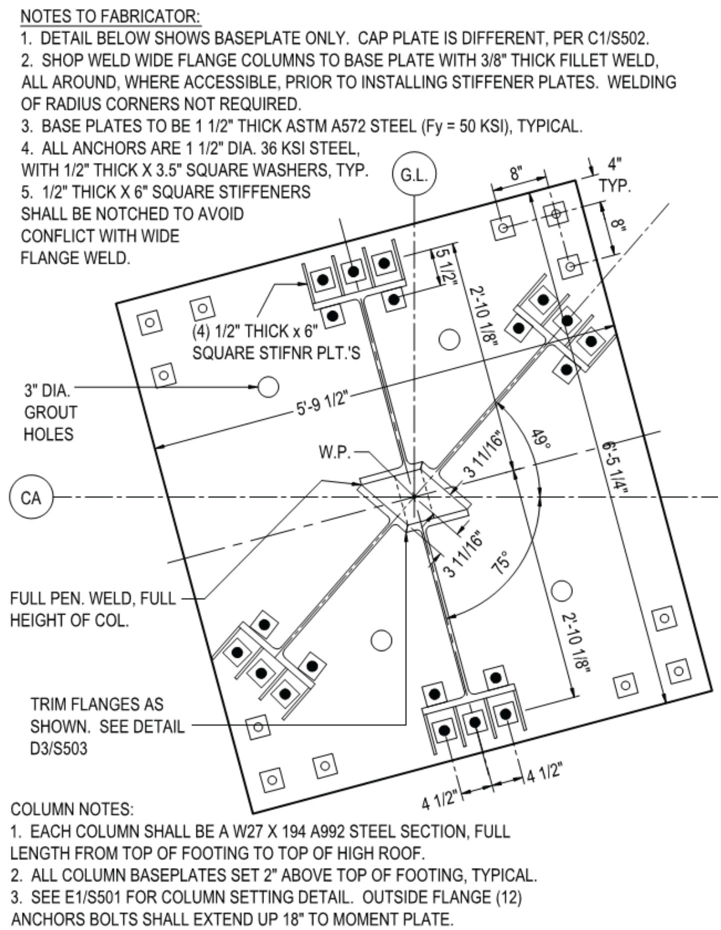
the west wing, the existing roof panels could be removed and replaced with a modern acoustic dovetail-style long-span metal deck. Extending over 45 ft, the new low-slope dovetail deck contrasts with the exposed red oxide and orange painted purlins and moment frames. New steel members were painted while existing steel was clear-coated to differentiate between new and old. The original steel columns, roof purlins, and yellow crane rail structure stand tall, proudly showing off the steel from the industrial age. With some modifications to meet the 2012 *IBC* wind and seismic demands, original 36-ksi steel blended well with today's 50-ksi steel (ASTM A992).

Means and methods are often too quick to be pushed onto general contractors and on this project the construction management joint venture of Skanska and Clancy & Theys were with faced with a unique challenge in supporting the southeast portion of the building on unsuitable soils along the south wall. With several concepts presented by the urban design team, it was elected to bring train-goers in under a new train bridge which dropped the entry level on the east wing roughly 14 ft below the existing slab-on-grade elevation. The structural engineering team designed a family of 45-ft-tall temporary steel pipe columns and footings to support the south end of bays 4 through 16 (there are 17 bays in all). The moment frame turned into a temporary cantilever system to allow the new foundations, site wall, and soil-nail wall to be installed. Due to the diligence of the general contractors, the total existing baseplate drop after the entire south foundation removal was only ⅜ in. New steel columns were then field welded with bearing on new lower deep foundations for a permanent foundation solution, bypassing the unsuitable soil conditions below.

Another task for the designers was determining how to securely get passengers from the main concourse to the new elevated train platform. CALYX Engineers and Consultants, an NV5 Company, sent its structural team to collaborate with Clearscapes to evaluate all solutions considering the many site constraints. After much debate, a naturally lit descending concourse and short underground tunnel below the train tracks and elevators was selected to serve as the passenger corridor. Clearscapes elected to reuse original metal building panels as the interior "artwork" as passengers descend down the long corridor to travel from the concourse to the train platform island. Emerging from the tunnel onto the platform, passengers are greeted with a graceful steel canopy that zig-zags down 320 ft of the platform, offering weather protection. The contour of the platform had to follow the layout of the adjacent tracks to permit passenger access to the trains, and this was achieved by coordinating track layout drawings and as-built survey points.

Uniting Form with Function

Because it is primary building entrance from downtown, the designers knew the facility's plaza canopy had to make a statement, punctuated with hot-dipped galvanized columns. Each column was comprised of four W27×194 sections, with asymmetrical flanges, and welded into a cruciform shape with over 500 lb of weld material per column. With a height of nearly 34 ft, the 15.5-ton assemblies could not fit into most galvanizing kettles and were shipped from North Carolina to Mississippi to be galvanized, then shipped back to North Carolina for erection. In addition, an impressive 37-ft galvanized cantilever off each side of the columns allows passengers from the Martin Street entrance to stay dry as they enter



right: A typical quad W27×194 column assembly detail. The flanges are trimmed asymmetrically to create the unique diamond shape.

below: In-shop fit-up of a canopy column.

the Viaduct Building. The canopy was specifically designed to support various panels from local artists, adding local flair to the iconic building.

Similarly, the galvanized steel platform canopy is supported by a single, center row of wide-flange columns and tapered W18×65 double cantilever beams. Beyond the canopy, the platform construction changes to steel to more easily accommodate future expansion and modification.

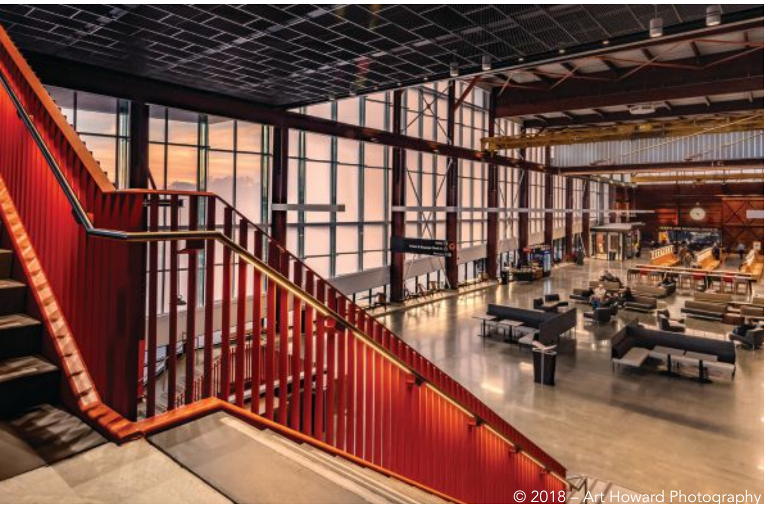
Another statement piece, this one inside the building, is a large orange steel-framed monumental stair at the west entrance. The multi-level double-cantilever kick-back stair incorporates fully welded quad HSS20×4 stringers to create an asymmetrical A-frame, eliminating the need for support columns in the main concourse. The erection for the stair had to be closely coordinated to ensure exact placement of the stringers and cantilevers. When it came to load testing, deflection at the end of the cantilever was laser measured to be less than ⅜ in., which was ⅛ in. less than the ½-in. theoretical calculated deflection during temporary cable release.

When it came to the main framing system for the building, elevated platforms aided the moment frame design and were requested to cantilever out of the south wall, highlighting the natural light from the east. The original steel wall plates would not serve any meaningful lateral resistance, so braced frames (3-in. pipe X-bracing) were added in select bays. Elevated pavers, on a V-style metal deck, along with bolted moment connections and web stiffeners were used to support new 100-psf live loads off of existing W24 building columns.

A key feature of the south wall is a mesh of zig-zag steel framing, suspended from the roof, above a cantilevered walkway. The south-facing façade design was intended to mirror that of a passing commuter train. A unique dynamic-shading insulating glass unit system was selected which was configured to allow optimal light penetration without overheating the space in warmer months. Radiant heat piping in a fiber-reinforced slab along with layers of rigid insulation on the roof contributed to the building's targeted LEED Silver certification.

Also, two new green space areas were incorporated into the expansive roof areas taking advantage of the ample sunlight inherent to the site. One is located above the new underground passenger corridor between the main concourse and train platform, and the other is a roof terrace accessible via the monumental stair. A pollinator mound is located at grade along the north side of the building.

In addition to the current passenger platform and two train lines entering the station, there are plans for future expansion for a third line and second platform. The City of Raleigh also has plans



above: Architect Clearscapes elected to reuse original metal building panels as the interior "artwork"in some areas.

left: The main hall maintains the building's historial industrial aesthetic.

below: The galvanized plaza canopy serves as a dramatic entrance.

to open a multi-story bus station with retail, offices, and parking in a nearby site, fully integrating the train and bus terminals in a true transportation district. While the design of the Raleigh Union Station met a significant current need for the city and region, it also serves as a catalyst for things to come in this quickly developing market. ■

Owner
City of Raleigh, N.C.

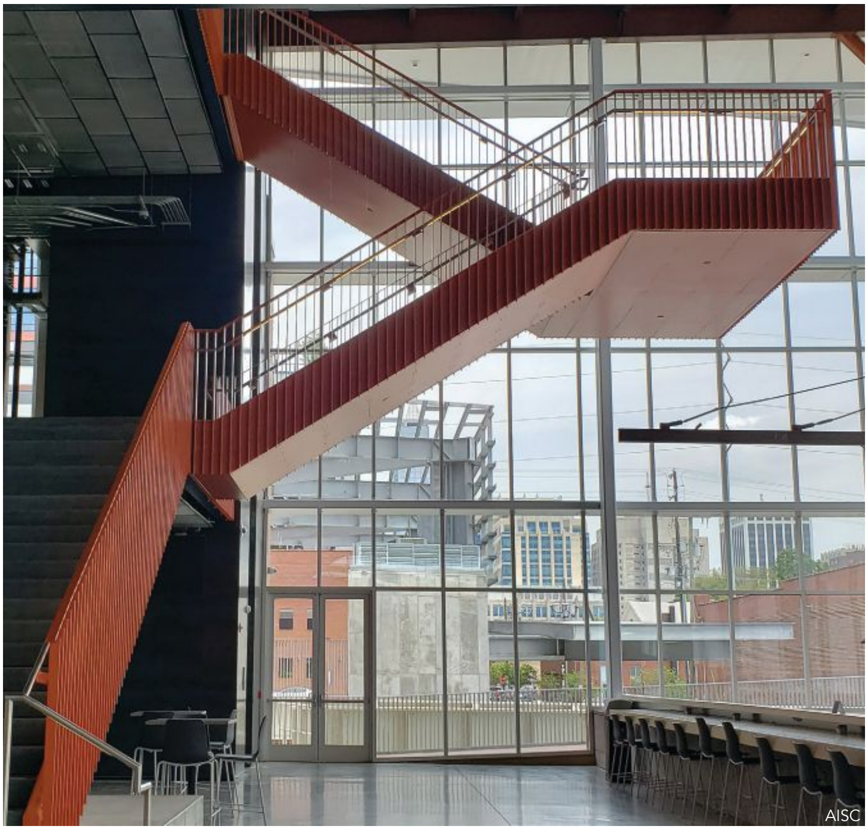
General Contractors
Skanska, Durham, N.C.
Clancy & Theys, Raleigh
Holt Brothers, Raleigh

Architect
Clearscapes, Raleigh

Structural Engineers
Lysaght and Associates, Raleigh
CALYX Engineers and Consultants, an NV5 Company, Raleigh
STV, Raleigh

Steel Team

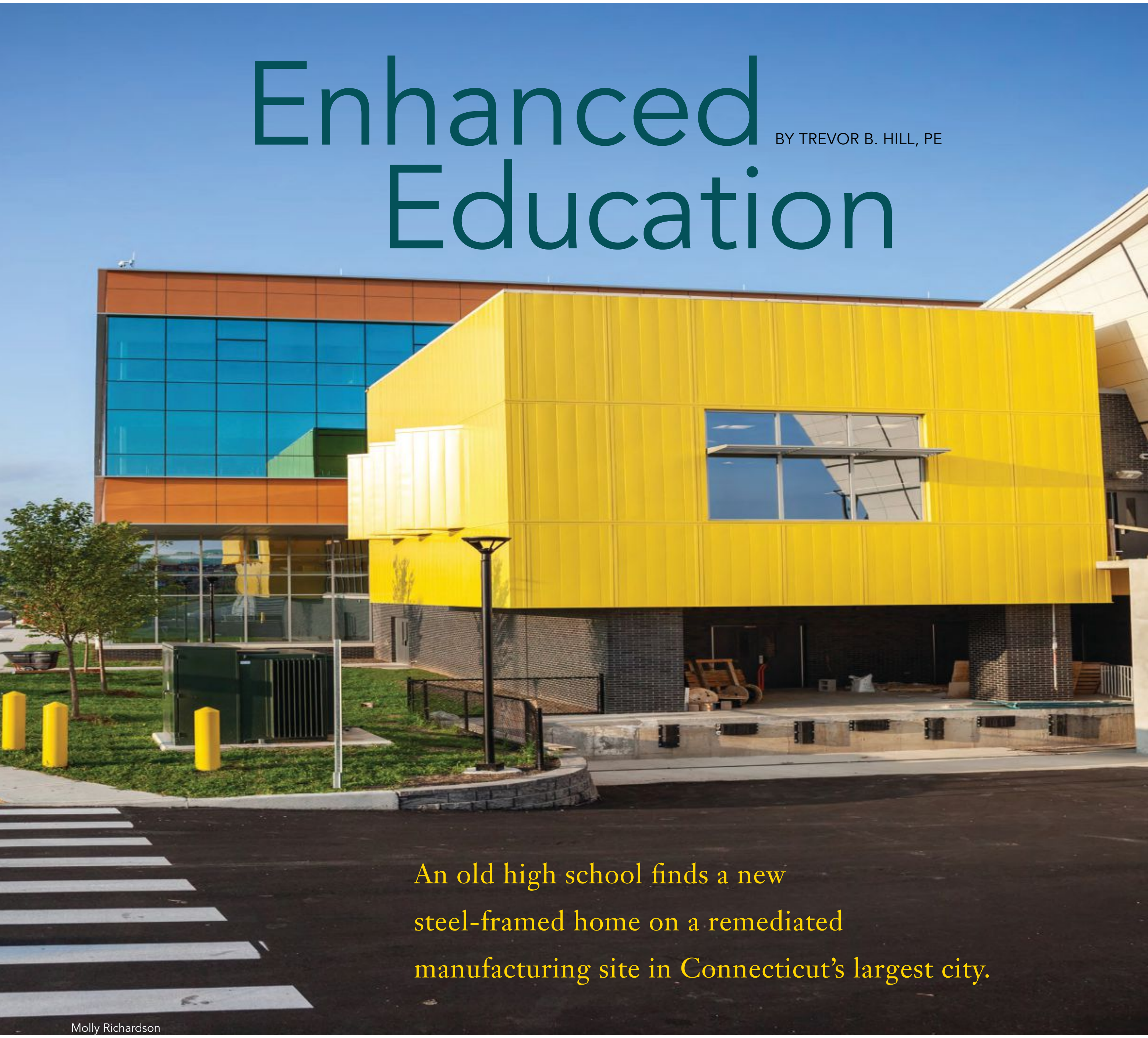
Fabricators
SteelFab, Inc., Raleigh (AISC Certified Fabricator)
North State Steel, Greenville, N.C. (AISC Certified Fabricator)



The steel-framed monumental double-cantilever kick-back stair incorporates fully welded quad HSS20×4 stringers and doesn't require support columns.

Enhanced Education

BY TREVOR B. HILL, PE



An old high school finds a new steel-framed home on a remediated manufacturing site in Connecticut's largest city.

