Modern Steel Construction

March 2019

Modern Steel Construction

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ON THE COVER:
A high school expansion gets into the swing of things via a pendulum framed by a steel stair, p. 26. (Photo: Garrett Rowland/Courtesy of Mancini Duffy)

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editor's note

Whether it's on politics or who's going to win an upcoming sporting event, I'm always happy to offer an opinion.

But as Charlie Carter, one of my oldest friends and AISC's current president, likes to remind our newer colleagues, I'm just as happy to take the other side in almost any argument. It's not that I'm wishy-washy, it's that I'm a contrarian. And that's why I'm really looking forward to Ozan Varol's keynote at this year's NASCC: The Steel Conference (**www.aisc.org/nascc**).

Varol is a rocket scientist turned law professor—but at heart, he's a contrarian, or as the dictionary defines it: *Contrarian* /noun/. A person who takes up a contrary position, especially a position opposed to the majority view, regardless of how unpopular it may be.

In Varol's own words: "We're genetically programmed to follow the herd. Thousands of years ago, conformity to our tribe was essential to our survival. If you didn't conform, you'd be ostracized, rejected, or worse, left for dead. Not anymore. Continued success in the modern world requires continued innovation. The ability to disrupt established methods and find new ways of looking at old ideas is one of the most sought-after qualifications in all fields. It's a superpower that allows you to be right when others are wrong. Yet this superpower is becoming increasingly rare. We've been brainwashed from an early age to toe the line, use #2 pencils and color between the lines."

"But here's the hard truth. You can't get ahead if you're simply following. When you learn how to challenge the status quo, you won't just change the way you view the world. You'll be empowered to change the world itself."

Of course, I can also make a good case (and by that, I mean argue) that the second keynote, featuring Jon Magnusson of MKA Associates, will be even better. A couple of years ago, I asked Jon to pull out his crystal ball and give a talk on what trends will impact us in the near future. He responded with a brilliant look at innovations ranging from how virtual reality will impact design to one of our first looks at the new SpeedCore system (and yes, there are multiple sessions on SpeedCore at this year's conference!). It was just a continuation of amazing talks I've heard from him, beginning with his conference session in the early 2000s explaining what happened (from a structural standpoint) on 9/11. This year, he's talking about lessons he's learned on his lifelong journey as one of the nation's leading designers.

But as a contrarian, I might just be rooting for the third keynote: Ron Ziemian's Higgins Lecture on stability. Last year, I was blown away by Rob Connor's Higgins Lecture on fatigue; everyone in the audience was riveted, and I've since used it as a great example for how to render a technical topic spellbinding. Can Ron duplicate the feat?

It's a fun argument to debate which will be the best keynote, and I'm sure it's going to be just as much fun after the conference. If you want to join the fight, er, discussion, register today for the 2019 NASCC: The Steel Conference (April 3–5 in St. Louis) and let me know which one you think was best, so we can argue about it!

Scott Melnick
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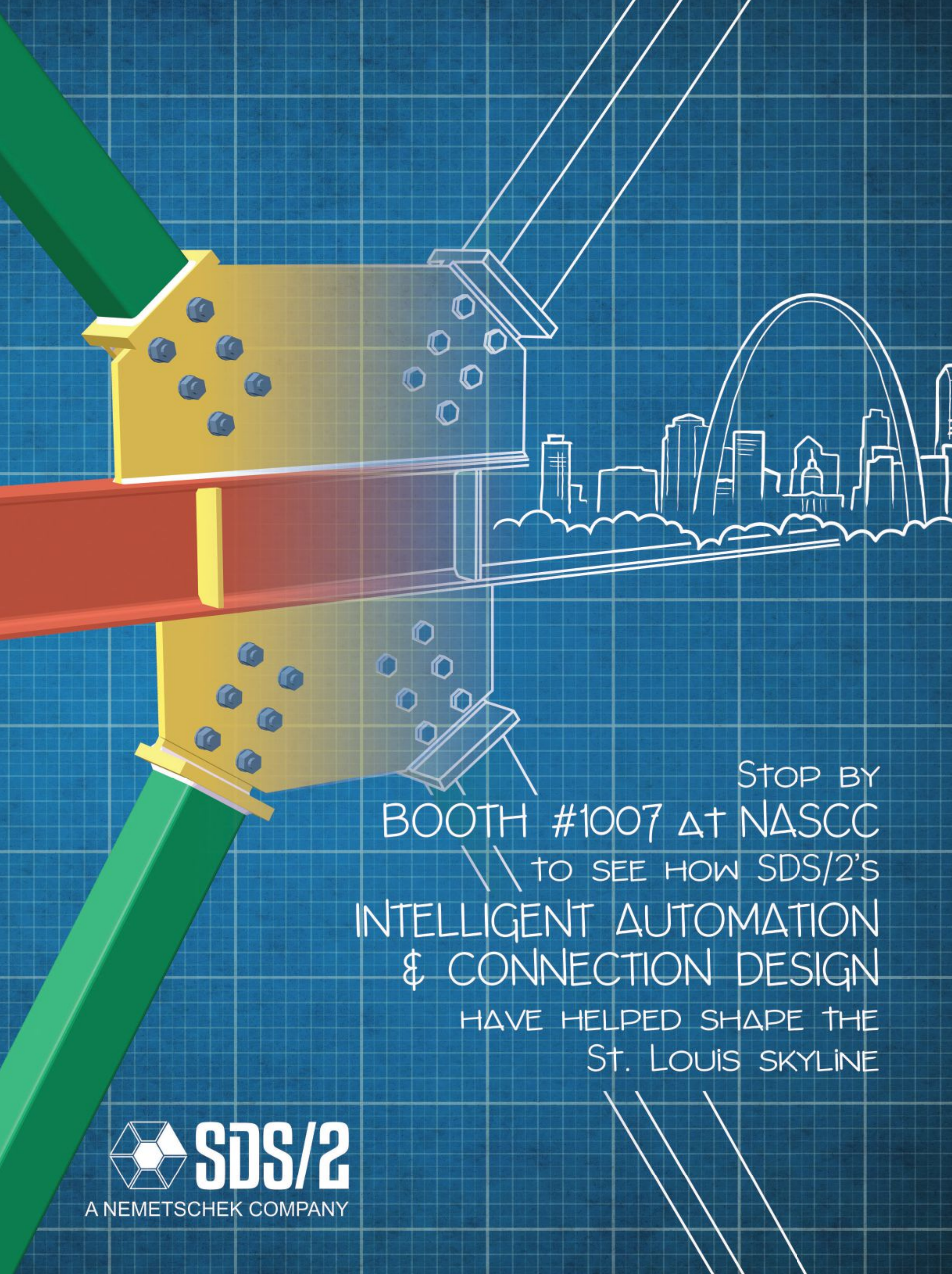

If you've ever asked yourself "Why?" about something related to structural steel design or construction, *Modern Steel*'s monthly Steel Interchange is for you! Send your questions or comments to **solutions@aisc.org**.

steel interchange

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

Bracing Multiple Beams

We are currently looking at bracing the bottom flanges of around ten wide-flange beams with an angle. We plan to check the adequacy of the angle as point bracing using Section 6.3.1b of the AISC *Specification for Structural Steel Buildings*. Since the angle is bracing ten beams, would the required strength determined from Equation A-6-7 need to account for largest of the required flexural strengths of all ten beams acting simultaneously?

It is conservative to assume the loads are cumulative because it is unlikely that all of the beams will have the maximum allowed geometric imperfection in the same direction. In a real structure with random imperfections, each beam will add to, or subtract from, the total required brace force by a different amount. Also, depending on the situation, it may be unlikely that all beams are fully loaded at the same time.

An equation was developed by Chen and Tong (1994) to predict the average geometric imperfection in columns based on random imperfections in each column. The equation, which is on page 16.1-557 of the 2016 *Specification* (ANSI/AISC 360) Commentary, can be modified to apply to situations where multiple beams are braced. Using the Chen and Tong (1994) equation, the total brace force is $P_r = P_{br}(n_o)^{0.5}$, where n_o is the number of beams and P_{br} is the brace force for a single beam, calculated according to Equation A-6-7 of *Specification* Appendix 6.

Bo Dowswell, PE, PhD

Concentrated Forces on Channels

Is Section J10 of the AISC *Specification* only applicable to wide-flange sections, as stated in the opening sentence, or can it be used to evaluate other sections such as channels? Would the equations need to be modified to account for the reduced flange stiffness?

Section J10 of the AISC *Specification* states: "This section applies to single- and double-concentrated forces applied normal to the flange(s) of wide-flange sections and similar built-up shapes." The checks included in Section J10 have been developed for use with wide-flange sections, and the results of the checks have often been confirmed by physical testing on wide-flange sections. This does not mean that they can't be used to check other sections. However, the engineer will have to exercise their own judgment when doing so.

The Commentary states: "The provisions in J10 have been developed for use with wide-flange sections and similar built-up shapes. With some judgment, they can also be applied to other shapes. The Commentary related to the individual subsections provides further detail relative to testing and assumptions. A brief guidance related the application of these checks to other sections is provided here. When applied to members with multiple webs, such as rectangular HSS [hollow structural section] and box sections, the strength calculated in this section should be multiplied by the number of webs."

