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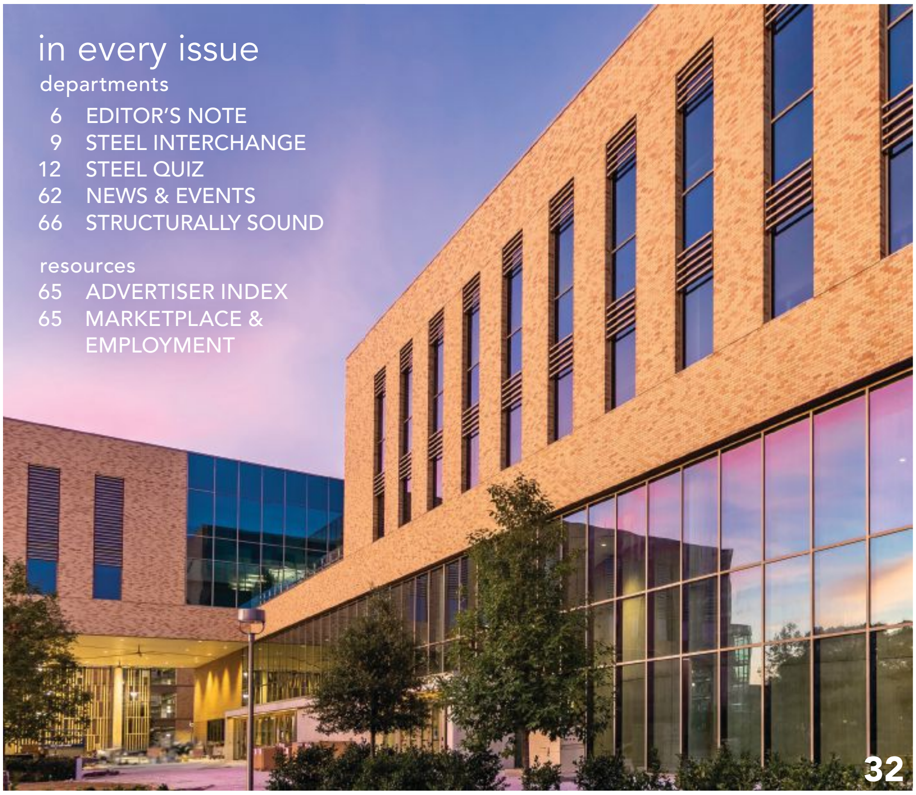

in every issue

columns

features

ON THE COVER: Things (and people) are looking up for Philadelphia's new tallest building, page 24. (Photo: Thornton Tomasetti/Bess Adler)

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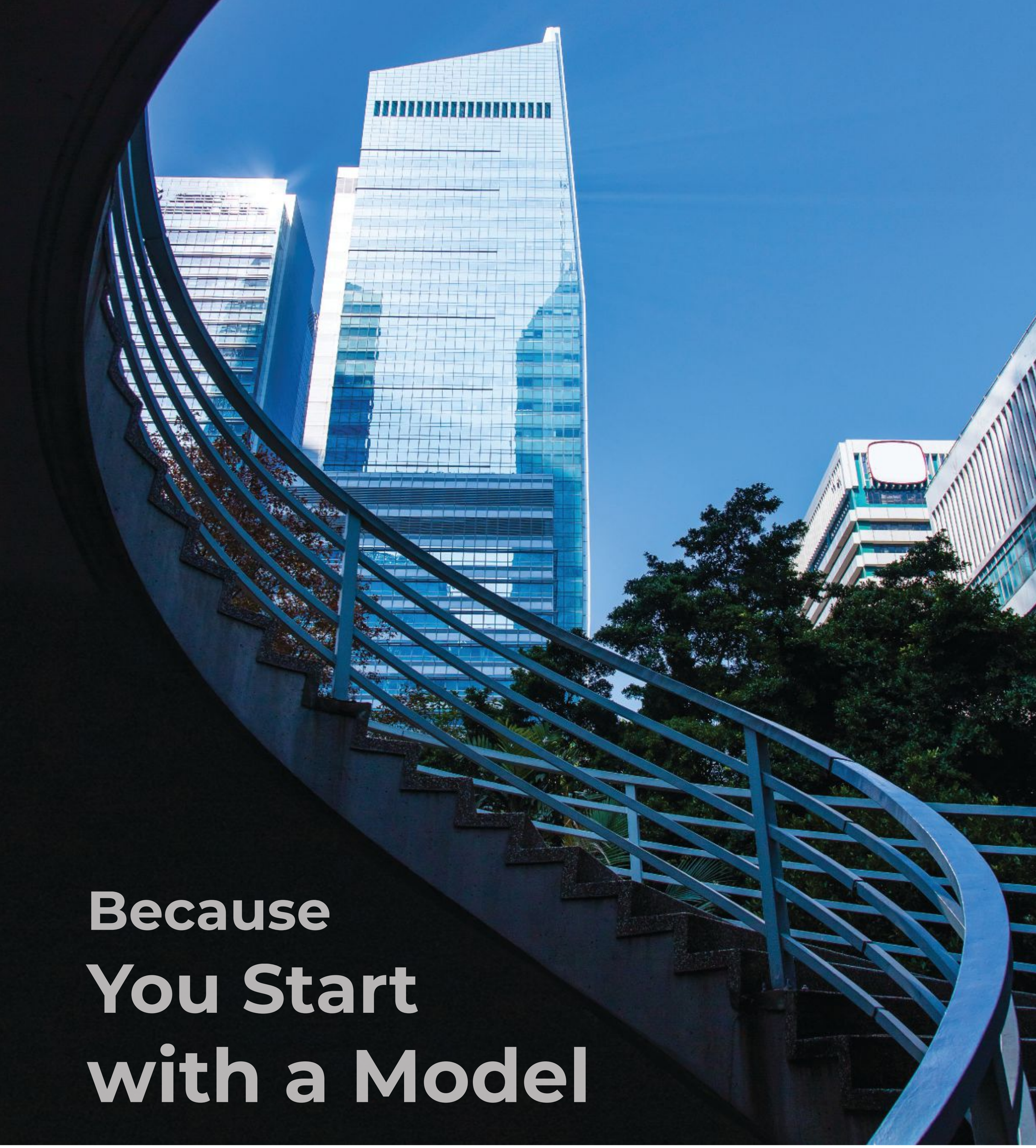
Because
You Start
with a Model

editor's note

A few of my friends from elementary school get together monthly, virtually, to chat. Our conversations cover the esoteric (last month someone told a story about an argument he had witnessed 40 years ago as an intern in the House of Commons) to the much more prosaic (a "discussion" of the pros and cons of New York, Chicago, and New Haven pizza).

During one such conversation, we disclosed our favorite presidents and there was some surprise when I named Dwight Eisenhower as one of my top three. But I think the creation of the interstate highway system is one of America's crowning achievements.

Unfortunately, our elected officials seem to have lost their enthusiasm for this marvel, despite the obvious benefits a fully functional and successful infrastructure brings to America's economy. As the American Society of Civil Engineers (ASCE) dutifully notes every year, America's infrastructure is failing. If we were students being graded, we'd barely earn a D.

As my colleague Brian Raff, AISC's director of communications and public affairs, likes to point out, transportation and infrastructure provide the backbone of our economy, allowing our nation to collectively move goods and services within and across state lines efficiently. In 2018, the Bureau of Transportation Statistics estimated that the country has a whopping nine million roadway lane-miles, and our National Bridge Inventory consists of more than 617,000 bridges.

These crucial links must be maintained to ensure that people and goods get to their destination safely. The highway and public transportation funding authorized by the Fixing America's Surface Transportation Act (FAST Act; P.L. 114-94) expires on September 30, 2020, and the Highway Trust Fund is expected to run out of money by 2021 if we don't do something soon to fix it.

Members of America's leading steel associations—the American Institute of Steel Construction (AISC), the American Iron and Steel Institute (AISI), the Steel Manufacturers Association (SMA), The Committee on Pipe and Tube Imports (CPTI) and the Specialty Steel Industry of North America (SSINA)—recently sent a letter to senate leadership urging them to pass a broad infrastructure package to kickstart the economy.

"As a result of economic hardships in states across the country, DOTs have been forced to delay or cancel key infrastructure projects because of revenue shortfalls and the impact of COVID-19," the groups wrote. "To ensure that these projects can proceed and create demand for essential products and support good wage jobs used in the transportation sector, the steel industry requests Congress include at least $37 billion for state DOTs in the future relief bill that will be considered by Congress this month. Ensuring that state DOTs have appropriate funding to carry out essential projects is an important first step in our nation's economic recovery."

I urge everyone to contact their legislators and encourage them to be like Ike and fix this problem. It's good for the economy today and tomorrow.

Scott Melnick

Scott Melnick
Editor

To learn more about AISC's advocacy efforts in infrastructure and other areas, visit ***aisc.org/advocacy****.*

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

Warping Stresses

I am working through Example problem 5.1 (see Figure 1 below) in AISC Design Guide 9: *Torsional Analysis of Structural Steel Members*, and I am struggling to understand why the example includes calculations for the torsional warping stress. The problem statement indicates that the beam ends are torsionally pinned. Shouldn't the warping stresses be zero?

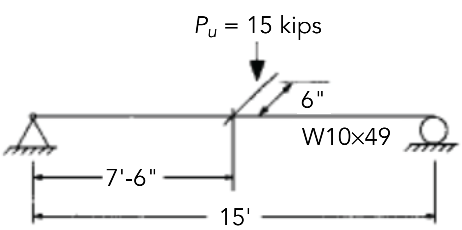

Fig. 1. Example 5.1.

Warping stresses are always present when open-shapes with torsionally pinned end conditions are subjected to torsion. $\theta''(GJa/T)$ is plotted at the top of page 63 (see Figure 2) of Design Guide 9. Because the warping stress is a function of θ'', the graph shows the relative magnitude of warping along the beam length. Note that, at the beam ends, the warping stress is zero. When the end connections are restrained against warping ("Torsionally Fixed") the warping stresses are high at the beam ends, as shown at the top of page 73 of the guide for Case 6 (see Figure 3).

The torsionally fixed and torsionally pinned end conditions shown in Figure 3.3 of the design guide (see Figure 4) are analogous to flexurally fixed and flexurally pinned end conditions for beams. A simply supported beam (flexurally pinned ends) has a moment within the span, but not at the ends. Using the analogy, a torsionally pinned beam has warping within the span, but not at the ends.

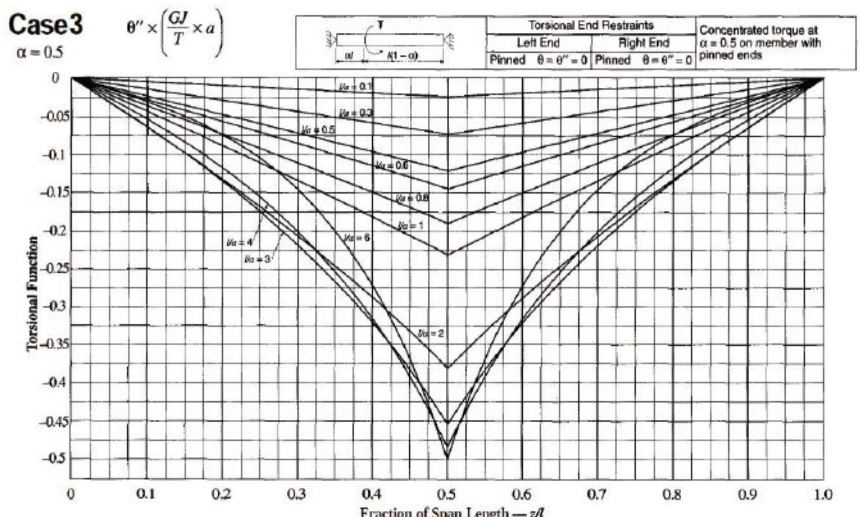

Fig. 2. Plot on page 63.

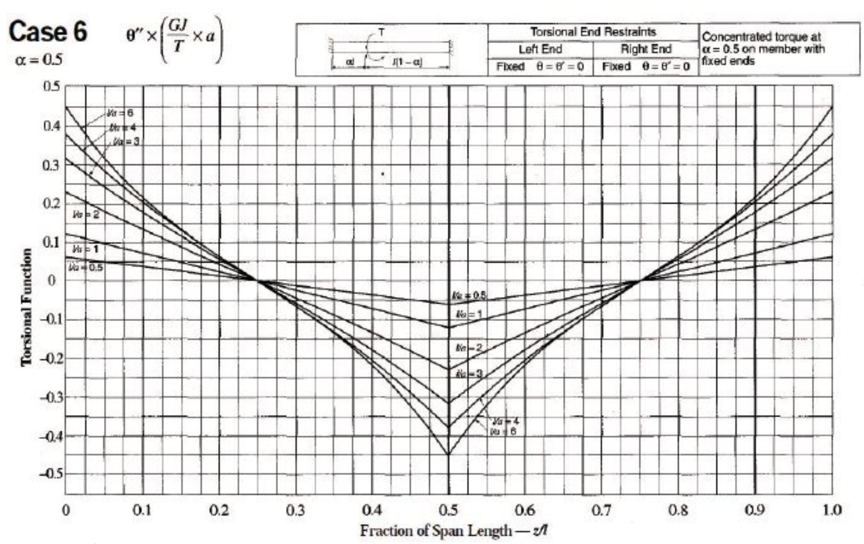

Fig. 3. Plot on page 73.

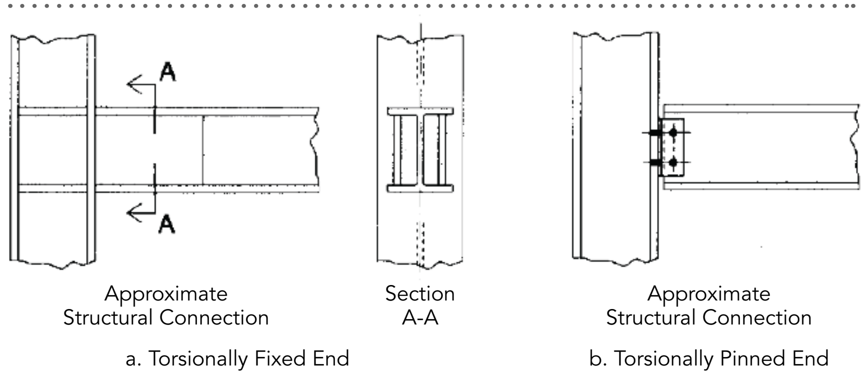

Fig. 4. Figure 3.3 in Design Guide 9.

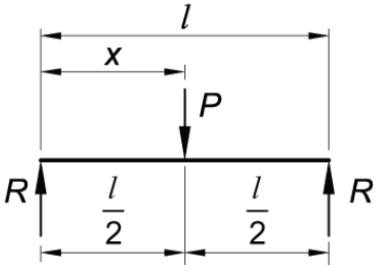

Fig. 5. Case 7. Simple Beam – Concentrated Load at Center.

To further the analogy, the top flange can be isolated, as discussed in Section 4.1.4 of Design Guide 9. This "Isolated Flange Method" is a simple way to approximate the warping stresses by modeling the flange as a flexural member. The flexural boundary conditions at the ends of the isolated flange should match the torsional boundary conditions of the member. For example, for a member with torsionally pinned end conditions, the isolated flange should be modeled with flexurally pinned ends. In Example 5.1, the moment diagram for the isolated flange is shown in Case 7 of Table 3-23 of the 15th Edition AISC *Steel Construction Manual* (see Figure 5). The shape of the curve is similar to the curve at the top of page 63 of Design Guide 9.

Bo Dowswell, PE, PhD

Placing Welds on Existing Welds

I am designing a shear connection that runs over an intersecting partial-joint-penetration (PJP) weld in the supporting member. Is it acceptable to deposit a pair of fillet welds over an intersecting groove weld?

The AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360) does not prohibit placing a weld on top of another weld. There is some concern about the performance of overlapping welds, but much of that is a misunderstanding. Intersections of overlapping welds are not uncommon. One example would be at a groove welded web and flange plate girder splice that intersects with the web-to-flange fillet weld of the built-up plate girder. There are, however, some issues to consider. If toughness is a concern, some self-shielded filler metals are not compatible with other filler metals welded over them. When the incompatible filler is welded over a self-shielded weld metal, the toughness may be reduced. Filler metal manufacturers have conducted intermix tests of some of their products to determine compatibility.

Section J2.7 of the AISC *Specification* states: "When Charpy V-notch toughness is specified, the process consumables for all weld metal, tack welds, root pass and subsequent passes deposited in a joint shall be compatible to ensure notch-tough composite weld metal." The commentary provides further guidance, stating: "Potential concern about intermixing weld metal types is limited to situations where one of the two weld metals is deposited by the self-shielded flux-cored arc welding (FCAW-s) process" and "Many compatible combinations of FCAW-s and other processes are commercially available."

More information can also be found in AWS D1.8/D1.8M *Structural Welding Code – Seismic Supplement* Annex B or Subclause 6.28 of the 2020 edition of AWS D1.1/D1.1M *Structural Welding Code – Steel*. AISC Design Guide 21: *Welded Connections – A Primer for Engineers* includes a good discussion on FCAW-s intermix concerns in Section 2.3.10.

Where the welds are large and complex connections restrain deformations in three directions, the performance of connections under weld shrinkage and applied stresses can be affected, but this should not be a problem with typical shear connection sizes. Regarding the design of the underlying PJP weld, in most cases the stress applied to the PJP weld would be neglected. If that stress is a concern, a designer could evaluate whether the shear connection would work if the PJP weld were not present under the fillets. In other words, assume that the stresses in the fillet over the PJP weld location is redistributed to the fillet on either side of the PJP weld. If that was still unsatisfactory, a designer could add the stresses in the fillets to the stress in the PJP weld, but that would be very conservative.

Tom Schlafly

Tom Schlafly (schlafly@aisc.org) is AISC's chief of engineering staff.
Bo Dowswell is a consultant to AISC.

correction

The August 2020 Steel Interchange included a question on intermittent PJP weld spacing that requires further clarification. While AWS D1.1 does permit intermittent PJP welds in some cases as stated in the response, AWS D1.5 does not. Use of intermittent groove welds is prohibited per Clause 2.14 in AASHTO/AWS D1.5M/D1.5:2015-ADM1.

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**

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

steel quiz

Can you *expose* the answers to this month's Steel Quiz?

The questions are all about architecturally exposed steel (AESS) and the answers can be found in the current AISC *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/AISC 303), available at **aisc.org/specifications**. And to learn more about AESS, see the articles "AESS Success" and "AESS Answers" in this issue.

1 **True or False:** All exposed steel is assumed to be AESS and must follow the requirements found in Section 10 of the *Code*.

2 Explain the main reasoning for producing an AESS mock-up. (And if you want to see one, turn to Structurally Sound on the last page of this issue.)

3 Which AESS category likely to be specified for a steel member/assembly with a viewing distance of 17 ft?

4 **True or False:** For AESS, copes, miters, and cuts in all surfaces exposed to view shall have a uniform gap within $\frac{1}{8}$ in. for open joints and $\frac{1}{16}$ in. if shown to be in contact.

5 **True or False:** Any grease or oil present will be removed during blast cleaning and does not need to be addressed prior to that step.

6 **True or False:** Bolt heads in connections must be on the same side for AESS 3 and 4.

7 Weld show-through is a visual indication of the presence of a weld or welds on the opposite surface from the viewer. How can one remove show-through if deemed necessary in the mock-up?

TURN TO PAGE 14 FOR THE ANSWERS

steel quiz ANSWERS

1 **False.** Section 10.1 states that members must be specifically designated as AESS in the contract documents for the requirements to apply.

2 Mock-ups or other visual samples are required for AESS 3, 4, and C (Custom) and may be required for others if specified in the contract documents. Mock-ups allow for acceptance criteria to be established and agreed upon by all parties to prevent future contractual disputes by setting expectations.

3 **AESS 3.** Section 10.1.1 of the AISC *Code* defines the five categories of AESS. AESS 3 shall be specified for feature elements viewed at a distance less than 20 ft.

4 **False.** Section 10.4.6 provides the requirements stated in the question for AESS 3 and 4 only.

5 **False.** Section 10.4.11 states that grease or oil shall be removed by solvent cleaning to meet the requirements of SSPC-SP1 *before* blast cleaning.

6 **Trick question!** Bolt orientation is a not a category-specific requirement. Section 10.6(f) states this provision generally. Thus all bolts heads should be on the same side and must be consistent from one connection to another. Section 10.2 (e) provides requirements for what is required to be indicated on Contract Documents regarding the orientation of bolt heads.

7 The weld show-through can be minimized by hand-grinding the back-side surface. The degree of weld-through is a function of weld size and material, as is explained in the User Note to Table 10.1.

STEEL SOLUTIONS CENTER

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


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steelwise

SHEARLY PERFECT

BY LARRY S. MUIR, PE, AND CARLO LINI, PE

Experts from AISC's Steel Solutions Center provide practical guidance on ensuring that your modeled connections, particularly shear connections, turn out as "perfect" as possible.

Larry Muir (**larrymuir@larrymuir.com**) is a consultant to AISC. **Carlo Lini** (**lini@aisc.org**) is AISC's director of technical assistance.

ALL STRUCTURAL DESIGN is based on models—whether a computer model or a model in a hand calculation. All models are based on assumptions, and all assumptions are wrong—or at least imperfect.

For instance, no practical connection is *perfectly* pinned. All connections in the real world will possess some degree of rotational strength and stiffness, and even the most flexible and ductile simple connection comes with limits on the rotation that it can accommodate. Likewise, no practical connection is perfectly fixed.

Many of the assumptions made in structural design are related to restraint. Such assumptions are often made without the engineer performing explicit calculations. Instead, they are commonly made by inspection based on engineering judgment and experience—and much of the time this is adequate. However, engineers must be careful to ensure that all assumptions are subject to appropriate inspection and consideration.

If you know, with a high degree of certainty, that you can prove the validity of an assumption with explicit calculations, then the assumption can be judged acceptable by inspection. But if you're not sure you can prove the validity of an assumption with explicit calculations, then it cannot be judged acceptable by inspection, and explicit calculations should be performed.

Performing explicit calculations for a few cases will often quickly lead an engineer to realize that the strength and stiffness requirements relative to some actions are quite trivial and easily satisfied in reasonable configurations, thereby forestalling the need to perform such calculations in the future. However, we assert that practicing engineers should seek to verify their assumptions relative to every class of assumptions at least once so as to develop a "feel" for what is required.

Design models must adequately (but not perfectly) reflect the behavior of the actual structures that will exist in the real world and vice versa. There are code requirements that require design models to be reasonable and sufficiently consistent with the physical structures they are intended to represent. This is, in fact, essentially what Section B1 of the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, **aisc.org/specifications**) requires. Following is a discussion of other relevant provisions.

Pinned vs. Fixed

Specification Section B3.4 provides requirements related to the strength and stiffness of both simple and moment connections. There is a lot packed into the single paragraph provided at the beginning of this section, and it is worth discussing each sentence line by line. (Note that the *Specification* language is in blue.)

"Connection elements shall be designed in accordance with the provisions of Chapters J and K." One needs to design a connection for the applicable limit states in Chapters J and K.

"The forces and deformations used in design of the connections shall be consistent with the intended performance of the connection and the assumptions used in the design of the structure." If you model a connection as fully restrained, the connection should be designed so that it behaves like one (see the example on the following page).