Molly Richardson

Trevor B. Hill (trevor@tdeg.com) is a principal with the the Di Salvo Engineering Group.

FOR MORE THAN A DECADE, the City of Bridgeport, Conn., scoured its east side for a site to replace the 90-year-old Warren Harding High School building, which was considered to be too costly to renovate and upgrade. And in 2013, they found it.

While the tight, urban, 77-acre parcel of land, located on Bond Street, was suitable for building the new high school, it was a picture of urban decay, complete with dilapidated buildings and graffiti. Owned by GE since 1920, the site served as a manufacturing facility for small motors and electrical devices and employed more than 20,000 people at its height. Alas, it ceased operations and closed in 2007, leaving behind an empty complex—13 buildings comprising 1.5 million sq. ft—which was demolished between 2010 and 2012. As such, the Harding High School project killed two birds with one stone, creating a new school in the desired area and redeveloping a massive brownfield site in an urban area. In addition, the school building meets LEED Silver certification requirements, making it a low maintenance and environmentally-friendly building and surrounding site—e.g.,

Molly Richardson

opposite page and left: The new Warren Harding High School in Bridgeport, Conn., replaces a 90-year-old facility that was deemed too costly to renovate.

below: The curved portion of the roof combines form and function, incorporating the wide range of roof deck heights required by a high school auditorium, classrooms, and office space while at the same time creating an opportunity for a signature architectural feature.

Schenectady Steel

on the northern corner of the property, a solar array provides roughly 783 MWh of energy to the school annually.

The city tasked architect Antinozzi Associates, who called upon the engineering expertise of the Di Salvo Engineering Group (TDEG), to design a new state-of-the-art high school campus. The new 208,000-sq.-ft school is four stories and is designed for 1,150 students. It contains 55 classrooms, virtual and graphic laboratories, computer and traditional science and language laboratories, art classrooms, music rooms,

Jason Henion

Structural steel (1,750 tons in all) was selected to frame the project.

a 600-seat auditorium, one gymnasium with bleacher and floor seating to accommodate the entire school population, and a second, auxiliary gym. The interior space features the two stories of classrooms over the gymnasiums and cafeteria and three two-story-high "Collabagoras"—a portmanteau of collaboration and agora, the ancient Greek word describing a public, open space—at the second floor along the center of the building, allowing a view through the glass railings to the floors above and below and bringing natural light into the central portion of the building. Other site facilities include a football/soccer multipurpose field, a baseball field, an eight-lane running track, and a field house.

Structural steel (1,750 tons in all) was selected to frame the project. Preliminarily, long-span two-story trusses were designed to carry the structural load of both floors and the roof. However, the two-story truss chord forces exceeded 1,200 kips and became uneconomical given the amount of welding that

right and below: To carry the structural loads of two floors and the roof, multiple 30-in.-deep beams cambered at 2 in. maximum mid-span were implemented, spanning up to 81 ft.

Jason Henion

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Molly Richardson

above: The new 208,000-sq.-ft school is four stories high and is designed for 1,150 students.

above and below: The building contains 55 classrooms, virtual and graphic laboratories, computer and traditional science and language laboratories, art rooms, music rooms, an auditorium, and two gyms.

Molly Richardson

would have been required. The team determined that jumbo wide-flange sections were the optimal solution, and multiple 30-in.-deep beams cambered at 2 in. maximum mid-span were implemented, spanning up to 81 ft. Beam camber was reduced at each end of each framing bay to increase stiffness adjacent to short-span framing, which doesn't deflect as much. The beams were also cambered near quarter-span at the roof's peak height so as to follow the pitch.

An 87-ft beam span at the north end of the auditorium supports both the third floor and roof level. The original beam specified was a W40×593 (cambered 2 in.), which was later revised to be a 43-in.-deep plate girder consisting of 32-in. by 2-in. flanges and a 39.75-in. web (also cambered 2 in.). The flange needed to be wide enough to support the masonry/curtainwall above approximately 16 in. from the centerline of the beam. The plate girder (fabricated by High Steel) was also required to be used

Beams were shipped from the fabrication shop to the site via rail in lengths up to around 80 ft long.

above: A built-up column mock-up.

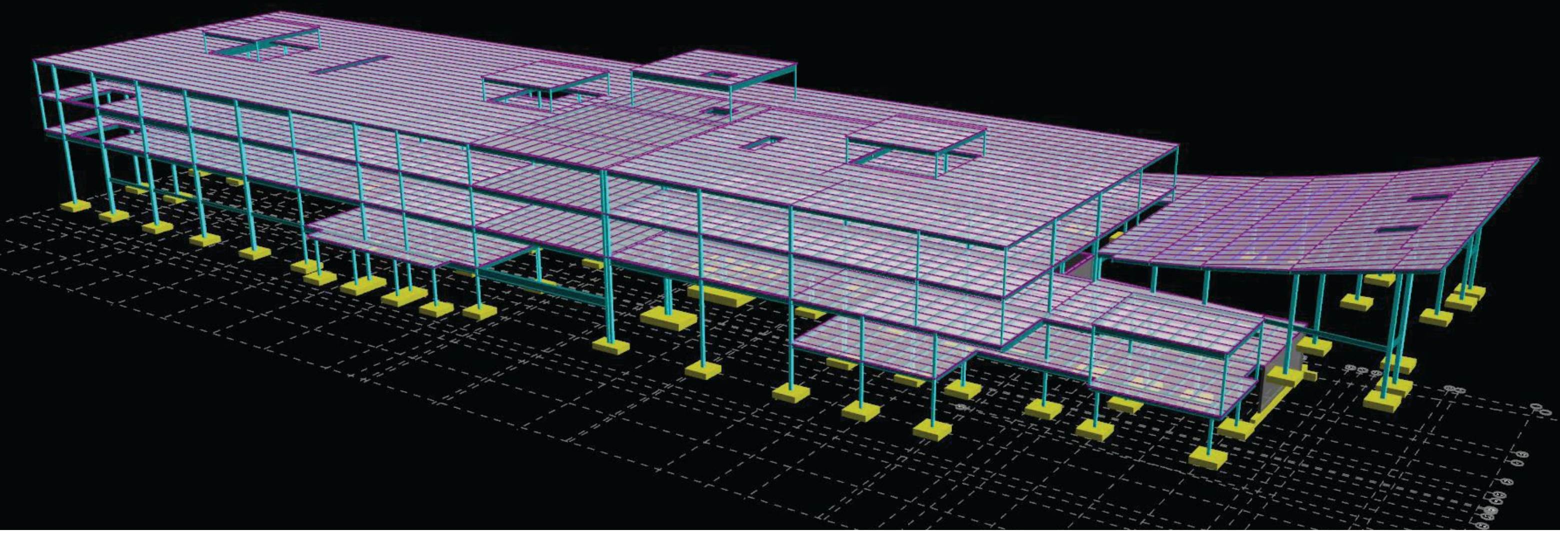
right: A sample bent member for the roof framing.

as a moment frame, with flanges welded to adjacent W14×233 and HSS14×14×7/8 columns. In addition, a 20-ft beam cantilever (W44×290) supports two floors and the roof at the southwest portion of building, and multiple 12-ft beam cantilevers (W40×183) perform the same duties at the northwest end.

A 3D modeling approach, incorporating Revit, was used to coordinate the project amongst architect, engineer, and general contractor and helped locate and address problems quickly, and early on, to ensure design accuracy. Revit was helpful in locating the edge of cantilevered steel/top of steel elevations along the curved portion of roof, as not only do portions of roof slope vertically (convexly), but portions of the exterior façade slope outward as well so each gridline has a unique cantilevered length and elevation. Clash detection was also used to avoid numerous interferences with ductwork/steel framing and to locate required steel beam penetrations. It was also instrumental in coordinating many small items such as steel framing locations where conduit feeds science lab tables, slab depressions below eyewash stations, and other areas.

left: Cantilevered sections appear at the southwest and northwest corners of the building.

below: One of the three two-story-high "Collabagora" areas.



Countless hours were spent in 3D model coordination meetings to ensure that the building components fit together, and dozens of clashes were avoided by careful use of the process.

Thinking outside the Tube

Like just about any steel building project, Warren Harding High School involved a combination of compromise and collaboration.

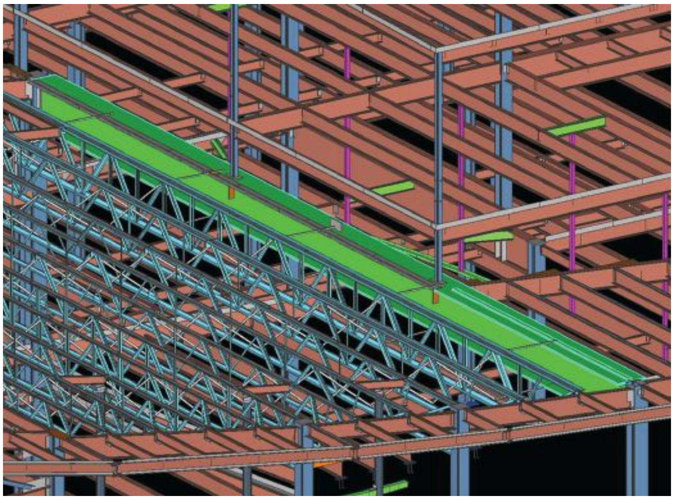
For example, structural engineer TDEG looked to implement jumbo tube columns in some areas. However, the designers recognized the difficulty of acquiring some of the desired sizes to the point of noting it on the structural drawings. Not only would the lead times for these items interfere with the project schedule, but they were also not available domestically at the time. Fabricator Schenectady Steel worked closely with TDEG to select wide-flange members that met the section properties of the jumbo tubes, and also came up with a method to build out the profile of the wide-flange members to resemble hollow structural section (HSS) profiles to satisfy arch requirements.

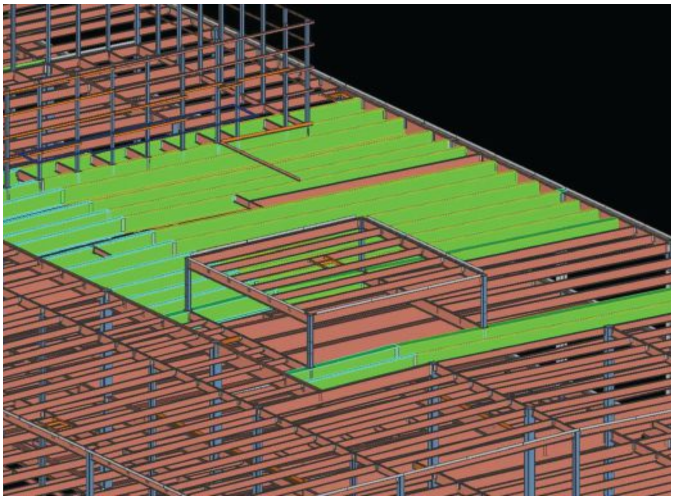
Another structural scenario that required modification involved supporting the third floor and roof level at the north end of the auditorium. The original design called for a W40×593 to address the span of 87 ft, which would have required custom rolling. Instead, TDEG designed and reviewed a plate girder with the section properties required to satisfy the loads. The efficiency at which both companies were able to come up with these solutions played a critical role in maintaining the aggressive schedule.

Schenectady Steel was able to assist with the long, heavy beams required for the roof system. With 40 roof beams of 80 ft or longer, the shop's location played as much of a role in the success of the project as its employees, leveraging a rail siding to deliver these long members directly into the plant from the steel mill by train. The facility houses enough space to process and fabricate these items, removing many of the costly field splices typically required with this type of construction. From there, delivery routes were mapped out and route surveys completed to ensure safe delivery of these massive loads to the project site. Delivering the beams at full length, without splices, allowed the erection crew to reduce the overall erection schedule by installing each one in a single pick.

The building's curved, sloping roof system presented another challenge in the form of a very demanding geometry to navigate, let alone fabricate and install. Maintaining the roof surface at varying slopes required thousands of plate shims across beams, columns, and joist members so the deck would lay flat. Countless hours were spent in 3D model coordination meetings to ensure that the building components fit together, and dozens of clashes were avoided by careful use of the process—e.g., the model approach was crucial for defining openings and spacing in an HSS and steel angle screen wall assembly that enclosed the rooftop units.

—Claudio Zullo, President, Schenectady Steel





Grading on the Curve

Chicago Metal Rolled Products curved 40 tons of structural steel members (TS 16” x 8” x .500” wall and TS 10” x 4” x .375” wall material) the hard way for the framing of the Cottrell Hall dome.

Eight of the TS 16 x 8 x .500’s “ribs” were detailed with a single radius; the tightest outside radius being 25ft 5.6875in. The other eight TS 16 x 8 x .500 “ribs” did not have a specified radius, but instead had specified points along the arc which the tube needed to hit. CMRP calculated multiple, specific radii to roll the tubes to in order to match the curvature defined by the multiple points required – without any costly splices.

Cottrell Hall,
High Point University,
High Point, NC

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2. **Angle Leg In**
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3. **Flat Bar The Hard Way**
   INSIDE DIA.
   24" x 12" Flat

4. **Flat Bar The Easy Way**
   INSIDE DIA.
   36" x 12" Flat

5. **Square Bar**
   INSIDE DIA.
   18" Square

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

7. **Beam The Hard Way (X-X Axis)**
   INSIDE DIA.
   44" x 285#

8. **Channel Flanges In**
   OUTSIDE DIA.
   All Sizes

9. **Channel Flanges Out**
   INSIDE DIA.
   All Sizes

10. **Channel The Hard Way (X-X Axis)**
    INSIDE DIA.
    All Sizes

11. **Tee Stem In**
    OUTSIDE DIA.
    22" x 142 1/2# Tee

We bend ALL sizes up to:

12. **Tee Stem Out**
    INSIDE DIA.
    22" x 142 1/2# Tee

13. **Tee Stem Up**
    MEAN DIA.
    22" x 142 1/2# Tee

14. **Angle Heel In**
    INSIDE DIA.
    8" x 8" x 1" Angle

15. **Angle Heel Out**
    OUTSIDE DIA.
    8" x 8" x 1" Angle

16. **Angle Heel Up**
    MEAN DIA.
    8" x 8"x1" Angle

17. **Square Tube**
    INSIDE DIA.
    24" x 1/2" Tube

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

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

20. **Square Tube Diagonally**
    MEAN DIA.
    12" x 5/8" Square Tube

21. **Round Tube & Pipe**
    MEAN DIA.
    24" Sched. 80 Pipe

22. **Round Bar**
    MEAN DIA.
    All Mill Produced Sizes

The $107 million project was completed on time for the 2018-2019 school year.

Towards the end of summer, it was a race against time to complete the project ahead of the 2018-2019 school year, and workers were on-site ten hours a day. Fabricator Schenectady Steel was able to deliver the very long steel beams in a single piece, eliminating costly field splices, which greatly assisted in meeting the schedule. Any other structural material would have slowed the construction.

The $107 million project was completed on time and when students stepped through the doors of their new school at the beginning of the fall semester, they were greeted by a school building beyond expectation. Familiar signs of their old school were there, such as trophy cases and sculptures of athletes from past years, but the new building itself represented a new beginning, one that would enhance the high school experience. ■

Owner
City of Bridgeport

General Contractor
Epic Management of CT, Milford, Conn.

Architect
Antinozzi Associates Architecture and Interiors, Bridgeport, Conn.

Structural Engineer
The Di Salvo Engineering Group, Danbury, Conn.

Steel Fabricator and Erector
Schenectady Steel Co., Inc., (AISC Certified Fabricator & Erector) Schenectady, N.Y.
High Steel Structures, LLC, (AISC Certified Fabricator) Lancaster, Pa. (Plate Girder)

Detailer
Lehigh Valley Technical Associates, (AISC Detailer) Inc., Northampton, Pa.