It goes on to state: "Flange local bending assumes a single concentrated line load applied transverse to the beam web. It is not generally applicable to other shapes or other loading conditions. For instance, point loads, such as those delivered through bolts in tension, are typically addressed using yield-line methods… The web local yielding provisions assume that concentrated loads are distributed into the member spread out with a slope of 2.5:1. This model is likely appropriate for conditions beyond rolled wide-flanges. For example, it could be used to determine the local yielding strength for C-shapes where the concentrated load is delivered opposite the web…"

In some cases, the equations may need to be modified.

Section J10.1: Flange local bending, as stated in the Commentary, is not directly applicable to C-shapes. One approach is to simply limit the effective length of the weld to an area close to the web. A yield line analysis is another means of checking flange bending.

Section J10.2: Web local yielding as stated above "is likely appropriate for conditions beyond rolled wide-flanges…"

Section J10.3: Web local crippling is not directly applicable to C-shapes, and I am not aware of any research that has looked at this phenomenon for C-shapes. I suspect that channels are generally not deep and slender enough for this to be a consideration. One approach is to apply the equations in J10.3. If the predicted capacity is much greater than the demand (or the web local yielding strength), then you might conclude that web crippling is not a consideration.

Section J10.4: The web sidesway buckling check was developed for use with wide-flange members. I am not aware of any research that has looked at this phenomenon for C-shapes. It would probably be best to brace a channel such that this limit state need not be considered.

Section J10.5: Web compression buckling equation J10-8 is based on the equation for the elastic buckling strength of a simply supported plate subjected to equal and opposite concentrated forces.

Based on work by D.E. Newlin and W.E. Chen (*Strength and Stability of Column Web in Welded Beam-to-Column Connections*, Fritz Engineering Laboratory, Report No. 333.14, Lehigh University, Bethlehem, Pa., May 1971), the coefficient, 24, has been adjusted downward to reflect tests results.

Jonathan Tavarez is a staff engineer and **Jennifer Traut-Todaro** is a senior staff engineer, both with AISC's Steel Solutions Center. **Larry Muir** and **Bo Dowswell** are consultants to AISC.

Where the flanges are not restrained against translation (pinned at each end), Section J10.5 is not applicable, and there is no practical way to determine the strength of the web. In such cases, the effective length used to determine the compressive strength of the members delivering the concentrated loads must be adjusted to reflect the actual conditions. You can refer to Appendix 6 to help determine adequate restraint.

Section J10.6: For web panel-zone shear, it would probably make sense to limit the shear strength of the panel zone based on Section J4 and neglect any effects from inelasticity.

While the Commentary and my above thoughts provide some considerations, you will ultimately need to use your own judgment.

Larry S. Muir, PE

Section Properties for Historic Shapes

In looking through the structural drawings for a structure built around the late 1920s, I was having trouble determining the geometry of the historic existing steel shape of a few of the beams. Where can I look to find information on the geometry of these shapes?

AISC has a free, downloadable historic shapes database: **www.aisc.org/historicshapes**.

Also note that AISC Design Guide 15: *Rehabilitation and Retrofit* (a free download for members) also provides tables of dimensional and material properties for historic steel shapes that would be helpful—particularly Table 5-3.1 for your case. The design guide also contains example problems as well as guidance for handling other design or analysis nuances that arise when dealing with historic steel structures.

Jonathan Tavarez, PE

Longer Deck Spans

I am used to designing and seeing a beam maximum spacing of 10 ft in composite construction. I have a case where the designer showing 13-ft, 4-in. composite beam spacing. Does this seem reasonable for an office building?

Generally, 10 ft is a good compromise span that takes advantage of the capacity of the deck and the composite beam. We follow the 10-ft deck span rule of thumb in the Steel Solutions Center as well (**www.aisc.org/conceptual**). Splitting a 40-ft bay into three spans using 3-in. deck is another economical way to do things, depending upon the concrete type (lightweight or normal-weight) and slab thickness if 18- or 16-gage deck is used. Also, the SDI generally accepted practice for construction span length for floor deck is the clear distance between the tips of the beam flanges, which does reduce the design span from the more conservative center-to-center of beam span.

There are no hard and fast rules, as every project is unique and every manufacturer has its own deck profiles and span capacities. We would encourage you to use your own engineering judgment in this regard, though we suspect the goal is to reduce steel piece counts by stretching the beam spacing. This is a discussion you should have directly with the engineer of record.

Jennifer Traut-Todaro, SE

Updated List of Certified Fabricators

We are looking for an updated list of AISC certified fabricators. Can you point me to one?

You can search for AISC certified fabricators at **www.aisc.org/certification**. The list is linked to a database that is updated daily, so what is displayed on our website will be the latest information we have. In addition, AISC is establishing a new website verification system for certified fabricators. See page 34 of this issue for more information.

Jonathan Tavarez, PE

STEEL SOLUTIONS CENTER

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

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

steel quiz

This month's Steel Quiz is based on AISC Design Guide 1: *Base Plate and Anchor Rod Design* (Second Edition), available at **www.aisc.org/dg**.

1 What is noted as the preferred material when designing a 5½-in.-thick base plate that will experience eccentric column tension and shear?
a. ASTM A572 Grade 50
b. ASTM A36
c. ASTM A588
d. ASTM A572 Grade 42

2 A contractor discovers that there is not sufficient projection for the anchor rods, and a welded extension to the anchor rods is needed. For what grades of ASTM F1554 is welding permitted?

3 A 1¼-in. anchor rod has been installed $\frac{7}{16}$ in. off in the horizontal direction from what was shown in the approved embedment drawings. Is this within tolerance?

4 **True or False:** A 1-in.-diameter ASTM F1554 Grade 36 anchor rod was bent during construction activities. As long as the bend is limited to 45°, this rod can be cold straightened.

5 Calculate minimum plate thickness for the base plate connection in Figure 1, based on the limit state of plate yielding. Use the load and resistance factor design (LRFD) method.

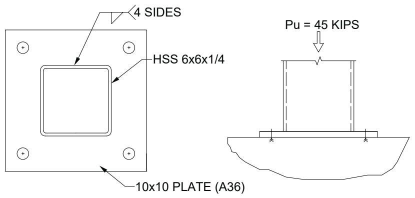

Figure 1

6 The engineer of record (EOR) should examine things carefully when designing a base plate connection for shear to be resisted by anchor rods. What are some things they should look for?

7 **True or False:** A triangular pressure distribution often requires a slightly thicker base plate and slightly smaller anchor rods than a uniform pressure distribution.

TURN TO PAGE 14 FOR THE ANSWERS


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1 **b.** The preferred material for base plates is ASTM A36 no matter the thickness and loading configuration. This is shown in Table 2.1.

2 ASTM F1554 Grade 36 and ASTM F1554 Grade 55 with Supplement S1. Welding is not recommended for ASTW F1554 Grade 55 without Supplement S1 and ASTM F1554 Grade 105. Additional information on welding to anchor rods can be found in AISC Design Guide 21: *Welded Connections – A Primer for Engineers* (Second Edition).

3 No. The 7⁄16-in. dimension exceeds the 3⁄8-in. tolerance discussed on page 8 of the Design Guide 1. Note that tolerances for anchor rod installation are addressed in Section 7.5.1 of the AISC *Code of Standard Practice for Buildings and Bridges* (ANSI/AISC 303, **www.aisc.org/specifications**).

4 **True.** Rods up to 1 in. in diameter can be cold bent, but any larger sizes should be heated up to 1,200 °F to make bending easier. In accordance with OSHA, the engineer of record must be informed of any alterations to anchor rods during construction.

5 Using the analysis procedure detailed in Section 3.1 for concentric compressive axial loads and the dimensions provided in Figure 1, a minimum base plate thickness is calculated. F_y = 36 ksi, d = 6 in., B = 10 in., N = 10 in., $n = m = 0.95 \times d$ = 0.95 × 6 in. = 5.7 ft, therefore l = 5.7 in., P_u = 45 kips. Note that for rectangular HSS, both m and n are calculated using yield lines at 0.95 times the depth and width of the HSS. ϕ = 0.9 using the LRFD equation on page 16:

$$t_{min} = l\sqrt{\frac{2P_u}{\phi F_y BN}} = 0.95 \text{ in.}$$

For an actual design, the plate thickness would be specified as 1.0 in.

6 The use of anchor rods to transfer shear forces must be carefully examined for several reasons. Considerable slip of the base plate may occur before the base plate bears against the anchor rods. It is also likely that not all of the anchor rods will receive the same force. The design guide's authors recommend a cautious approach, such as using only two of the anchor rods to transfer the shear, unless special provisions are made to equalize the load to all anchor rods. Should anchor rods be elected to resist shear, a high level of attention is required in the design process to the construction issues associated with column bases. Section 3.5 of the design guide provides guidance on the design of anchor rods subject to shear.

7 **True.** Both distributions represent simplifying approximations that are equally applicable. However, a triangular assumption moves the centroid of the pressure distribution closer to the cantilevered edge of the plate and often requires a slightly thicker base plate. Appendix B provides information on triangular pressure distributions.