"Self-limiting inelastic deformations of the connections are permitted." This statement is what makes the recommended design procedures for single-plate connections in Part 10 of the AISC *Steel Construction Manual* (**aisc.org/manual**) possible. When using single-plate or extended single-plate connections (a fairly rigid type of connection if you think about it) rotation capacity (a requirement per Section B3.4a) is provided for by configuring the connection such that a ductile limit state controls (bolt bearing or flexural yielding of the plate). This ductile limit state would allow "self-limiting inelastic deformations," which is what provides sufficient rotation capacity. Page 10-4 of the *Manual* states: "The simple shear connections shown in this *Manual* are suitable to accommodate the end rotations required per AISC *Specification* Section J1.2." Therefore, the standard shear connections tabulated in Part 10 of the *Manual* can be assumed to be simple shear connections and also to accommodate the simple beam end rotations associated with serviceable beams.

"At points of support, beams, girders and trusses shall be restrained against rotation about their longitudinal axis unless it can be shown by analysis that the restraint is not required." The requirements used to size flexural members in Chapter F are based on the assumption that the member is restrained against rotation about their longitudinal axis at points of support. The *Steel Construction Manual* recommends but does not require (on page 10-7) that simple shear framed connections "be one-half the T-dimension of the beam to be supported" as this provides sufficient restraint against rotation during erection.

The Commentary provides further guidance, including thresholds for simple and moment connections, as illustrated in Figure 1.

If the secant stiffness of the connection at service loads, $K_s = M_s/\theta_s$, is more than 20 times greater than the flexural stiffness of the member it restrains, then it is acceptable to consider the connection to be fully restrained (i.e., a fully restrained moment connection). If the secant stiffness of the connection at service loads is less than twice the flexural stiffness of member it restrains, it is acceptable to consider the connection to be simple. "Connections with stiffnesses between these two limits are partially restrained and the stiffness, strength, and ductility of the connection must be considered in the design (Leon, 1994)."

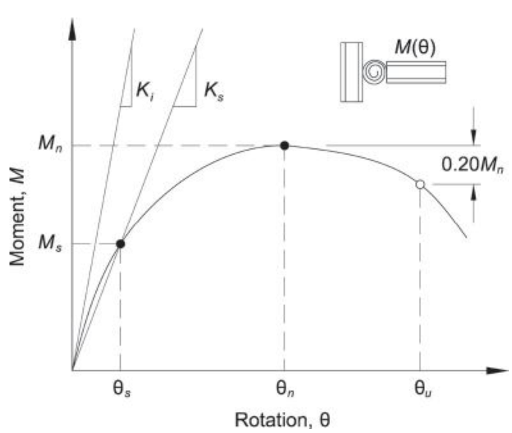


Fig. 1. Definition of stiffness, strength, and ductility characteristics of the moment-rotation response of a partially restrained connection (*Specification* Commentary Figure C-B3.2).

Example: Would the W16×31 beam (span = 30 ft) to HSS10×10×½ column connection shown in Figure 2 be considered a fully restrained moment connection?

As mentioned previously, the Commentary provides guidance, not requirements. However, we can use the guidance provided to help determine if a particular connection configuration has a connection restraint consistent with what was assumed in the structural analysis model. In this example, Figure 2 has been assumed to be a fully restrained moment connection.

We can start with a simplified approach to investigate whether this connection restraint warrants further scrutiny. What is presented in only a rough check to get a feel for where the connection might be relative to fixed versus pinned; other models are possible. For this particular check, let's assume a model where the HSS cantilevers out to the beam flange tip to pick up the beam flange load (See Figure 3). A virtual load of 10 kips is placed at the location of the beam tip.

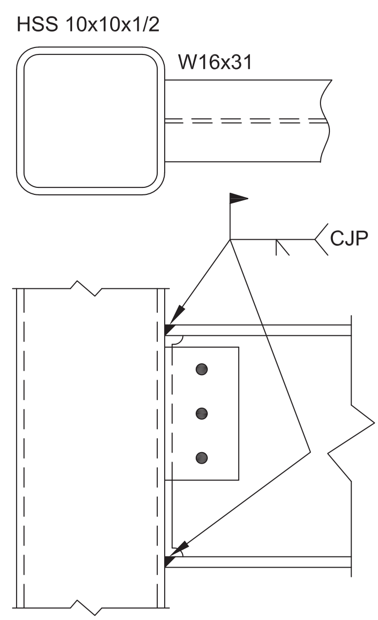


Fig. 2. Wide-flange-beam-to-HSS-column moment connection.

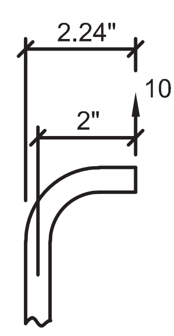


Fig. 3. Cantilever model.

Effective width, B_{eff}, at centerline of sidewall:

Use the 3.5b distribution tributary length provision discussed in the recommended prying procedure checks in Part 9 of the 15th Edition *Manual*.

$$B_{eff} = 3.5 \times 2 = 7 \text{ in.}$$

Moment of inertia of HSS wall:

$$I_x = \frac{B_{eff} t^3}{12} = \frac{7 \times 0.465^3}{12} = 0.059 \text{ in.}^4$$

Deflection of HSS wall at tip of beam flange:

$$\Delta = \frac{Pl^3}{3EI_x} = \frac{10 \times 2^3}{3 \times 29000 \times 0.059} = 0.016 \text{ in.}$$

Calculate HSS wall rotation:

Assuming rotation occurs about the centerline of the beam-to-HSS-wall work point, the rotation is equal to

$$\theta = \frac{0.016}{(15.9/2)} = 0.002 \text{ rad}$$

The moment that corresponds to a virtual load of 10 kips applied at each tip of the W16×31 beam is equal to

$$M = (2\times10)15.9 = 318 \text{ kip-in.}$$

Calculate the secant stiffness, K_s:

$$K_s = \frac{318}{0.002} = 159{,}000 \text{ kip-in./rad}$$

Check rigidity:

$$\frac{K_s L}{EI} = \frac{159{,}000\times30\times12}{29000\times375} = 5.3 < 20$$

Based upon this analysis, it is doubtful that the connection can be shown to be a fully restrained connection, although a more accurate model may result in a restraint closer to 20. When designing moment connections to HSS columns, one should pay close attention to the load distribution from the beam flange into the HSS sidewalls and whether sufficient rigidity exits based on the detail selected. The 1997 *Hollow Structural Sections Connections Manual* suggested that when using directly welded connections, the beam flange should be at least 95% of the HSS width. For the example above, this would indicate that a beam flange of 9.5 in. or greater is recommended if a directly welded flange-to-wall connection is used. Because the sections are hollow, when attaching near the center of the face of a rectangular HSS—where connections are commonly located—there is nothing backing up the supporting element (the middle of the face). The difference can be seen in Figure 4.

The estimated rigidity lies between the thresholds for a simple connection and a fully restrained moment connection. Therefore, the connection would be considered a partially restrained moment connection relative to the criteria described in the Commentary. Section B3.4b states: "In the analysis of the structure, the force-deformation response characteristics of the connection shall be included. The response characteristics of a PR connection shall be documented in the technical literature or established by analytical or experimental means…" While PR connections are sometimes used, establishing the response characteristics can sometimes be a challenge and may not be worth the effort in the eyes of many engineers.

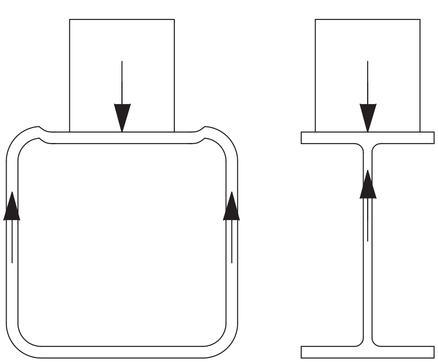


Fig. 4. Weak-axis versus strong-axis stiffness.

For structures that are intended to remain nominally elastic (so-called *R*=3 systems) and arguably ordinary systems expected to provide minimal inelastic deformation capacity, assuming connections that could be considered partially restrained moment connections to be simple connections in the analysis will usually result in conservative designs. Rational justification for this practice can be found in corollaries to the lower bound theorem of limit analysis, which indicates that adding restraint to a structure will not weaken it. See the July 2020 SteelWise article "How Low Can You Go?" (available at **www.modernsteel.com**) for a brief look at the lower bound theorem. For structures that are expected to provide greater inelastic deformation capacity, such assumptions will less clearly create conservative results, and rotational ductility may have to be more rigorously considered.

While the criteria provided in the Commentary is directed at beam-to-column connections in moment frames, they can sometimes be useful as a guide for other conditions as well. It is important to recognize that this criteria represents guidance, not requirements; other criteria are possible. AISC Design Guide 16: *Flush and Extended Multiple-Row Moment End-Plate Connections* (**aisc.org/dg**) describes another possibility, stating: "Traditionally, Type 1 or FR connections are required to carry an end moment greater than or equal to 90% of the full fixity end moment of the beam and not rotate more than 10% of the simple span rotation (Salmon and Johnson 1980). A Type 2 connection is allowed to resist an end moment not greater than 20% of the full fixity end moment and rotate at least 80% of the simple span beam end rotation. A Type 3 connection lies between the limits of the Type 1 and Type 2 connections. A PR connection is any connection that does not satisfy the FR requirements." Note that the Commentary to Section B1 in the 2010 AISC *Specification* refers to Type 1 as "rigid frames," Type 2 as "simple frames," and Type 3 as "semi-rigid frames." In the 2016 AISC *Specification* Commentary to Section 3.4, these connections are referred to as fully restrained (FR) for the Type 1 connections and partially restrained (PR) for both the Type 2 and Type 3 connections.

Part 12 of the *Manual* provides examples of connections that are generally assumed to be fully restrained. While no published report exists, it is our understanding that tests were run on end plate moment connections framing to the webs of wide-flange columns, and that the strength and stiffness that resulted were insufficient to consider the conditions fully restrained moment connections.

Rotational Ductility

As indicated earlier, the standard shear connections tabulated in Part 10 of the *Manual* can be assumed to satisfy *Specification* Section B3.4a. These connections can also be assumed to satisfy deformation compatibility when used with high ductility seismic force resisting systems, as is indicated in the Commentary to the AISC *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341, **aisc.org/specifications**). More specifically, the Commentary to Section F2.6b states: "The provision allows the engineer to select from three options. The first is a simple connection (for which the required rotation is defined as 0.025 rad). The connections presented in *Manual* Part 10 (AISC, 2011) are capable of accommodating rotations of 0.03 rad and therefore meet the requirement for a simple shear connection." It may also help to visualize how much ductility is provided. If we look at the W16×31 that spans 30 ft, the beam would need to deflect at least 5.4 in. (based on a 0.03 rad rotation at the beam supports) to exhaust the rotation ductility of a Part 10 shear connection. That is equivalent to *L*/67, so serviceability requirements alone would prevent beams from getting close to the rotational ductility capacity of simple shear connections.

For connections not tabulated in Part 10 of the *Manual*, Part 9 describes some of the mechanisms by which rotational ductility can be ensured.

Practices addressed are:

- Keeping the weak-axis flexural strength of connection plates and angles weaker than the bolts and welds to promote relatively free flexing and rotational ductility.
- Allowing the top or side stability angle to flex to accommodate the simple-beam end rotation at seated connections.
- Keeping the strong-axis flexural strength of the plate weaker than the bolts and welds at extended single-plate shear connections.
- Keeping the bearing strength at the bolts weak relative to the strength of the bolts and the welds to promote elongation of the holes.

In each case, the rotation is assumed to be large, though the rotation is not directly quantified.

There are other means to accommodate rotation as well:

- Short-slotted holes can allow freer movement of the bolts. Even if the bolts are pretensioned and the connection tends to behave like a slip-critical connection, it is unlikely that the slip resistance will be greater than the shear strength of the bolts—though it may be prudent to design the less ductile elements (usually the bolts and the welds) to resist a realistic estimate of the slip resistance.
- If the attachment is to a relatively weak and flexible element, such as a connection to only one side of a beam or column web, flexure of the support may be sufficient to accommodate the simple beam end rotation.

Collectors (sometimes referred to as drag beams) can present more of a challenge. In additional the transferring vertical reactions, these members must also transfer axial loads. Keeping the flexural strength of connecting elements or supports low is impractical, as is the use of short slots to accommodate rotation.

For structures that remain nominally elastic, it can be useful to note that Section B3.4a does not require the accommodation of unlimited rotation or even some arbitrarily high level of rotation. Instead, it requires only that the connection "accommodate the required rotation determined by the analysis of the structure." Members that are designed as beam-columns tend to be shorter, deeper, and stouter than members designed for gravity loads alone. This will result in more modest end rotations.

However, for structures expected to undergo large inelastic deformation, the governing "rotation determined by the analysis of the structure" will likely not be derived from simple beam behavior relative to the gravity loads, but rather from the rotations resulting from the large lateral drifts. Three practical solutions are presented here:

1. In some cases, the checks in Part 9 of the *Manual* can be satisfied, and this is generally sufficient as discussed in the Commentary to the *Seismic Provisions*.
2. The idea of designing the collector beams as pinned-pinned can be abandoned, and these connections can be designed as fixed. When this is done, it cannot be done solely as the connections are being designed, as this is likely to be a significant change with ramifications for other elements in the structure.
3. The transfer (collector, drag) forces are assumed to be delivered from the diaphragm to the top flange of the beam and to remain there. At the beam ends, these forces are transferred to the rest of the structure through top-flange plates. These top-flange plates have significant axial strength and presumably good ductility. They allow the connection to the web to remain modest in terms of strength and stiffness, thereby permitting significant capacity.

Rotational Ductility and Delegated Connection Design

When connection design is delegated, questions sometimes arise related to rotational ductility. This seems to be especially true for end connections to collectors, where providing (and proving) rotational ductility can be a challenge. If it cannot be provided, then there may be no alternative but to assume that the joint is fixed (or at least partially restrained) which may require reanalysis and perhaps redesign of the members, which can be a real issue if the problem is caught after the steel has been purchased.

The problem can sometimes be worsened or even caused by the engineer of record's (EOR) insistence that "standard" details be used and/or treating interpretations of the *Manual* guidance as requirements. It is easy to state that the load must be transferred only through the web and that the "requirements" of Part 9 of the *Manual* must be satisfied when it is someone else who is charged with performing such Herculean tasks.

In the vast majority of cases, it will be the EOR who decides whether the end connections will be assumed to be pinned or fixed in the model. As the model is developed, the EOR should give some thought to how the design assumptions will be realized in the physical world and potentially make adjustments to the model to reflect real-world constraints. Any restrictions on the types of connections that are permitted, including restrictions related to rotational ductility, must be provided in the contract documents.

It may be impossible in some instances to satisfy both the specified loads and the specified restrictions during connection design. Such cases represent a discrepancy that must be promptly brought to the attention of the EOR for resolution.

The Final Rotation

We call them simple connections for a reason. While this article provides a lot to consider regarding restraint—and many more articles could be generated, expanding this discussion to trusses, base plates, stability, etc.—keep in mind that most steel connections (simple or moment) can be judged based on inspection and experience. There are times where connection restraint requires further consideration. We hope this article serves as a useful resource when such cases arise. If you still have questions, you can always reach out to us at **solutions@aisc.org** for additional assistance. ■

field notes

PERFECT PAIR

INTERVIEW BY
GEOFF WEISENBERGER

Two architects that came into the profession from very different angles have joined forces to bring their creative visions to life.

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

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

THIS TIME AROUND, our subjects are **Rosannah Harding** and **Matthew Ostrow** with HardingOstrow, a New York-based design practice (**www.hardingostrow.com**); they both practice architecture individually as well, at Young Projects and Ennead Architects, respectively. Rosannah enrolled in college at the age of 12 and became the youngest architect member in the history of the American Institute of Architects (AIA) at the age of 23. Matt has over 20 years of professional experience and is a visiting assistant professor at Pratt Institute and Parsons School of Design. Together, they live in Brooklyn's Cobble Hill neighborhood, where their dining room table currently serves as their work and life command center. They are also the winners of this year's AISC Forge Prize Award for their design Footbridge. They discuss their winning project, their architectural inspirations, life in a commute-less world, and more.

When did you both first realize that architecture was something you wanted to do?

Rosannah: I think Matt and I came at it from opposite ways. For me, it was very early on. I must have been 9- or 10-years-old and I think it had a lot to do with moving around so much in the military and being very curious about how things get decided upon or what makes places the way they are. I'm one of ten kids. And we were homeschooled, so travel served as school field trips. I went to Hearst Castle as a kid and it really struck me, that's what I want to do. It was pretty direct, linear path.

Matt: I'm the oldest son of a couple of self-described hippies, so they actually built our first house. I was pretty young, probably three-years-old, and I remember my dad building our first house paycheck to paycheck in the hills in New Hampshire before I moved to California. We had a big piece of land where we raised pigs and chickens and had a Christmas tree farm, and we were always building things growing up. So I think I got the bug to start building things myself. It was kind of in my blood.

What's the origin story for HardingOstrow? How did you two meet and how did you decide to start a practice together?

Matt: We were both working at Diller Scofidio + Renfro (DSR) in New York. We happened to wind up on the same project together, The Shed in Hudson Yards. I'd been working on and off on that project for a while, and Rosannah and I clicked over our ability to both design things together and also deal with the different aspects of construction. So we decided we were going to try to make a go of things.

Was it scary striking out on your own?

Rosannah: It was, but on the other hand, it's something we'd been thinking about for a long time, so in that way it was kind of a dream come true: to be able to come up with a concept and design it all the way through—sharing the drawing, the modeling, and everything. It's wonderful to work with someone that is like-minded and see these projects come to fruition. I'd say the excitement factor outweighs the fear factor.

Matt: We'd also taught together—that's one of the things that led us to be able to finish each other's sentences—having various teaching engagements in design studios. We connected that way first by helping each other out, and then projects started to come out of that.

When did HardingOstrow actually become a thing?

Rosannah: Actually, we're coming up on our one-year anniversary.

Congratulations! So you're still a fairly new practice, but can you identify your most memorable project together so far?

Rosannah: We recently submitted for a competition to reimagine the Brooklyn Bridge. We found that we didn't win, but it was actually one of the most fluid experiences we've had together on a project. It was to rethink it as a public space and as a pedestrian connection, and it was one of those projects where we were just up late one night and had a sketch, and then that sketch was like a snowball and rolled into the project and it was very fluid. And even though we didn't ultimately get the project, it's one of those ones where you look back and you think, wow, that was kind of an amazing process and we were very happy with the result.

Let's talk a little about your design Footbridge, which won our Forge Prize. Was it a situation where when you first heard about the competition, you thought, "Ah, we have just the thing!" or was it something that you had to kind of think about a little bit and then come up with it?

Rosannah: The High Line is a critical artery in Manhattan, which currently stops at Hudson Yards, and there have been other competitions and premises for that connector to the new Moynihan Station. So it's something we had already been thinking about. We had conceived the idea prior to the Forge Prize and then as we found out about the competition, it was like an aha moment where we recognized this is exactly our kind of thing we've been mulling over. So let's go for it! And we pushed hard for phase one and we were very happy to get through that, and then phase two was such an enjoyable process. It was kind of a luxury in a way to be able to think about things practically, both design and fabrication, in our own process together. We had been dealing with some of these questions and issues in our professional lives at other offices, so to have the opportunity to really go for it together was really a great opportunity for us.

Matt: It's wonderful to come across a competition that's judging based on execution and not just the possibility of this clear blue sky, when you're so deep in the reality of getting something built, that balance sometimes swings to one side. So it was nice to do a competition that had a tone to it that was very clear.

Rosannah: Our collaborator, Glenn Tabolt, our AISC member fabricator partner for the second phase of the Forge Prize program, was so interested in the big ideas, and I think he was also a little bit surprised at how much we were treating it like a real project. He even mentioned after the fact that, at times he thought he was working on a real project and almost forgot it was a competition!

So here's the topic we can't seem to stop talking about. How has the COVID situation affected your work and life in general?

Rosannah: I think it's affected our dining room table the most. The dining room table is now the epicenter of everything from conference calls to homeschooling to dinner. It's like we're constantly shuffling things left and right. We're right in the thick of Brooklyn, and we have two kids with us, and so it's kind of a Tetris game on an hourly level!

Matt: It's interesting to imagine the future of how we do architecture and if everybody truly needs to be in the in the same room. One of the things that I particularly miss is the interaction with fabricators, with building things, with being on the site, with being an engineer's offices and collaborating, so that human aspect of just collaborating has been a bit of a challenge for the past three or four months. Luckily, the two of us are in the same room together, and I'm not sure we could have done all this if that weren't the case.

Good or bad, it has eliminated commutes for many of us.

Rosannah: There are certainly efficiencies that we have now realized by working from home, but it's interesting because when you think about the time we normally spend in transit, and we don't spend *any* time in transit now, but that time was a place for your mind to not have to be immediate or to be doing a specific task. It's a time for your mind to wander or listen to podcasts or music or just prepare for going into a meeting. It also gives you a chance to amp up: OK, I've got to go deal with this room of ten contractors and I'm going to have to defend this crazy design that we've come up with. But now you just wake up and shift gears. It's a strange inversion. ■

This article is excerpted from my conversation with Rosannah and Matt. To hear the podcast in its entirety, visit ***modernsteel.com/podcasts****.*

The Forge Prize

And to learn more about their winning Forge Prize project and the award program in general, visit ***www.forgeprize.com****.*

You can also read about all three of this year's finalists in "Forging the Future" in the August issue.

business issues

LOOK AHEAD

BY DAN COUGHLIN

Keeping your eyes at least partially on the future can help you anticipate and remove potential obstacles.

Since 1998, **Dan Coughlin** has educated for-profit and nonprofit executives to consistently deliver excellence in management, leadership, and teamwork. He serves as a business coach and teacher. Visit his free Business Performance Idea Center at **www.thecoughlincompany.com**.

In addition, Dan has presented multiple sessions at NASCC: The Steel Conference. Visit **aisc.org/education-archives** and search on "Coughlin" to access them.

YOU AND YOUR TEAM are on a quest.

You are trying to fulfill some meaningful purpose and achieve some important objectives. On this journey, there will be obstacles that will try their very best to stop you and prevent you from ever fulfilling that purpose and achieving those outcomes. Here, we'll focus on three types of obstacles: human dynamics, logistics, and the unforeseen.

Human Dynamics and the Importance of Orchestration

If you announce a new way of doing something or a new product or service that you want your company to sell, it could be embraced by your employees, suppliers, and customers—or it could be undermined by them.

A lot of the challenge is in the way you communicate the new item. Who are the key individuals you need to get on board before you announce it to everyone else? What is the order in which you need to talk with these key individuals? What do you need them to support and champion to other people?

Answering these three questions is what I call orchestration, and I believe that it's critically important. Actually take the time to write down your answers to those questions. And then follow your plan. Don't fall into the temptation of telling everyone about the new thing until you have worked your way through your plan of who to talk with, in what order to talk with them, and what the key points are that you want to get them excited about. In addition, I encourage you to read a timeless classic called *The Tipping Point: How Little Things Can Make a Big Difference* by Malcolm Gladwell.

Logistics and the Importance of Detailed Planning

Almost nothing ruins the initial excitement of a big idea more than not being prepared to execute the details down the road. Consider this simple example on a non-business level. Imagine you are redoing the kitchen in your home. You are excited about the drawings. You take pictures as your old kitchen is taken out and the work is being done to get all the electrical outlets prepared and the new floor is put in.

And then you end up waiting nine months for the cabinets to arrive.