Switching Convention

BY KILEIGH SHEA, SE, PE

LOOK EAST DOWN 4TH STREET from the main north-south artery of Congress Avenue in downtown Austin, Texas, and you will see an array of tall white steel pipes, fanning outward at a slight angle, floating 50 ft above the street below.

Look closer and you might see people weaving between these slender pipes. This sculptural art piece has changed the downtown skyline of Austin, known for music, innovation, and technology—and now, distinctive sky bridges.

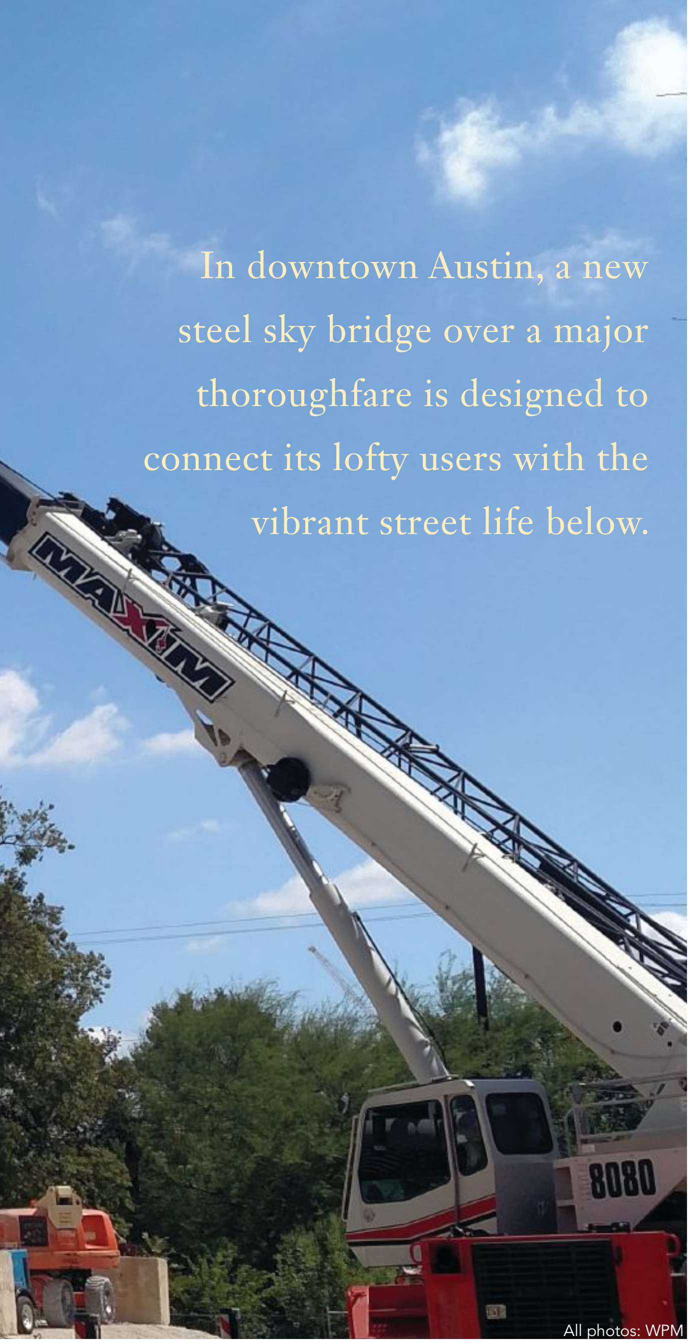
As Austin experiences a construction boom that has resulted in many new hotels rising throughout the downtown area, the Hilton Austin was looking to increase its competitiveness as the city's primary convention center hotel. As part of a total hotel renovation and remodel, as well as a revitalization of the Austin Convention Center district, the Hilton and convention center hired Gensler to design an outdoor event space and a sky bridge between the two buildings. This new 1,800-sq.-ft elevated balcony is fully supported on the existing Hilton and provides additional entertainment space for the hotel, as well as access to the Hilton Overhead Walkway, the artistic open-air sky bridge spanning nearly 100 ft across the busy street 50 ft below. This direct connection between the two buildings, using 90 tons of steel in all, increases the usable conference space of the convention center as well as its competiveness, allowing for larger conferences to consider it as a possible venue—while also providing safer access over 4th Street for pedestrians.

Overcoming Opposition

On any given day, the streets of downtown Austin are busy, energetic, and filled with pedestrians ranging from out-of-town vacationers or conference attendees, to local business people and university students. This vibrant street life adds to the character of Austin, and the city council's long-standing perception of sky bridges is that they detract from the pedestrian experience and lead visitors away from streetscape and the city itself. This perception is why only a handful of sky bridges exist in the city today—and also why the Hilton Overhead Walkway initially faced intense opposition.

With this in mind, the design team and the general contractor committed to a design that more resembled a sculptural art

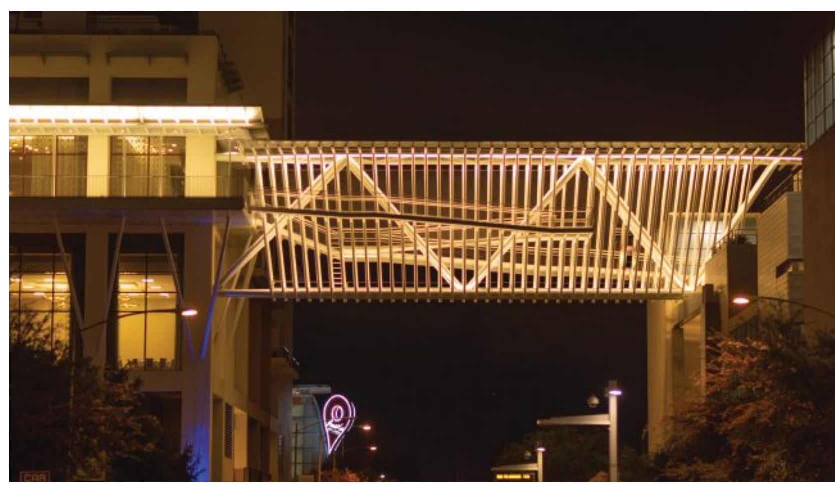
In downtown Austin, a new steel sky bridge over a major thoroughfare is designed to connect its lofty users with the vibrant street life below.



All photos: WPM

above and left: In the course of one weekend, the bridge was transported down 4th Street on self-propelled mobile transporters, where a 900-ton erection crane lifted it into place.

below: The Hilton Overhead Walkway, which uses 90 tons of structural steel, connects the Hilton Austin and the Austin Convention Center above a vibrant section of the city's 4th Street.



installation rather than a traditional pedestrian bridge. The completely open-air walkway was an unconventional shape, incorporated skyline views and was open to the public to invite non-conference attendees and non-hotel guests to experience the Austin skyline from 50 ft above street level. The team also highlighted the safety factor. Without a bridge, conference attendees cross a busy multi-modal street that includes heavy car, pedestrian, and bike traffic, as well as the outdoor main station for the MetroRail, Austin's commuter train line, which has long term plans to add additional train lines to this stop.

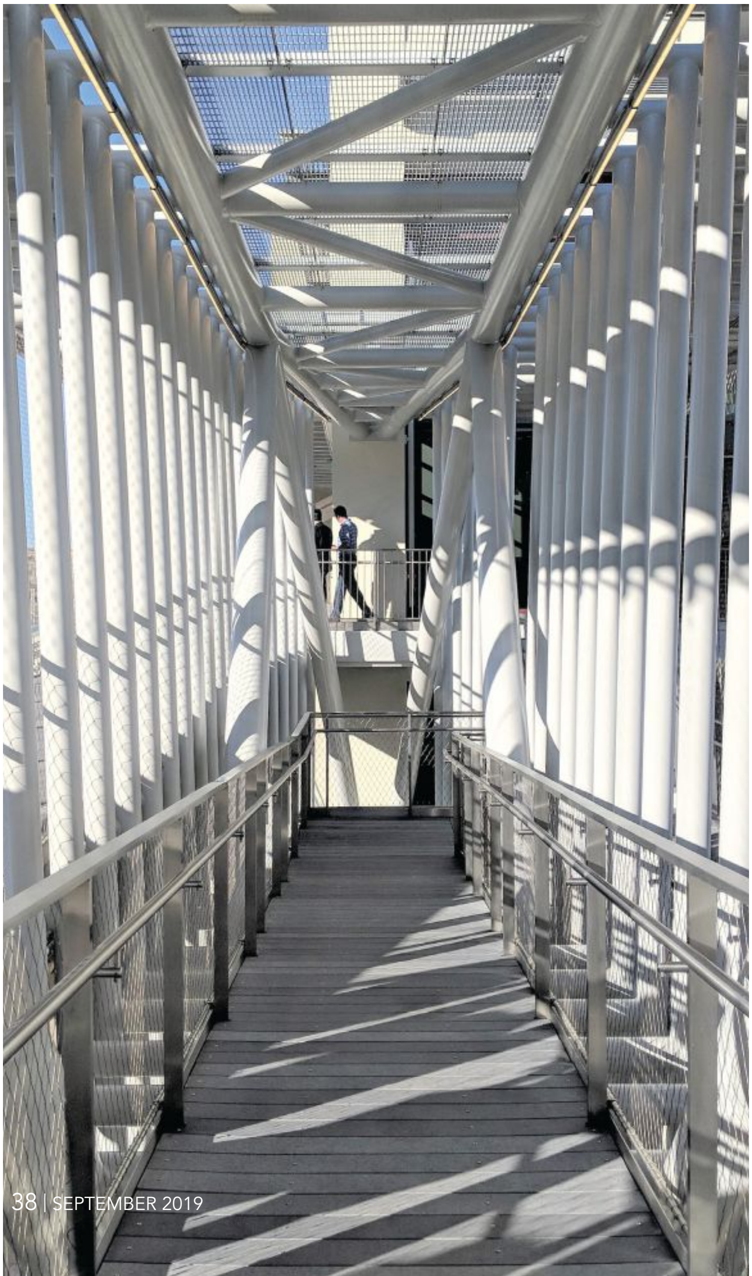
A bridge design that acknowledges Austin's artistic roots and connects people to the city rather than secluding them from it, paired with the obvious need for safety provisions, led to the project's approval.

Challenging Geometry

The balcony and walkway connect to the sixth floor of the Hilton and the third (top) level of the Austin Convention Center. To complicate matters, the convention center has an existing expansion joint passing directly through the new bridge connection point, resulting in the bridge actually joining three buildings together instead of two.

One of the design requirements for this new bridge was that the construction would have minimal impact on the existing buildings, and that the hotel and convention center would be fully operational during all phases of the construction. Having been the original engineer of

Kileigh Shea (**kshea@walterpmoore.com**) is an associate with Walter P Moore in Austin and the project engineer for the Hilton Overhead Walkway.



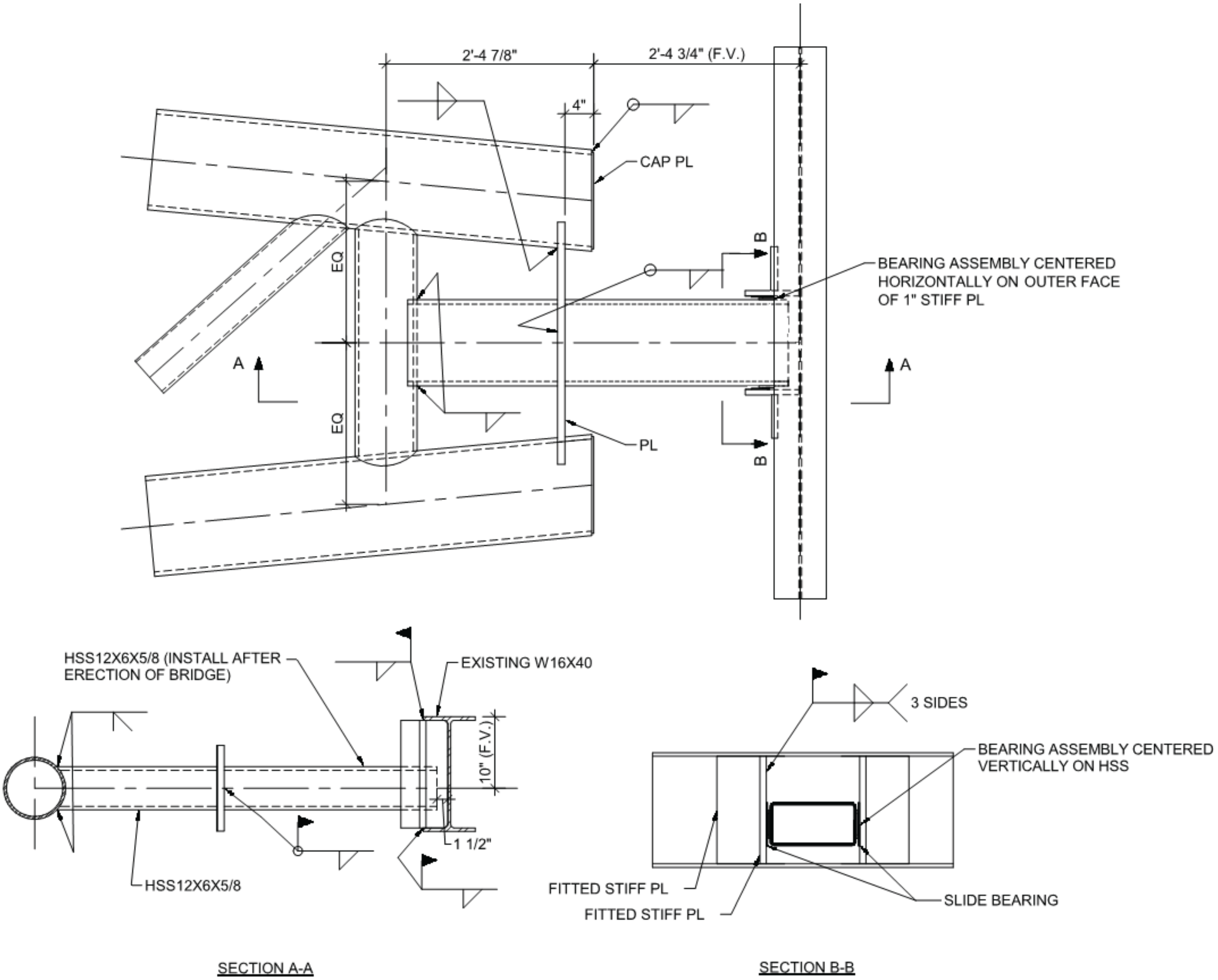
above and left: The balcony and walkway connect to the sixth floor of the Hilton and the third (top) level of the Austin Convention Center, 50 ft above street level.

record (EOR) for the existing hotel, Walter P Moore advised on possible connection points to the existing structure, and it was determined the walkway could be fully supported off a single corner column on the Hilton side. The bridge geometry and existing conditions of the convention center at the existing terrace presented many support issues. Since retrofitting the existing structure was not an option, two new concrete columns and new foundations were installed on the outside of the convention center, and a new built-up W36×262 with side plates was installed to support the bridge bottom chord and transfer the bridge loads to the new columns.

There is an 11-ft elevation different between the connection points of the two buildings, meaning that the bridge had to cross perpendicular to the street below, a straight-run distance of only 92 ft. This horizontal distance was not long enough to comply with ADA slope and landing requirements, so the length of the walkway on the bridge needed to be increased, while the straight-run distance remained unchanged. The final walkway layout incorporated two switchbacks, which added an additional 90 ft of walkway length. The cantilevered perimeter walkways allow pedestrians to have unobstructed views of the downtown skyline before the first switchback, where pedestrians cross into the interior of the structure and walk inside the main truss system and the 79 30-ft tall 6-in. OD hollow structural sections (HSS) that fan out from the midspan of the bridge at 0.44°. On the final switchback, the sloping walkway meets up with a cantilevered staircase to allow pedestrians the option of a straight-run between the two existing buildings.