STEEL SOLUTIONS CENTER

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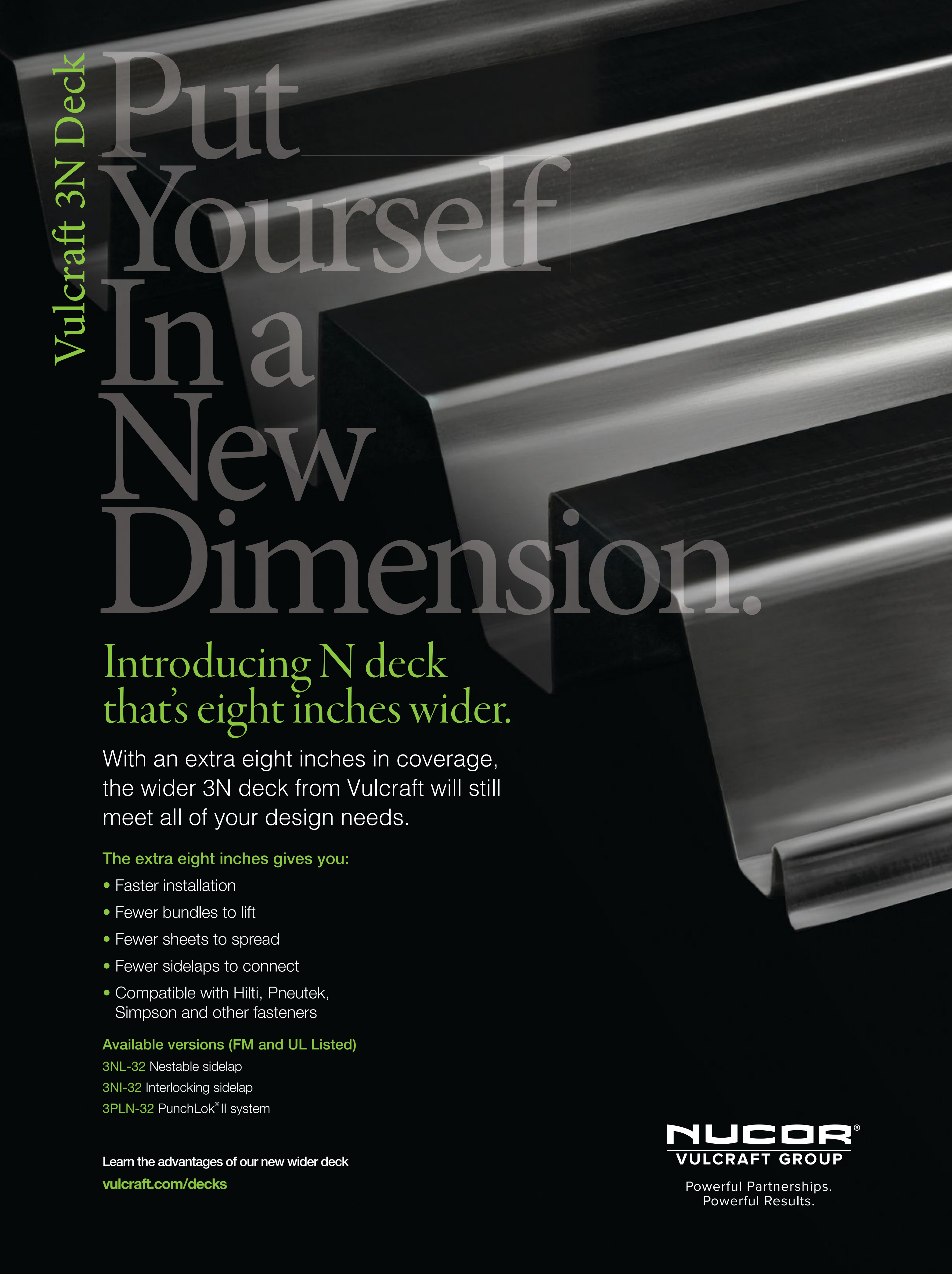
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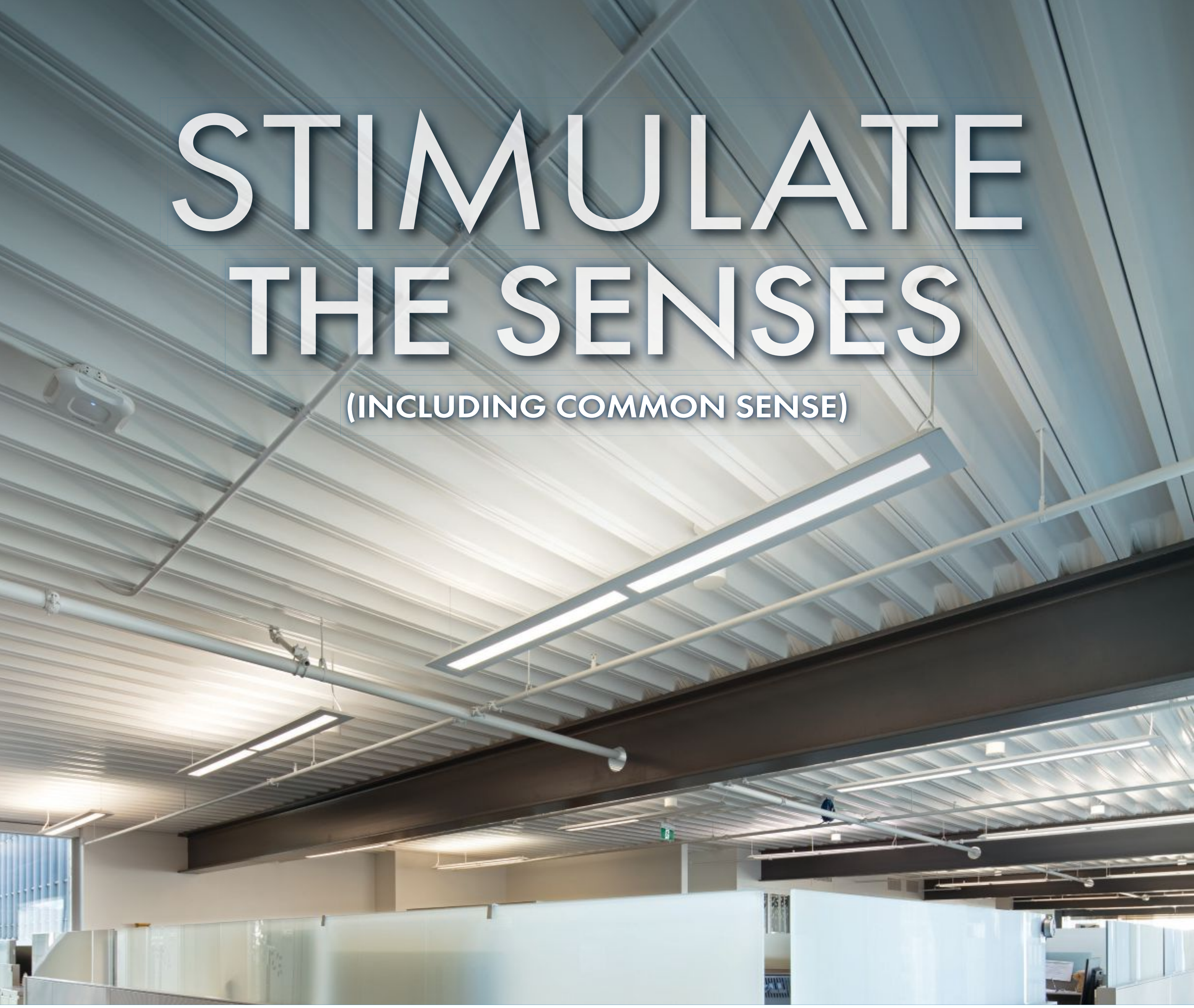
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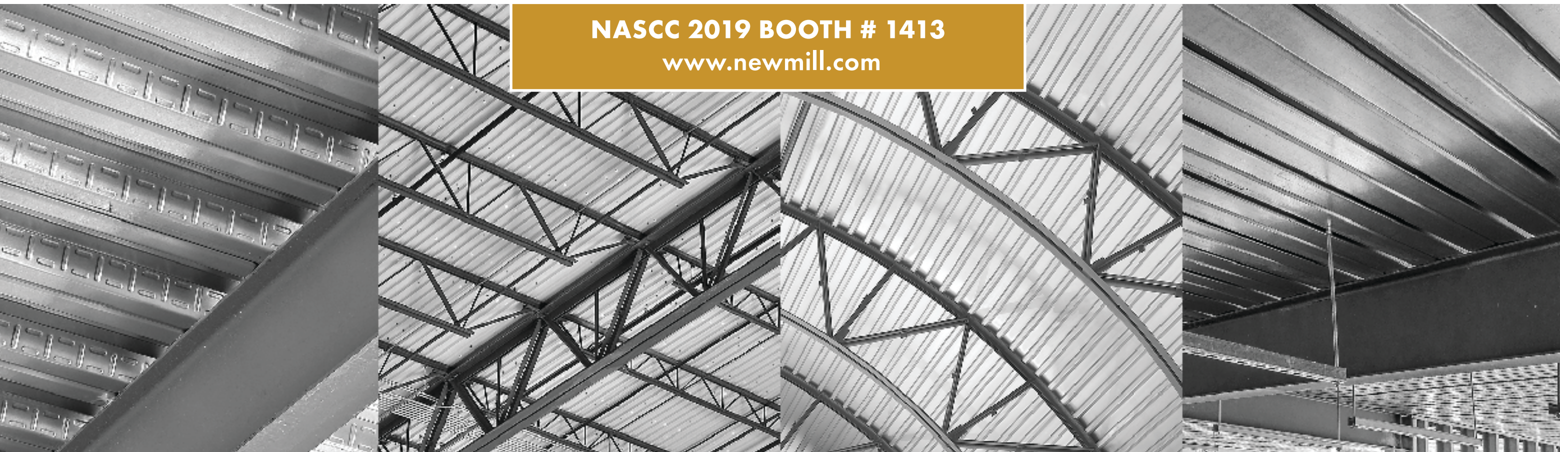
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steelwise

GETTING THE WELDS YOU WANT AND NEED

BY ROBERT E. SHAW, JR., PE

Engineers can play a prominent role in charting the course for successful welded connections.