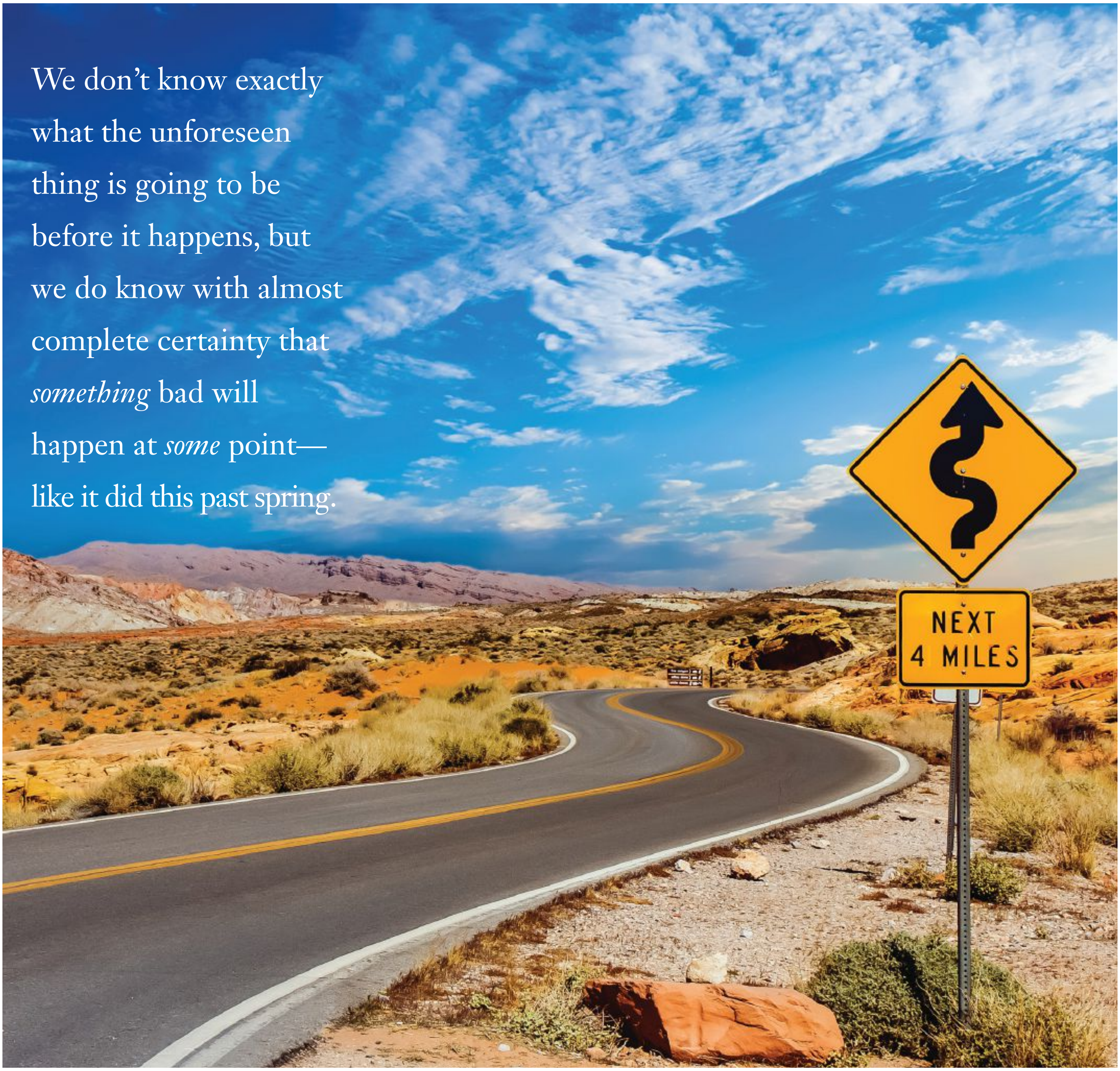
This same lack of logistical preparation happens in business. You announce an exciting new product or service offering. The employees and customers are hyped for what is about to happen. And then you miss the rollout of the new product or service by nine months beyond the announced date because some key items are missing.

Write out a plan of everything that will be needed to deliver the new item on time. Then spend even more time focused on making sure each of those details is executed better than planning the big announcement of the new item.

The Unforeseen and the Importance of Staying Calm

We cannot predict the future. We don't know what new crisis is coming our way. We can't see every unforeseen war, tragedy, and disease before it happens.

However, one thing we can predict with almost 100% certainty is that *something* bad is *going* to happen at *some* point. It's like how people in cold weather areas appear



surprised by the first snowfall of the year [Editor's note: like Chicago]. Folks, it snows every year. You *know* it's coming. This is not an unexpected event. You *know* how to prepare for it both mentally and physically. You just need to *do* it.

We don't know exactly what the unforeseen thing is going to be before it happens, but we do know with almost complete certainty that something bad will happen at some point.

When that *something bad* happens, stay calm and stay focused. Do what you can while you can do it. Acting like the world is coming to an end in the next five minutes is not going to help you or your team. Staying calm and maintaining poise is one of the most important things you can offer.

Prior Preparation

To remove or reduce the effects of distant obstacles, think into the future. Imagine what you need to communicate and in what order you need to communicate with individuals and groups. Write down all the details that need to be executed in order for the new item to be delivered on time and focus on doing all of those details.

Foresee that something unforeseen is going to happen and be prepared emotionally to stay calm through that storm. And that storm *is* coming. Being ready for it makes it that much easier to weather, and then eventually move on to calmer waters. ■

Thornton Tomasetti/Bess Adler

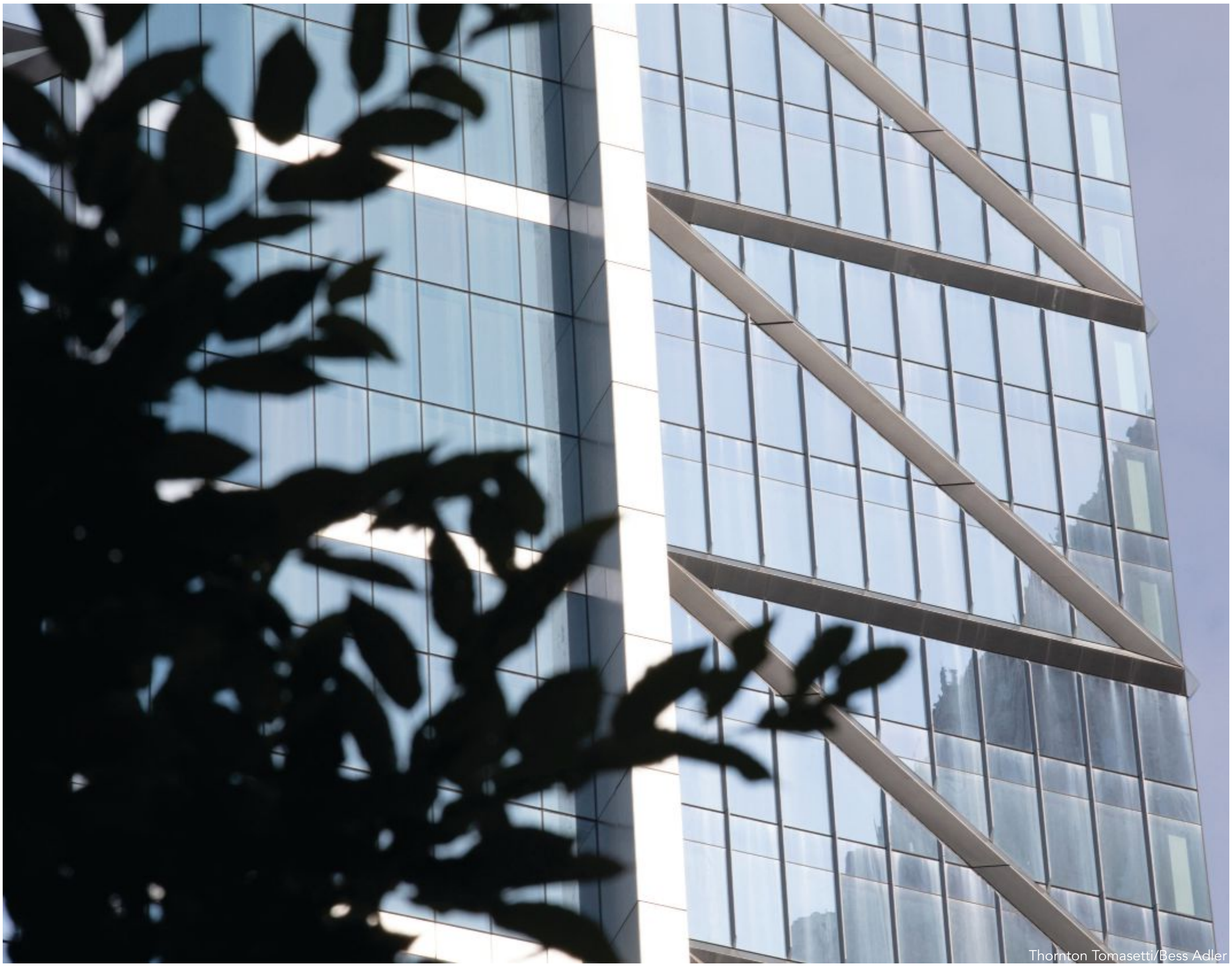
Center of Innovation

BY STEPHEN KANE, PE

Philadelphia's new tallest building, dedicated to technology and accommodation, uses steel to successfully address disparate structural challenges.

opposite page: At 1,121 ft, Comcast Technology Center is now Philadelphia's tallest building.

below: Three-story diagonal cover-plated outriggers provide lateral resistance as well as a visual focal point.



Thornton Tomasetti/Bess Adler

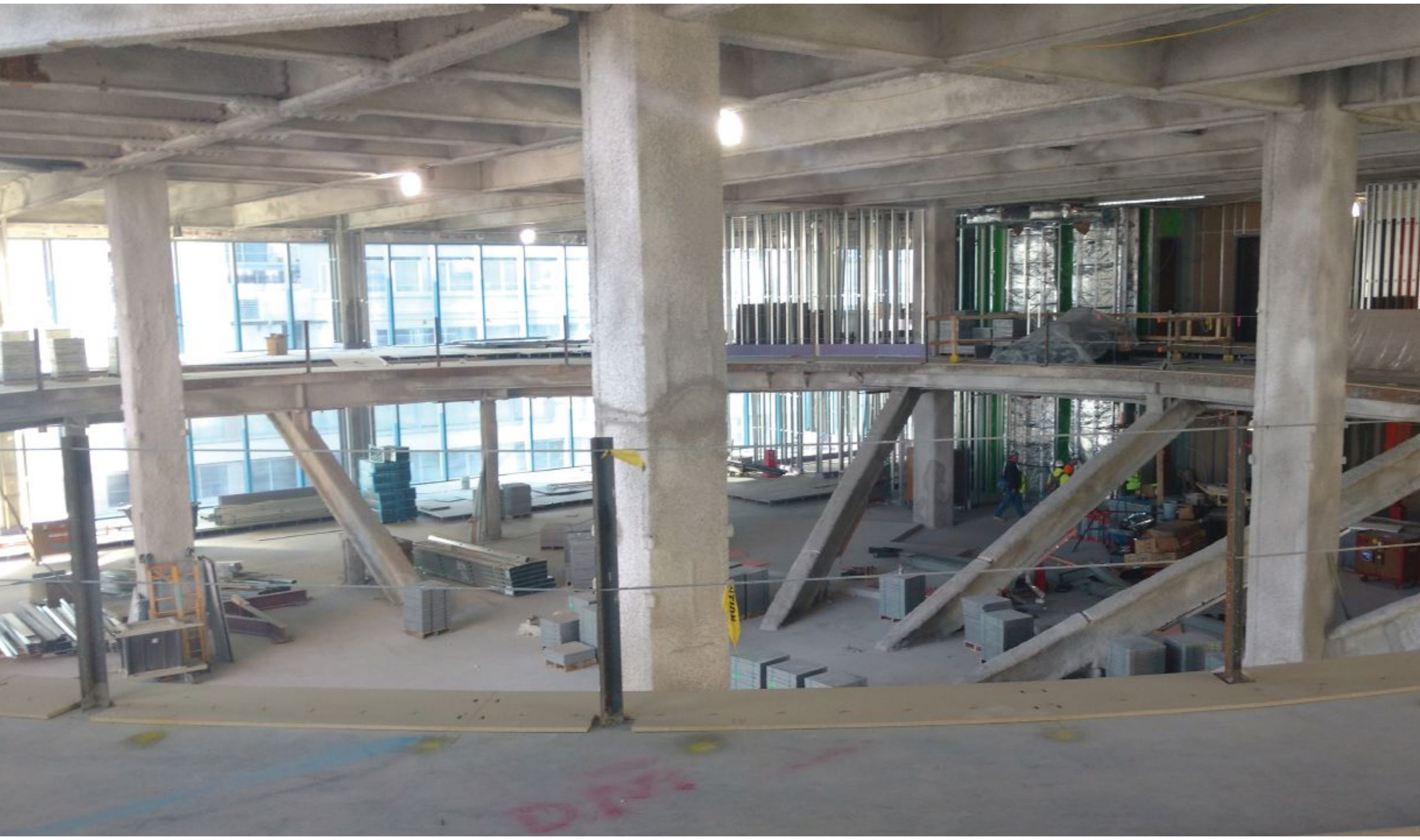
PHILADELPHIA'S COMCAST TECHNOLOGY CENTER is an urban, high-rise alternative to the sprawling, suburban high-tech campuses of Silicon Valley.

Built to become an East Coast center of innovation, the new high-density development has produced more than 4,000 permanent jobs, with an expected annual economic impact of more than $720 million.

The 60-story steel-framed, mixed-use building comprises 1.5 million sq. ft of research and development space and serves as an incubator for new apps, software, and services. Designed by Norman Foster, the 1,121-ft-tall tower—currently the tallest building in the U.S. outside of New York and Chicago—is pursuing LEED Platinum status and features a glass façade, glass elevators, and three-story atriums with green space located on every third office floor. The top 12 stories function as a luxury Four Seasons hotel, with more than 200 rooms and amenities that include a spa, fitness center, event space, and a rooftop restaurant, with a 360° view of the city. In addition, there are two levels of below-grade retail space and parking. At the building's base is a winter garden plaza with restaurant and retail space, and below this area, rail transportation and other city services are easily accessible via a subterranean concourse that connects to the Suburban Station regional rail hub and the existing 975-ft-tall Comcast Center.

This one-of-a-kind center for technology and innovation required advanced steel solutions that go above anything done before in the City of Brotherly Love, and beyond the typical steel-framed office building. A truly mixed-use structure, blending art and architecture, Comcast Technology Center incorporates a variety of structural steel systems to bring to life a modern vertical campus for employees and the public alike, using more than 22,000 tons of structural steel in all.

Stephen Kane, PE, (**skane@thorntontomasetti.com**) is a senior project engineer with Thornton Tomasetti's Philadelphia office. **Andrew Blasetti, PE**, a vice president with Thornton Tomasetti, contributed to this article.



The 18th floor "town hall" features stadium-style seating supported by steel rakers, which were made from multiple segmented pieces of wide-flange that came down from the 19th floor to frame the oval-shaped area.

Structural Lateral System

Challenge: Control building twist due to offset concrete core located to one side.
Steel solution: Use three-story steel diagonal braces, chevrons, and outriggers.

The primary lateral system consists of a concrete core positioned eccentrically on the west side of the plan to accommodate the largest possible uninterrupted floor plan. The split core creates a central east-west vision corridor, which was a key component of the architectural project vision. The core not only steps as the low-rise and mid-rise elevators drop out, but also the east and west walls transfer to the center of the hotel floor plate, allowing for a more efficient hotel room configuration. Three-story steel braces on the east and west sides of the office floors, cover-plated W14×730 steel outriggers off the core at MEP floors, and chevron bracing in the hotel supplement the asymmetrical split concrete core. These diagonal expressions are a key architectural feature of the building and work in tandem with five sloshing damper tanks beneath the hotel lobby floor help to increase occupant comfort. The bracing and damper positions control accelerations in the primary *X-Y* axes as well torsional velocities propagated by wind buffering from the 58-story (similarly named) Comcast Center located on the next block.

Office Floor Sky Gardens

Challenge: Accommodate three-story tall sky gardens.
Steel solution: Use architecturally exposed structural steel (AESS) hollow structural section (HSS) as built-up wind girts.

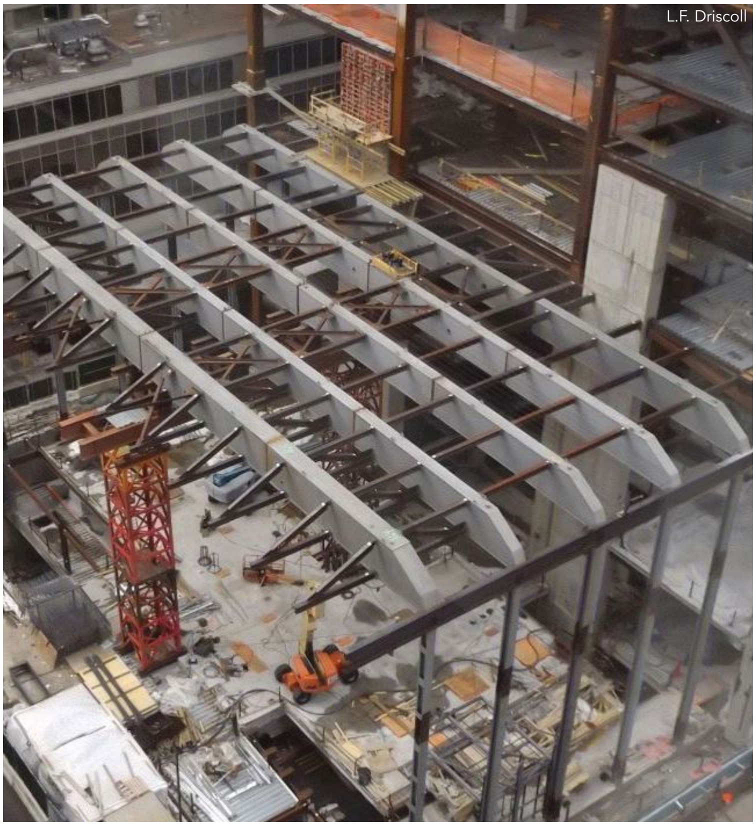
With the core located to provide the large unencumbered floor plate, the floors form three-story groups with sky gardens at the east façade of each group. The base floor of each group is the entire floor plate, with the middle floor cut back 60 ft at the center bay and the top floor cut back 30 ft to create a large atrium space with interconnecting stairs in each group of floors. Diagonal steel hangers accent these floor groupings and 50-ft-long wind girts, consisting of steel members (typically HSS18×6, designated as AESS 1: Basic Elements) with custom concealed connections, brace the three-story curtain wall. The girts are supported by ASTM A316 stainless steel rods with custom clevises. On the 18th floor, the sky garden features a "town hall" area with stadium-style seating supported by steel rakers. These rakers were made from multiple segmented pieces of wide-flange steel and came down from the 19th floor to frame the oval-shaped area.

Public Winter Garden

Challenge: Accommodate a tall, wide public space while eliminating columns.
Steel solution: Use built-up steel box girders (with plates up to 3 in. thick).

The main entrance on the east side is an open public space connecting the building to the underground concourse, featuring retail and restaurant space, living trees, and artwork. In order to span the 70-ft-tall, 143-ft-wide space and keep it column-free, as well as frame the skylight roof, the design team implemented 6-ft-deep built-up girders. Each box girder was shipped in four sections and field welded to accommodate camber and meet the stringent tolerances for the glass fin wall on the east side.

Thornton Tomasetti/Steve Kane



L.F. Driscoll

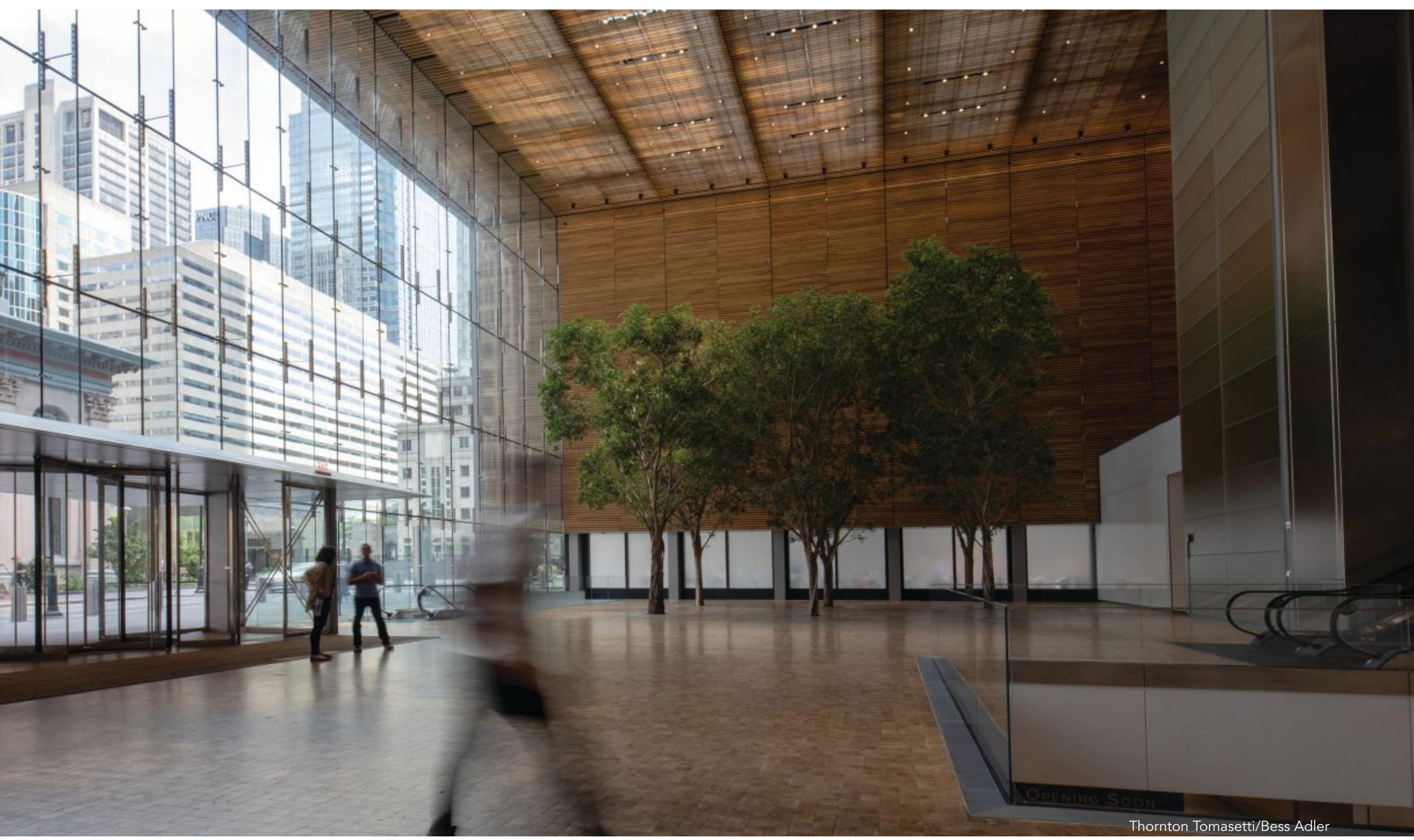
above: Box girders above the main entrance on the east side were shipped in four sections and field welded to accommodate camber.

below: These girders allow the 70-ft-tall, 143-ft-wide space to remain column-free.