Boundary Conditions

While assigning boundary conditions and fixity during analysis can always present some difficulty, it was especially



Details of the top chord slide bearing connection. Connections on the convention center side used various slide and pot bearings to accommodate the lateral movement of the bridge due to wind, as well as the building's differential movement.

challenging for a bridge with unique geometry that was connecting three separate existing buildings.

The bridge design and connections to the existing structures needed to allow for movement due to thermal expansion of the exposed steel, lateral translation of the bridge due to wind loads, and differential movement between the buildings. Since the Hilton had more reserve capacity to support the bridge than the convention center, the only fully pinned connection was at the bottom chord on the Hilton side. Slide bearings were utilized at the top chord connection on the Hilton side since this connection was located at mid-height on a two-story column, thereby eliminating the point moment on the column due to the large force couple between the top and bottom chords. The slide bearing connection laterally restrained the top chord from sway and allowed for vertical load transfer. The remaining connections on the convention center side used various slide and pot bearings to accommodate the lateral movement of the bridge due to wind, as well as the building's differential movement.

Originally the design intent was for the top chord on the convention center side to remain unattached from the building to give the impression from the convention center terrace that the bridge was floating. However, this presented a sway issue, and combined with the flexible 30-ft-tall HSS that support the cantilevered walkways, vibration, both vertical and lateral, was a concern due to pedestrian foot traffic. (The design team consulted AISC Design Guide 11: *Vibrations of Steel-Framed Structural Systems Due to Human Activity*—**aisc.org/dg**—to address vibration considerations.) Extensive time history analyses were performed to determine the accelerations pedestrians would perceive while on the bridge, and it was determined various connections to the existing structure needed to be stiffened. This was accomplished by including stiffener plates at some of the connections and by also connecting the top chord to the Convention Center. The design team created a minimally invasive connection that reduce the amount of cladding and waterproofing demolition of the existing building and did not add significant load onto the convention center framing. This connection met the owner's aesthetic expectations as well as their expectations for keeping the building fully functional during construction. The resulting design increased the overall natural frequency, reduced sway, and thereby reduced the perceived accelerations to a comfortable level, all without increasing the overall tonnage of the structure or impacting movement capacity.

Construction Challenges

Due to the location of the walkway over the street and train station, it was not feasible to stick-build and shore the bridge in-place, as this would result in shutting down the train, and the street, for an extended period. During the schematic design process the design team met with the general contractor, steel fabricator, steel erector, and erection engineer to devise a solution that maintained the original design intent of clean lines with no exposed bolted connections without disrupting the street traffic below.

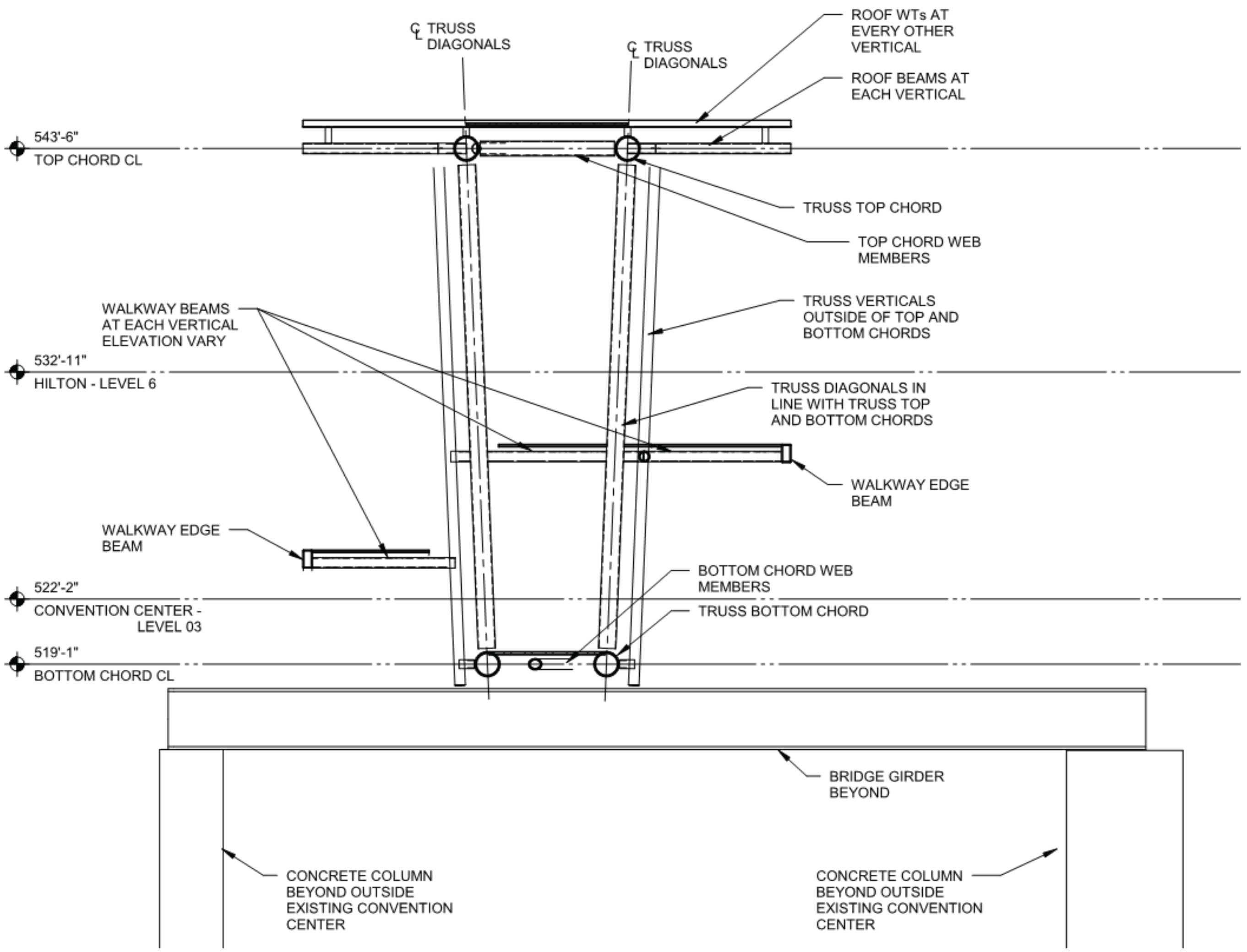
The solution was to prefabricate the walkway in the fabrication shop and then ship large pieces to a parking lot a few blocks from the construction site, where the entire bridge was reassembled on cribbing blocks and falsework over several months. Then, in the course of one weekend, the bridge was transported down 4th Street on self-propelled mobile transporters, where a 900-ton erection crane lifted it into place. It fit perfectly and was bolted to pre-installed connections on the existing buildings. This construction and erection plan eliminated the majority of the dangerous overhead structural work, as well as difficult and costly field welding. The off-site assembly and the use of bolted connections to the existing structures, which would later be covered with building cladding, allowed the crane to be brought in, the bridge to be transported and lifted, the crane removed, and the street reopened—all in under 48 hours and with no safety issues.

Innovation

Since the steel structure is fully exposed, the owner and design team desired a clean and beautiful finish, but chose not to implement architecturally exposed structural steel (AESS) requirements—especially considering that not all the steel would be equally visible to the bridge pedestrians. The design team worked with the general contractor and fabricator to create mockups of the major connections to approve the weld and paint finishes. These approved mockups allowed the design team to specify the desired level of finish at various locations, without requiring unnecessary finishes on pieces that would not be visible. This proved to be more cost-effective than specifying AESS on the entire structure, and most importantly, allowed the design team and owner to visualize and understand what the final product would be prior to fabrication.

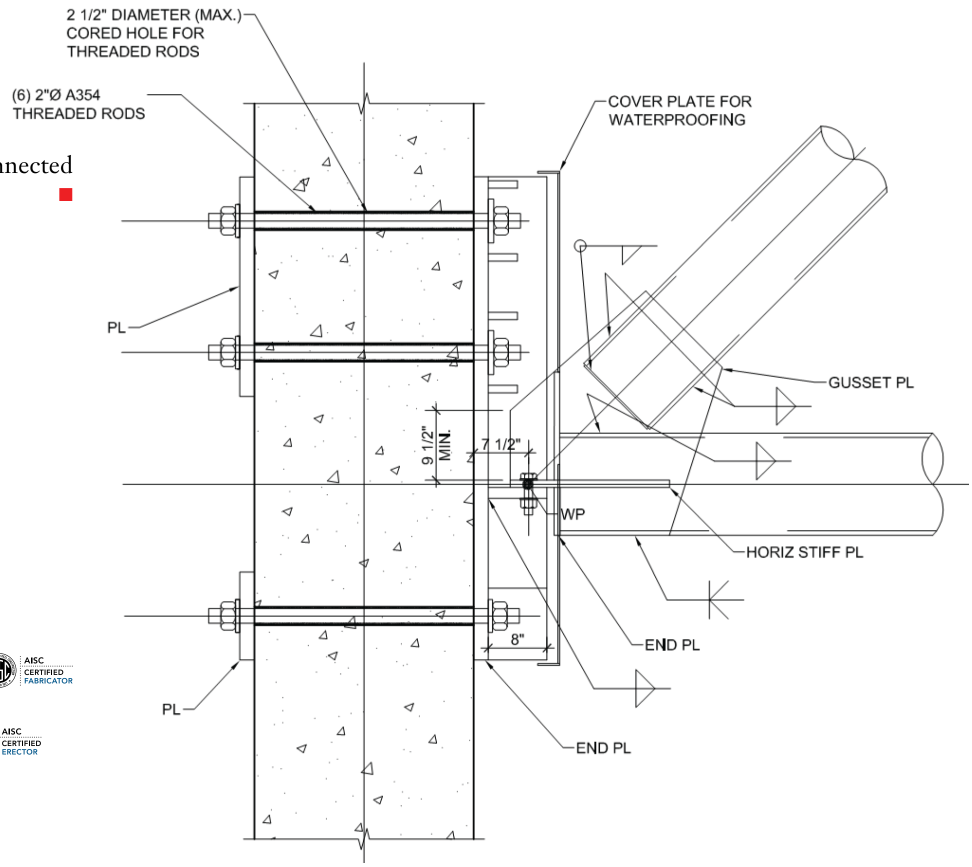
The design teams shared their 3D models with the construction team to facilitate quicker steel fabrication, and Walter P Moore shared its 3D structural analysis model with the erection engineer, Genesis Structures, to aid in its analysis of the stresses and stability during the various stages of construction and erection.

The Hilton Overhead Walkway is now a prominent feature of the downtown Austin skyline, an elegant example of how structural steel can support and enhance architectural design. The bridge now serves as an unofficial gateway to the city as it greets visitors arriving on the MetroRail and welcomes convention cen-



A cross section of the bridge.

A detail of a bottom chord through-bolt connection to a girder.



ter organizers and attendees with a well-connected convention center district. ■

Owner
Joint ownership between Hilton and the City of Austin

General Contractor
JE Dunn Construction, Austin

Architect
Gensler, Austin

Structural Engineer
Walter P Moore, Austin

Erection Engineer
Genesis Structures, Inc., Kansas City

Steel Team

Fabricator
W&W/AFCO Steel, San Angelo, Texas (AISC Certified Fabricator)

Erector
Bosworth Steel Erectors, Inc., Dallas (AISC Associate; AISC Certified Erector)

Detailer
Consteel Technical Services, Ltd., Saltburn-by-the-Sea, U.K. (AISC Detailer)

On a Mission

BY MARIA MNOOKIN AND BRENT LEU, PE

Join AISC on our mission to provide educational opportunities to both students and professionals.

Maria Mnookin (**mnookin@aisc.org**) is education program manager and **Brent Leu** (**leu@aisc.org**) is manager of continuing education, both with AISC.

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AISC's continuing education team has plenty to offer those in the working world, although students wishing to get a jump on their careers and faculty looking to expand the knowledge they share to students often find these programs useful as well. Counting just live webinar presentations alone, AISC is on pace to offer 63.5 hours of continuing education opportunities in 2019. So how do you find time for continuing education in an already busy schedule? AISC is pleased to offer daytime, nighttime, and your time options for furthering your knowledge.

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If nighttime (or late afternoon for those on the West Coast and beyond) works better for your schedule, AISC offers Night School courses that are broadcast live at 7:00 p.m. Eastern Time. A course consists of eight 90-minute sessions that take a deep dive into a single steel topic or theme. For example, this fall's course will cover welded connections and is the perfect opportunity to learn from the foremost expert on structural welding, Duane Miller of Lincoln Electric. This course will address everything from the basics of welding codes and welded joints to welded seismic connections and compliance with code requirements.

Even if the evening time slot doesn't fit your schedule, Night School can still work for you—on your time. AISC offers a flexible registration option that allows you to view the session recordings for three weeks following the live session. You'll need to take and pass the quiz to receive PDH credit for the recorded version. For those who meet attendance, quiz, and final exam requirements, AISC will recognize your efforts with a certificate of completion. For more information, visit **aisc.org/nightschool**.

If you need to learn about a specific steel topic or need to meet your continuing education requirements at any and all hours of the day, the Education Archives is a great on-demand option. Not only can you find session recordings from NASCC: The Steel Conference here (like Ron Hamburger's "Is It Likely My Design Will Fail?"), but you also can find past webinars (like Carol Drucker's "Stiffeners, Doublers and Web-Plates, Oh My!") and past Night School sessions (like Rafael Sabelli's "Seismic Design in Steel"). The best part is that all of these videos can be viewed for free. If you need continuing education credit, there are 144 presentations eligible for earning PDHs by purchasing and passing a quiz. Whether you need to learn about steel stair design for your next project or you need just two more hours of continuing education for your professional engineer license renewal, stop by the Education Archives at **aisc.org/educationarchives**.

Finally, don't forget about in-person seminars. The 2019 Louis F. Geschwindner Seminar covers AISC's *Seismic Design Manual*, 3rd Ed., and application of the 2016 *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341), written by Thomas M. Sabol; both are available at **aisc.org/specifications**. The eight-hour seminar highlights the proper application of key design and detailing requirements and introduces important technical changes in the recently updated *Seismic Provisions*. Keep up on the state-of-the-art in steel seismic design and take advantage of the opportunity to purchase the *Seismic Design Manual* at a discounted price. This seminar will be touring select cities this fall and throughout 2020 and is also offered as a contract seminar brought in-house to your company or organization.

above: Facility tours, such as of a steel mill, are a great way to educate yourself on the steel supply chain.

University Programs

While students and faculty can take advantage of all of our continuing education opportunities, AISC's university programs are especially geared toward them—though industry professionals can also get involved in some of them (more on that in a bit). For starters, both full-time faculty and students at schools within the U.S. are offered free AISC membership. Members enjoy special discounts on seminars, webinars and publications, access to *Modern Steel Construction*, *Engineering Journal*, and over 15,000 pages of free technical information.

In addition, educator members receive discounted registration to The Steel Conference while student members can register for free! AISC educator and student members can also attend unique sessions specially developed for them and can receive travel reimbursement along with other benefits. And educators can attend the Educator Session to hear about the latest updates from AISC's university programs and research teams along with presentations related to teaching the latest design and construction topics. At the Students Connecting with Industry Sessions (SCIS), students attend speaker presentations and a networking event with some of the most influential leaders in the steel construction industry today. If your company would like to participate in this networking event, you'll be able to speak with over 200 of the brightest students in the country. You can find more information on SCIS at **aisc.org/scis**.