STRUCTURAL ENGINEERS don't just design building frames.

In addition to structural analysis, designing members and coordinating with (and sometimes bringing back down to earth) the architect and other disciplines, we are also challenged with structural connections—and for welded connections, with how to properly communicate welded joint requirements on contract documents, how to properly specify inspection and NDT (nondestructive testing) requirements using AISC and American Welding Society (AWS) requirements (including considerations for additional testing) and how to address the document submittals regarding welding. In other words, engineers can and should play a big role in getting the most out of welds.

Codes and Standards

Let's take a closer look at these tasks and how to perform them so as to produce the best results in terms of welds, starting with the relevant codes and standards. The first is the AISC *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/AISC 303). In Section 3: Structural Design Documents and Specifications, the owner's designated representative for design is assigned nine items, three related to welding, and assisted by the User Note, with 11 items related to welded joints.

Another AISC standard is the *Specification for Structural Steel Buildings* (ANSI/AISC 360). Section A.4: Structural Design Drawings and Specifications refers readers to the *Code*, with a User Note addressing six specific items mentioned in the *Specification*, with five being related to welded joints.

Next is the 2015 AWS D1.1/D1.1M: *Structural Welding Code*, specifically Clause 1.4.1: Engineer's Responsibilities, which lists eight specific items to be specified or addressed. The first item includes "*Code* requirements that are applicable only when specified by the Engineer" that requires a knowledge of this code to know when specific aspects (e.g., backing removal, weld tab removal and contouring fillet welds) are to be specified.

For projects subjected to seismic concerns, AISC's *Seismic Provisions for Structural Steel Buildings* (ANSC/AISC 341), specifically Section A4: Structural Design Drawings and Specifications, which begins with five general items but also lists 13 items (in A4.1) related to structural steel, all but one related to welded joints.

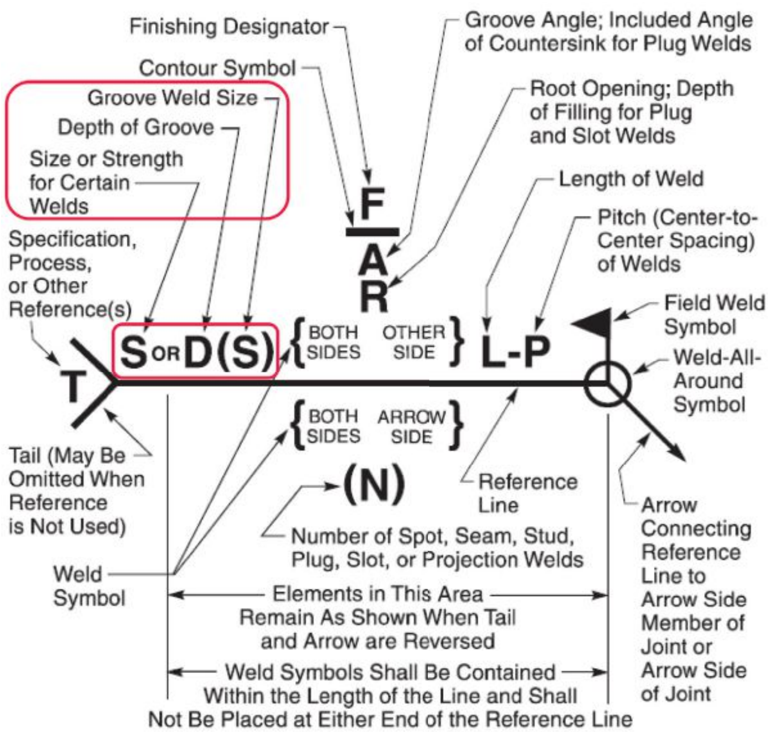
In addition, the 2016 AWS D1.8: *Structural Welding Code–Seismic Supplement* Clause 1.4.1: Engineer's Responsibilities, lists a total of 14 items.

(Note: All of the AISC publications mentioned are available as free downloads at **www.aisc.org/specifications**.)

Welding Symbols

Equally important to familiarity with the relevant codes and standards is having a thorough understanding of how to properly use welding symbols—which, ironically, have often mystified structural engineers, whether placing them on their design documents or when reviewing submitted approval documents. Errant or misused weld symbols can lead to strength and performance issues and the subsequent quality, inspection, NDT and cost implications. Common points of confusion, and sometime

Robert Shaw (**rshaw@steelstructures.com**) is president of the Steel Structures Technology Center, Inc., and is actively involved with AISC, the American Welding Society (AWS) and various international standards.



A welding symbol chart from AWS A2.4.

contention, include the weld-all-around symbol, the flat symbol without the "G," end returns (boxing) and the configuration of the arrow line. In addition, recent and pending changes to AWS standards regarding the change from S(E) to D(S) have and will create confusion for some time to come.

Welding Inspection

Specifying the amount of third-party (independent) welding inspection can be considered a simple task if managed in one form, which can be a simple reference to Chapter N or Chapter J of the AISC *Specification* and the *Seismic Provisions*, respectively. However, expansion of the minimum requirements of these two documents may be warranted for complex welded joints, particularly joints with thick materials, high levels of constraint or difficult access for production welding. Establishing and defining expectations for the frequency of welding inspection tasks can be a challenge, as can addressing the nature and frequency of inspection reports.

Specifying inspection personnel's qualifications may be needed to ensure their competency and the quality of their inspections. The *Specification* provides options currently not mentioned by AWS D1.1. Also, AWS D1.8 requires a higher level of competency, and is referenced by the *Seismic Provisions*.

Nondestructive Testing

Next, let's address NDT. Specifying NDT methods, locations and frequencies requires a background level of knowledge of the strengths and weaknesses of each method, as well as consideration for the performance implications of various types of discontinuities and their location. Beyond visual inspection, the choices are penetrant testing (PT) and magnetic particle testing (MT) for surface and near-surface discontinuities, and these are generally good at finding planar flaws. Ultrasonic testing (UT) and radiographic testing (RT) can be used for internal discontinuities, with both strengths and weaknesses for finding both planar and volumetric flaws.

Magnetic Particle Testing

Discontinuity	Ability	
Cracks	A	(2)
Laminations	A	(2,3)
Porosity	O	(2)
Overlap	A	
Undercut	O	
Inadequate Joint Preparation	U	
Incomplete Fusion	U	
Slag Inclusions	O	(2)

A – Applicable O – Marginal U – Generally Inapplicable
(2) Surface and slight subsurface (3) Weld preparation or base edge

The *Specification* and *Seismic Provisions* both provide minimum requirements for specific types of joints and conditions. However, are there specific situations where NDT may be needed but is not required by these specifications? AWS D1.1 itself requires NDT for only two specific conditions, and AWS D1.8 defers to the requirements of the quality assurance plan, which needs the input of the engineer.

An example of notches and poor quality welding around the end of stiffeners and connection plates.

Reviewing Documents and Submittals

AISC and AWS specifications and codes call for various documents to be submitted to the engineer, and if not submitted, to be available for review by the engineer or the engineer's designee, often the inspection agency. What may be designated as a choice in one standard may be addressed as a requirement in another. The *Specification* requires a welding procedure specification (WPS) to be available, the *Seismic Provisions* requires their submittal and both AWS D1.1 and AWS D1.8 require the engineer's approval for certain conditions.

One of the more challenging areas for engineers is reviewing and/or approving the WPS. Subjects for concern include unlisted base metals, filler material properties, preheat and inter-pass temperatures, heat input, polarity and numerous other operating parameters. Questions also arise as to when procedure qualifications records

left: A rectangular slot cut into an HSS seismic brace wall, for fitting onto a gusset plate.

(PQRs) are required or may be advisable for special conditions.

Requests for information (RFIs) are a means to resolve issues regarding welding questions, as well as a means to address welding quality issues. The engineer is given the authority by AWS codes to use their judgement in the final determination of acceptance or rejection of a weld that has failed to meet AWS acceptance criteria. Resources and standards are available to assist in this area.

Step by Step

A review of welding requirements should be performed for the project, looking first at applicable requirements in the specifications and codes, and then identifying those conditions and joints that may not be adequately addressed. In addition, every engineering detail of welded joints should be reviewed for not only accuracy of welding symbols but also evidence of efficient welding without problem-causing requirements. Rational inspection and NDT requirements appropriate for the welded joints in the project should be established, which often means abandoning broad-brush general approaches and addressing specific welded joints by type, loading and importance.

Addressing all of the above in the bid documents and project specifications is ideal, but sometimes not feasible before completion of the design itself. But a more comprehensive knowledge of welding and welded joints can greatly assist in achieving a safe, economical steel structure, both in developing the initial contract documents and in resolving subsequent items that may arise as the project progresses. ■

*For more on this topic, consider attending the session "Engineers: Getting the Welds You Want and Need" at the 2019 NASCC: The Steel Conference, taking place April 3-5 in St. Louis. For more information, visit **www.aisc.org/nascc**.*

Conflict happens.