Bottom to Top

A brief look at the various vertical parcels of the 1.8-million-sq.-ft, 1,121-ft-tall, 60-story office/television studio/hotel tower that is Comcast Technology Center, from below grade to the tip of the spire.

- Floors B3 through L4: Retail, public spaces, office lobby, hotel entry, winter garden
- Floor L5: Ballroom and hotel function spaces
- Floors L6 through L44: Office, local NBC 10 and Telemundo studios, amenities (cafeteria and fitness center)
- Level 45: Luxury condo unit with outdoor terrace
- Floors 46 through 60: Four Seasons Hotel, including rooms, amenities (pool and spa), restaurant (L59) and lobby (L60)
- Top of the roof to 126 ft higher: The Lantern, a structural steel-framed spire serving as a beacon in Philadelphia's Center City/downtown



Thornton Tomasetti/Bess Adler

Elevators and Artwork

Challenge: Support unique artwork and cinematic ride.

Steel solution: Use AESS (Category 1) HSS framing and rods, custom connections, and cover plates for strict deflection requirements.

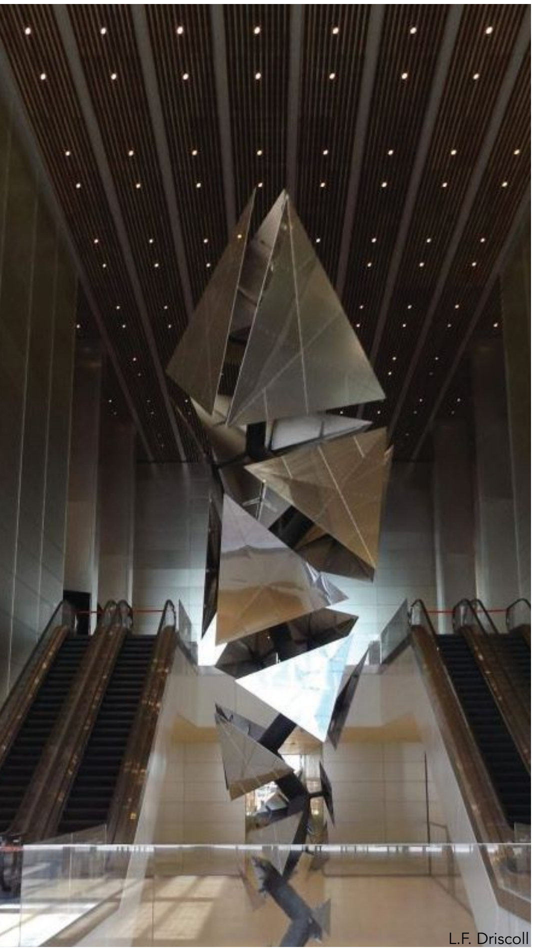
At the hotel and service elevator, located on the exterior of the building on the west side, AESS HSS10x4 framing and diagonal 1-in. rods create clean, aesthetic connections for the all-glass elevator cabs and enclosures. In addition, the public spaces have multiple large-scale pieces commissioned for the project, including a Conrad Shawcross piece called *Exploded Paradigm* and an LED feature element by Jenny Holzer that creates the ceiling of the three-story escalator to the hotel ballroom—both of which required additional unique steel supports. In addition, the steel-framed Universal Sphere, an immersive cinematic ride, inspired by Steven Spielberg and located inside a 40-ft-diameter sphere on the second floor, was introduced late in the project, and required steel cover plates and upgraded connections to support the additional weight of the sphere and hydraulic lift structures.

above: HSS elevator framing.

below: The steel-framed Universal Sphere and its hydraulic lift total about 75 tons.

below-left: The *Exploded Paradigm* sculpture uses WT outriggers with low-friction bearing pads for stability, above which the piece extends 50 ft.

opposite page: The 60-story steel-framed, mixed-use building comprises 1.5 million sq. ft of research and development space and serves as an incubator for new apps, software, and services—with a Four Seasons Hotel at the top.



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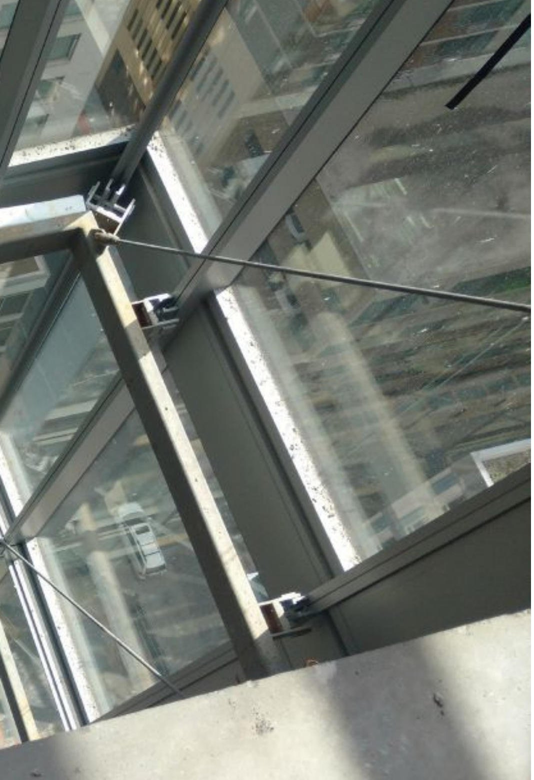
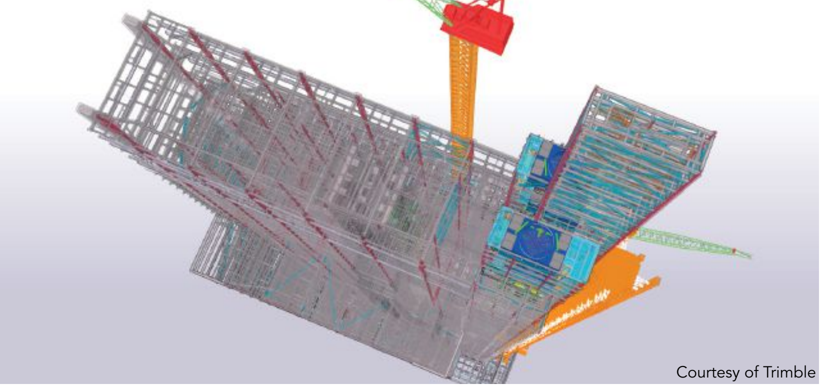


Thornton Tomasetti/Steve Kane

Thornton Tomasetti/Bess Adler

Head Start

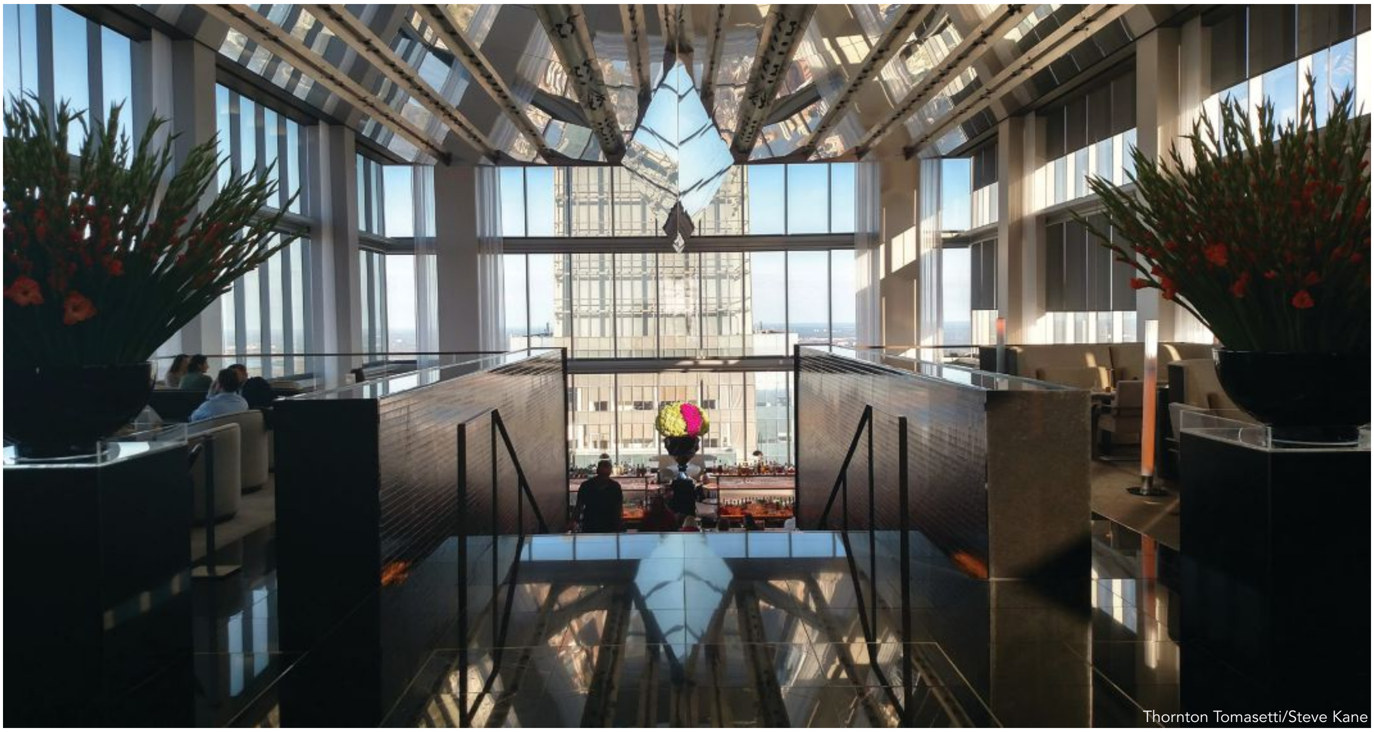
With a project the size of Comcast Technology Center, precision was critically important, both in detailing the steel and maintaining the schedule. Steel detailer Prodraft detailed more than 20,000 tons of steel using Trimble's Tekla Structures 3D modeling software—and dividing the structure into three separate models that were detailed simultaneously helped accelerate the process. The models created a multi-user environment and high-speed import/export of reference models for exchange with other trades, allowing Prodraft to identify potential issues in advance. For example, much coordination was required between Prodraft and the curtain wall and elevator suppliers to ensure that their connections would match the steel. Prodraft even got somewhat of a head start, as it had previously used Tekla's Open API to write a program to streamline the creation of custom reports. This significantly accelerated the preparation of data files on all submittals and was essential to the Comcast Technology Center project.



Courtesy of Trimble

left: A top-down 3D model view of the tower, with the Lantern and mechanical equipment framing at the right.

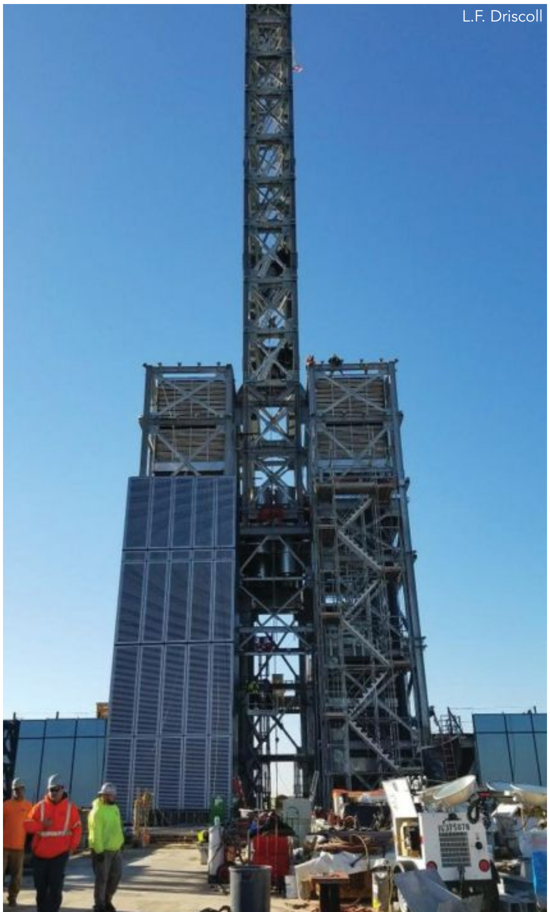
below: The lobby of the Four Seasons Hotel, which is located on the top 15 floors of the building (46-60).



Thornton Tomasetti/Steve Kane

below and right: The Lantern, a 126-ft-tall, braced frame tower clad in a metal curtain wall, tops the tower. It was made of nine separate levels of framing that were shop assembled with the grating installed so that the erector could quickly put each level in place and move on to the next one.

Thornton Tomasetti/Steve Kane



L.F. Driscoll

Hotel Lobby and the Lantern

Challenge: Support 200-plus vertical ft of feature space, MEP enclosures, and architectural features on top of the building.

Steel solution: Use steel moment frames, braced frames, and HSS wind girts.

The concrete core stops beneath the 59th floor, which is a three-story restaurant and hotel lobby for the Four Seasons Hotel. Steel box columns (up to 24 in. by 20 in. and using 3-in. plate) and moment frames provide the lateral system, along with AESS HSS wind girts similar to the office floors. Higher still is a two-story, steel braced frame structure on the west side (using W14 columns, HSS framing for the cladding support, and 2L cross bracing) housing the building's four cooling towers. Finally, the steel-framed cherry on top of the building is the Lantern, a 126-ft-tall, braced frame tower clad in a curtain wall and backlit to create an iconic presence in the city. The lantern was made of nine separate levels of framing that were shop assembled with grating installed so that the erector could quickly put each level in place and quickly move on to the next one.

From the bottom to the top of the Comcast Technology Center, methodical, expressive use of steel was able to tackle a list of structural challenges for what is now Philadelphia's tallest building. And thanks to exposing the framing in different areas and ways, its support of this high-tech center of innovation and creativity is apparent to any who wish to see it. ■

Owner
Liberty Property Trust, Philadelphia

General Contractor
L.F. Driscoll Company, Philadelphia

Design Architect
Foster + Partners, Ltd., London

Architect
Kendall/Heaton Associates, Inc., Houston

Structural Engineer
Thornton Tomasetti, Philadelphia

Steel Team

Fabricator
SteelFab, Inc. of AL, Norcross, Ga.

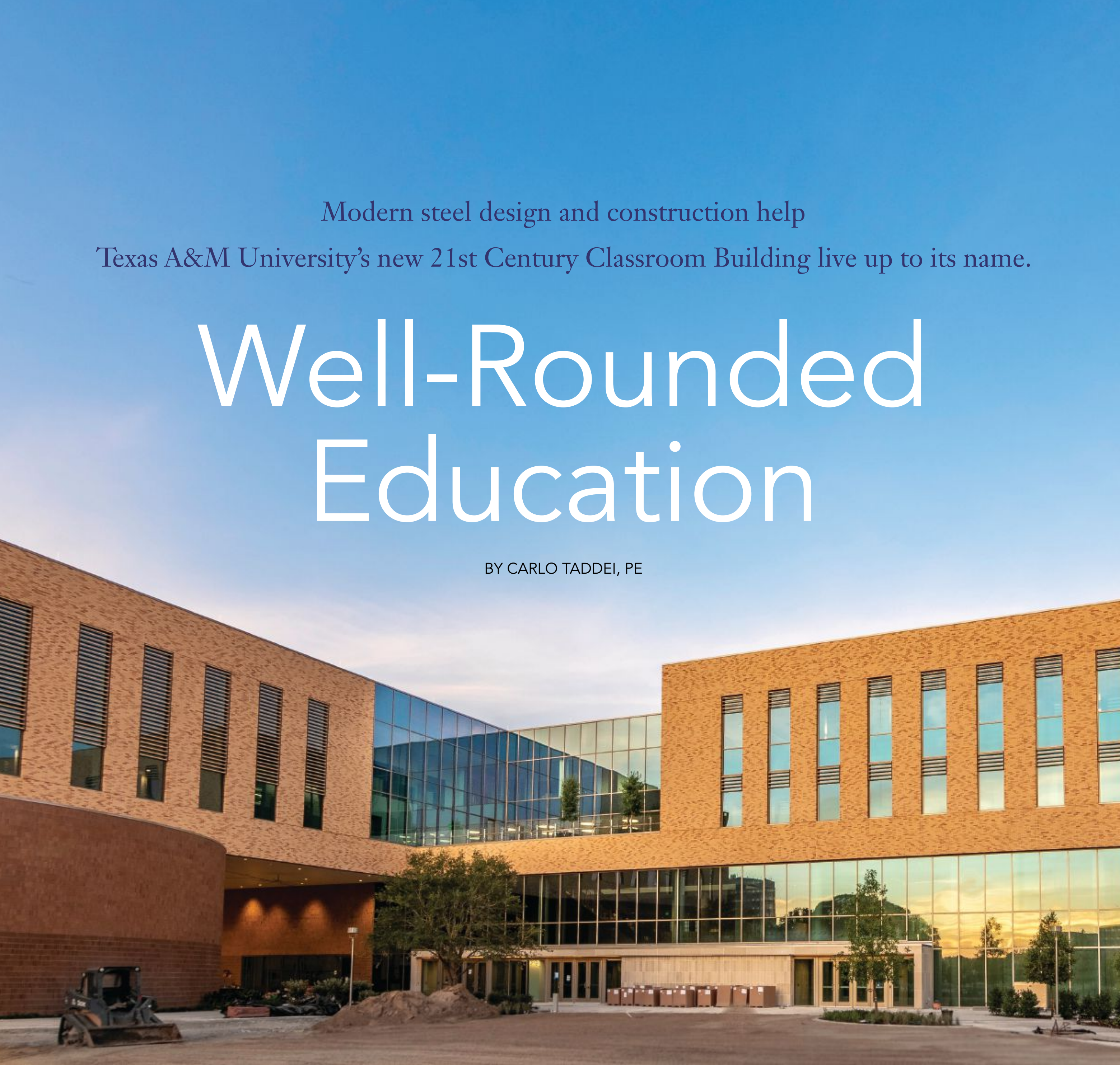
Erector
Cornell and Company, Inc., Westville, N.J.

Detailer
Prodraft, Inc., Chesapeake, Va.

Modern steel design and construction help Texas A&M University's new 21st Century Classroom Building live up to its name.

Well-Rounded Education

BY CARLO TADDEI, PE



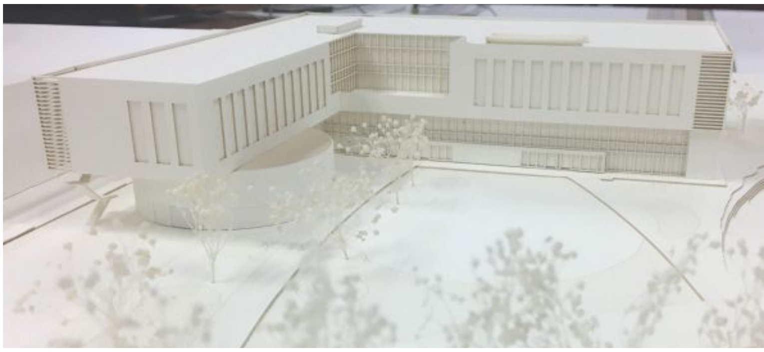
Carlo Taddei, PE, (ctaddei@jqeng.com) is a principal with JQ Engineering. **Mike Lavi, PE**, project manager, and **Norm Rinehart**, associate and BIM manager, both also with JQ Engineering, contributed to this article.

IN THE NEVER-ENDING COMPETITION amongst colleges to attract the best and brightest, Texas A&M University (TAMU) has built a world-class facility to bring top talent to its flagship campus in College Station, Texas.

The primary goal of this new addition to the TAMU campus, the 21st Century Classroom Building (21CCB), is to build a culture of excellence in teaching and learning by creating dynamic learning environments that foster student engagement. According to TAMU president, Michael K. Young, "Building a modern classroom facility advances our goal of increasing student success through transformational learning. This facility in both layout and technology will be built to optimize how students today learn and will meet the needs of our innovative faculty."

Scheduled to open this fall, the 120,000-sq.-ft building contains 2,200 general purpose seats across 10 classrooms at a total project cost of $85 million ($53 million in construction cost). Classrooms range in size from a 600-seat auditorium to 72-seat learning studios, and are complemented by informal study spaces. The top floor has offices for three instructional support groups: Center for Teaching Excellence, Office of Academic Innovations

above, left, and below: Two lecture halls in TAMU's new 21st Century Classroom Building can seat hundreds of students apiece while still feeling intimate and engaging.

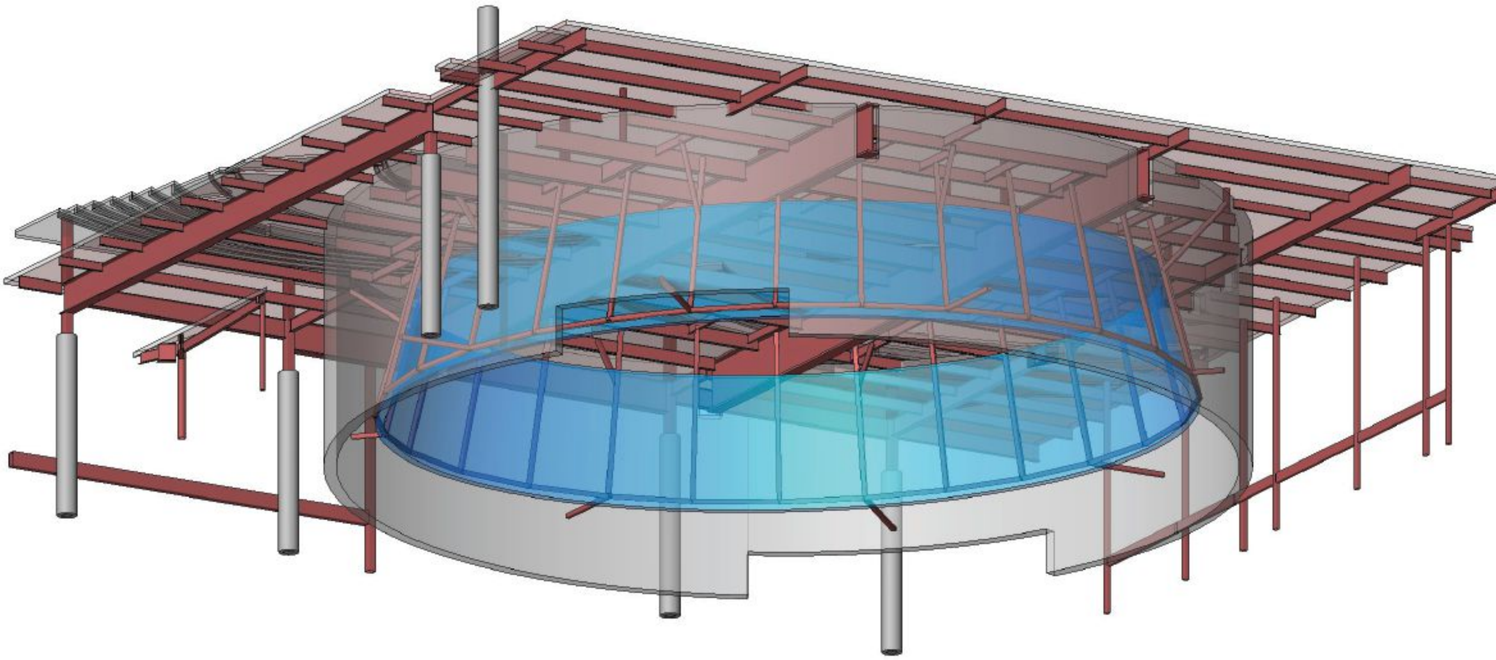


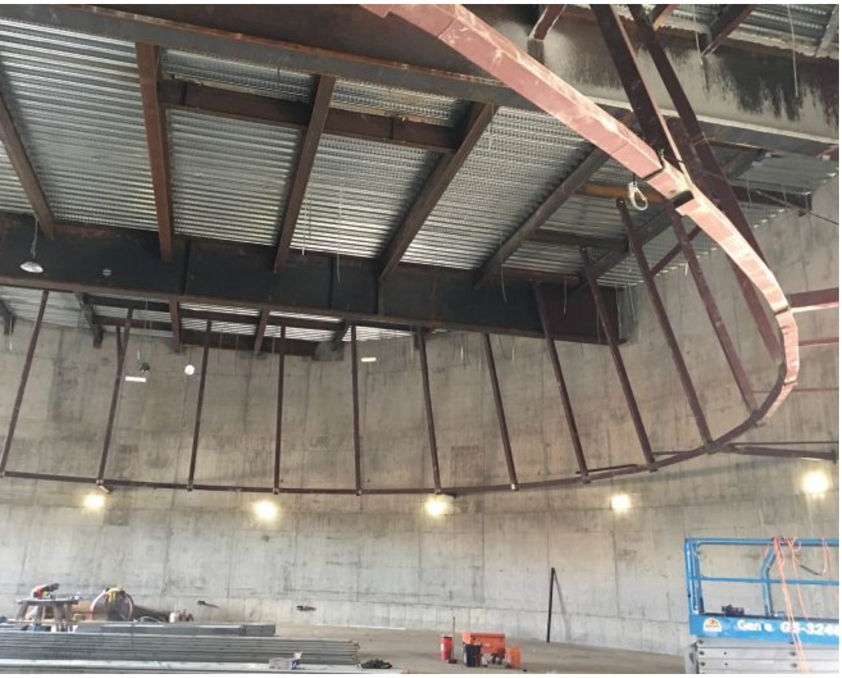
and Instructional Media Services. These departments are collocated in the building to enhance and better promote active learning pedagogies at TAMU. Except for the cast-in-place concrete walls of two large auditoriums, the entire building is steel-framed via approximately 1,085 tons of structural steel.