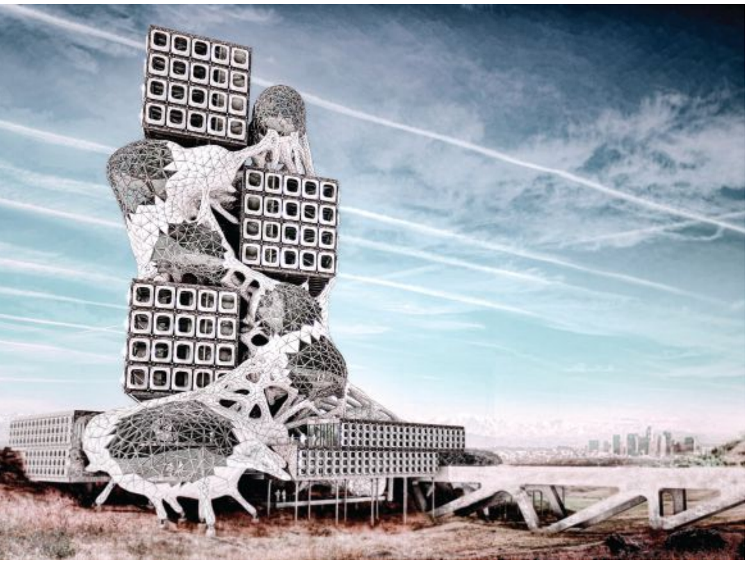
above and below: AISC educator and student members can attend unique sessions specially developed for them at NASCC: The Steel Conference, and can receive travel reimbursement and other benefits.

AISC also provides a host of teaching aids for faculty to enhance their work in and outside the classroom. The AISC Teaching Aids are a collection of resources including PowerPoint slides, handouts, images, and videos that are free to download and can be used in whole or part. The newest AISC Teaching Aid, authored by David Dinehart of Villanova University, follows the development of an innovative structural steel system, Girder-Slab, in order to expose students to the entrepreneurial side of engineering. This and all other AISC Teaching Aids can be found at **aisc.org/teachingaids**.

On top of that, AISC offers students an outlet to show their skill and creativity in the world of steel with two major competitions. For engineering students, the Student Steel Bridge Competition (SSBC) challenges student teams to create a scale-model steel bridge that spans approximately 20 ft. and can carry 2,500 lb.

above: The Student Steel Bridge Competition.

below: One of the winning designs from the 2018 Steel Design Student Competition.



below: Touring the Wilshire Grand project on a past SteelDay. There are plenty of project site tours to check out on this year's SteelDay, taking place September 27.

Each bridge must be efficiently constructed while meeting all other specifications of the competition rules. Through the SSBC, students not only deepen their understanding of engineering skills learned in the classroom, but also gain other essential skills like budgeting, project management, communication and teamwork. (See "Trussed to the Nines" and "Wild Ride to Carbondale" in the August issue at **www.modernsteel.com** for more on the 2019 competition.)

For architecture students, the ACSA Steel Design Student Competition challenges students, working individually or in teams, to explore a variety of design issues related to the use of steel in design and construction. Steel must be used as the primary structural material and contain at least one space that requires long-span steel structure, with special emphasis placed on innovation in steel design (see "Amazingly Affordable" in the November 2018 issue for the winners of last year's competition, and keep an eye out for this year's winners in the upcoming November issue). Learn more about both competitions at **aisc.org/studentcompetitions**. Also note that volunteers for judging the 2020 SSBC will be needed beginning early next year, so consider getting involved!

And then there are the scholarships. By year's end, AISC will have administered over $250,000 in scholarships to students through several programs for 2019. Over half of this amount will be awarded to juniors, seniors, and master's-level students studying civil engineering, architectural engineering, construction engineering, construction management, and architecture. Another AISC scholarship program provides scholastic aid to the families of our steel industry members with college freshman and sophomore students. All of our scholarships are funded through various sources such as the AISC Education Foundation, regional fabricator associations, and other industry contributors. Individual donations to the AISC Education Foundation are welcomed and are deductible as charitable contributions. See more on AISC Scholarships and how to contribute at **aisc.org/scholarships**.

In addition to these various initiatives, professionals and industry firms have plenty of opportunities to help prepare students for their careers after graduation. Professors often search for opportunities for their students to learn beyond the traditional classroom. Construction site visits, engineering office visits, fabrication shop tours, research or lab material donation, SSBC team sponsorship or mentoring, and summer internships are just a few examples. Contact **universityprograms@aisc.org** if you would like to share your knowledge and experience with students. More formal, long-term partnerships between companies and schools can be established and recognized through AISC's Adopt-a-School program, which is further detailed at **aisc.org/adoptaschool**.

All of our continuing education and university programs will continue to expand and evolve in response to the industry's ever-changing landscape and the dynamic needs of employers looking to fill entry- to executive-level jobs with quality, highly knowledgeable employees. Professionals, faculty, students: We've got you all covered. For more on any of our programs, visit **aisc.org/education**.

Partners in Education

We're looking to expand our collection of teaching tools, and we want your ideas! AISC is accepting proposals for teaching aids to be used in the classroom, including videos, presentations, design examples, instructions for hands-on demonstrations, and more. Together with the Partners in Education Committee, we'll evaluate the proposals, and those accepted will be awarded funding in the form of a grant. Visit **aisc.org/teachingaids** or contact Kristi Sattler (**sattler@aisc.org**) for more information.

The 11th incarnation of SteelDay takes you from the heights of New York's skyline to Major League Baseball's newest stadium (in Texas) to a Heartland steel mill to a boat off the coast of Southern California—and everywhere in between.

SteelDay 11

BY ERIKA SALISBURY

STEELDAY 2019 is almost here, and this year we're focusing on what makes steel great: our industry's dedicated, hard-working people. This SteelDay's theme is "We Are Steel," and you can use the **#WeAreSteel** hashtag in your social media posts to show the world your pride in what you do every day.

And for AISC full and associate members, being a SteelDay host is a fantastic opportunity to showcase your facility, projects, and capabilities while making connections and helping to raise the profile of the industry.

Here's a look at some of the events taking place this year. This is just a small taste; the complete list is online at **www.steelday.org**. If you're near one of these cities—or feel like taking a trip (long weekend, anyone?)—consider signing up for one of them. And if you need more incentive, many of them involve a free lunch!

Site Tour of Globe Life Field – Arlington, Texas

As the Texas Rangers wrap up their final season at Globe Life Park in Arlington, their new state-of-the-art home—the similarly named Globe Life Field—is rising across the street and is expected to open for the 2020 Major League Baseball season. Join us for SteelDay and get a behind-the-scenes tour of the new stadium, with commentary from the designers, fabricators, erector, and contractors.

Space Needle Presentation – Seattle

This breakfast event, taking place in the Microsoft Auditorium of the Seattle Library, will feature a presentation by the steel fabricator and erector that performed the renovation work at the city's famed Space Needle.

Smokey Hollow Site Tour – Raleigh, N.C.

Downtown Raleigh's Smoky Hollow redevelopment is a three-phase, multi-year project— developed by Kane Realty—and this event will feature a presentation and site tour led by the design team of the steel-framed Phase II Harrington office portion. Please note, this event will take place on SteelDay eve, September 26th.

Charles R. Jonas Federal Courthouse Annex Site Tour – Charlotte, N.C.

The Charles R. Jonas Federal Courthouse Annex project in the heart of Uptown Charlotte features unique design concepts and connections to meet strict GSA and Federal standards, which will be highlighted in a lessons learned presentation and site tour. Get in the SteelDay spirit as AISC and the Charlotte chapter of the Structural Engineer's Association team up for this event on Wednesday, September 18th.

Erika Salisbury (**salisbury@aisc.org**) is the production coordinator for AISC's publications group.

The Exchange at 100 Federal Street IDEAS^2 Award Presentation – Boston

An angular plate steel and glass prism, inspired by a folded piece of graph paper, makes quite the entrance at the 100 Federal Street office building in the heart of Boston's Financial District. Known as The Exchange at 100 Federal Street, the entry pavilion is a sharply faceted form with an exposed steel structure, whose main rib plates form the structure's main lateral load resisting system. The project was one of this year's AISC IDEAS^2 Merit Award winners. Join us for a presentation on the project as we honor various companies involved in its design and construction.

One Vanderbilt Topping Out Celebration and Panel Discussion – New York

This year NYC will celebrate the topping out of one of the tallest and greenest supertall buildings in the country, One Vanderbilt. The design/build team, including AISC member and certified fabricator Banker Steel, will discuss the creation of a new landmark in the heart of Manhattan.

First Annual AISC Topgolf Tournament – Minneapolis

AISC will hold a tournament at the Brooklyn Center, Minn., Topgolf location on the evening of Thursday, **September 26**, with engineers, architects, contractors, fabricators, and building owners participating. Dinner and drinks will be provided and prizes will be awarded to the top teams.

110 N Wacker Site Tour and Presentation – Chicago

110 N Wacker isn't just another office building. Join AISC in Chicago for a behind-the-scenes look at the newest project changing the city's riverwalk landscape. Participants will have the opportunity to see it firsthand during a site tour and will learn about the challenges and highlights of this unique project during a lunch presentation.

SteelDay Seminar – Philadelphia

On **October 24th**, AISC and the Mid-Atlantic Steel Fabricators Association will host a half-day seminar for architects, engineers, and general contractors. Attendees will have the opportunity to learn about structural steel, network with local steel fabricators, and earn continuing education credit.

St. Petersburg and Tampa, Fla.

We're working on some exciting site tours in St. Petersburg and Tampa. Details are still being finalized, so check the SteelDay website for updates and more details!

Steel Innovations Symposium – San Francisco

This SteelDay, join us for the Steel Innovations Symposium. Attendees will have the opportunity to hear Ron Klemencic of MKA talk about SpeedCore and their experiences on the Rainier Square Project, build relationships with industry innovators, and network with their colleagues over drinks.

Steel Festival – Atlanta

Join AISC to meet and network with industry vendors and fabricators at our first Steel Fest! You'll have a chance to watch demonstrations and check out the latest products. This two part event will host students from local universities in the morning and AEC industry professionals in the afternoon with a happy hour to follow.

Student Welding Competition – Cheyenne, Wyo.

Join Puma Steel, Laramie County Community College, and AISC in the final judged events for the 2019 Student Welding Competition at Puma Steel's fabrication shop. Over $10,000 in scholarships will be awarded to the student contestants in conjunction with AISC's David B. Ratterman Scholarship program. Lunch will be provided after the shop tours for all attendees. Read more about this event in "Winning Welding in Wyoming" on page 48.

AIA Orange County Reception – Newport Beach, Calif.

This networking reception will be held at the AIA Orange County's new office in Newport Beach. Drinks and tacos will be provided, along with live music and discussions about structural steel. Note that this event takes place the evening of Thursday, **September 26**.

SteelDay on the Seas – Marina Del Ray, Calif.

This networking event for industry professionals will take place on a chartered yacht in Marina Del Rey, and drinks and appetizers will be provided. In addition to networking, there will be a brief presentation on seismic standards in Southern California.

International Spy Museum Celebration and Networking Event – Washington, D.C.

Come enjoy drinks and hors d'oeuvres as we celebrate the completion of the new steel-framed International Spy Museum. Members of the museum's project team will be on hand to share the unique challenges and solutions they encountered from inception to completion.

Steel Bridge Forum – Houston

A Steel Bridge Forum will be held in Houston on Wednesday, **September 25**. Presentations, catered lunch, and coffee breaks will be provided to attendees. The all-day agenda is packed with nationally renowned presenters specializing in areas such as corrosion protection, fabrication, detailing, fracture control, design for improved efficiency, accelerated bridge construction, and redundancy.

Steel Bridge Forum – Dallas

Couldn't make it to our Houston event? A second Steel Bridge Forum will be held in Dallas on Thursday, **September 26**. Presentations, catered lunch, and coffee breaks will be provided to attendees. The all-day agenda is packed with nationally renowned presenters specializing in areas such as corrosion protection, fabrication, detailing, fracture control, design for improved efficiency, accelerated bridge construction, and redundancy.

Valley View Bridge Site Tour – Cleveland

The new 4,155-ft-long I-480 Valley View bridge sits nearly 200 ft above the Cuyahoga River Valley and is currently being constructed between two existing steel bridges via a gantry crane system. The bridge location, which sees nearly 180,000 vehicles a day during peak travel times, is one of the most traveled spans in Ohio, and the new and existing structures comprise one of the longest crossings in the state. AISC and NSBA, in conjunction with the Northeast Ohio chapters of ABCD and WTS, will host a site tour of this large steel bridge construction project along with a networking event at a nearby location. Short presentations will be given by the contractor, Walsh Construction Company; the designer, Jacobs; and the steel fabricator, Stupp Bridge (an NSBA member and certified fabricator).

SSAB Steel Day Mill Tour and Bridge Presentations – Montpelier, Iowa

Join us as SSAB opens their doors for a SteelDay mill tour and bridge presentations. Guests at this full-day event will have the opportunity to attend presentations on "Recent Innovations in Short Span Steel Bridges," "Steel Plate Considerations for the Bridge Design Engineer," and "Steel Plate Production for the Bridge Market" before touring both the steel mill and the research and development facility.

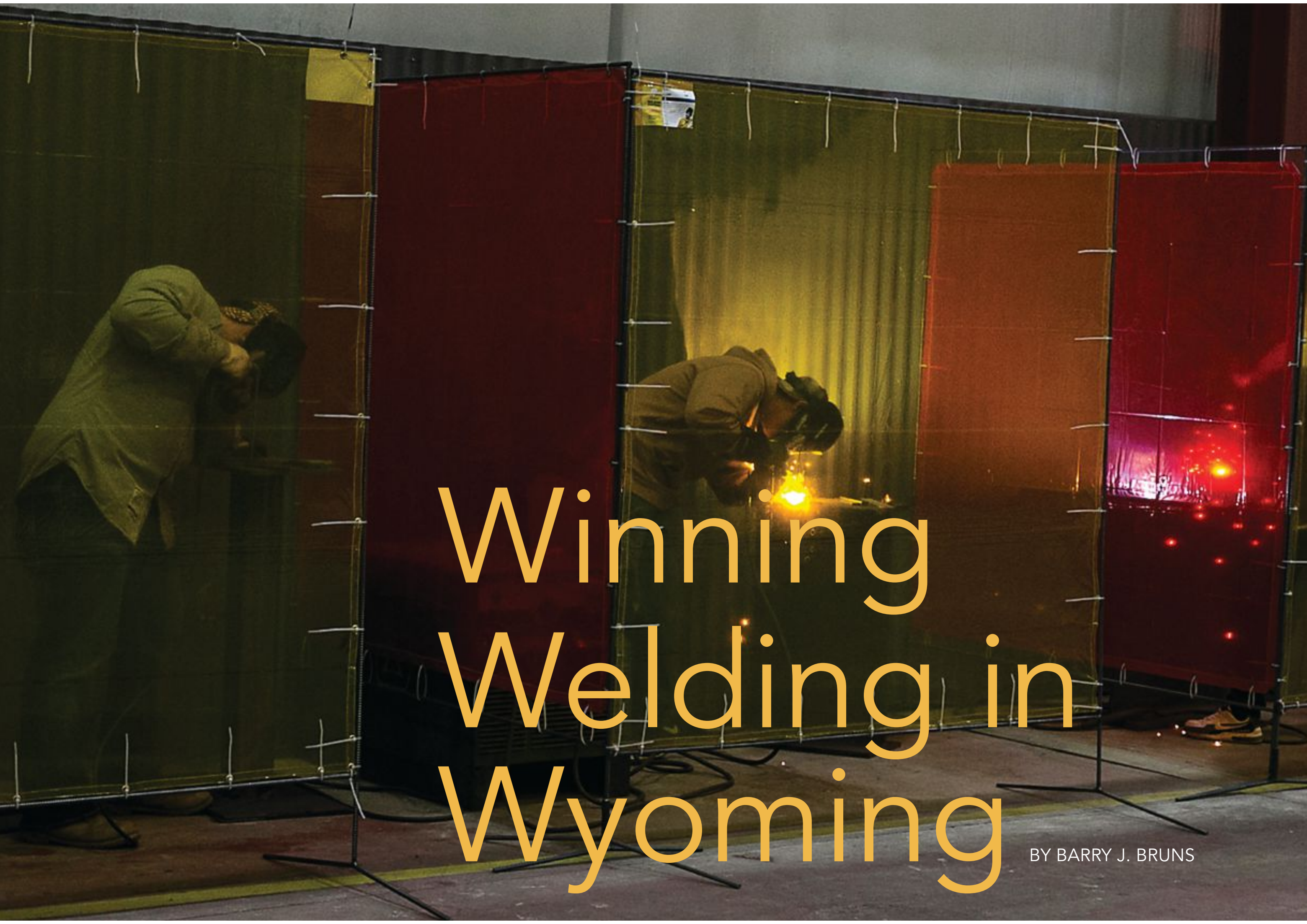
Equity in The Trades: Building a Bright Future With Women in Mind – Houston

We don't just build structures; we build aspirations for all people. This year AISC has partnered with AIA Houston and Women in Architecture to celebrate SteelDay by sharing not only the story of women in the steel trade, but also the story of how we can achieve diversity, inclusion, and equity for women in all the trades as part of building a stronger future. The evening begins with a panel discussion by local trailblazing women in the AEC fields and will culminate with networking over cocktails, appetizers, and a tour of the sculpture-like Moody Center for the Art

For more on these events and others taking place across the country on or around Friday, September 27, visit **www.steelday.org**.