Keeping it under control is crucial.

business issues

DEFUSING THE SITUATION

BY JIM REEVES

HAVE YOU EVER BEEN INVOLVED in a heated discussion or negotiation?

Things fall apart, people get angry, deals are lost, relationships are broken and at some point you might step back and think, "What happened? How did we get here?"

Often, these discussions become emotional, and we all know how easy it is to lose focus in a negotiation when emotions get involved. We might be trying to resolve a disagreement with a client, customer or project team, and the temptation is to point fingers and blame. Or we might be trying to make an important deal leading to a lucrative contract, and we think the other side is just being unreasonable. When people get frustrated and angry, opportunities can be lost.

The reality is that we are humans, and emotions play a part in our negotiations. We can't eliminate them, we are hardwired to experience them and they can actually play a positive role by focusing our minds and energizing us to be good advocates. However, when we stop thinking with our heads and begin acting solely out of emotion, things quickly get out of control and escalate before we even realize what has happened.

Some negotiations are difficult. Time pressures, money pressures and different personalities all play a role in how we interact at the negotiation table. Some people are firm, fair and effective negotiators. Some people are difficult to deal with. In some situations, even reasonable people lose their tempers. That's just a reality.

Another reality is that we can't change anyone's personality. We can't force anyone to behave differently at the negotiation table—as much as we often wish we could. We can, however, have a significant influence over the person across the table through the one thing we can control: our own behavior. What we do and say at the negotiation table, as well as our actions away from the negotiation table, all influence the other party and can mean the difference between a productive conversation and one that escalates into an all-out battle of wills.

Two foundational concepts form the core of influencing behavior and avoiding escalation at the negotiation table. First is the **rule of reciprocity**. As humans, we have a tendency to reciprocate and react to a behavior in the same way we perceive a behavior impacts us. If someone pushes us, we will often react by pushing back—sometimes harder. At the negotiation table, if we perceive behavior that is unproductive, threatening or unreasonable we have a tendency to return the behavior. An unproductive cycle begins and the negotiations quickly become unproductive—or worse, escalate into a larger fight having nothing to do with the substance of the negotiation.

The second key concept is **awareness**. When conflict escalates, we are often unaware of that escalation until it is too late. Or sometimes, we are aware in the back of our minds that something is going "off the rails" but we just keep going. We don't want to stop until we win the argument. Building awareness that the negotiation is going in a bad direction and understanding why the discussion is becoming unproductive are critical to avoiding escalating a conflict.

So, the question becomes what can we do—and just as importantly, what can we avoid doing—to keep critical conversations productive and avoid escalation of conflict?

Jim Reeves (**jreeves@clearbridge-consulting.com**) is a principal with ClearBridge Consulting.

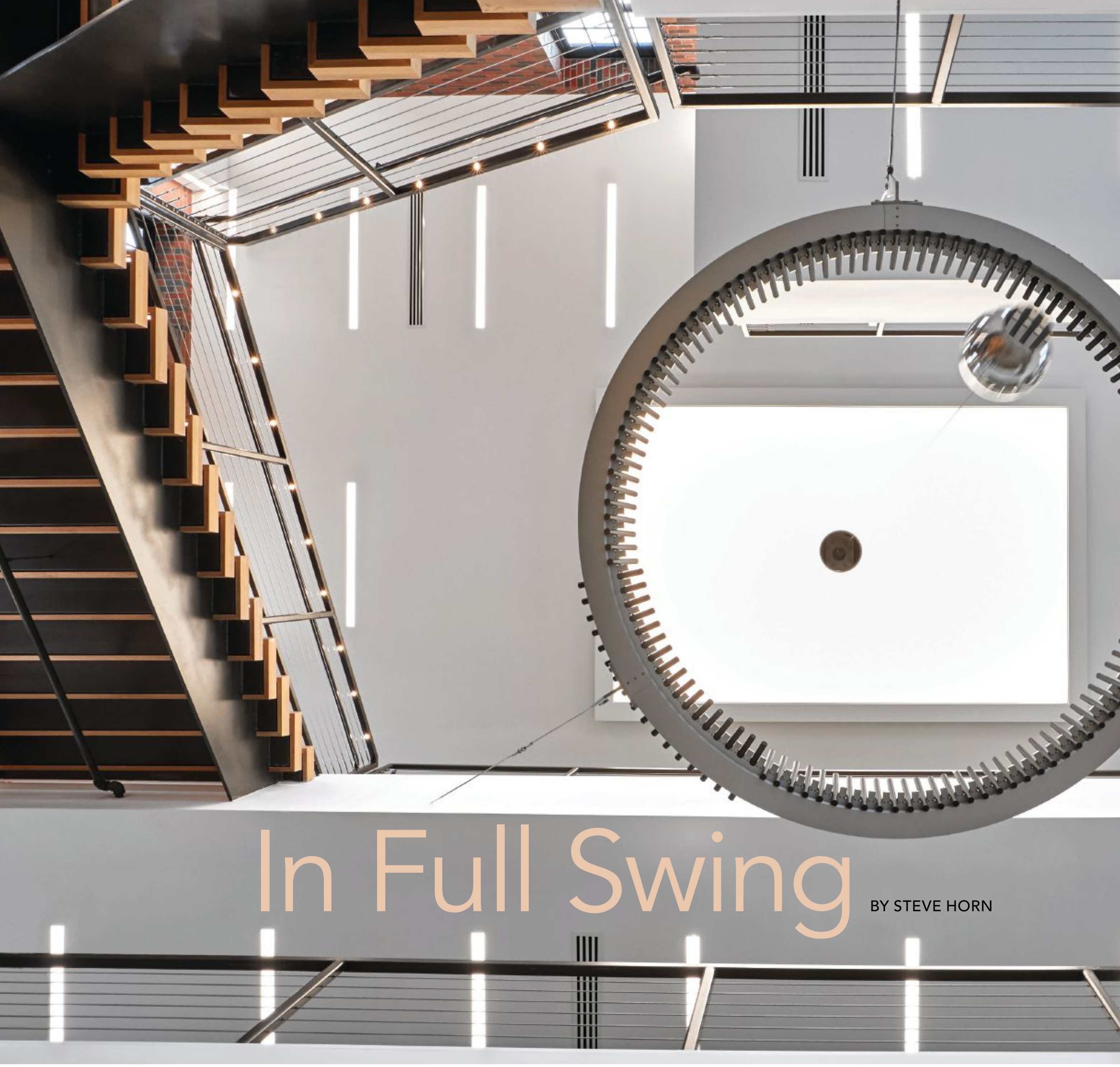
The first culprit in escalating conflict is **not listening to the other party**. I know, I know, the importance of listening has almost become cliché. The fact is that listening is the *most powerful tool* in an argument. Think about it. When you're in a heated discussion, the last thing you want to do is listen. What will the other person say that could possibly change my mind? They're wrong and I'm right! Our minds begin to think about the 10,000 ways we're planning to attack what the other person is saying, rather than actually *listening* to what they're saying. As a mediator, I cannot count the number of times I have watched two people in a heated negotiation actually agree with each other—and just not realize it. When I point out to both parties that they are, in fact, agreeing with each other, the room gets silent, they look at each other, shrug and calmly say, "Oh! Well, OK then. Good. Let's move on." Escalation avoided. They were so busy arguing their case that they didn't hear what was really being said. Failure to listen guarantees escalation.

Another escalator of conflict is **reciprocating bad behavior**. Reciprocity is powerful. As we discussed earlier, the impulse to push back can be irresistible. And there are so many ways to push back. Screaming and yelling, attacking through email, denigrating through social media, etc. Reciprocity, however, can be used to create a more constructive, positive interaction. Instead of reciprocating the bad behavior, respond with the behavior you want to see in the other person. Create an environment of *positive* reciprocity. Positively reciprocating doesn't mean you back down. It just means you don't engage in the same behavior demonstrated by the other party.

You've heard the old adage about what happens when you assume? (You make an **ass** of **u** and **me**.) It can be even more damaging in a conflict situation. Acting on **erroneous assumptions** about the other person will escalate conflict every time. In conflict situations, we often make negative assumptions about the other person and attribute evil motives to them. Making assumptions about others may not be, in itself, harmful. But when we *act* on those assumptions in a negative way, conflict escalates—especially when our assumptions are wrong.

Want to hear several more conflict escalators and how to avoid them? Come to my session at NASCC: The Steel Conference. See you in St. Louis! ■

*For more on this topic, consider attending the session "The Top 10 Things Guaranteed to Escalate Conflict (and How to Avoid Them)" at the 2019 NASCC: The Steel Conference, taking place April 3-5 in St. Louis. For more information, visit **www.aisc.org/nascc**.*



In Full Swing

BY STEVE HORN

A signature steel staircase showcasing a pendulum benefits from some fabricator intuition.

IF YOU'RE GOING TO PUT a multi-story pendulum in a building, you're obviously going to show it off.