Theaters in the Round

The two "theater in the round" auditoriums—one seating 600 and the other 400—are located on the ground floor and place the instructor in the middle of the arena, surrounded by tiered seating, to give every student the same vantage point no matter where they sit; both auditoriums also include 360° video screens. The building is L-shaped, with one auditorium in each leg, and the walls of the two auditoriums act as bearing walls for the structure above and as shear walls for lateral load resistance, providing lateral resistance in all directions.

To bridge the 104-ft-diameter span of the 600-seat area, a variety of framing layouts were evaluated as the floor structure not only had to clear span the large arena, but also needed to support transfer columns for the third floor and roof above. The final framing configuration consisted of two steel plate girders located at the one-third points of the circular auditorium, which reduced the span of the girders and as well as the tributary loading. This also helped keep the secondary floor beams to a reasonable depth to allow for routing of the MEP services to the auditorium. The plate girders were 6 ft deep with a web thickness of 1¼ in. and use 3-in. by 18½-in. flange plates (ASTM A572-GR 50) with a length of 100 ft and an approximate weight of 34 tons apiece. The flanges were welded to the web plate with continuous 5⁄16-in. fillet welds on each side of the web, and the girders were cambered 1 in. and designed to act compositely with the concrete-filled steel deck,





above and left: Both round auditoriums implement a theater-in-the-round layout and 360° video screens (supported by hanging steel frames) allowing every student to have the same vantage point from any location in the room.

which required 255 ¾-in.-diameter by 5-in.-long headed stud anchors.

The construction was sequenced such that the concrete on the second-floor decking was placed and cured prior to erecting the third floor and roof to allow for the plate girders to be fully composite before the transfer loads were applied. This yielded a more economical design and reduced the size of the girders. The top of the concrete wall was formed with a 3-ft-wide block-out to receive the plate girders, which were set on 1½-in.-thick bearing plates anchored to the top of the concrete wall with 1-in.-diameter anchor rods. The block-outs were then filled with non-shrink grout after the framing was installed.

While the 400-seat auditorium had a smaller diameter (90 ft) it came with its own unique set of challenges. The auditorium was placed such that the north edge extended 25 ft beyond the face of the building, and the east edge was inset 15 ft from the face of the building above. As the auditorium was placed within an open breezeway, the architect wanted to give the appearance that the upper portion of the building was floating above the auditorium. Thus, the building columns had to be transferred at level 2 along the north and east faces, and the floor structure had to cantilever up to 20 ft past the face of the auditorium to transfer the roof support columns along the east face.

The plate girder along the north face of the building is 6 ft, 2-in. deep plate with a web thickness of 1 in. and 3-in. by 1-ft, 8-in. flange plates (ASTM A572-GR 50) with a cantilever of 20 ft and back span of 83 ft. This plate girder not only supports the transfer columns for the roof but also

The building incorporates nearly 1,100 tons of structural steel.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1	Angle Leg Out	INSIDE DIA.	10" x 10" x 1" Angle
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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 142½# Tee
12	Tee Stem Out	INSIDE DIA.	22" x 142½# Tee
13	Tee Stem Up	MEAN DIA.	22" x 142½# 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 ½" Tube
18	Rectangular Tube The Easy Way (Y-Y Axis)	INSIDE DIA.	20" x 12" x ⅝" Tube
19	Rectangular Tube The Hard Way (X-X Axis)	INSIDE DIA.	20" x 12" x ⅝" Tube
20	Square Tube Diagonally	MEAN DIA.	12" x ⅝" Square Tube
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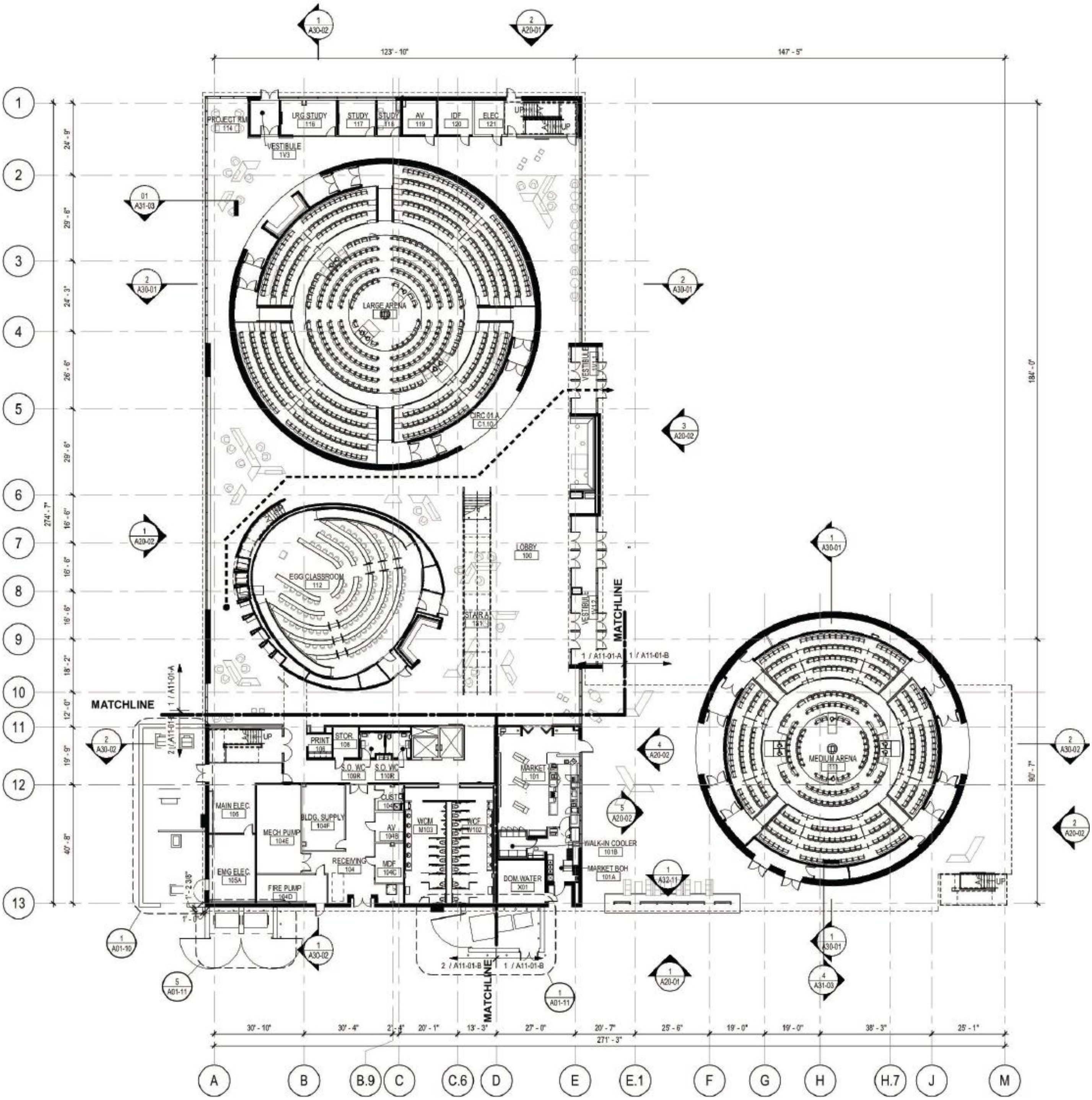
The "PG3" plate girder, weighing approximately 20 tons, being lifted into place. The project's heaviest plate girder weighs 34 tons.

the low roof structure over the portion of the arena that projects beyond the building face—which includes a landscaped roof—and 32 ft of brick veneer. The center girder was located 12 ft, 6 in. south of the center of the auditorium and consists of a 5-ft, 4-in.-deep plate girder with a web thickness of 1 in. and 2-in. by 1-ft flange plates (ASTM A572-GR 50) with a cantilever of 16 ft and back span of 90 ft. The southern girder was located close to the edge of the arena, which shortened the loading and clear span of 64 ft and a cantilever of 27 ft, thus permitting the use of a W44×290 in lieu of a plate girder.

Plate girders were also used for the level 2 floor structure south of the 600-seat auditorium, where spans up to 84 ft were required to bridge over the "egg" classroom at level 1 (called this for its egg-shaped design). These long-span girders were also required to support transfer columns for level 3 and the roof. As this area was in the direct path from the mechanical room at the south end of the building and the 600-seat auditorium, and a high ceiling was desired for the lobby below, the deep plate girders created conflicts with mechanical ducts and pipe runs. As such, web penetrations—as many as five per girder—were made in the members to allow for the MEP runs to be uninterrupted. These web openings were analyzed using the procedures presented in Omer W. Blodgett's book *Design of Welded Structures* and AISC's Design Guide 2: *Design of Composite Beams with Large Web Openings* (**aisc.org/dg**).

right: Web penetrations—as many as five per girder—were made to allow for MEP runs to be uninterrupted.

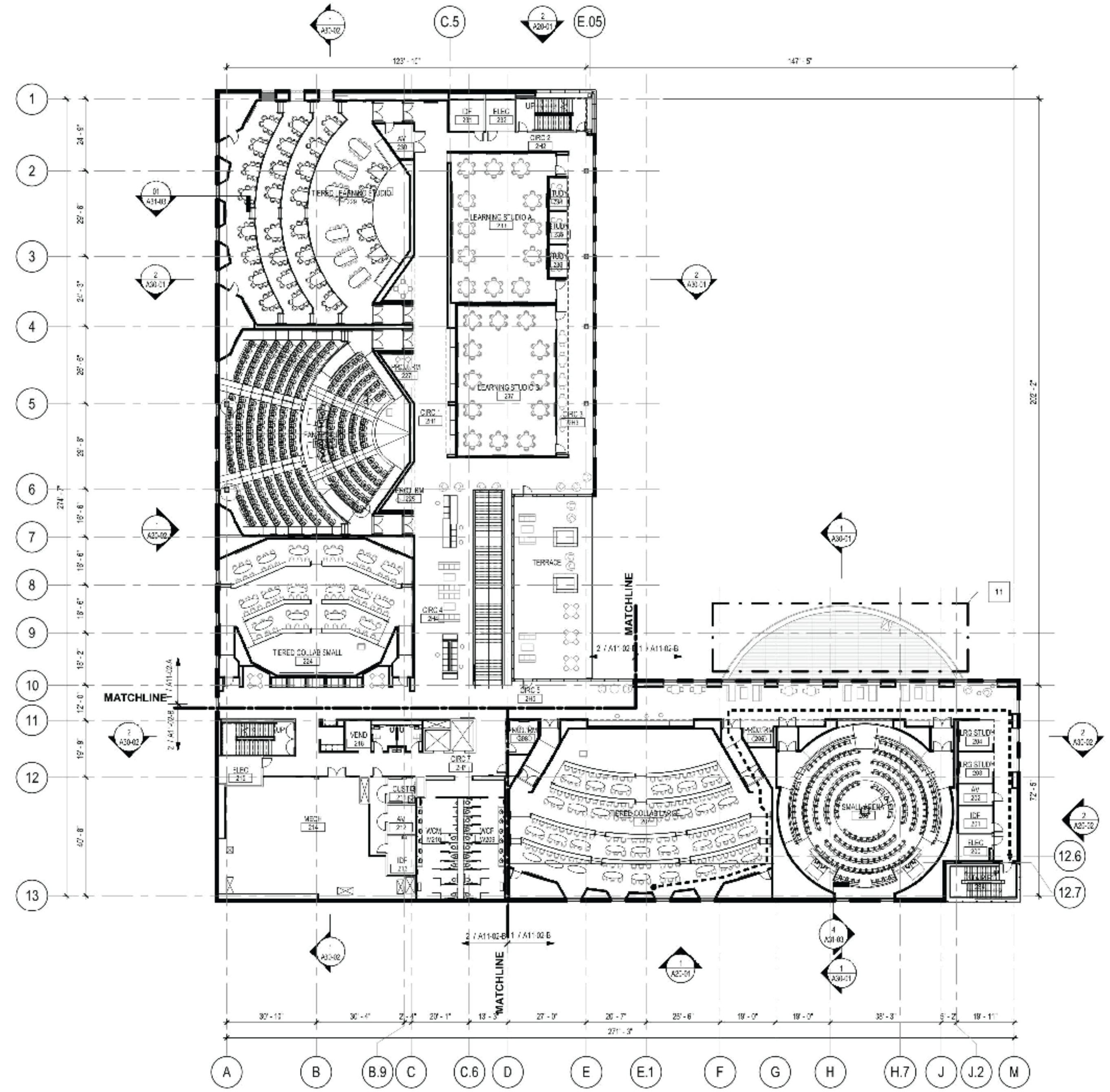
below: The 120,000-sq.-ft building contains 2,200 general purpose classroom seats across 10 classrooms.



Connecting the plate girders to the steel columns presented some challenges, as the maximum service load was 585 kips, which could not be achieved with a typical beam-to-column shear connection due to the bending introduced into the column from the connection eccentricity. Thus, the engineering team at JQ designed the HSS14×14×⅝ columns to be spliced to create a bearing connection for the plate girders. In total, six plate girders of four different types were used on the project, each one transported fully assembled from fabricator MSD Building's facility in Pasadena, roughly 100 miles from the project site. Welding the plate girder splices was a continuous operation to maintain a constant temperature, which required around-the-clock heating, welding, and two forms of non-destructive testing (NDT) for the welds: magnetic particle testing and ultrasonic testing.

Exterior and Roof

The tall floor height between levels 1 and 2 allowed mid-height location of an 11,500-sq.-ft mezzanine framed with steel beams and girders supporting a composite steel deck. While the mezzanine was largely dedicated to mechanical and building support functions, it also extended over the egg classroom on the first floor to provide a prominent study space. The tall floor height also posed challenges for bracing the façade as several areas contained long strip windows up to 80 ft in length, with 16 ft of masonry veneer overhead. This required large wind girts at the window heads to brace the wall out-of-plane and to serve as lintels for the masonry veneer. Wind girts up to HSS24×12×⅝ were required to span between the building columns, which were up to 32 ft, 8 in. apart. As the girts were required to be within the wall system and



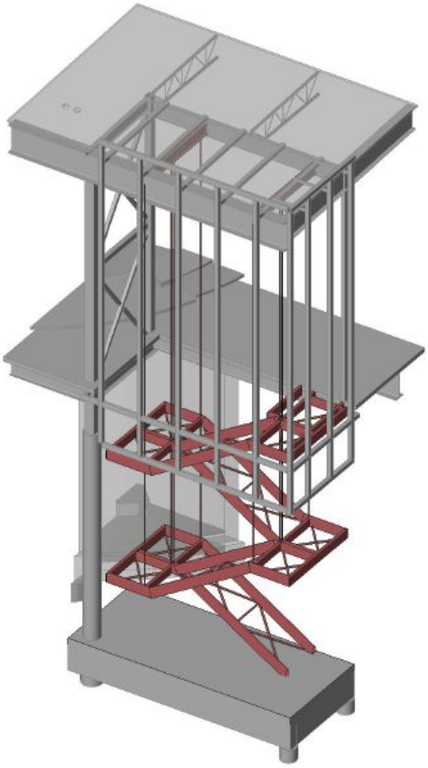
opposite page: The first floor is highlighted by the two round auditoriums as well as the "egg" classroom.

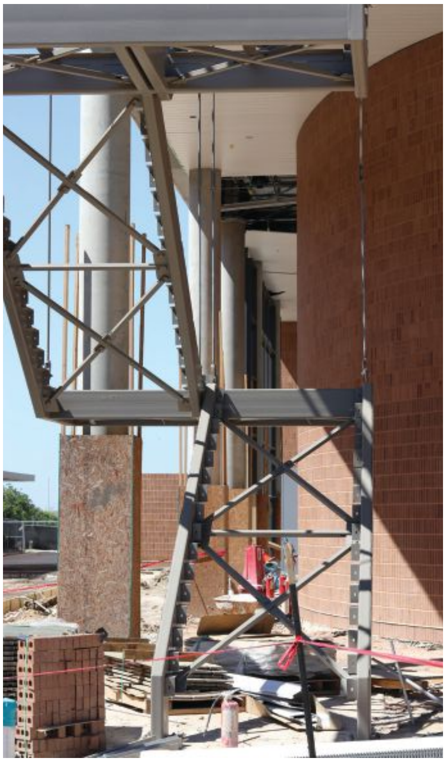
above: The second floor of the L-shaped building includes several more traditionally shaped classroom spaces.

the center lines of the columns were inset up to 3 ft from the building face, steel haunches off the face of the columns were required to support the girts.

Roof framing above the large classrooms at level 2 consisted of 40-in.-deep, double-pitched top chord LH-series joists spanning up to 63 ft, and deep-rib steel roof deck (3 in.) was used to maximize the spacing of the long-span structure. The building façade at level 2 projected approximately 1 ft beyond the façade at level 1 and extended 7 ft below level 2 (the top of the parapet is 32 ft, 9 in. above level 2). As the façade consisted of brick masonry and had a series of closely spaced tall narrow windows that begin at level 2 and stop approximately 5 ft below the 25-ft-tall roof, the design team decided to relieve the brick at the window head around the entire building perimeter. To achieve this brick relief, top chord extensions for the steel joists and HSS6×4×¼ outriggers at 5 ft on center were used to support the channel frames and brick relief angles. The roof beams were designed to limit deflections to $L/600$ ($^3/_8$ in. maximum) which required stiffer roof structure around the perimeter. Aside from the large number of windows and expanses of curtain wall, four 6-ft-wide, 22-ft, 6-in.-long roof monitors were introduced over the third-floor structure in the north wing to bring in additional daylighting.

Steel columns consisted of a mix of wide-flange and hollow structural sections (HSS), and 50-ksi steel was used for the HSS (ASTM A500, Grade C) to provide higher axial strength for the tall building height and transfer structure loading, with wide-flange columns (65 ksi) used only in the back-of-house mechanical room spaces. In these areas, there was a desire to have the columns bear





above: A monumental stair stretches 65 ft horizontally and 33 ft vertically through the interior lobby.

above: The exterior "spring" stair at the southeast corner of the building contains three intermediate landings that give the appearance of a coiled spring.

below: The building's 21st century learning goals are defined by the "four Cs": critical thinking, communication, collaboration, and creativity.

on top of the foundation slab instead of recessing these base plates, and using wide-flange columns allowed for the anchor rods to be located within the webs of the columns and not create a tripping hazard. Lateral bracing around the back-of-house area and throughout the building from the podium at level 2 up to the roof consisted of concentrically braced frames in X-brace and Chevron configurations.

Exposed Steel Stairs

Two other focal points of the building were the interior monumental stair that stretches 65 ft horizontally and 33 ft vertically through the interior lobby, and the exterior stair. The monumental stair stringers consist of 20-in.-deep architecturally exposed structural steel (AESS), specified as AESS 1 (Basic Elements), and HSS members supported at two intermediate points by HSS8×8 beams (for more on the various AESS categories, see "Maximum Exposure" in the November 2017 issue, available at **www.modernsteel.com**). In order to achieve the one-hour fire rating for the steel columns, architect Perkins+Will wanted them to be encased in concrete. This created a

construction sequence issue with the connections of the HSS8×8 beams to the stair support columns. The intent at this joint was for the HSS beam to be directly connected to the column, but the contractor wanted to pour the concrete before installing the stair. This required a revision to the connection shown in the construction documents to include a HSS stub with an end plate that could be installed before the concrete was cast. After the concrete pour, the contractor was able to connect the HSS beam to the end plate.

The exterior "spring" stair was located at the southeast corner of the building at the cantilevered second floor and contains three intermediate landings that give the appearance of a coiled spring. The stair consists of 14-in.-deep HSS beams and is suspended from the roof structure above with eight 1-in.-diameter high-strength rods. Aside from the hangers, the stair is connected to the structure at the second floor and the foundation. Since there are no columns at this corner, the roof girder along the south edge of the building cantilevers 25 ft to catch the intersecting north-south beam and to support the stair hangers, and a W44×335 girder was required to provide stiffness for the stair and terra cotta louver system. As the stair is exposed (also adhering to AESS 1 requirements) and subject to wind loading and racking, horizontal bracing was provided between stringers to provide lateral stability to the stair.

The use of structural steel helped bring the project vision to life by providing a lighter solution to achieve the long spans, column-free auditoriums and lobby space, lower foundation costs, and faster construction time—culminating in a 21st century solution for a 21st century building. ■

Owner
Texas A&M University System

Construction Manager
Vaughn Construction, Houston

Architects
Perkins+Will, Dallas (Architect of Record)
Bora Architects, Portland, Ore.

Structural Engineer
JQ Engineering, Dallas

Steel Team

Fabricator
MSD Building Corp., Pasadena, Texas (AISC Certified Fabricator)

Bender-Roller
Chicago Metal Rolled Products, Chicago (AISC Associate)

Considering AESS on your next exposed steel project?

Then consider these tips to help ensure an attractive, successful outcome.

AESS Success

BY RYAN CURTIS, PE

Courtesy of AISC

EARLY IN MY CAREER, a student intern in my office asked a talented architectural designer why a specific building had a certain shape to its exterior.

The designer paused, then responded with a question that still resounds with me today, more than a decade later. He simply asked the intern, "Why do we have art?"