And if you're interested in hosting an event, sign up today at **www.steelday.org/hosts**, which includes SteelDay logos, a marketing kit, and more information. ■

Now in its third year, a SteelDay competition at a Wyoming fabricator starts students on a welding career path at a local community college.



Winning Welding in Wyoming

BY BARRY J. BRUNS

Barry J. Bruns (barrybruns@aol.com), Col., USAF (Ret.), is a Puma Steel Board Member.

THEY SAY the third time's the charm.

For the third year in a row, Puma Steel, an AISC member and certified fabricator in Cheyenne, Wyo., is working with AISC, Laramie County Community College (LCCC), and local and national welding suppliers to conduct its welding competition for area high school students. Winners will receive AISC David Ratterman Fast Start Scholarships to LCCC's robust and growing welding program for the next academic year. Since its inception, the competition has grown surprisingly rapidly from a humble idea of giving back to the community's young people into an annual event involving dozens of participants.

The idea for the competition was conceived in the summer of 2017, when the Lewis family, Puma's owners, inquired with AISC about conducting a welding competition on SteelDay for local high school students to provide a couple of modest scholarships to LCCC's welding program. It seemed like a perfect situation. However, things got off to a less-than-perfect start.

The LCCC's welding instructor and technology dean both loved the idea, and Puma began contacting the high schools. However, every instructor was unavailable due to the summer break. And since SteelDay was scheduled for mid-September, there would simply not be enough time to put the program together after the high schools resumed classes.

Students showing off their skills at Puma's Cheyenne shop.

Former Wyoming governor, Matt Mead, handing out awards at last year's competition.

Then Puma received a request to use its facility for a National Association of Manufacturers (NAM) Manufacturing Day presentation in early October—and saw the opportunity to kill two birds with one stone.

"The event was only a few weeks after SteelDay, but it gave us the opportunity to restart our welding competition and still participate in SteelDay," recalled Rex Lewis, Puma's president and a former AISC Board Chair. "All of the players were up for a time-crunched challenge, so we dove in.

As staff at Puma canvassed local and national steel service centers and welding suppliers for some materials and equipment to provide for the contestants, they received a remarkable response. Not only did suppliers want to contribute the requested items, but they were also interested in providing scholarship funding, as were various erectors, consultants, and even an anonymous trust. The scholarship fund quickly rose from Puma's initial contribution of $2,000 to $10,000. Lewis contacted AISC to help administer the funding, and they responded by tying it into the Ratterman Scholarship program.

Area high schools began producing competitors, and the organizers soon had to plan a preliminary competition at LCCC to winnow the several dozen applicants down to the top ten, who would go on to compete at Puma Steel's Manufacturing Day event, which was attended by then-governor of Wyoming, Matt Mead, who provided a presentation on the scholarships, as well as local press. LCCC's welding students, area designers, and others also attended the presentation and took advantage of the plant tours provided by Puma staff.

"We filled one of the plant's production bays with people from at least three states," noted Lewis. "The Wyoming Business Council [the state's economic development agency] helped with event planning and audio-visual services, recorded interviews, and handled social media postings after the event, and we were frankly amazed at how rapidly a 'cancelled' event turned into a rousing success."

After the dust settled and Puma's production bay returned to service, nearly everyone involved asked what they could do for the next year. By January of 2018, Puma was back in planning mode for a second year of the competition—this time well ahead of the high schools' summer break.

LCCC cranked up its outreach system, more area high schools expressed interest, and everyone determined that this time the competition could become an official SteelDay event. AISC collected the funds and made sure they were available for the winners who went on to LCCC that fall, and Puma arranged for scholarship money that students did not use for whatever reason to roll over into the next year's fund. LCCC and its welding advisory committee determined that local high school vocational agriculture instructors, as well as some welding instructors, could use more training in welding and how to teach it, so it created a program called Weld Works to bring in those instructors for a two-day concentrated training program centered on individual instruction—taking participants' skills to the next level.

Fortunately, Weld Works happened right at the beginning of the summer break, and nearly all of the instructors who attended prepared students for the 2018 Ratterman Scholarships. Candidates for the scholarships more than doubled to more than 70 who signed up, with 53 from two states competing. Scholarship funding increased to over $13,000, spread over 13 scholarships from a foundation and various steel service centers. Welding equipment and materials (approximately $7,000 worth) were so plentiful that every competitor received something, from a shirt or ball cap to welding gloves; two high-end welding machines were even part of the mix. Once again, Mead presented the scholarships and took the opportunity to promote all levels of skills training. This highlights the increasing need for skilled workers as well as the growing opportunities for rewarding employment and economic development in the trades.

Puma's welding competition is on again for 2019, and AISC has even moved SteelDay until September 27 to give high schools the extra week or two they need to prepare their students for the competition.

above: Prizes range from baseball hats to welding machines.

below: One again, this year's competition will tie into AISC's SteelDay, taking place September 27 (for more on SteelDay, see page 45).

More than 50 students from two states competed in the 2018 competition.

Participants in last year's competition, which provided $13,000 in welding scholarships.

It's not uncommon for someone to have a grandiose vision for a program... that ultimately never materializes. In the case of the welding competition, what started as a modest vision opened the doors of an entire industry to shine light on a new vision of systematic growth to meet an obvious need. LCCC is expanding its skills training program, particularly welding, and now boasts a new facility, a growing instructor corps, and the capability to produce trained welders who can rapidly begin making a good living while providing the skilled labor that manufacturers, fabricators, and construction companies so desperately need. And these entities are willing to support programs like this to help grow the workforce. Political and governmental organizations recognize the needs of these industries and the opportunities they provide, and young people are being drawn to them—and more importantly, now have a smoother pathway to participating in them.

"All of us who have experienced this growth are humbled and excited by what we are learning," said Lewis. "We see only the upside for all players; there are no losers. Even the young folks who compete but do not win scholarships find they improve their skills, as well as their motivation, through this competition."

Visit **www.pumasteel.com** for more on Puma Steel, **www.lccc.wy.edu** for more on Laramie County Community College, and **aisc.org/steelday** for more on SteelDay, taking place Friday, September 27, 2019. You can also check out the article on page 45 for a list of SteelDay events taking place across the country. ■

AISC's ongoing research projects vary in size and scope. Here's an inside look at what we're doing to improve steel design and construction.

Revealing Research

BY DEVIN HUBER, PE, PHD

Devin Huber (huber@aisc.org) is AISC's director of research.

AS YOU THUMB THROUGH your AISC *Manual*, *Specification*, or one of our dozens of Design Guides, do you ever wonder how we've come so far in understanding how to design and build things with structural steel?

Or have you read an article in this magazine about an innovative product or process and thought, "How did they come up with that?" The answer always starts with an idea and is followed by research to figure out how it can work, where it can be applied, and who it will benefit.

AISC has been conducting research for almost as long as we have been an organization (which is nearly a century, if you're counting). Sometimes we research topics to be incorporated into future versions of the *Specification*, and end users may not be fully aware of what we've been working on until they're using it in day-to-day practice. Other times our research is geared toward an innovation that has potential to increase structural steel's market share or enhance an existing idea or application. And oftentimes AISC joins forces with other organizations—such as the Charles Pankow Foundation, ASCE, or NSF—to co-fund research, which spreads out the financial commitment as well as the benefits of a particular project.

Below is a brief overview of our research initiative, including the basic setup, how ideas are developed, timelines for funding, and how we disseminate the results of our various projects. I'll also highlight a few ongoing AISC research projects to provide a sense of the scope of the studies we conduct.

Research Q&A

First, let's address a few common questions about AISC's research program.

How much money does AISC spend on research and how many projects are currently funded?

AISC generally spends more than $1 million annually on research endeavors, which is spread across the 20-plus projects we are either fully funding or jointly funding with other organizations.

Where can I see the results of AISC's Research?

Quite simply, they can be seen everywhere, ranging from specifications and standards to real-world application in structural steel design, fabrication, and erection. More specifically, our research results are shared or incorporated into:

- AISC Research Reports (**aisc.org/research**)
- Peer-reviewed journal articles, including those found in *Engineering Journal*
- AISC specifications
- AISC Design Guides
- Specifications developed by other organizations, such as AASHTO, AWS, etc.

Who decides what to fund for research?

Both AISC staff and the AISC Committee on Research help determine which projects will be funded.

I have an idea! How can I submit it for potential research funding?

In general, we accept both unsolicited proposals and Research Needs Statements (RNS) and we also solicit proposals as needed. (Read on for details on how to submit a proposal.)

AISC Research: Who We Are

AISC research personnel consists of AISC staff—primarily me (the director of research)—and a 26-member Committee on Research (COR) made up of practicing engineers, fabricators, erectors, academic researchers, and steel product producers.

The COR meets face-to-face twice a year, once in October and once in April (typically right before NASCC: The Steel Conference), and also holds periodic conference calls. The intent of these meetings/discussions is to identify steel industry topics that might benefit from research, discuss ongoing research, review received proposals or RNS, and ensure that AISC stays aligned with the broader steel and construction industries in funding research endeavors.

Topics and Timelines

When it comes to how research topics are selected for funding, again, AISC accepts both solicited proposals (developed with the help of the COR) as well as unsolicited proposals. Solicited calls for proposals are sent out as needs arise and topics are identified that the COR and AISC feel should be further investigated via a funded research project. Many of these topics are proposed by AISC's Committee on Specifications in an effort to improve the *Specification for Structural Steel Buildings* (AISC 360).

Unsolicited research ideas come in the form of either an RNS or a fully developed proposal. An RNS is a brief document (typically two to five pages) highlighting a proposed structural steel-related research topic, with the submitter either being willing to perform the research themselves (with AISC funding) or simply suggesting an idea for AISC to further develop and potentially consider for research. The great thing about an RNS is that it allows *anyone* in the industry to put forth an idea.

Full proposals, solicited or unsolicited, are generally submitted by the party who plans to do the research and are typically far more detailed then an RNS, systematically laying out how the research will be conducted and the results disseminated. More information and templates for both RNS and full proposals are available at **aisc.org/research**.

In order to adhere to our scheduled COR gatherings, and in alignment with AISC budgets being set on a calendar year, the latest a proposal/RNS can be received and considered for funding in the subsequent calendar year is, in most cases, August 31. However, it should be noted that budgeted activities begin around July of the current year in preparation for the following year's budget. Hence, getting proposals to AISC to review ahead of the spring COR meeting (the deadline is February 28) is helpful in getting them approved for the following year.

Rainier Square Tower in downtown Seattle, the first building to use the SpeedCore system.

A SpeedCore prototype specimen being tested for behavior under axial and wind loading at Purdue University.

Current Research

So what are we working on currently? As a matter of fact, we're involved in a multitude of ongoing projects. Here, I've highlighted a few to give you an idea of the breadth of work we fund and support.

SpeedCore
Current research being led by Amit Varma, Purdue University and Michel Bruneau, University of Buffalo

If you have been paying attention to this publication recently—and any others covering structural steel—you have likely heard of the SpeedCore system. First used by structural engineer Magnusson Klemencic Associates (MKA), this innovative structural system uses plain concrete sandwiched between exterior steel plates acting compositely with the concrete to form a robust structural system that can be used as the building core in mid- to high-rise steel structures. And the first real-world application of the system, Rainier Square Tower in Seattle—also designed by MKA and fabricated by AISC member Supreme Steel—is currently ongoing (see "At Its Core" on page 66 for a snapshot of the project).

While this is the first full-scale implementation of the system, it has been the subject of research studies for several years by both AISC and the Charles Pankow Foundation. In fact, these "sandwich" panel systems have been used in several different applications previously, most notably in the nuclear industry in containment internal structures and shield buildings. But Rainier Square Tower is the first use of SpeedCore as the core system in a high-rise building.

For the current application in building cores, some of the first published research came out in 2009 and since then, several AISC co-funded research endeavors have helped to further develop and refine the system such that it is now demonstrated as feasible for use in steel construction. Further, the research performed to date has helped establish key structural behavior for the system as well as an $R = 8$ for the system when used in seismic areas—which is the best value that can be obtained when using it as a seismic lateral force-resisting system.

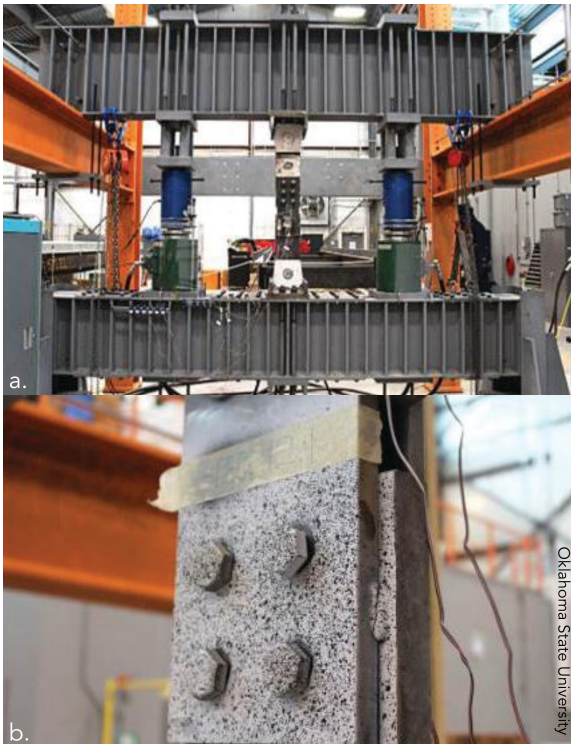
Weld Design Requirements in Continuity Plates and Doubler Plates for Moment Frame Applications
Current research being led by Chia-Ming Uang, University of California-San Diego

The intent of this research is to experimentally investigate potential design and construction efficiencies for both continuity plates and doubler plates used in special moment frame (SMF) connections.

As is currently written in the AISC *Seismic Provisions for Structural Steel Buildings* (AISC 341-16), the weld that connects the continuity plate to a column flange in a welded beam-column connection of an SMF is required to be a complete-joint-penetration groove weld. Similarly, the use of doubler plates in conjunction with continuity plates can be challenging to fabricate as the groove or fillet welds connecting the doubler plate to the column are required to develop the design shear yielding strength of the doubler plate thickness.

The use of groove welds in these applications, or very large fillet welds in doubler plates, leads to time-consuming connection

A moment connection specimen being tested at the University of California-San Diego by Chia-Ming Uang and Mathew Reynolds to determine if fillet welds can be used in lieu of CJP welds in SMF connections.