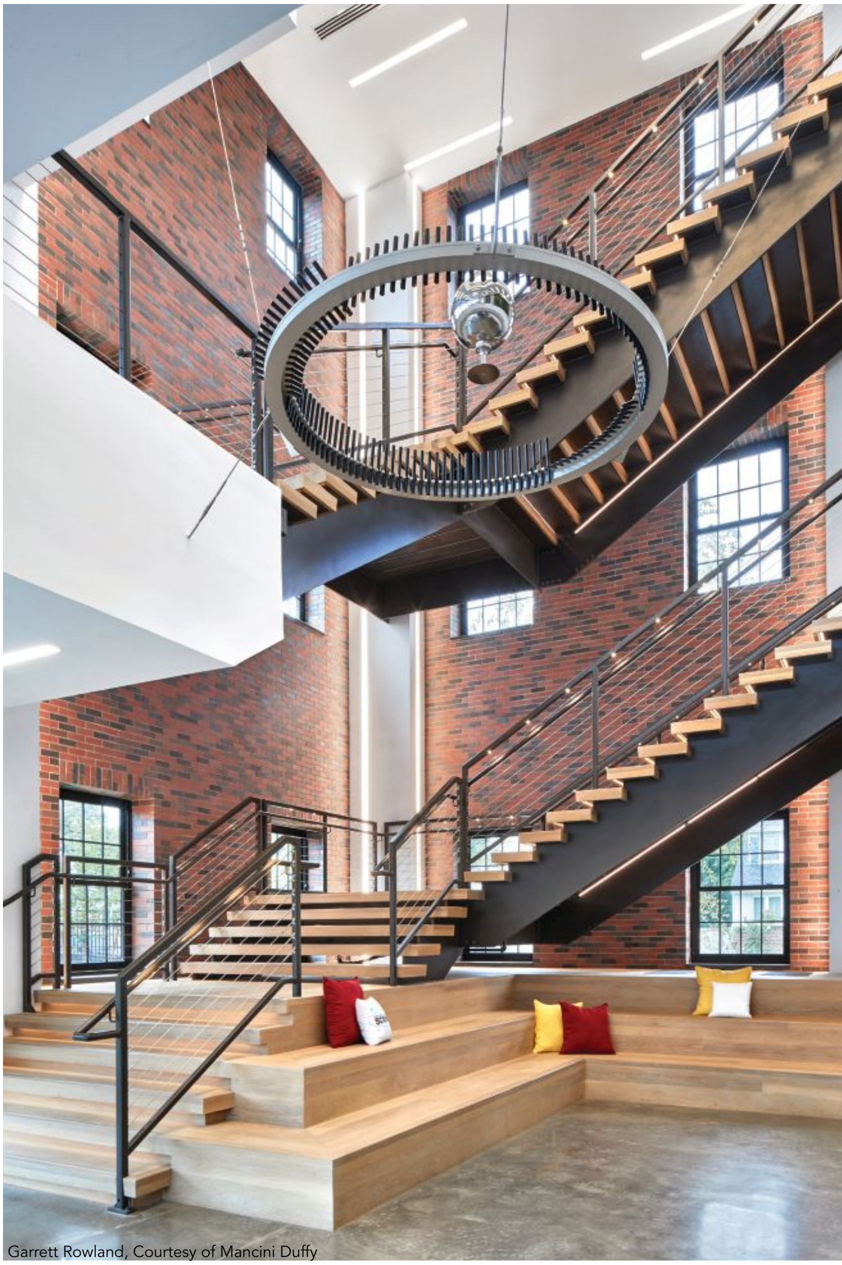
And what better way to do so than by putting it next to an eye-catching staircase—steel-framed, of course!

This was the path taken by Chaminade High School, a prestigious Catholic college preparatory school for boys in Mineola, N.Y. The school recently opened its new three-story, 34,000-sq.-ft Science, Research and Technology Center to enhance its existing science, technology, engineering and mathematics (STEM) curriculum.

The building's signature design element is the two-level, open-riser, steel stair that wraps the entrance atrium—once side of which is a living wall comprised of plants, mosses and lichens—and surrounds a Foucault pendulum intended to provide a perpetual demonstration of scientific concepts and an inspiration to students. The Foucault pendulum, named for its inventor, French physicist Léon Foucault, was first conceived in 1851 as an experiment to demonstrate the earth's rotation.

Garrett Rowland, Courtesy of Mancini Duffy

The entry atrium for Chaminade High School's new STEM facility puts science on display in the form of a Foucault pendulum suspended in the middle of a signature steel stair.



Garrett Rowland, Courtesy of Mancini Duffy

The architect, Mancini Duffy, originally envisioned the staircase as an L-shaped design with unsupported intermediate platforms that would allow for unobstructed views of the building's interior from an exterior vantage point, preserving a feeling of openness within the atrium. As the project progressed, however, it became apparent that the initial design wasn't practical. The quantity of steel necessary to support the stair would have been prohibitively expensive and so bulky as to be aesthetically unacceptable.

Striking Stairs

Chaminade contacted steel fabricator Sure Iron Works for a fresh perspective on how to rework the atrium yet still be consistent with the desired open intent. The original stair design involved a switchback approach with no support. It called for approximately 80 tons of structural steel framing and relied on a stringer system using hollow structural sections (HSS) that would require significant end- and intermediate-moment continuity. While technically buildable, the design was deemed too heavy

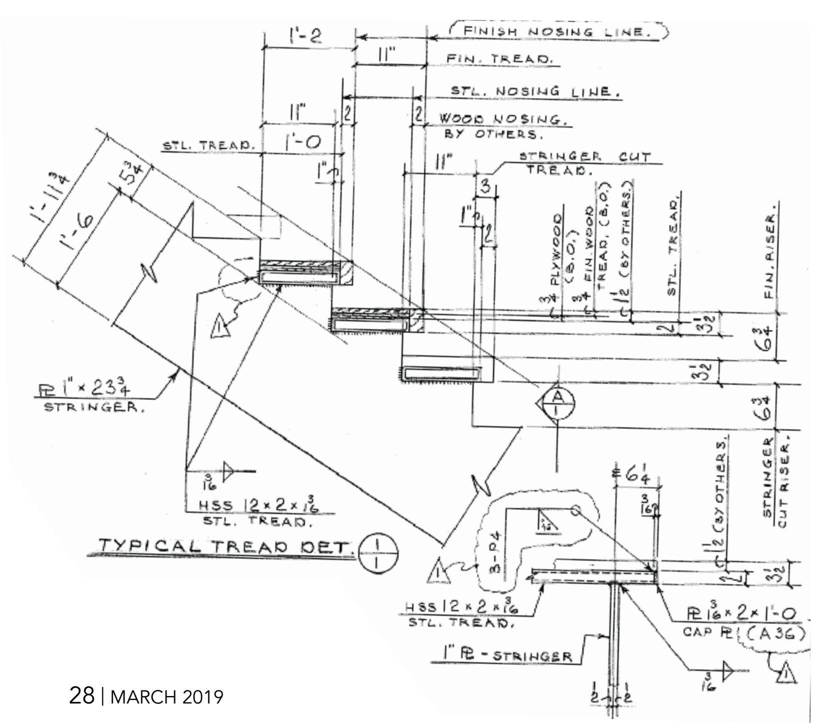
Steve Horn (**stevehorn@sureiron.com**) is president of Sure Iron Works in Brooklyn, N.Y.

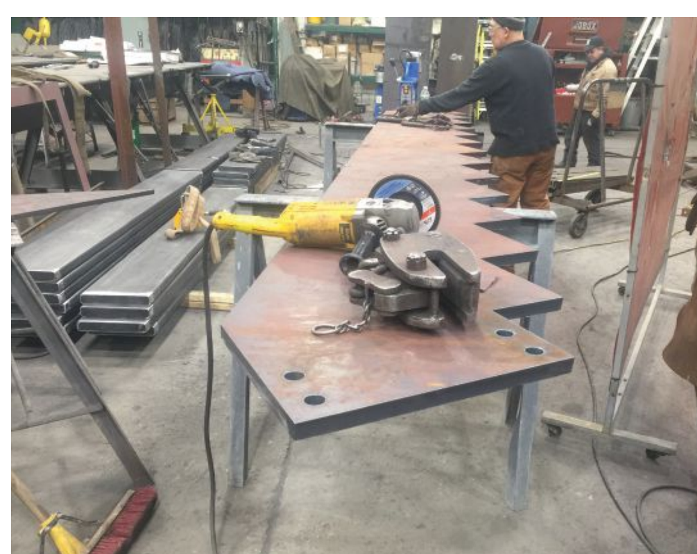
Steve Horn

above: Sure Iron incorporated a full 3D model of the staircase into its plasma cutting operation to achieve precision dimensional tolerances.

below: The entire stair was erected in one day.

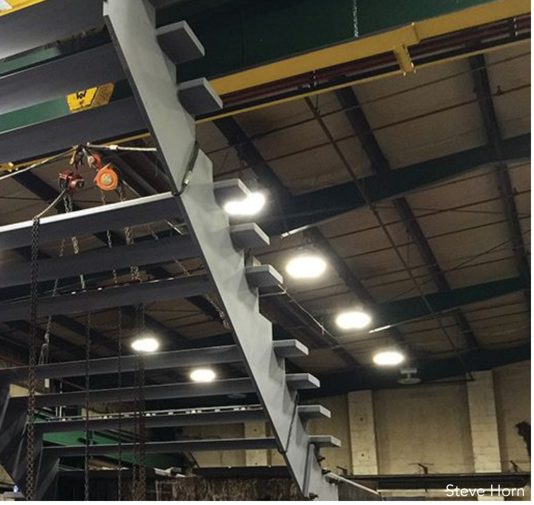
Steve Horn





Steve Horn

Stair stringers on paper (left) and in the shop (above).