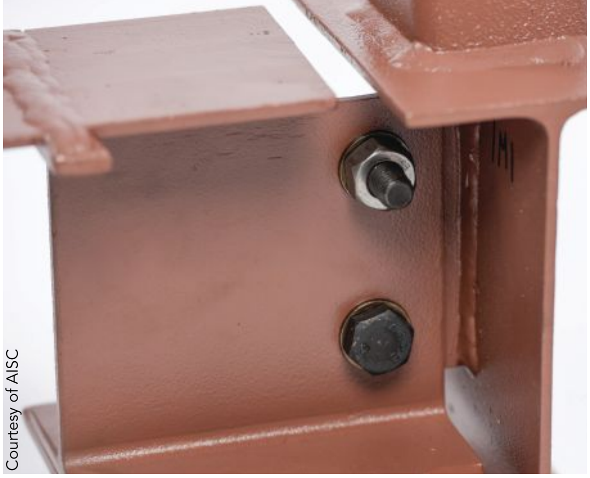
When designing steel buildings, engineers and architects are often given the ability to expose and even highlight steel members that serve not only as building superstructure elements, but also as architectural elements—as art. And in many cases, this exposed steel must meet enhanced requirements, specifically those of AISC's architecturally exposed structural steel (AESS) system.

The most recent revamp of how AESS is addressed came about in the 2016 AISC *Code of Standard Practice* (ANSI/AISC 303, **aisc.org/specifications**). This document implements a defined approach to specifying AESS in the project's Contract Documents by using five categories: AESS 1, 2, 3, 4, and C that differentiate levels of fabrication and erection, with each higher level specifying more refined surface requirements and increased attention to detail from the fabricator, erector, and design team. Simply put, AESS 1 is Basic Elements, AESS 2 is Feature Elements not in Close View, AESS 3 is Feature Elements in Close View, AESS 4 is Showcase Elements, and AESS C is Custom Elements. (For detailed descriptions of each category, see "Maximum Exposure" in the November 2017 issue, available at **www.modernsteel.com**.) Here, we'll go through the design process for steel specified as AESS, providing advice and best practices.

Owner and Architecture "Huddle"

In a structural steel-framed building, or perhaps a building with steel components included, the first step in the AESS process is communicating with the design team to describe the different levels of AESS. An explanation of member visibility and viewing distances is a significant discussion point as they likely highlight certain areas of the project's exposed steel where you can truly define the visual expectation and user experience of the space.

Keep in mind that many projects all over the world have exposed structural steel—but not all exposed steel is AESS. If a project's designer wants a more industrial look with exposed steel (mill marks, blemishes, sharp edges, backing bars, etc.), or perhaps the owner is not at all interested in enhancing the steel "look," AESS is likely not your best option. AESS is a larger commitment in terms of time and money, and in some exposed steel projects simple steel surface preparations and priming/painting can make exposed steel pleasing to the eye—or pleasing enough. But if the project is a higher-end commercial building with a marquee lobby, a museum, a healthcare facility, or another structure type with high aesthetic standards—perhaps involving exterior canopies, interior exposed framing and connections, monumental stairs, or prominent art pieces composed of structural steel—this is where AESS shines and elevates the look of a project.



Courtesy of AISC

opposite page: From left to right, these models show standard structural steel (SSS), AESS 1, AESS 2, AESS 3, and AESS 4.

above/below: Can you spot the differences (besides coating color) between the above model (SSS) and one below (AESS 1)?

right: Interior exposed steel adhering to AESS requirements.

Courtesy of AISC

All images, unless otherwise indicated, are courtesy of LEO A DALY.

Specifying the Scope

Ideally, by the time the project has passed beyond schematic design and is creeping into the design development phase, the areas of AESS should be very clearly and concisely annotated on the design drawings. Very often, contractors may be bidding an early steel package prior to the construction documents to get a good feel for the overall project costs, which include steel fabrication and erection—both areas that are affected by AESS. With steel components labeled correctly, the contractor's steel bidders should be able to understand the scope of AESS on the project and give appropriate costs to them even at an earlier time in the design phase. As an author of contact documents, the designer must work to ensure that the structural general notes, framing plans, and project specifications all work in unison. But when AESS is factored in, steel framing on the general structural notes shall point the contractor to the framing plans and/or details where the AESS items are located. Once at the framing plan stage, these annotations—specifically called out by clouds, bubbles, or arrows—shall clear up any misinterpretation of what is and what is not included in AESS.

If your project has multiple levels of AESS, make sure to specify, in your notes on the drawings, which *areas* get which *category* of AESS. Lastly, the current AISC *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/AISC 303, **aisc.org/specifications**) issues a workable specification for AESS: Division 05 12 13. This specification is divided up into General, Products, and Execution Sections. In Section 1.0 (General), the designer can specify the AESS levels on the project to the specific steel components. This language should match directly with the nomenclature and area as defined on the project plans. Specifying sheet names to this section is helpful, but make sure that if you have different levels of AESS on the same sheet, they are all identified appropriately.

Ryan Curtis (**rbcurtis@leoadaly.com**) is a senior structural engineer and project manager for LEO A DALY in Omaha.

An exterior canopy structure framed with steel adhering to AESS 3 (Feature Elements in Close View) requirements.

above/below: A site visit to a fabrication shop to inspect steel with AESS requirements. The weld spatter below will need to be addressed.

Fabricator and Erector Selection

The benefits of having as AISC Certified fabricator and erector on a steel framed project are obvious to both designers and contractors alike. After all, the goal of AISC Certification is to build quality steel structures from the start by focusing on error *prevention* rather than error *correction*. And when the enhanced criteria of AESS are injected into a project, the qualifications of a Certified company are increasingly justified. Division 1.6: Quality Assurance of the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, **aisc.org/specifications**) states the following:

"Engage an AISC Certified Fabricator, experienced in fabricating AESS like that indicated for this Project with a record of successful in-service performance, as well as enough production capacity to fabricate AESS without delaying the Work. Engage an AISC Certified Erector, experienced in erecting AESS work similar in material, design, and extent to that indicted for this Project and with a record of successful in-service performance."

It is essential during the selection of the steel partners that the awarded fabricator and erector can perform work at this level. If not, the risk of not meeting AESS requirements increases. Tighter tolerances and enhanced care in maintaining surfaces clear of blemishes and weld spatter requires added diligence and care from the project installation team. A general contractor who is not familiar with AESS requirements shall also be educated on the systems and methods of installation. After all, it is the contractor that typically manages all construction activity, so their project manager, superintendent, and field engineers all need to buy in on the process and emphasize the significance of AESS to its subcontractors.

From my experience, tolerances require significant additional consideration and care when using AESS. For example, AESS 2 requires one-half fabrication tolerances and AESS 3 requires joint gap tolerances to be minimized. Keep in mind, joint gaps for beams or girders that connect to columns require column placement (and subsequently anchor rod placement) to be carefully located and constructed to ensure that the joint gaps in the fabricated steel framing can be executed.

It's All About the Coatings

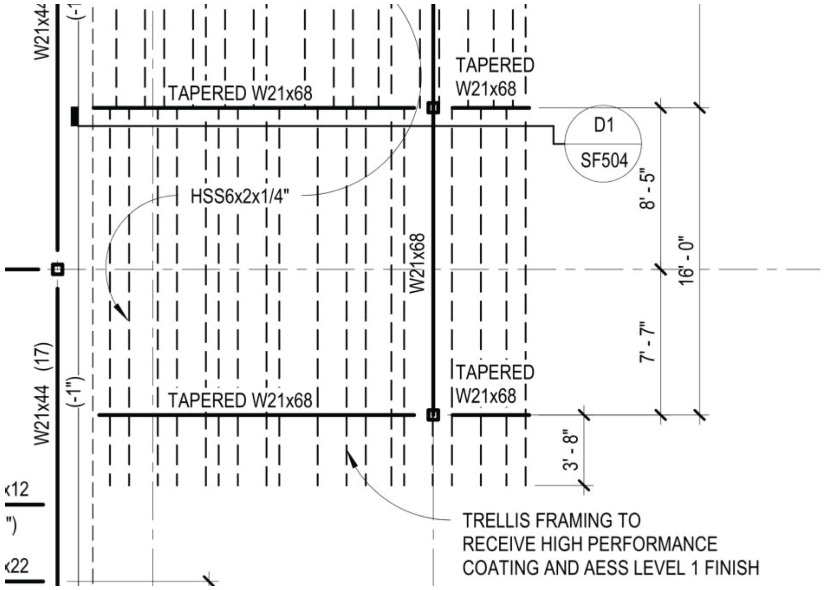
Whether or not the exposed steel on your projects is AESS, it generally falls under categories: interior and exterior. Interior steel shall meet the requirements of Division 09: Interior Painting with regards to any surface preparation. Primer colors shall also be compatible with final field coatings for color. For example, if the exposed steel is intended to be painted a pure white, the primer should also be a light color so as to not negatively impact the color of the finished surface. Always remember that when choosing a final surface finish, a matte finish is more forgiving than a glossy finish. The surface preparation requirement of AESS 1 invokes the requirements SSPC-SP 6, which essentially means a commercial blast cleaning. This cleaning removes all visible oil, grease, dust, dirt, mill scale, rust, and other foreign matter on the surface and lends itself well to both glossy and matte finishes. And AESS 4, for example, is a very compatible level to a glossy finish as it requires surfaces free of imperfections and sanding down textured surfaces.

Exterior steel that is exposed to environment and weather conditions shall also be uniquely protected with methods or applications of high-performance coatings (typically specified in Division 09) such as galvanizing and the use of zinc-rich primers. Any areas of the steel members that are unprimed due to field welding must be primed after the field welding is completed. This is essential in the high-performance coating scenario, as the primer material is often the most protective layer of a zinc-rich coating of 2–4 mils. As with any exterior steel member, hollow structural section (HSS) ends and other openings should be covered or capped to prevent moisture intrusion into the member, which can lead to damage from freeze-thaw cycles and corrosion.

Lastly, don't forget about AISC's sophisticated fabricator paint program, which includes various endorsements P1, P2, and P3 (see the Sophisticated Paint Endorsement link at **aisc.org/certification/certification-categories** for information) for painting application environments. These endorsements allow fabricators the ability to demonstrate that the shop is proficient in both the surface preparation and painting operations that are necessary to meet the AESS requirements for your project. Paint runs or drips from the primer application will show through the subsequent coats applied in the field. Specifying the painting qualifications and reviewing primers during the mock-up will keep such issues from occurring.

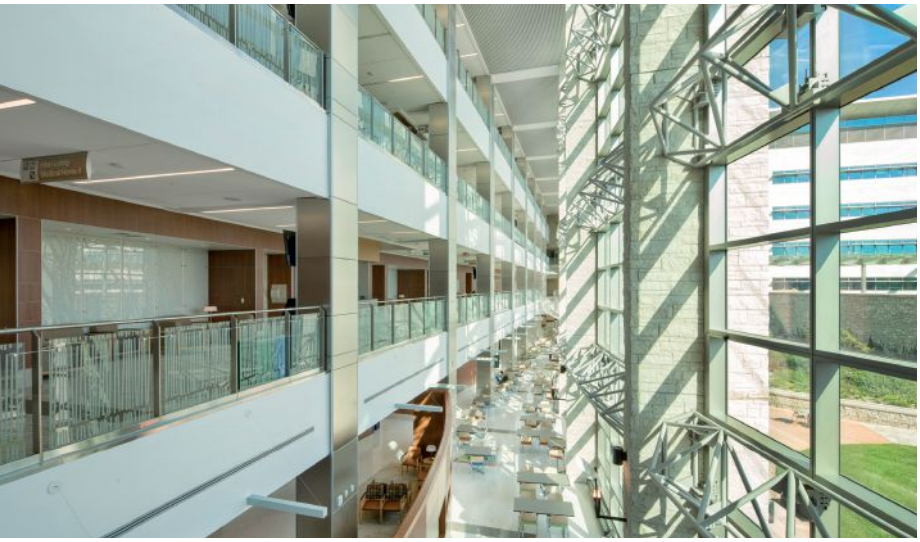
above/below: AESS using high-performance coatings in exterior applications.

above: Interior exposed steel with no AESS requirements.



above: AESS requirements should be noted on steel drawings.

below: AESS in a curtain wall application.



Construction Administration

Construction administration begins the day your project's contract documents are issued. From the preinstallation conference to the building's ribbon-cutting, the designer has significant roles to play through this process.

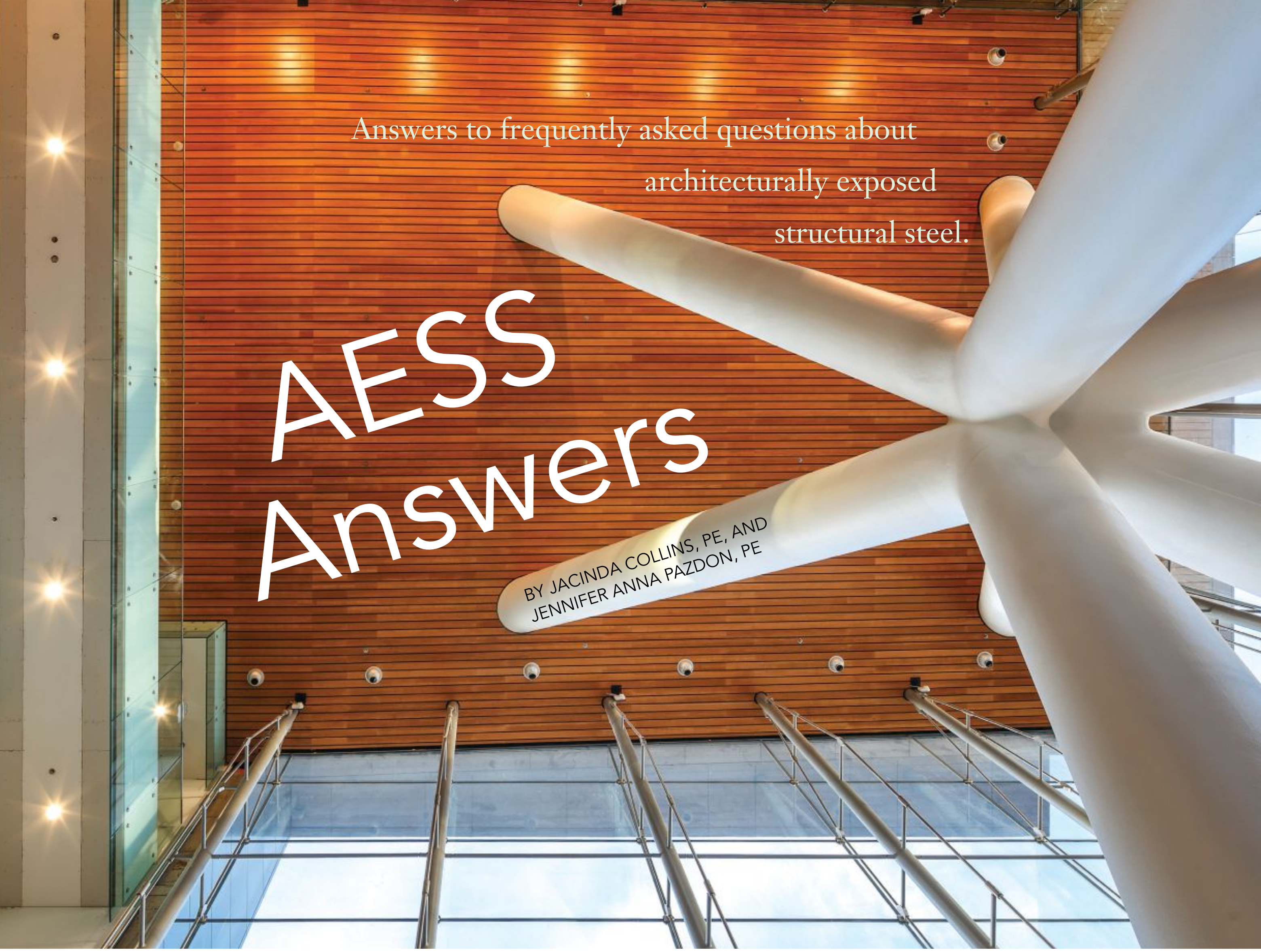
Shop drawings. At this stage, your fabricator has correctly identified the areas of AESS that you have specified on the project. Pay close attention to the level of AESS and verify that the shop drawings specify the precise level the design team is targeting. For all AESS members, the surface preparation and priming (when applicable) shall also be notated on the fabricator's drawings. If backing bars or any temporary erection aides are indicated, make sure to comment that they are to be removed as required by the AESS specification in the AISC *Code*. These removals can add time to the steel erector's job, so be sure the construction team is aware of what is expected from them as early as possible so they can make the proper preparations.

Mock-ups. AESS Levels 3, 4, and C all require mock-ups unless indicated otherwise. Mock-ups can be full-scale or as simple as a commonly used connection. The idea is to make sure all team members understand the expected level of the finished product. At a mock-up, pay close attention to all AESS requirements, but especially to the more obvious craftsmanship such as painting runs and uniform coatings. I suggest that not only should the architect and structural engineer visit the mock-ups at the fabricator's shop, but so should the general contractor and steel erector so that all parties can discuss best practices to ensure the field construction matches the care and quality of the mock-up. If a mock-up is desired for AESS 2, don't be overly critical with your review in close view at the shop, as that level is defined for items *not* in close view (AESS 2 is for items more than 20 ft away). In other words, don't worry too much how these elements look when you're close enough to touch them in your shop examination; you won't be that close in the field. (Think of it as a seeing-the-forest-for-the-trees situation.) However, if your item is AESS 3 or 4, the mock-up review shall be made within arm's length, as the members are intended to be near users of the space.

Site visits. During the construction phase, is important to attend the scheduled activity meetings with the steel erector and general contractor. At this point in the project, the entire construction team should be aware of the AESS scope on the project, and these meetings will allow the specifier the ability to answer any questions. Visiting the site after erection has occurred is also helpful in terms of making any course corrections, if needed, prior to coatings being applied to the steel members. Also, the post-erection site visit gives a truer visual feel for the AESS members in the context of their surroundings, as they are in their permanent spot and at an appropriate distance from viewers' eyes. While on site, it is also appropriate to ensure the contractor is handling and protecting the AESS material per the requirements of the specifications. This includes using nylon slings or wire rope with softeners for handling/working near the steel on-site (and during transit as well). Erected AESS members in the path of workers or equipment can also be protected with a wrapping material (e.g., foam rolls, fire blankets, bubble wrap, rigid insulation, etc.) to avoid any potential damage to the members or its paint job.

AESS provides boundless ways for a structure to demonstrate strength and beauty. When done right, with team buy-in and ongoing communication, the results will add tremendous value to the final product that an owner, contractor, architecture, engineer, and steel team can be proud of. As I learned from that question posed by a design intern over a decade ago, artistic value, aesthetics, style, pizzazz—whatever you want to call it—is a major driver for the created environment that we, as designers present, to the world. AESS takes it a step further as it is a blend of art and physics. It can take simple materials and beautify them. And as Vincent Van Gogh once said, "The great artist is the simplifier." ■

An exterior trellis adhering to AESS 1 (Basic Elements) requirements.



Jacinda Collins (collins@aisc.org) is AISC's New York senior structural steel specialist. **Jennifer Anna Pazdon** (j.pazdon@castconnex.com) is vice president of Cast Connex.

FOUR YEARS AGO, AISC fined-tuned the definition of AESS, allowing designers to more clearly specify their expectations for the execution of steel fabrication.

Defined in the 2016 AISC *Code of Standard Practice for Steel Bridges and Buildings* (ANSI/AISC 303, **aisc.org/specifications**), the new architecturally exposed structural steel (AESS) category system offers varying levels of refinement. And while this new approach has clarified many of the requirements for fabrication craftsmanship, questions remain about how to best communicate expectations of the design team. To help address some of those questions and help design teams understand how the category system can be leveraged to facilitate communication and ensure a satisfactory outcome for all, AISC and Cast Connex have compiled some guidelines and advice for the most frequently discussed topics.

The New Category System and Tools

If you're considering applying the AESS category system for exposed structural steel in your project, we suggest that you and your design team review the *Code*, which provides an understanding of the standard trade practices when contracting for structural steel. During this review, you may find that the standard treatment of structural steel meets the desired aesthetics for your project's exposed steel, and thus the use of AESS is not needed. (Remember, not all exposed steel is or needs to be classified as AESS.)

If you do go the AESS route, Section 10: Architecturally Exposed Structural Steel of the *Code* outlines the requirements of the five categories: AESS 1, 2, 3, 4, and C (Custom). Project teams are encouraged to use the additional publications and tools available at **aisc.org/aess**. Here, you can find the 2016 *Code*, an editable sample AESS specification, an editable budget estimating tool, sample shop drawings, helpful images, webinars, and case studies.

left: Massive AESS elements in Toronto's Queen Richmond Centre West, protected with an intumescent coating.

below: Angular AESS defines the look of Central Arizona College's Maricopa Campus in Arizona, a 2015 AISC IDEAS[2] Award winner (for more on the project, see the May 2015 issue at **www.modernsteel.com**).

Courtesy of Cast Connex

Bill Timmerman

A pedestrian bridge in downtown Austin is an example of a high-profile exposed steel assembly that wasn't specified as AESS. See "Switching Convention" in the September 2019 issue for more on the project.