The overall setup for testing combined bolt and weld specimens (a) and a close-up of the tested specimen (b) at Oklahoma State University.

details from both a detailing and construction/fabrication aspect. Additional constraints on fillet weld thicknesses and stability limits can make these connections very challenging to fabricate.

This research is investigating ways to economize the detailing, and subsequent fabrication, of continuity and doubler plates. One item being investigated is the use of fillet welds for the continuity plate-to-column flange weld connection. Another item being considered in the research is to provide a design methodology to size the weld in doubler plate applications for the proportion of the panel zone shear that is actually required. These approaches, if shown to be adequate, will challenge conventional design approaches but might also yield a more efficient design in the process. Also, the required weld capacity for both doubler plates and continuity plates will be generated from a consistent set of seismic demands.

This research is partially completed and is in its second (and final phase) of testing along with ongoing analytical studies. The first testing phase looked at one-sided moment connections, while the second phase focuses on two-sided moment connections (or interior beam-column connections). To date, it appears promising that a proposed reduction in welding can be realized; however, this cannot be confirmed until all testing and analyses are complete and results have been reviewed by an AISC oversight committee. Ultimately, any changes to AISC *Seismic Provisions* would need to be balloted and approved per approved processes.

Understanding the Behavior of Steel Connections with Bolts and Welds in Combination
Current research being led by Mohamed Soliman, Oklahoma State University

This project focuses on investigating the behavior of steel connections with bolts and welds sharing the load. The need to combine bolts and welds can occur if the design load changes, when there are unforeseen difficulties in the make-up or matching of bolt holes, or when retrofitting an existing structure.

As is currently understood, a welded connection possesses relatively small capacity for deformations when reaching maximum strength and slip-critical bolted connections remain stiff during loading. Therefore, the structural engineering community remains skeptical about these combination connections due to the uncertainty regarding deformation capacity of both welded and bolted connections.

The current research, taking place at Oklahoma State University, is an extensive experimental program involving more than 100 specimens and also uses complex analytical tools to help fully understand the behavior of combined bolt and weld connections. The overarching goals of the project are to provide design guidance for realistic configurations of connections employing bolts and welds in steel buildings and bridges as well as to provide the structural engineering community the necessary tools to design with and understand the behavior of bolted connections supplemented by welds.

This project is ongoing and is in its second and final phase of testing. The first phase of testing focused on concentrically loaded specimens, while the second phase is focusing on eccentrically loaded specimens. So far, the results indicate that there may be more capacity in combined bolted and welded connections then what current AISC provisions calculate. However, these results are still being analyzed and any final recommendations will subject to review and formal balloting procedures for any

Current AISC Research Projects

Project Title	Principal Investigator(s)	Affiliated Organization/ University	Funding Partners
Advancing Performance-Based Structural Fire Engineering Design in the U.S. through Exemplar Procedural Guidance	Kevin LaMalva	ASCE	Charles Pankow Foundation ASCE MKA Foundation
Analysis and Design of Eccentric Stiffeners in Moment Connections to Column Flanges	Keith Kowalkowski	Lawrence Technological University	AISC solely funded
Bearing and Tearout of Bolted Connections	Mark Denavit	University of Tennessee, Knoxville	AISC solely funded
Behavior of Steel Connections with Bolts and Welds in Combination	Mohamed Soliman Bruce W. Russell	Oklahoma State University	AISC solely funded
Comprehensive Revision of Design Considerations for Column Base Connections in Steel Moment Frames	Amit Kanvinde	University of California, Davis	Charles Pankow Foundation
Evaluating and Fixing a Potential Fracture Problem with Extended Stiffened End-Plate SMF Connections	Matthew Eatherton Tom Murray	Virginia Polytechnic Institute and State University	AISC solely funded
Extra-Long Slots for Slip-Critical Bolted Joints	Gian A. Rassati James A. Swanson	University of Cincinnati	AISC solely funded
Fillet Weld Size and Length Effects	Bo Dowswell	ARC International	AISC solely funded
Fundamental Evaluation of the Lateral-Torsional Buckling Resistance of Welded I-Section Members	Don White	Georgia Tech	Metal Building Manufacturers Association (MBMA) American Iron and Steel Institute (AISI)
Investigation into Shear Stud Fatigue Demands: Towards Modification of the Existing AASHTO Stud Fatigue Provisions	Gary Prinz	University of Arkansas	AISC solely funded
Pre-Standard for Performance-Based Design for Wind	Donald Scott	ASCE	Charles Pankow Foundation ASCE
Skewed T-Welds	Bo Dowswell Fouad H. Fouad	University of Alabama at Birmingham	AISC solely funded
Steel Diaphragm Innovation Initiative (SDII)	Benjamin Schafer Matthew Eatherton Jerry Hajjar	Johns Hopkins University Virginia Polytechnic Institute and State University Northeastern University	AISI MBMA Steel Deck Institute (SDI) Steel Joist Institute (SJI)
Qualification Testing for Artifacts in the Protected Zone	Matthew Hebdon Matthew Eatherton	Virginia Polytechnic Institute and State University	AISC solely funded
Parametric Investigation of Chevron Braced Frames	Charles Roeder	University of Washington	AISC solely funded
Seismic Performance Assessment of Steel Multi-Tiered Ordinary Concentrically-Braced Frames	Larry Fahnestock	University of Illinois	AISC solely funded
Seismic Stability Design of Steel Frames	Larry Fahnestock	University of Illinois	AISC solely funded
Seismic and Wind Behavior and Design of Coupled Concrete-Filled Composite Plate Shear Walls (CF-CPSW) Core Walls (SpeedCore) for Steel Buildings	Amit Varma Michel Bruneau	Purdue University University at Buffalo	Charles Pankow Foundation
Performance Based Structural Fire Engineering of Buildings with CF-CPSWs (SpeedCore)	Amit Varma	Purdue University	Charles Pankow Foundation Steel Institute of New York
R-Factors for Coupled Composite Plate Shear Walls – Concrete Filled (Coupled-C-PSW/CF, SpeedCore)	Amit Varma Michel Bruneau	Purdue University University at Buffalo	Charles Pankow Foundation
Weld Design of Continuity and Doubler Plates for IMF and SMF	Chia-Ming Uang	University of California, San Diego	AISC solely funded

implementation into future versions of the AISC *Specification*.

Advancing Steel

Ultimately, the goal of our research endeavors at AISC is to advance the structural steel industry through a variety of studies that cover a wide range of topics. We strive to stay a step ahead and ensure that the steel industry and our members are equipped with the most sound and forward-thinking technical solutions to the infinite number of challenges associated with structural steel design and construction. Visit **aisc.org/research** for more on our research initiative, including information on submitting proposals and reviewing AISC Research Reports. ■

The Milek Fellowship

One portion of our research program that stands alone from other projects/proposals is the annual Milek Fellowship (formerly the AISC Faculty Fellowship) for which AISC selects a promising young non-tenured university faculty member. The award was renamed for William A. Milek Jr., AISC's former vice president of engineering and research, in recognition of his invaluable contributions to AISC and the structural steel industry as a whole. The award provides the fellow with $50,000 a year for four years to perform their research. The deadline for submitting a proposal for the Milek Fellowship is between August 31 and September 15 of the current year, with funding to commence in the following year. Visit **aisc.org/milek** for more information as well as a list of all past fellowship recipients

Active AISC Milek Fellowships

Project Title	Principal Investigator(s)	Affiliated Organization/ University
Thin Composite Two-Way Flooring Systems for Steel Structural Systems	Will Collins	University of Kansas
Performance-Based Design of Passive Fire Protection for Floor Systems in Steel-Framed Buildings	Spencer Quiel	Lehigh University
Seismic Performance of Moment Resisting Frames with Fuse-Type Connections	Patricia Clayton	University of Texas at Austin
Steel Seismic Systems with Architectural Flexibility	Gary Prinz	University of Arkansas
Inelastic Design for Steel Structures Subjected to Wind Loads	Johnn P. Judd	University of Wyoming

Industry Impact

BY BRIAN RAFF

AISC needs to provide the International Trade Commission with a full picture on the impact of imported fabricated structural steel—and you can help!

Brian Raff (**raff@aisc.org**) is AISC's director of communications and public affairs.

IN FEBRUARY 2019, the full member fabricators of AISC filed a trade case against imports of fabricated structural steel from China, Canada, and Mexico. This was in response to a surge of unfairly traded fabricated structural steel imports from these countries, amounting to more than 1 million tons in 2018. If this case is successful, duties will be imposed on imports of fabricated structural steel from China, Canada, and Mexico at amounts intended to reflect the extent of unfair trade, specifically, dumping (or selling in the United States at less than fair value) and industry subsidization by foreign governments. (See the sidebar for more on anti-dumping and countervailing duties.)

In March, the International Trade Commission (ITC) preliminarily determined that imports from these countries are causing injury to domestic fabricators. This was an important first step in obtaining relief for the domestic fabricated structural steel industry.

The case has now moved to the U.S. Department of Commerce (DOC) to determine the extent of dumping and subsidization of foreign industries. On July 8, 2019, the DOC issued preliminary results in the three subsidy (also known as countervailing duty or CVD) investigations.

- In the China investigation, the DOC found that exporters received countervailable subsidies at rates ranging from 30.3% to 177.43%.
- In the Mexico investigation, most preliminary duties range from 13.62% to 74.01%.
- In the Canada investigation, the DOC found that the countervailable subsidies were at de *minimis* levels, or too minor to merit consideration.

Based on these preliminary determinations, the DOC has instructed U.S. Customs and Border Protection to collect cash deposits from importers of fabricated structural steel from China and Mexico, effective upon the determinations' publication in the Federal Register on July 12.

These preliminary determinations are a major positive development in AISC's efforts to obtain relief from unfairly traded imports, and they are a credit to the AISC Members whose participation to date has been invaluable in supporting the domestic fabricated structural steel industry. AISC's trade counsel continues to pursue all avenues to increase the preliminary subsidy margins for the final determination. We also believe that there is a path forward to a final affirmative determination in the Canada subsidy case, despite the initial findings, and AISC will do everything it can to ensure a positive result for the American fabricated structural steel industry.

It's important to remember that these CVD rate findings are separate from the results in the anti-dumping (AD) duty investigations. Any duties ultimately imposed on imported structural steel will largely be cumulative, *i.e.*, CVD duties plus AD duties. Commerce is expected to issue preliminary determinations in the three anti-dumping investigations on September 3.

The case will then return to the ITC for the final phase of its injury investigation, in which the ITC will go through an information collection period in the fall, prior to holding a hearing and a final vote (likely to take place in early 2020). As part of its information-gathering process, the ITC will issue questionnaires to American fabricators to obtain information about the domestic industry. A number of fabricators participated in this process during the ITC's preliminary investigation. However, in its Preliminary Determination, the ITC noted that it expected "more extensive cooperation from domestic [fabricators] in responding to the Commission's questionnaire" in the final phase. Curious to see what these questionnaires look like? You can download a sample ITC questionnaire at **aisc.org/tradecase**. The ITC will likely issue final phase questionnaires in October or November.

As a result, the full support and participation of domestic fabricators will be critical to the success of this case. It is important that domestic fabricators complete these questionnaires, whether or not they receive one directly from the ITC, to ensure that the agency has a full picture of the industry and the impact of imported structural steel during the final phase of its investigation.

AISC has received many reports from its fabricator members regarding the adverse effects of import competition, which may take many forms and can impact the entire market. Many fabricators are experiencing the direct impact of these imports, such as losing a project to unfairly traded imports or being forced to lower a bid price as a result of import competition. Others are experiencing the indirect effects of import competition; e.g., a domestic fabricator may lose a project to unfairly traded imports elsewhere in the market and then be forced to move into another market, resulting in negative price and volume effects throughout the entire market.

This case is critical for ensuring a competitive playing field for the entire U.S. fabricated structural steel industry. A successful case could cause market prices to return to fairly traded levels and allow domestic fabricators to recapture their fair market share. These benefits would be experienced across the industry—by large and small fabricators alike.

If you would like more information and updates on the trade case—AD/CVD case details, example ITC questionnaire, etc.—visit **aisc.org/tradecase**. ■

We encourage all domestic fabricators to complete the International Trade Commission's (ITC) questionnaires, whether or not they come directly from the ITC, to ensure that the body has a full picture of the industry and the impact of imported fabricated structural steel during the final phase of its investigation.

Anti-dumping and Countervailing Duties

The full member fabricators of AISC filed petitions for anti-dumping (AD) and countervailing (CVD) duties on certain fabricated structural steel imports from China, Canada, and Mexico.

Anti-dumping Duties (AD) According to U.S. Customs and Border Protection (CBP), dumping occurs when a foreign manufacturer sells goods in the United States at less than fair value. Anti-dumping duties can be imposed to offset unfair trade.

Countervailing duties (CVD) cases are established when a foreign government provides subsidies, such as tax breaks to manufacturers that export goods to the U.S.

U.S. manufacturers or businesses can file petitions with the International Trade Commission (ITC) and the Department of Commerce (DOC) when unfair trade is occurring.

For a trade order to be imposed, the DOC must find that unfair trade is occurring and the ITC must find that the domestic fabricated structural steel industry is materially injured as a result.

SAFETY

AISC Recognizes Companies via New Safety Program

Safety is a primary goal of structural steel fabricators and erectors. And this year, AISC is providing SteelDay host companies with a way to promote exemplary safety efforts and achievements.

This safety emphasis program, Safety on SteelDay, encourages self-reflection and aims to show the design and construction industry that AISC member companies make an extra effort to work safely on SteelDay and throughout the year. Participants were asked to perform either a safety self-audit or a safety climate survey for their company, followed by submitting a letter detailing their audit or survey. All participants received a free, customized banner from AISC to hang in their workspaces.

AISC is delighted to recognize the following companies for their participation in the program and their commitment to safety:

- Camelot Metals
- Crystal Steel Fabricators, Inc.
- Crystal Metalworks
- Crystal Steel Memphis
- Crystal Steel Federalsburg
- G.M.F.
- High Steel Structures
- J.B. Steel
- Steelworks of the Carolinas

AWARDS

There's Still Time to Submit Projects for the 2020 AISC IDEAS² and NSBA Prize Bridge Awards

AISC's annual IDEAS² Awards program recognizes outstanding structures that illustrate the amazing things that are possible with structural steel—and there's still time to enter. The program recognizes outstanding buildings of all sizes and scopes and is organized into three total project cost categories: under $15 million, $15 million to $75 million, and more than $75 million. Visit **aisc.org/ideas2** for more information and to enter.

In addition, AISC and its bridge division, the National Steel Bridge Alliance (NSBA), are accepting entries for the 2020 Prize Bridge Awards program. Our industry-expert jury will judge all submissions entries for this biennial competition in several categories, defined by bridge size and function, weighing each project's innovation, economics, aesthetics, design, and engineering solutions. Visit **aisc.org/prizebridge** for more information and to enter.

Entries for both awards programs will be accepted through September 27 and the winners will be publicly announced in early 2020 and featured in presentations at NASCC: The Steel Conference and the World Steel Bridge Symposium in Atlanta (April 22-24, 2020) as well as in *Modern Steel Construction*.


Kelly Thibodeaux

The University of Texas at Austin's Engineering Education and Research Center, a 2019 IDEAS² Award winner.

Detroit's Fort Street Bridge over the Rouge River, a 2018 Prize Bridge Award winner.