Test-assembling the stair at Sure Iron's facility in Brooklyn.

Shipping stair assemblies to the site.

and expensive. As an alternative, Sure Iron proposed using a hidden post set in the corner of the intermediate platforms that would accomplish the desired unobstructed exterior views while simultaneously solving torsional issues. On top of that, this change would significantly reduce the quantity of steel required for the stairs—to 45 tons—and also result in a design that makes the staircase appear to float alongside the building's walls.

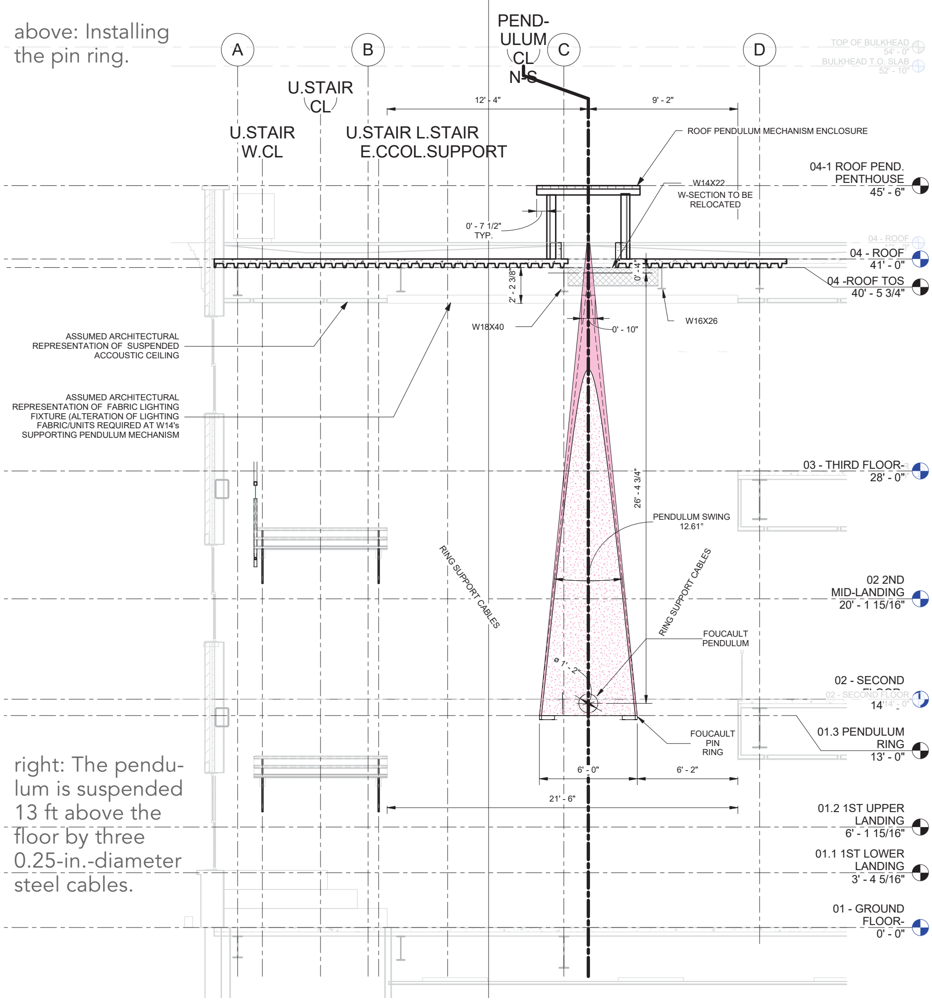
The school not only agreed to move forward with a new approach, but also requested that Sure Iron manage its design. As such, the company employed the services of Geiger Engineers, and the two worked alongside Mancini Duffy to bring the new design to life. Once the team arrived at a final design, Geiger created a full 3D parametric physical and analytical model of the staircase, which Sure Iron incorporated into the 2D CAD software of its plasma cutting machine to achieve the precision dimensional tolerances necessary to fabricate and erect the stair.

The result was a diaphragm of stringers made from 1-in. Grade 50 steel plate stitched together with HSS treads. Everything was shop-welded together into unitized assemblies, and one flight was test-assembled in the shop to ensure stability prior to all elements being shop-painted.

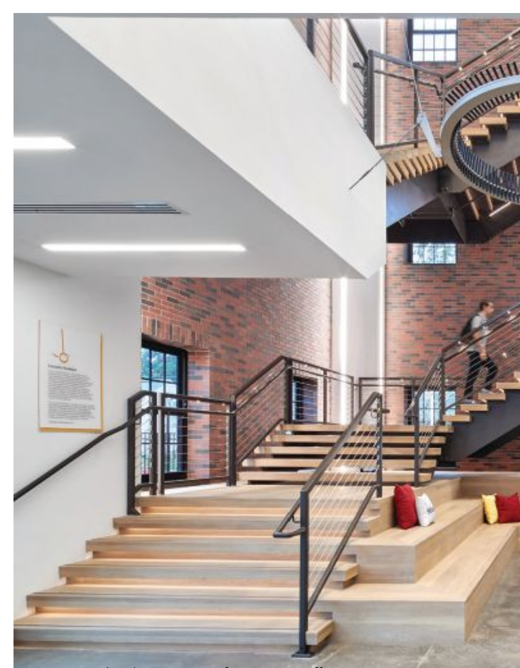
In preparing for erection, critical single-plate shear connections were welded to the structural framing before shipping the assemblies. These assemblies were then connected on-site with splice plates and 1-in.-diameter ASTM F1852 bolts. Because the main framing for the atrium was already in place, a portion of the roof had to be left off to set the stairs from above. The stair units were all installed in one day with a hydraulic crane.

Steve Horn

above: Installing the pin ring.



The roof framing had to be slightly reconfigured so as to allow the pendulum to swing without structural elements interfering with the cable.



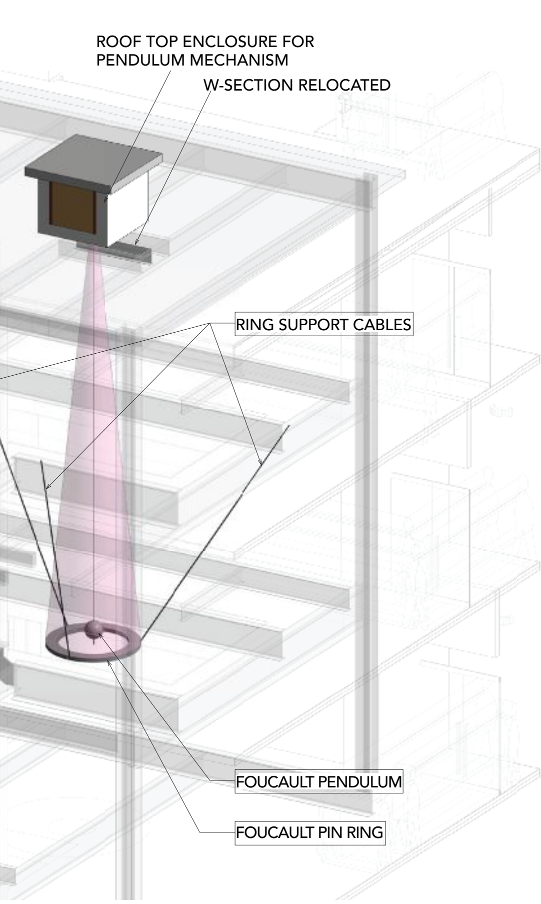
Garrett Rowland, Courtesy of Mancini Duffy

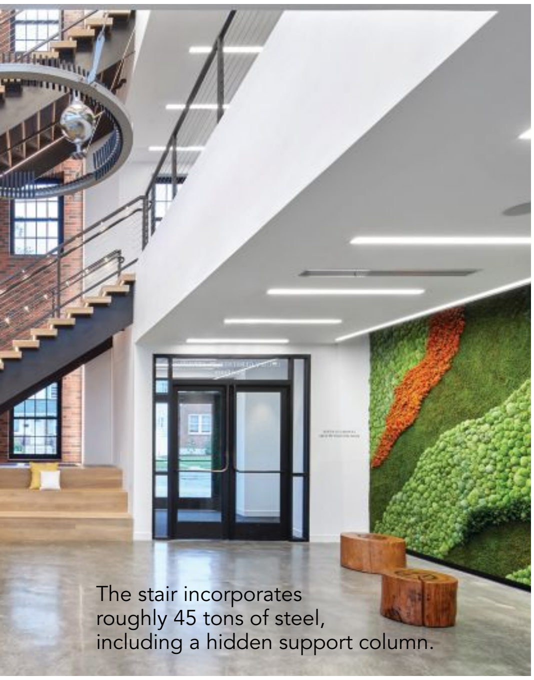
right: The pendulum is suspended 13 ft above the floor by three 0.25-in.-diameter steel cables.