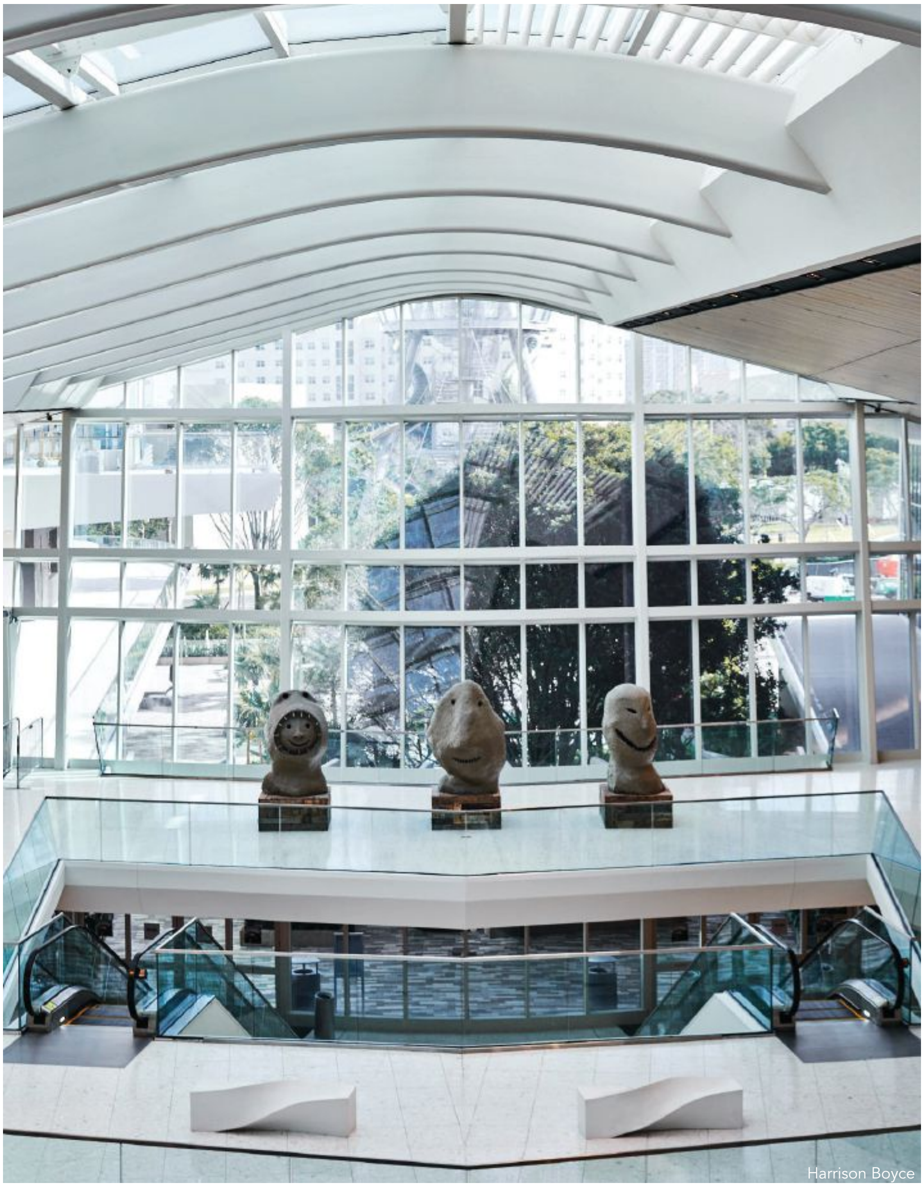
Walter P Moore

Using the New Category System with Older AISC Specifications

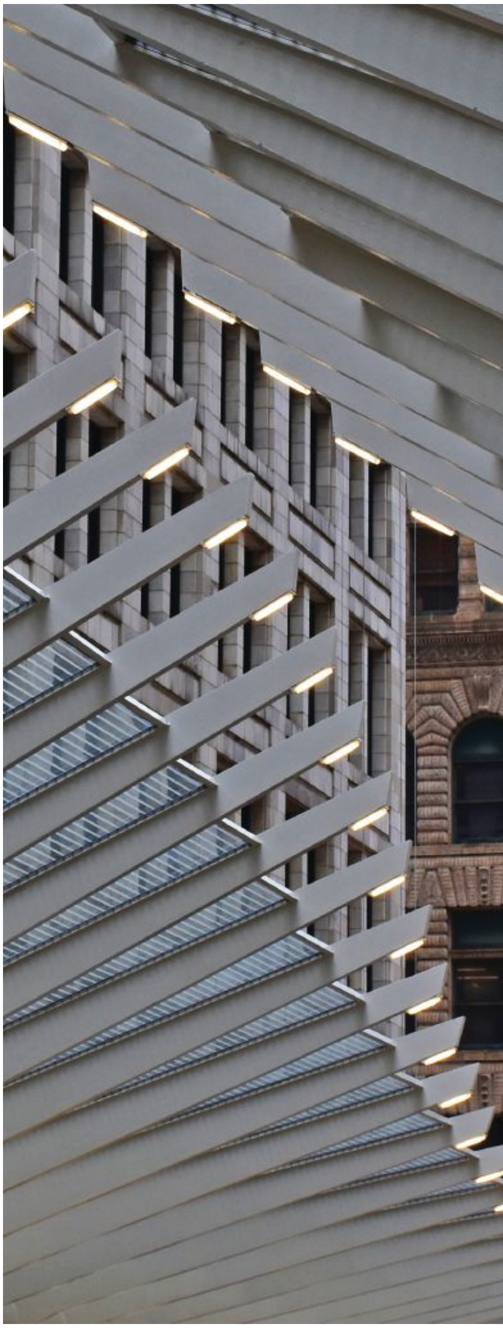
The AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, **aisc.org/specifications**) establishes the design requirements for buildings, and the *Code* establishes complementary commercial and technical requirements. The *Code* can be adopted in the contract documents for structural steel fabrication and erection even if the steel framing system is designed to building code conformance using an older version of the *Specification* (i.e., before the 2016 version). The contract documents should clearly establish the 2016 *Code* as the standard of care, and all contract and approval document requirements of Section 10 shall be completed.

below: An expansion to Miami's Aventura Mall features a 51-ft by 80-ft window wall supported by AESS (for more on the project, see "Exposed Expansion" in the June 2019 issue).

right: Structural steel, exposed not only architecturally but also to the elements, lets Chicago's Washington/Wabash "L" station take on its own unique look and feel.



Harrison Boyce



Considerations for Weathering Steel

- Understand the variance of aging of different weathering steel grades and shapes
- Discuss matching of corrosion resistance and reddish appearance of the welding material with the base metal for welded connections
- Clarify the direction of the weathering steel high-strength bolts and seams of hollow structural sections (HSS)
- Review areas of potential drainage patterns on the patina for weathering steel
- Assess the impact of patina runoff on surrounding elements and surfaces with consideration for viewing distance

Weathering Steel

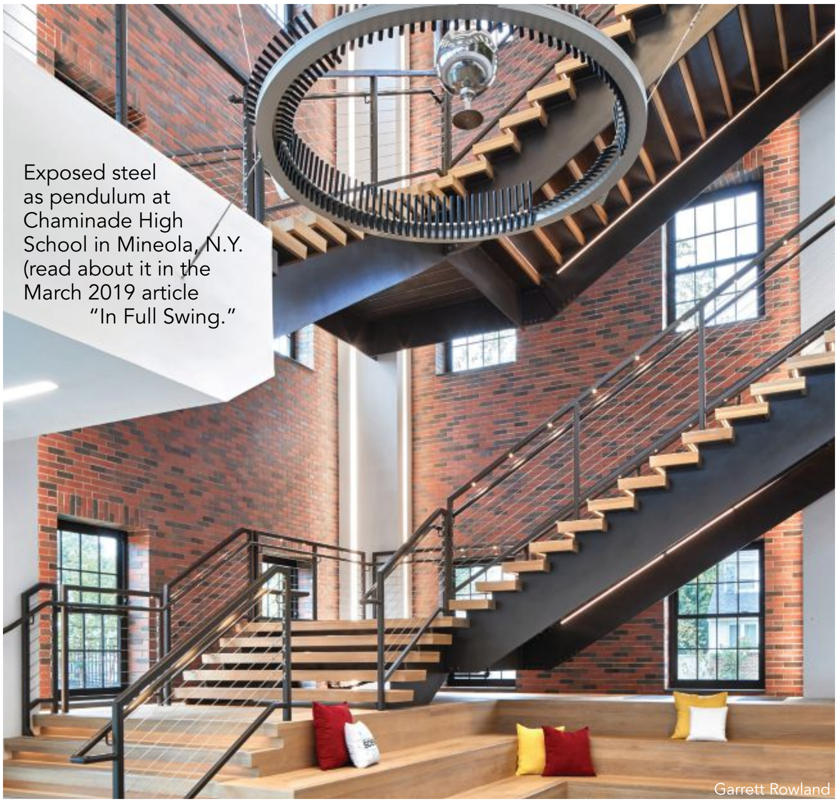
The rustic look of the protective patina on weathering steel makes this steel type an excellent low-maintenance option for exterior AESS projects. Standard fabrication processes or AESS Categories 1 through 4 can capture this more rustic appearance as the AESS is allowed to have erection marks, painted marks, or other marks on surfaces in the completed structure.

AESS C is suggested for weathering steel projects that have special cleaning specifications or are seeking a desired age and aesthetic for the patina. Where the requirements of AESS Categories 1 through 4 do not include means and methods for artificial wet/dry cycles or homogenous surface preparation for weathering steel elements, AESS C defines clear requirements for the fabricator and erector regarding cleaning, surface preparation, advanced aging, and other items. The required mock-up, when using AESS C, also ensures that design, fabrication, and erection teams work together to achieve the final desired aesthetic, thus ensuring that the level of care is achieved and the anticipated cost for the additional craftsmanship is clear. (For guidance on proper channeling of runoff when using weathering steel, see the presentation "Building with Weathering Steel" at **aisc.org/2018nascconline**—search for "N21"—as well as the February 2009 SteelWise article "Out in the Open" at **www.modernsteel.com**.)

Structural Metal Other than Steel

Section 2.2: Other Steel, Iron or Metal Items in the *Code* identifies those items that are not defined as structural steel. Stairs, steel castings (more on this below), handrails, and other popular items are not considered structural steel, even though those items are at times shown in the structural design documents or are attached to the structural steel frame. These other items are not within the scope of the *Code* and therefore, the AESS category system does not apply to them. However, project teams are encouraged to use the *framework* of a category-like system to outline the fabrication, erection, and finishing requirements of these items.

To create this system, identify where additional craftsmanship is needed for nonstructural steel items and apply tiers based on the viewing distance, visibility, context, lighting, architectural style, location, and finishing techniques. AISC suggests pre-project meetings with fabricators and manufacturers of other steel, iron, or metal items to create a realistic and practical in-house category system that captures project budgets of any size or architectural style.



Exposed steel as pendulum at Chaminade High School in Mineola, N.Y. (read about it in the March 2019 article "In Full Swing."

Garrett Rowland

Galvanized Steel

Galvanized steel is another excellent low-maintenance option for AESS projects in exterior or corrosive environment settings. For projects that require more craftsmanship for the aesthetic of the galvanized surface and connections, we suggest using AESS C. The hot-dip galvanizing process may require steel elements to have vents and drainage holes, plus the process has the potential to affect the contouring and blending of welds required for AESS 4. Thus, the use of AESS C creates clear expectations and communication channels for the design team, fabricator, and galvanizer. Again, the required mock-up, when using AESS C, ensures that design, fabrication, and erection teams work together to achieve the final desired aesthetic.

Considerations for Galvanized Steel

- Understand the surface preparation requirements and element and assembly size capacities of the hot-dip process
- Discuss the acceptability of runs, skimmings, roughness, and excess zinc from the hot-dip process
- Discuss an aesthetically acceptable touch-up process for repairs and welding in the field
- Coordinate which welds will be completed prior to and after the hot-dip process
- Clarify the direction of the galvanized high-strength bolts and seams of HSS sections
- If applying a duplex system (painting or powder coating on galvanized steel) include coating manufacturer requirements
- Understand that the appearance and thickness of the galvanizing will vary depending on the grade of steel and fabrication and handling techniques; expect visual variation in both appearance and thickness of the galvanizing even within a single galvanized assembly

Considerations for Steel Castings

- Unlike rolled structural steel, steel castings can be produced to have a range of surface finishes—anything from a rough, industrial as-cast look to a polished mirror finish—so the design team should clearly identify the required surface finish of the castings in their performance specification
- Structural steel castings are readily weldable to AESS elements
- Structural steel castings can be produced in ASTM grades with similar mechanical properties to the structural steel grades included in AISC, including weathering steel, and also stainless steels
- Structural steel castings can be galvanized or coated for weather and/or fire protection in the same fashion as connecting AESS elements

Considerations for Stainless Steel

- Understand the variance in appearance, aging, and corrosion resistance of different stainless steel grades and shapes
- Understand that fabrication, fitting, and finishing of stainless steel varies greatly from carbon steel
- Understand that stainless steel is traditionally fabricated in separate fabrication shops to eliminate carbon steel contamination of stainless steel items
- Understand the aesthetic implications of adding protective coatings (e.g., electroplating) for stainless steel
- The area around welds will differ in appearance based on type of weld, welding process, and type of welding material

Steel Castings

Steel castings are commonly used for connecting AESS elements, as they offer a high-quality AESS aesthetic with simplified fabrication and erection. However, per Section 2.2 of the *Code*, castings are not structural steel. Therefore, castings are not within the scope of the AESS Categories. But as mentioned above for other materials, a category system similar to that established in Chapter 10 of the *Code* can be used to define aesthetic expectations for fabrication with structural steel castings.

Connecting Steel Castings and AESS

It is suggested that the fabrication, fitting, and finishing of the connection between AESS and steel castings follow the requirements of the AESS category of the adjoining structural steel element.

First, the design team will need to create guidance to ensure that the casting receives a level of finish that is similar to the connecting AESS element. Next, they must clearly identify and define the architecturally sensitive transitions/connections on the approval documents. Per Section 10.3 of the *Code*, architecturally sensitive connection details shall be submitted for approval by the owner's designated representative for design before completion of the approval documents. This process will ensure that the transition between AESS and castings achieves the desired aesthetic.

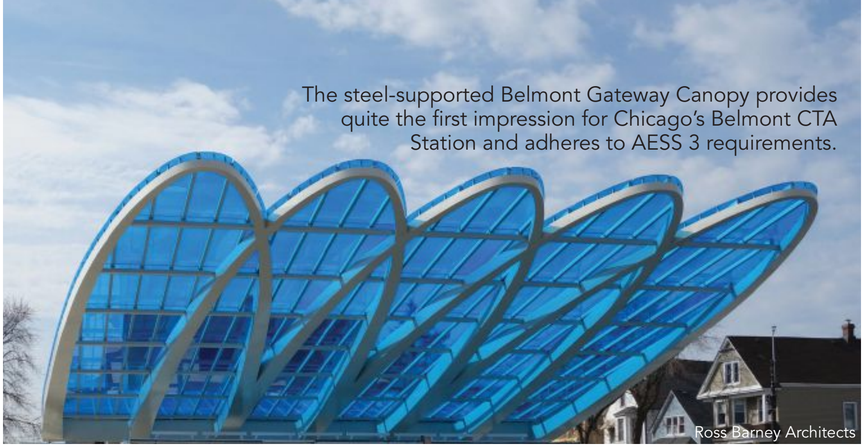
Stainless Steel

Stainless steel, like other steel, iron or metal items, does not fall within the scope of the *Code*. As with castings and other metal items, project teams are encouraged to use the framework of a category-like system for exposed stainless steel. Again, AISC suggests pre-project meetings with stainless steel fabricators to create a realistic in-house category system that ensures the life of the corrosion protection and captures project budgets of any size or style. Currently, AISC Design Guide 27: *Structural Stainless Steel* (**aisc.org/dg**) is a useful source of information and can be used to facilitate the discussion and creation of a customized stainless steel category system. And in 2021, the new AISC *Code of Standard Practice for Structural Stainless Steel Buildings* (AISC 313) will introduce a formal category system for architecturally exposed structural stainless steel (AESSS).

right: Exterior exposed steel at the 2500 Smallman development in Pittsburgh ("Under the Boardwalk," June 2020).

BradFeinknopf

above: AESS at Embry-Riddle Aeronautical University's student union ("Winging It," November 2019).



The steel-supported Belmont Gateway Canopy provides quite the first impression for Chicago's Belmont CTA Station and adheres to AESS 3 requirements.

Ross Barney Architects

Mock-Ups

AESS Categories 3 and 4 require a mock-up, and the approved conditions of acceptance shall be specified in the contract documents. AESS Categories 1 and 2 have the option of using a mock-up, with all criteria again specified in the contract documents.

A mock-up can include everything from a sample of fabricated steel, a connection, a steel element, or a full-scale assembly that includes other steel, iron, or metal items. The project team must determine what size mock-up is practical while allowing for an accurate representation of the design to be evaluated. The project team must then specify the nature and extent of the mock-up in the contract documents. The creation and approval of the mock-up should be addressed during the early project budget and schedule meetings. (See the Structurally Sound item on page 66 for an example mock-up.)

Considerations for Mock-Up Viewing

- Understand that acceptability of the mock-up can be affected by many factors, including the distance of view, lighting, and finishing
- Create in-place conditions when viewing the mock-up for the most realistic review of craftsmanship
- Consider the opportunity to use the approved mock-up in the finished structure
- Understand that more complex mock-ups may require additional lead time for advanced craftsmanship and fit-up
- Understand the effect of mock-up approval on the timeline of the project

Ed Massery

Contracts

AESS contract documents are the primary communication tool for designers to establish project expectations and identify steel team responsibilities. And clear contract documents allow the steel team to provide realistic bids for the scope of craftsmanship to be performed.

AESS 1, 2, and 3 elements are on display in the BB&T Leadership Institute's headquarters in Greensboro, N.C. ("Seeing the Forest for the Trees," June 2020).

Black Horse Studio

TABLE 10.1: AESS Category Matrix

CATEGORY		AESS C	AESS 4	AESS 3	AESS 2	AESS 1	SSS
I.D.	CHARACTERISTICS	CUSTOM ELEMENTS	SHOWCASE ELEMENTS	FEATURE ELEMENTS IN CLOSE VIEW	FEATURE ELEMENTS NOT IN CLOSE VIEW	BASIC ELEMENTS	STANDARD STRUCTURAL STEEL
1.1	Surface preparation to SSPC-SP 6		×	×	×	×	
1.2	Sharp edges ground smooth		×	×	×	×	
1.3	Continuous weld appearance		×	×	×	×	
1.4	Standard structural bolts		×	×	×	×	
1.5	Weld spatters removed		×	×	×	×	
2.1	Visual Samples		×	×	optional		
2.2	One-half standard fabrication tolerances		×	×	×		
2.3	Fabrication marks not apparent		×	×	×		
2.4	Welds uniform and smooth		×	×	×		
3.1	Mill marks removed		×	×			
3.2	Butt and plug welds ground smooth and filled		×	×			
3.3	HSS weld seam oriented for reduced visibility		×	×			
3.4	Cross-sectional abutting surface aligned		×	×			
3.5	Joint gap tolerances minimized		×	×			
3.6	All welded connections		optional	optional			
4.1	HSS seam not apparent		×				
4.2	Welds contoured and blended		×				
4.3	Surfaces filled and sanded		×				
4.4	Weld show-through minimized		×				
C.1							

A matrix is provided in Section 10 of the AISC *Code*, outlining which fabrication processes are present within each category. And for exposed steel goals that don't fit into categories AESS 1 through 4, a Custom category (C) and blank matrix space are available for teams to discuss and create their own unique guidelines.

For AESS contract documents, all members designated as AESS shall be identified as either AESS 1, 2, 3, 4, or C, per Section 10.2 of the *Code*. It is suggested that the AESS categories appear on both the architectural and structural drawings. At a glance, having the designations on both drawings may seem redundant. However, having the AESS categories on both drawings ensures that the entire design team (architects and engineers) agree with the level(s) of craftsmanship required for the project. If design teams have to select one location, Section 3.2 of the 2016 AISC *Code* states: "All requirements... shall be shown or noted on the structural design documents."

Painting and Coatings

Proper surface preparation is necessary for painting and coating systems to achieve their optimal performance and longevity. The default surface preparation for AESS 1 through 4, SSPC SP-6 Commercial Blast Cleaning, may create a surface that is too smooth or too rough for proper adhesion of certain systems. Design teams should verify the required surface preparation by reviewing the painting or coating manufacturer's specifications. If a surface preparation other than SSPC-SP 6 is needed, then design teams can use AESS C or clearly state within the contract documents the optimal surface preparation.

Affordability

The more labor required for any structural steel project, the more the cost of the steel package. By nature, the cost of AESS is higher than that of standard structural steel due to the additional craftsmanship, starting at AESS 1. The AESS steel package cost will rise as the AESS category number increases. Furthermore, AESS C varies from being lower than AESS Category 1 to higher than AESS 4, depending on the labor selected for the desired aesthetic. Project teams are encouraged to reach out to structural steel fabricators and other steel, iron, and metal manufacturers to evaluate material and labor costs, explore cost-saving solutions, and fine-tune their contract documents. Finally, feel free to use numerous AESS categories in different regions of the project, including multiple C categories, to create a finish level that best fits the project budget. ■

Considerations for Painting and Coatings

- Review the appearance of finishes on adjacent steel materials of different ASTM grade to ensure a cohesive final aesthetic
- Discuss the color and textures of the final steel finish; dark/shiny finishes amplify the appearance of surface imperfections, while light and matte finishes minimize the appearance of surface imperfections
- Understand that the same painting or coating may look different on adjacent structural steel and non-structural steel structural elements or may require specific measures to ensure uniformity
- Consider that thicker coatings (e.g., intumescent coatings) minimize the appearance of surface and weld imperfections
- Understand that surface preparation techniques ensure optimal adhesion of the painting or coating and are not indicative of the final overall finish

Dry Run

BY KRISTI SATTLER, SE, PE, PhD

When it came to the 2020 AISC Student Steel Bridge Competition, the events may have been cancelled, but the preparation and dedication that students put into their bridges were in full swing. And teams will be able to hit the ground running when the competition returns.

Kristi Sattler (**sattler@aisc.org**) is a senior engineer with AISC's University Relations department.

JUST AS THE 2020 AISC Student Steel Bridge Competition (SSBC) Regional Events began, so did the list of COVID-19-related cancellations. Like everything else, the SSBC was put on the shelf until next year. Campuses closed, activities were cancelled, and many students returned to their hometowns.

While the nearly 200 teams that were signed up for the 18 Regional Events didn't all get to put their best foot forward (though not into the river) in competition, they worked long and hard in preparation.

The annual competition challenges student teams to develop a scale-model steel bridge that must span approximately 20 ft and be able to carry 2,500 lb while staying within tight tolerances in terms of lateral and vertical deflection when fully loaded. The team must determine how to fabricate their bridge and prepare for competition where they assemble the bridge under timed construction. The final bridges are also judged on aesthetics, economy, and weight.

Here is a glimpse into the hard work that three different teams put forth in anticipation of the 2020 competition.

Shop Talk

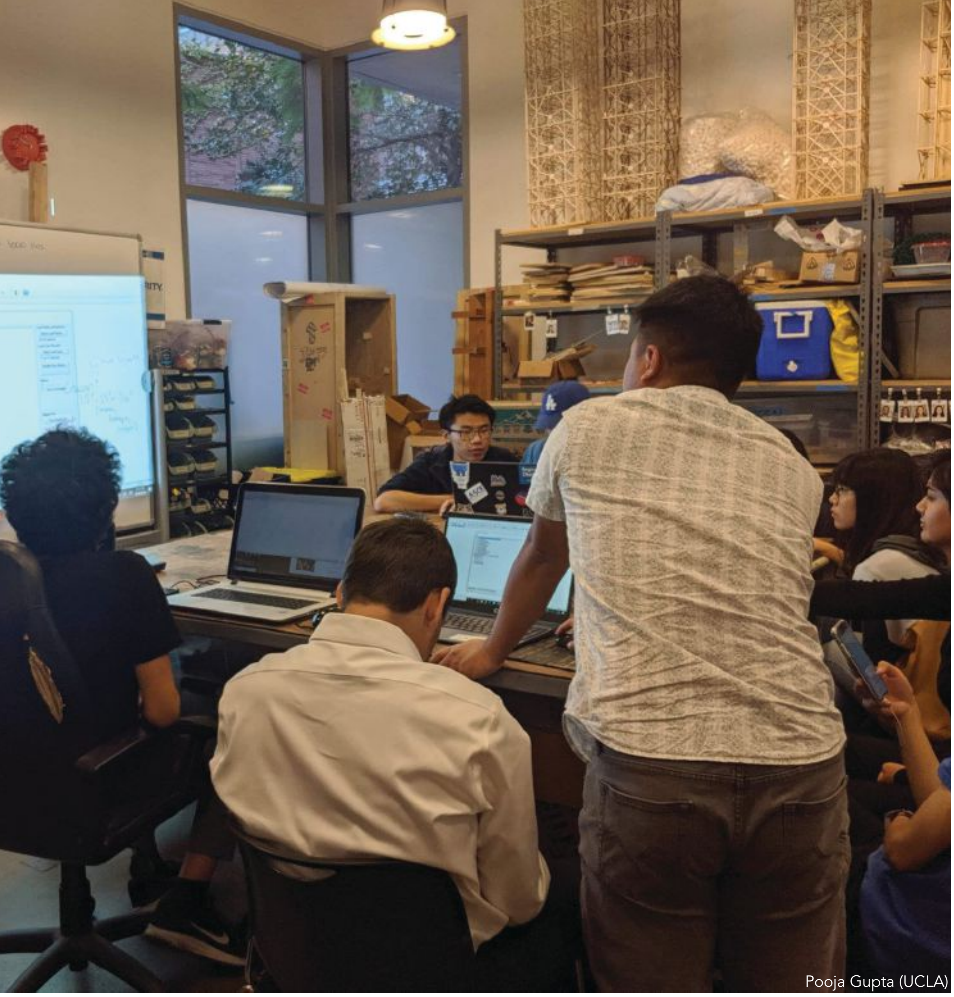
Walking into a machine shop for the very first time can be daunting—but also invigorating.