People and Companies

- **The Steel Erectors Association of America (SEAA)** announced that four new companies have joined its network of Craft Training providers. The program provides SEAA member companies access to nationally recognized credentials for ironworkers. There are now 26 training units throughout the U.S. AISC member **Steel Fabricators, LLC**, Fort Lauderdale, Fla., is one of the companies joining the training network. The company is an AISC member, advanced certified erector, and certified building fabricator and will offer SEAA/NCCER Ironworker training and assessments.
- **Jonathan Humble**, **FAIA**, regional director of construction codes and standards for the **American Iron and Steel Institute (AISI)**, was recently recognized with both the **ASHRAE** Distinguished Service Award and the **National Fire Protection Association (NFPA)** Committee Service Award. The ASHRAE award recognizes members "who have served the Society faithfully and with distinction on committees or have otherwise given freely of their time and talent on behalf of the Society," and Humble received the NFPA award for his contributions to the organization's Codes and Standards Making System.
- **Gregory G. Deierlein, PE, PhD**, was recently named a Distinguished Member of the **American Society of Civil Engineers (ASCE)**. A member of the AISC Specification Committee and a previous AISC Lifetime Achievement Award winner, Deierlein is a professor and director of the **J.A. Blume Earthquake Engineering Center at Stanford University**. He is well known for his research on steel and concrete composite structural systems, nonlinear structural analysis, and performance-based earthquake engineering.

PEOPLE

AISC Celebrates Ted Galambos' 63 Years of Service

AISC recently recognized Theodore "Ted" V. Galambos for his outstanding service to the organization on the occasion of his 90th birthday.

Galambos started serving on the AISC Committee on Specifications and Task Committees in 1956. He is an emeritus member of the AISC Committee on Specifications and a full member of AISC Task Committee 4 (Member Design).

"You have literally helped to build so many of us up from our start, and all of this you've done just by being who you are—to the great benefit of the industry and the profession," AISC President Charles J. Carter, SE, PE, PhD, told Galambos at a celebration June 12 in Chicago. "We celebrate your technical excellence, we celebrate your lifelong commitment and integrity, we celebrate how meaningful it is for all of us who have had the pleasure to work with you and know you."

Some call Galambos "the father of load and resistance factor design" (LRFD) after his pioneering research led to the introduction of LRFD in the 1986 AISC *Specification*. His numerous professional honors include the 1964 ASCE Walter L. Huber Research Prize, the 1981 AISC T.R. Higgins Lectureship Award, and the 1999 AISC Geerhard Haaijer Award for Excellence in Education.

Galambos, a Hungarian immigrant, earned a BS and MS in Civil Engineering from the University of North Dakota, supplementing his studies with other engineering experiences; as a surveyor in the Army Corps of Engineers, he earned the Distinguished Service Medal. He completed his PhD in Civil Engineering at Lehigh University in 1959 and taught and conducted research there for much of the late 1950s and early 1960s, focusing on the stability behavior and plastic design of steel beam-columns and multistory steel frames. He moved to Washington University in St. Louis in 1965, where he researched structural reliability, shakedown of steel structures, the behavior and design of composite joists, and, of course, LRFD of structures. Galambos left St. Louis for the University of Minnesota in 1981 and retired in 1997—though not from industry service.

"I don't know how many thousands of students Ted has taught," said Roberto Leon, a member of the AISC Committee on Specifications. "All of them, I think, carry with them a remembrance of a teacher that cared about their work."

In addition to the AISC Committee on Specifications and Task Committees, Galambos has served on the executive committee of the Structural Stability Research Council and on committees for several other industry groups.

From left to right: James Fisher, AISC's Cynthia Duncan, Galambos, and John Fisher gather at Galambos' celebration.

BRIDGES

NSBA Urges Support for Highway Funding Proposal

On July 29, the Senate Committee on Environment and Public Works (EPW) introduced a five-year, $287 billion highway bill representing a 27% increase over the current authorized funding from the Fixing America's Surface Transportation (FAST) Act. Additional items include more than $6 billion for a new competitive bridge investment grant program and increased transparency requirements for public-private partnership (P3) projects.

The National Steel Bridge Alliance (NSBA), a division of AISC, and the rest of the Transportation Construction Coalition (TCC) urge all members of the EPW committee to support the proposed America's Transportation Infrastructure Act (ATIA) during today's full-committee mark-up.

"A long-term, robust highway bill will put more Americans to work and energize commerce and quality of life across the cities, towns, and rural areas of our nation," said AISC president Charles J. Carter, SE, PE, PhD.

Among other things, the ATIA authorizes:

- $287 billion over five years in contract authority—an increase of roughly $12 billion annually when compared to the previous highway bill, the FAST Act. Some 17% of that funding increase would take effect the first year, which would help states address maintenance backlogs to improve safety and congestion
- More than $6 billion over five years for a new competitive bridge investment grant program, with 50% dedicated to bridge projects of $100 million or more. This is crucial for large bridge projects that traditionally struggle to secure adequate funding
- A required 15-day notice prior to a Buy American waiver being granted for federal aid projects
- Increased funding for the Technology and Innovation Deployment Program (TDAP). These funds include $100 million in new and innovative construction technologies for smarter, accelerated project delivery
- Increased transparency requirements for P3 projects

The 31 national associations and trade unions of the TTC sent a letter (**tinyurl.com/y3twkgps**) to Senators John Barrasso, Shelley Moore Capito, Tom Carper, and Ben Cardin and the rest of the EPW committee, commending the committee's effort to introduce ATIA as a bipartisan measure that will benefit all 50 states.

A summary of the bill is available at **tinyurl.com/y4mq32vy**, and the full bill text is available at **tinyurl.com/y2asecad**.

MEMBERSHIP

AISC Board Approves New Full and Associate Members

FULL

- Accu-Fab and Construction, Inc. Moss Point, Miss.
- Arcorp Structures, LLC, Chicago
- QWF, LLC, Tyler, Texas
- Blue Atlantic Fabricators, LLC East Boston, Mass.
- Bridge Brothers, Inc., Atlanta
- Construction Resources Group Russellville, Ark.
- DIS-TRAN Steel, LLC, Pineville, La.
- General Welding Co., Inc. Upper Marlboro, Md.
- Genesis Ironworks, Fallon, Nev.
- Gulf Copper Dry Dock and Rig Repair Galveston, Texas
- Helgeson Steel, Inc., Elkhart, Ind.
- Nick's Metal Fabricating and Sons, Inc. Brookfield, Ill.
- Red Dog Fabrication, LLC Vancouver, Wash.
- Steeltech Building Products, Inc. South Windsor, Conn.
- Swanson's Fabrication, Bradford, Pa.

ASSOCIATE

- BMWC Constructors, Indianapolis *Erector*
- Detailing Group, San Diego *Detailer*
- eLogic Solutions India Pvt., Ltd. Telangana, India, *Nonstructural Fabricator*
- Gilfilen Steel Services, Inc., Cincinnati *Detailer*
- Hollywood Structural Detailing, Inc., Palm Coast, Fla., *Detailer*
- Klute Engineering, York, Neb. *Detailer*
- Nelson Service Group, Inc. Florence, Ala., *Coating Applier – Paint*
- Northern Valley Erectors, Inc. Kutztown, Pa., *Erector*
- PS Industries, Grand Forks, N.D. *Detailer*
- Steelmerger Engineering Pty., Ltd. Pakenham, Australia, *Detailer*
- Struzon Technologies Pvt., Ltd. Erode, Tamilnadu, India, *Detailer*
- Taino Steel Erectors, Inc. Fitchburg, Mass., *Erector*
- Team Detailing Solutions Pvt., Ltd. Semmancheri, India, *Detailer*

For a searchable directory of AISC full and associate members, visit **aisc.org/member-directory**.

NSBA

U.S. Steel Industry Helps Rural Bolivians Build New Bridge

The National Steel Bridge Alliance (NSBA) recently collaborated with Bridges to Prosperity (B2P), a nonprofit organization that builds footbridges in isolated communities across the world, to build a bridge in Azurduy, Bolivia. Ten volunteers and three B2P staff built the La Marca Suspension Bridge. At 361 ft long, La Marca is the largest bridge yet for an NSBA-sponsored team and the third largest for B2P. The new bridge provides pedestrian access to healthcare and schools and will also allow local residents to transport their goods to local markets.

The team flew into Sucre, Bolivia, and drove seven hours to the mountainous Villa Azurduy, about 8,000 ft in elevation and the closest town to the bridge site. The participants provided the labor and skills to construct the bridge during their two-week stay. In order to complete the project, the team worked 11 days straight, side-by-side with the community, to bring the bridge to fruition. During their time off, they did some sightseeing and enjoyed the local culture.

NSBA's very own John Hastings was very excited about taking his second trip with B2P. "I enjoy volunteering and building things, so this was an opportunity to do both of those and use my engineering skills to help a community have access to the basics," he said. "It is also an opportunity to build relationships with a diverse group of individuals in the bridge industry."

This was NSBA's third volunteer trip with B2P; the other two trips were in Lura, Panama, in 2016 and El Macho, Panama, in 2018. NSBA is excited to announce that it will sponsor another B2P project in Bolivia in 2020.

You can also learn more about NSBA and B2P's La Marca Suspension Bridge collaboration in a video on the AISC channel at **www.youtube.com**.

IN MEMORIAM

Srinivasa "Hal" Iyengar, AISC Lifetime Achievement Award Winner, Dies at 85

Srinivasa "Hal" Iyengar, known for his work on Chicago's John Hancock Center (now known as 875 North Michigan Avenue) and the Sears (now Willis) Tower, passed away in early July at the age of 85.

In 2000, AISC presented Iyengar with a Lifetime Achievement Award for his contributions in AISC's and the structural steel industry's success. In addition to the two famous Chicago supertall skyscrapers, Iyengar also had a hand in some of the world's most notable projects such as Bilbao's Guggenheim Museum, Chicago's Millennium Park, and London's Broadgate.

During his long-running career at Skidmore, Owings & Merrill, Iyengar moved from project engineer to senior structural engineer, eventually becoming a partner and director of structural engineering. During his tenure, he garnered a reputation as a man who often pushed the limits by turning visions of ultra-high structures into reality.

Read more about Iyengar's phenomenal career and contributions to steel in the May 2000 issue of *Modern Steel Construction* (**www.modernsteel.com**).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Quality Management Company, LLC (QMC) is seeking qualified independent contract auditors to conduct site audits for the American Institute of Steel Construction (AISC) Certified Fabricators and Certified Erector Programs.

This contract requires travel throughout North America and limited International travel. This is not a regionally based contract and a minimum travel of 75% should be expected.

Contract auditors must have knowledge of quality management systems, audit principles and techniques. Knowledge of the structural steel construction industry quality management systems is preferred but not required as is certifications for CWI, CQA or NDT. Prior or current auditing experience or auditing certifications are preferred but not required. Interested contractors should submit a statement of interest and resume to **contractor@qmconline.org**.

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LATE MODEL STRUCTURAL STEEL FABRICATING EQUIPMENT

Controlled Automation DRL-336 CNC Beam Drill, (3) 15 HP Spindles, 36" x 18", Hem WF140 Tandem Saw, 2005 **#29344**

Controlled Automation ABL-100-2 CNC Angle and Plate Punch Line, 8" x 8" x 1", 40' Infeed/Outfeed Conveyor, Windows Update 2009 **#29956**

Ficep Gemini 324PG CNC Plasma Cutting System, 10' x 40', 15 HP Drill, (1) Oxy, HPR260XD Plasma Bevel Head, 2014 **#28489**

Peddinghaus FPDB-2500 CNC Heavy Plate Processor, 96" Width, (3) Drill Spindles, HPR260 Plasma, (1) Oxy, Siemens 840, 2008 **#27974**

Peddinghaus FDB-2500A CNC Plate Drill with Oxy/Plasma Torches, (3) Head Drill, 96" Max. Plate Width, 2003 **#29542**

Peddinghaus PCD-1100 CNC Beam Drill, 44" x 18" Capacity, 900 RPM, 13.5 HP, (3) Spindles, 3" Max. Diameter, 13" Stroke, 2008 **#29286**

Peddinghaus Ocean Avenger II 1000/1B CNC Beam Drill, 40" x 40' Max Beam, Siemens 840Di CNC Control, 2006 **#29710**

Peddinghaus AFCPS 833A Revolution CNC Anglemaster Angle Line, 8" x 8" x 1", Loader, Conveyor, Fagor 8055 CNC, 2011 **#29959**

Voortman V630/1000 CNC Beam Drill, (3) Drill Units, Max Length 51", Power Roller Conveyor, 2016 **#29726**

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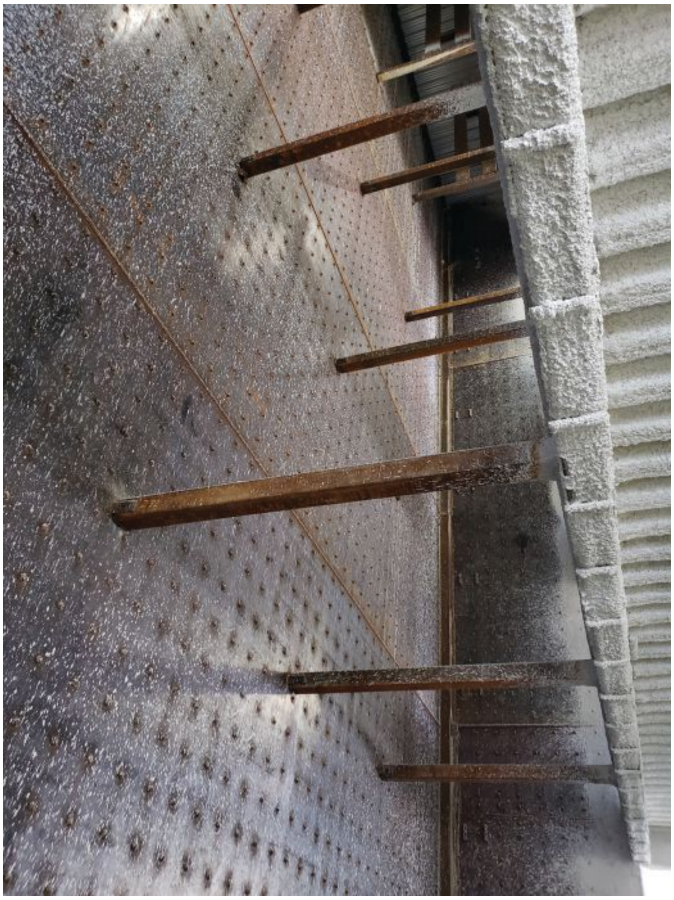

AT ITS CORE

SPEEDCORE IS LIVING up to its name.

The innovative concrete-filled composite steel plate shear wall (CF-CPSW) core system is being implemented on the Rainier Square Tower project in the heart of downtown Seattle. As of this printing, structural steel framing for the 850-ft-tall high-rise was expected to have topped out in August after being erected in only 10 months, approximately eight months faster than what would be expected if the building had been designed with a typical concrete core.

The building was designed by architect NBBJ and structural engineer Magnusson Klemencic Associates (MKA), with steel fabricated by Supreme Steel (an AISC member and certified fabricator). Once completed, it will house luxury apartments, offices, and retail space above six levels of below-grade parking.

The SpeedCore system, also developed by MKA (whose office is located in similarly named Rainier Tower, the building at left in the above photo), employs sandwich panels using steel plates filled with concrete. Cross-connecting tie rods hold the plates in place, supporting the wall panel before the concrete is poured, and the panels can support up to four floors of steel floor and metal decking even before the concrete is pumped in. What makes it come together so quickly is the elimination of the complex and time-consuming process required for a reinforced concrete core: setting formwork, installing reinforcing steel, placing embedded plates, installing sleeves and block-outs, and placing and curing concrete for each level.

In addition to speed, general contractor Lease Crutcher Lewis noted that the system also brings advantages in terms of safety, explaining that it remediates the danger of overhead work for ironworkers, which is constant as steel is typically intentionally paced behind the concrete wall pours in a concrete core structure.

While the CF-CPSW concept isn't new—it has been used extensively for nuclear power facilities worldwide thanks to its impact- and blast-resistant qualities—Rainier Square Tower is the first use of SpeedCore in high-rise construction. And it won't be the last. Thanks to the project's success, MKA is designing five new high-rise buildings in California that will implement the system.

For more on SpeedCore, visit **aisc.org/speedcore**.

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