Sparks flying from the grinder. The steady whir of the lathe. The smell of hot steel being welded.

University of California Los Angeles (UCLA) students Raion Domingo, Cade Luongo, and Stacy Kong all know that experience firsthand.

"It can be really scary and intimidating sometimes because it's really heavy stuff and potentially dangerous if you use it wrong," said Kong.

Even before the bridge design is finalized, UCLA team leadership—this year, including Domingo, Luongo, and Kong—focuses on mentoring new team members in the machine shop. They want to expose their teammates to the equipment and fabrication techniques early in the competition season. That way, once the design has been finalized and the materials have been procured, they are able to hit the ground running.



Pooja Gupta (UCLA)

Cade Luongo (UCLA)

above: The UCLA SSBC team hosts design workdays with their team members.

right and below: Small groups of newer UCLA team members learn new skills in the machine shop from team leaders.

Pooja Gupta (UCLA)

SSBC Team Engagement Award

As part of the 2019–2020 academic year, AISC planned to implement a new special award: the SSBC Team Engagement Award.

The award recognizes teams that foster equity, diversity, and inclusion, and all teams that compete at a Regional Event are eligible. Teams can submit a one- to two-page written narrative to demonstrate how they benefitted from their efforts toward equity and diversity during recruiting, training, and their work together in designing and creating the best bridge they can.

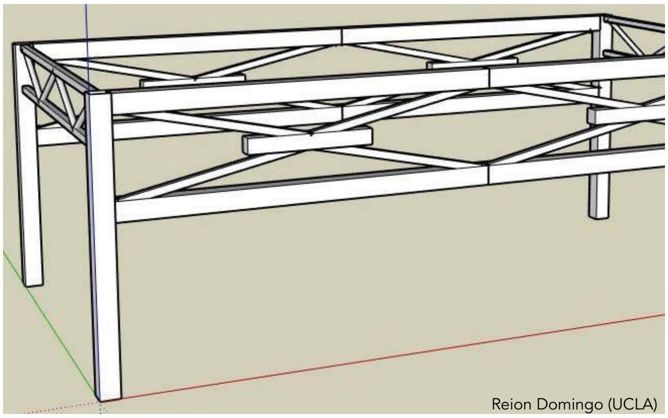
Since the SSBC program was unfortunately cancelled this year due to the COVID-19 pandemic, AISC was unable to distribute the award. However, we received an application from the UCLA team amidst the cancellations. We wanted to take this opportunity to acknowledge and feature their efforts as an example of what it looks like to create and foster an engaged team.

To do so, the UCLA team leverages a fall fabrication project to introduce newer members to the fabrication process. As part of the project, the new members make something in the shop, which helps sharpen their skills for the actual fabrication of the team's bridge.

In years past, the project consisted of fabricating some sort of hand-held item, like a phone stand. While the project was good for introducing new members to the equipment, the skills did not directly transfer to the team's final bridge. So for this year's competition, the team leaders created a project that challenged the team to fabricate a 1-ft-high, 2-ft-long mini-bridge, which provided the opportunity to practice some of the techniques that would be used for the actual 20-ft-long bridge.

But the new team members were not alone in the process. Each new teammate was paired with a project leader to provide one-on-one attention and an introduction to new skill sets.

"We want them to feel comfortable and walk them through the uncertainty and the anxiousness of machining for the first time," said Luongo, who served as the team's assistant project manager.



Reion Domingo (UCLA)

above: Rendering of the mini-bridge for UCLA's fall fabrication project.

below: The UCLA team takes a break from fabricating their bridge to gather for a baking night.

In addition to the fall fabrication project, the team also hosts design workdays over the fall quarter to help teach design principles to the project team. Recognizing that not all of the team members have yet obtained a high-level experience in structural analysis and steel design, the more experienced students strive to teach steel design concepts through the lens of basic structural mechanics. They want everyone to feel like they are a valued part of the team and the design process.

The team also holds several social activities throughout the year—things like baking nights and team dinners. With a team typically totaling approximately 30 students, the project leaders credit their team's success to all of these activities that have developed a sense of community.

The events of this past spring have not stopped the team from looking forward to the upcoming competition season. They still transitioned knowledge to next year's team by providing content for their team's "cookbook": a compilation of documents that captures the team's history from year to year.

"Project managers put what they did for the project, what they learned from the project, and how the competition went," said Domingo, who served as the 2019–20 project manager. "They can refresh their minds on what we learned and what they can improve on as well."

After this year's competition season came to an end and the torch was passed, the graduating students had the opportunity to be on the receiving end of the team's strong camaraderie. "One thing that we do every year is we have a little retirement party for the outgoing project managers," said Kong. The team acknowledged the contributions of the outgoing project managers and their commitment to mentoring newer members on the team.

Of course, this year, the retirement party went virtual, where the team gathered through Zoom to share their good wishes, play a few games, and reconnect from their hometowns. "That was a really fun opportunity to catch up with each other and still keep in touch," added Kong.

Certainly a bittersweet ending to an unusual academic year. But the team traditions and process are in place for when the competition is back on again.

Cade Luongo (UCLA)

UAF SSBC Team

above: Members of the UAF team with their bridge during the 2019 Regional Event.

below: A UAF team member fabricating bridge components.

Small but Mighty

Civil engineering student Benjamin VanderHart is living the dream.

Even before starting at the University of Alaska Fairbanks (UAF), he knew he wanted to be on the school's steel bridge team.

"When I toured the school, I saw the bridge hanging up from one of the older years, and I was like, 'Dang, that's cool!'" he said. "I want to weld on that. I want to be the welder. This year, I was finally the welder, and that was really a high point of my education so far."

And so VanderHart found his niche on the SSBC team at UAF, a small but mighty team with approximately ten active participants.

"One of the things that I think is the most interesting from observing how Steel Bridge works is the way that you have to coordinate, be organized, and really trust your teammates," said Jason Gresehover, also a civil engineering student at UAF. "It is such a large project and with literally thousands of man hours on it. One person can't do it."

Recruiting and engaging team members are vital to any team's success from year to year. Every fall, new freshmen students arrive, and in the spring graduating students move on to their next adventure in life. Upperclassmen on the UAF team are committed to the longevity of the team, especially as they look forward to what it will look like after they themselves have graduated.


UAF SSBC Team

Gresehover did not take that responsibility lightly. "While we had a really good quantity of people, they were almost all second-year engineering students and that worried me," he reflected. "So I kind of took it on myself to try to reach out to one of the Intro to Engineering professors and to get some students to come in and tour the steel bridge room. I'm hoping we can retain them for next year so that we can have some students from each class. I think that makes for a healthy participation group, rather than being so dominated by one year."

No experience is necessary to join the team. The leaders are dedicated to sharing their tangible skills in addition to their enthusiasm for the project, and they take a lot of pride in their work. "We train the people from the ground up. You really don't have to come in with any knowledge. We've got two mill machines and we will put you to work on those," said VanderHart.

"At UAF, we build everything ourselves, in-house," said Gresehover. "We get a lot of passion and high-quality because of that."

Their strong investment in the next generation helps ensure that any curiosity can be harnessed and used to build a successful SSBC team, year after year. In the case of VanderHart, the team was able to help transform his initial spark of enthusiasm into a fiery passion.

The team not only gained a welder, but also a teammate who is passionate about his work and who is genuinely enjoying the process. "Everything about it, from the design and fabrication, to the camaraderie and competitiveness, has been a great learning experience for me," said VanderHart.

Now it is VanderHart's turn to share his skills and enthusiasm with the next generation, and he is looking forward to doing so.


UAF SSBC Team

above and below: Members of the UAF team fabricating components for their bridge.


UAF SSBC Team

Sponsoring Students

Is your company looking to sponsor a school in your area? Teams typically raise funds for materials, other equipment, shop training, and travel expenses to the regional and national competitions. You can adopt an individual SSBC team and connect with college-level students to help foster their learning experiences. Contact Maria Mnookin (**mnookin@aisc.org**) to be connected to a SSBC team in your area.

And visit **aisc.org/ssbc** for more information on the competition and the list of 2021 Regional Event hosts.

Greg Kie (SUNY Canton)

above and below: Members of the SUNY Canton team assemble their bridge for the 2019 competition.

Greg Kie (SUNY Canton)

Host with the Most

Designing a bridge for the SSBC is no small feat.

Just ask John Drews, Grant Heath, and Forest Hathaway, recent graduates from the Civil and Environmental Engineering Technology program at State University of New York College of Technology at Canton (SUNY Canton).

"We were bending over backwards for it—between reading all the rule books, making sure pieces fit in the boxes, and all the other requirements as well," said Drews.

SSBC teams are typically run as extracurricular activities, which means that students make time for the project tasks on top of full course loads. Depending on the size of the team, students are often involved with several aspects of the project.

"I was up until about 2:00 a.m. a lot of mornings, trying to get the computer modeling side done," said Heath. "Even after that, we had the shop drawings to work on, which I worked on all over winter break," said Hathaway.

But as if all of the late nights and long hours weren't enough, the SUNY Canton team also took on the challenge of planning to host the 2020 Regional Event for the Upstate New York Region—an event where eight schools were expected to participate and vie for their chance to compete at the National Finals.

Planning to welcome about 150 students onto their campus in the spring took a lot of effort and coordination with the university. While AISC provides staff support for planning the event, it is really the host school that does the bulk of the work.

The event planning tasks are often in addition to students' SSBC team commitments, especially at smaller schools like SUNY Canton. Student-led teams are responsible for reserving venues, making catering arrangements, recruiting and organizing volunteers, and setting up the competition floor.

"It really kind of takes what they are learning in the classroom to a whole different level, just like normally with the competition," said Adrienne Rygel, PhD, Associate Professor and Department Chair of Civil and Environmental Technology at SUNY Canton. "And then you put hosting on top of that, and that's a whole other layer of coordination, organization, planning and scheduling while they are doing their own thing as well."

The university is there to provide support along the way, but faculty advisor Assistant Professor Yilei Shi, PE, PhD, acknowledges that the students are the ones driving the effort. "We are a small school, but we have very active students who take initiative in all the stages," he said.

The end result is that the students gain skill sets that they will carry forth into their careers, and they also forge strong friendships. "We are a smaller group and really do gel together and become almost like a second family," said Drews.

Of course, this year's Upstate New York Regional Event was cancelled due to the pandemic. But while it was disappointing not to be able to see their efforts on both the bridge and the event planning sides come to fruition, the SUNY Canton team is already looking forward to next year—and they even graciously volunteered to host again in 2021. ■

SteelDay: Everywhere

BY ERIKA SALISBURY

IN ANY OTHER YEAR, you'd be reading about how to attend a local SteelDay event right now.

But as we know, this isn't like any other year. Instead of attending SteelDay in your area, this year you can attend SteelDay everywhere—virtually!

After all, the things that make our industry so special haven't changed. We're still celebrating the remarkable people who have chosen to dedicate their lives to building our nation's future in steel and the extraordinary things they have achieved.

This year's SteelDay takes place Friday, September 25. It's never been easier to network, learn, and celebrate SteelDay from the comfort of your home or office! Here are a few examples of what you can experience virtually:

- Get to know the teams behind some of the country's most innovative projects as they receive their IDEAS² or Prize Bridge Awards
- Peek behind the curtain with a virtual tour of a steel mill, fabrication shop, or job site
- Pursue sweet, sweet trivia victory as you match wits with others in the industry
- Earn PDHs from free webinars
- Get the inside scoop on buildings and bridges that have recently won AISC awards
- Join a roundtable discussion for real talk about how people are getting work done today
- Hear thought-provoking insights from the industry's great minds during panel discussions

For a full list of events and to register, visit **aisc.org/steelday**.

As always, AISC will be hosting a national webinar on a topic of broad interest to the structural steel design and construction community. This year features an exciting new format: "The Structural Stability Game Show," where

a panel of engineers and academics present their views on the root cause of a structural collapse. Audience members will vote for what they think is the most likely cause before the moderator reveals the true nature of the collapse. The panel will include Cliff Bishop, Patricia Clayton, John Hooper, Larry Griffis, and Ron Ziemian and participants will be eligible for one PDH. Visit **aisc.org/steelday/webinar** for more info.

Local Events

As for potential live events, we don't have a one-size-fits-all solution for hosting on-site or in-person SteelDay gatherings this year since conditions and regulations differ throughout the country. Please follow local and national guidelines if you are comfortable hosting an event. The most important thing is the safety of you, your team, and any potential guests. This might also be a great time to start planning an extra-special in-person event for SteelDay 2021. To sign up to host an event, visit **aisc.org/steelday/hosts** or contact me at **salisbury@aisc.org** for more information. And to keep up with the latest details on any in-person events that do end up happening, check the individual event pages at **aisc.org/steelday**.

We look forward to celebrating SteelDay everywhere with you this year! ■

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

news & events

INFRASTRUCTURE

Steel Industry Organizations Urge Senate Leaders to Include Infrastructure in Next Stimulus Bill

Major domestic steel industry groups recently reiterated their support for significant funding for state departments of transportation (DOTs) and called on congressional leadership to support this funding in the next phase of COVID-19 stimulus legislation. Members of AISC, American Iron and Steel Institute (AISI), Steel Manufacturers Association (SMA), The Committee on Pipe and Tube Imports (CPTI), and Specialty Steel Industry of North America (SSINA) sent a letter to Senate Majority Leader Mitch McConnell (R-KY) and Minority Leader Charles Schumer (D-NY) urging the Senate to pass a broad infrastructure package to kick-start the economy.

"As a result of economic hardships in states across the country, DOTs have been forced to delay or cancel key infrastructure projects because of revenue shortfalls and the impact of COVID-19," the groups wrote. "To ensure that these projects can proceed and create demand for essential [steel] products and support good wage jobs used in the transportation sector, the steel industry requests Congress include at least $37 billion for state DOTs in the future relief bill that will be considered by Congress this month. Ensuring that state DOTs have appropriate funding to carry out essential projects is an important first step in our nation's economic recovery."

The groups noted that the American Association of State Highway Transportation Officials (AASHTO) estimates that state DOTs will average at least a 30 percent loss in state transportation revenues in the next 18 months. This causes delay or cancellation of key infrastructure projects, resulting in decreased demand for steel products.

"We can put more Americans to work, improve quality of life in our cities, towns and rural areas and drive commerce and medical supplies across our nation by making infrastructure investment a critical component of the next stimulus package by including Buy America provisions and using domestically produced and fabricated steel," the group wrote. "But, without immediate relief we fear that our national economy, and the steel industry that provides the backbone to that economy, will not recover."

The group also launched a new interactive map showing the nearly 600 steel industry organizations responsible for building America's infrastructure. Visit **aisc.org/nsba/transportation** to view the map.

STANDARDS

Specification, *Seismic Provisions* Available for Public Review

The 2022 edition of the AISC *Seismic Provisions for Structural Steel Buildings* (AISC 341) draft will be available for public review from September 4, 2020 until October 16, 2020 at **aisc.org/publicreview** along with the review form. This is the first public review of this draft specification that is expected to be completed and available in late 2022. Review copies are also available (for a $35 charge) by calling 312.670.5411. Please submit comments using the form provided online or to Cynthia J. Duncan, AISC's director of engineering (**duncan@aisc.org**), by October 16 for consideration.

In addition, the public review period for the 2022 *Specification for Structural Steel Buildings* (AISC 360) is open through September 14 via the same process described above.

correction

The steel detailers for two 2020 Prize Bridge Award winners were listed incorrectly in the July issue: the Portageville Bridge Replacement in Portageville, N.Y., and the Winona Bridge in Winona, Minn. The correct detailer for both projects is AISC associate member **DBM Vircon Services**.

People and Companies

- **Tom Muth** has been appointed executive vice president and COO of the Tubular Products Division of **Zekelman Industries**. He will oversee the company's newly created Tubular Products Division, which will include the businesses of several hollow structural section (HSS) and tube makers, including AISC member **Atlas Tube**. In addition, **Jeff Cole** has been promoted to president of Atlas Tube, where he has worked for 27 years.
- **David Deem**, president of **Deem Structural Services**, and **Bob Beckner**, retired senior vice president of **Peterson Beckner Industries, Inc.**—both AISC member erectors—were recently honored by the **Steel Erectors Association of America**. Deem was named SEAA's 2019 Person of the Year, and Beckner, who recently stepped down from the SEAA board of directors in anticipation of retirement, was honored with a Lifetime Achievement award. In other SEAA news, the **Ironworker Skills Institute**, Pell City, Ala., which educates future generations of ironworkers, has been awarded this year's **SEAA Craft Training Grant**. Designated for member companies who are newly implementing SEAA/NCCER Ironworker Training and Assessment programs, the grant covers initial setup, training for administrators, instructors, and coordinators, and custom training materials for Ironworker Levels 1-3 or similar curriculum. Now in its fifth year of operation, the Ironworker Skills Institute was established by **John Garrison** of AISC member **Garrison Steel Fabricators, Inc.**, for ironworkers to get training on rigging, welding, and the use of safety equipment and tools.

Welcome to Safety Matters, which highlights various safety-related items. This month's topic is fabrication shop safety.

Shop Mindset

Here a few things to consider in the fab shop environment:

- Slips, trips, and falls. In many shops, chord controls are a challenge as we use long leads for welding activities. Keep an eye out for them.
- Rigging and overhead hoists. A lot of rigging and lifting is needed to move materials in and through the shop, and the equipment requires frequent inspections.
- Electrocution. DC inverter welders carry lots of voltage, and workers are constantly exposed to grounding hazards.
- Pinch points. These are prevalent, especially when a worker has a crowded skid of work to be done, or their work is completed and they are waiting for member inspection.
- Eye irritation. A lot of tiny steel fragments are produced when grinding, which can result in accidental exposure and injury to the eye.
- Flash burn. Arc flash from welding operations can cause serious irritation to workers.
- Lacerations. Steel always has an edge that could be ground smoother. The grinder is thought of as the real threat here, but the steel is sharp too.
- Puncture wounds from electric welders and welding wire.
- Clamping equipment. Use it to prevent plates from slipping.
- On that note, be sure the right clamps are used for the right application.
- On that note, always use the right tools and don't manually lift and move materials if you don't have to.

Dates to Note

- Labor Day, September 7
- AISC SteelDay, September 25 **aisc.org/steelday**

We are always on the lookout for ideas for safety-related articles and webinars that are of interest to AISC member companies. If you have safety-related questions or suggestions, we would love to hear them. Contact us at **schlafly@aisc.org**. And visit AISC's Safety page at **aisc.org/safety** for various safety resources. In addition, AISC has established its own resource page with information on employment, contract, and safety issues regarding COVID-19. It's at **aisc.org/covid19**.

MILEK FELLOWSHIP

Applications for Milek Fellowship Due September 18

There's still time for outstanding university faculty members to apply for AISC's $200,000 2021 Milek Fellowship.

The Milek Fellowship program is designed to contribute to the research careers of young faculty who teach and conduct research investigations related to structural steel while producing research results beneficial to designers, fabricators, and erectors of structural steel.

The Milek Fellowship provides $50,000 annually and four years of complimentary registration to NASCC: The Steel Conference. At least half of the funds should be used to fund a doctoral candidate who demonstrates exceptional potential for contributing to the U.S. structural steel design and construction industry.

Recent recipients include Matt Yarnold of Texas A&M for his work on the behavior of hot-rolled asymmetric steel I-beams, Johnn P. Judd of the University of Wyoming for his work on an inelastic design method for steel buildings subjected to wind loads, and Gary Prinz from the University of Arkansas for his work on steel seismic systems with architectural flexibility.

Applications are due on or before September 18, 2020. Visit **aisc.org/milek** for more information.


Matt Yarnold


Johnn P. Judd


Gary Prinz

SPEEDCORE

SpeedCore Approved in NYC, Demonstrates Excellent Fire Resistance

SpeedCore, the groundbreaking composite superstructure system consisting of concrete sandwiched between steel plates, has undergone two major developments recently: successful completion of fire performance investigation and approval for use in New York City.

Purdue University researchers, supported by the Charles Pankow Foundation, have just completed an investigation of SpeedCore's fire performance. They found that SpeedCore panels under simulated fire and gravity loads demonstrate excellent fire resistance, even without additional fire-protective coatings.

"This will increase the speed of construction of a SpeedCore wall system even more than previously experienced over a conventional concrete core," said AISC's vice president of engineering and research Lawrence F. Kruth, PE. SpeedCore shaved 43% off the erection time of the Rainier Square Tower in Seattle, which was the first building to use the system.

In previous iterations of SpeedCore, panels have been treated for fire protection in their entirety. This research indicates that it is possible to meet fire resistance requirements with protection applied only locally around connections.

"With the completion of this research, no fireproofing should be required for any SpeedCore wall as long as it is at least 18 in. thick," Kruth said. "This will eliminate the need for a fireproofing contractor to apply cementitious fireproofing to the wall, thereby saving time and labor for application and cleanup."

Meanwhile, the New York City Department of Buildings has approved the use of SpeedCore for all five boroughs, meaning that erectors, contractors, and owners in the city can take advantage of the enormous time and cost savings that are possible with the SpeedCore system.

New York City high-rise projects commonly use a temporary brace frame core system so as not to slow the erection of structural steel. That temporary system would subsequently need to be removed, adding additional time to the process. "With the NYC Building Department's approval of the use of SpeedCore in New York City this will eliminate the need for the temporary braced core," Kruth noted. "This will further decrease the time for construction of the building as well as eliminate the need for a fireproofing contractor to fireproof the SpeedCore wall system."

New York-area steel fabricators are ready to manufacture SpeedCore panels for mid- and high-rise projects that require not only speed but remarkable strength. Local project teams can reach out to AISC structural steel specialist Jacinda Collins (**collins@aisc.org**) to learn more about how SpeedCore can save time and money on upcoming projects.

The second SpeedCore building is currently under construction in San Jose, Calif., and the team behind the third, in Boston, is expected to complete the design phase soon. To learn more about SpeedCore, visit **aisc.org/speedcore**.

advertiser index

NOW YOU SEE IT

CHECK OUT THIS COOL architecturally exposed structural steel (AESS) canopy going up near Penn Station.

Just kidding. It's not actually a finished product, but rather a mock-up of what the assembly might look like when fully constructed.

What's a mock-up? They're mostly used for high-profile AESS assemblies to help the project team visualize the finished product and finalize the extra labor and effort needed to achieve the ideal look for the steel. For this project, which involves a major façade revamp and horizontal expansion for the Penn 2 building in Manhattan (located above Penn Station and adjacent to Madison Square Garden), the owner also wanted to see what the large steel castings (made by AISC member Cast Connex) will look like in situ. Other motives included double-checking the selected AESS requirements (which actually changed after the mock-up was displayed) as well as drumming up publicity for potential tenants.

In most cases, the fabricator selected for the project will also create the mock-up. However, the situation is a bit different for this project, where the owner had the mock-up made and displayed *before* the fabrication bidding stage by a fabricator they'd previously worked with. The idea is to give local fabricators and erectors interested in the job the opportunity to see firsthand what additional work would be required (extra welding, grinding, etc.) so they can adjust their bids accordingly. AISC member Crystal Steel Fabricators was eventually chosen as the prime steel fabricator for the Penn 2 expansion project.

Want to find out more about mock-ups and AESS in general? Check on the articles "AESS Answers" and "AESS Success" in this issue. ■