Premiere Pendulum

Once the staircase structure and the railings were erected—leaving only the task of installing the white oak tread cladding—Sure Iron began to explore the design and installation of the atrium's centerpiece: the pendulum. Having never designed a pendulum before, it was indeed a learning experience. The pendulum, whose 200-lb bob is made of stainless steel filled with shot blast, is suspended from the 30-ft-high atrium roof by a 3⁄16-in.-diameter stainless steel cable. A challenge emerged in the form of a roof girder being located at the original proposed center of one pendulum axis in the middle of the stairwell, where it would interfere with the pendulum cable's swing. Therefore, the rooftop mechanism for the pendulum had to be offset in that axis, requiring the architect to approve a minor shift in the pendulum's centerline location.

At the bottom of the pendulum—and suspended 13 ft above the floor by three ¼-in.-diameter steel cables with swage fittings and turnbuckles—is a 6-ft-diameter pin ring, made of aluminum and stainless steel, on which stand the pins that the pendulum



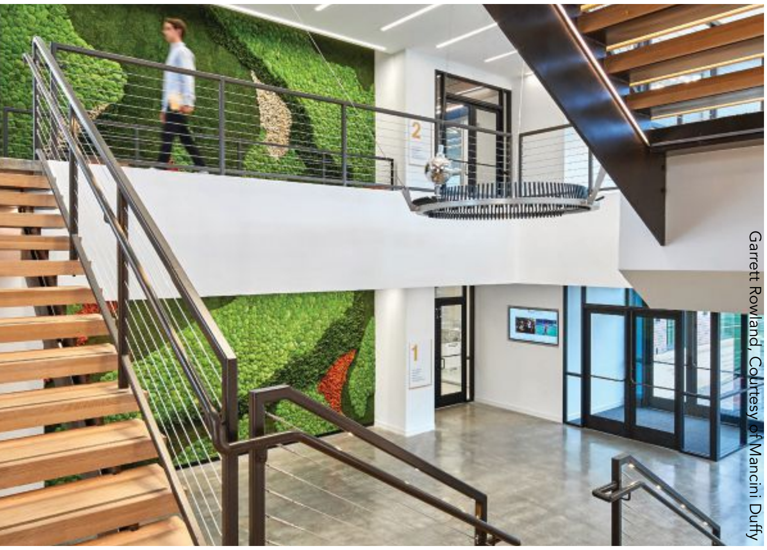


The stair incorporates roughly 45 tons of steel, including a hidden support column.

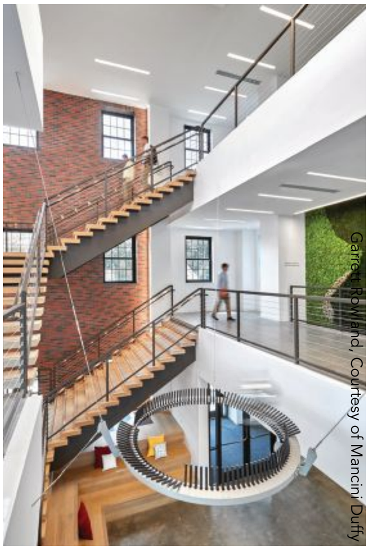
knocks down at regular intervals. Two of the cables are at same angle, while one is at a different angle to accommodate the geometry of the space. In addition, one of the cables is attached to a separate cable via a "delta plate" that has been incorporated into the mounting bracket that anchors it in place. While most pendulum pin rings are on the ground or floor, the suspended nature of this one allows viewers an unusual view of the system from below.

The system is designed to address another type of interference as well: humans. During construction, a drywall contractor accidentally came into contact with the pendulum cable, which required the pendulum to be restarted. Fortunately, the system can restart on its own from rest, via electromagnets, though it takes a whole day to get up to full speed.

Given the extreme precision required for a pendulum to operate accurately, it was tested for several months by machinist Kolb Machine and designer Broad Shoulder Consulting in Upstate New York. At one point during testing, snow loads on the shop roof impacted the results and the pendulum had to be remounted in a different manner in order to reduce deflection. This rigorous trial-and-error approach—and a lot of patience—ensured that the pendulum was able to start off in full swing, so to speak, when it was installed in the school's atrium. Students began attending classes in the new facility this past fall, and one of their first experiments was to use the pendulum to explore physical motion and force.



The living wall.



Three cables support the pin ring.

The new three-story Science, Research and Technology Center adds 34,000 sq. ft of space to enhance the school's existing STEM curriculum.

The Chaminade High School motto is "Fortes in Unitate," Latin for "Strength in Unity." This is certainly reflective of this unique atrium project as well. The architect, engineer and fabricator joined forces to produce a monumental steel staircase surrounding a moving pendulum that will be appreciated by students and faculty, as well as strengthen the school's educational reputation, for many generations to come. ■

Considering a challenging stair project of your own? Check out AISC's Design Guide 34: Steel-Framed Stairway Design, *available at **www.aisc.org/dg**.*

Owner
Chaminade High School

General Contractor
Cook and Krupa

Architect
Mancini Duffy

Structural Engineers
Geiger Engineers (Stairwell)
Thornton Tomasetti (Overall building)

Fabricator and Erector
Sure Iron Works (Stairwell)

Erecting the stair framing.

A stair assembly following in-shop coating.

Simplifying a Specifier's Life One Click at a Time

BY TODD ALWOOD

AISC's new Certification Smart Logos make it easier to verify a company's or facility's certification status.

A COMMON PROBLEM when specifying AISC certification for a project is confirming whether a fabricator or erector is indeed certified.

To make this process easier, AISC has introduced certification smart logos. Our certified participants can now install interactive logos on their website that will allow visitors to instantly verify a company's certification status.

So what exactly is a smart logo? Essentially, it's a standardized graphic (see above) that, when clicked, searches AISC's certification data to check the company's current certification status. The result of the query is a verification message, along with a list of the company's specific certifications and endorsements (see the example below). If a participant is no longer certified, the message will reflect this. And remember, certification status is verified with AISC in real time, so the smart logo will always provide up-to-date information.

Because not all of our certified participants have websites, you can also search for and verify a company's certification status at **www.aisc.org/certification** (this is one of the most visited pages on the AISC website). Similar to the smart logo, it provides certification status in real time. (Note that if a company is not certified, it will not show up at all in the search.) Keep in mind that AISC does not require certified participants to have a smart logo on their website, so if you don't see one, checking the AISC site is the way to go.

If you have any questions about the new smart logos or AISC certification in general, contact us at **certification@aisc.org** or 312.670.7520. You can also visit **www.aisc.org/certification** and click on "Specifiers" to find general information, related articles, sample specification language and many other tools related to AISC's certification programs.

Todd Alwood (**alwood@aisc.org**) is director of AISC Certification.

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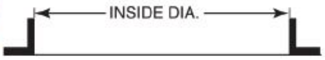
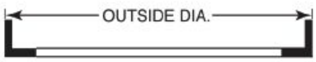
1 Angle Leg Out



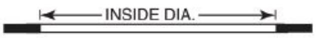
10" x 10" x 1" Angle

2 Angle Leg In



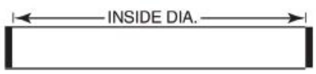
10" x 10" x 1" Angle

3 Flat Bar The Hard Way



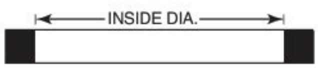
24" x 12" Flat

4 Flat Bar The Easy Way



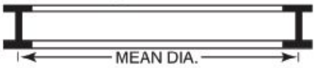
36" x 12" Flat

5 Square Bar



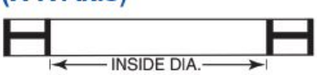
18" Square

6 Beam The Easy Way (Y-Y Axis)



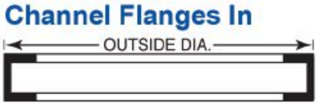
44" x 335#, 36" x 925#

7 Beam The Hard Way (X-X Axis)



44" x 285#

8 Channel Flanges In



All Sizes

9 Channel Flanges Out

All Sizes

10 Channel The Hard Way (X-X Axis)

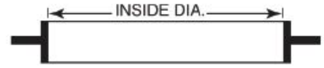
All Sizes

11 Tee Stem In

22" x 142 1/2# Tee

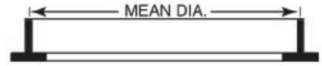
We bend ALL sizes up to:

12 Tee Stem Out



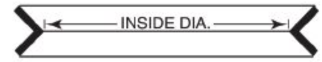
22" x 142 1/2# Tee

13 Tee Stem Up



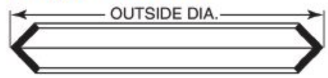
22" x 142 1/2# Tee

14 Angle Heel In



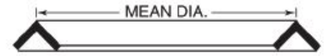
8" x 8" x 1" Angle

15 Angle Heel Out



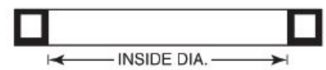
8" x 8" x 1" Angle

16 Angle Heel Up



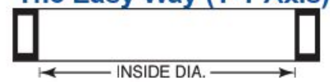
8" x 8"x1" Angle

17 Square Tube



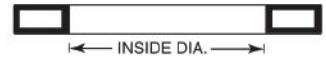
24" x 1/2" Tube

18 Rectangular Tube The Easy Way (Y-Y Axis)



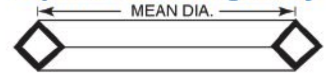
20" x 12" x 5/8" Tube

19 Rectangular Tube The Hard Way (X-X Axis)



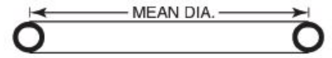
20" x 12" x 5/8" Tube

20 Square Tube Diagonally



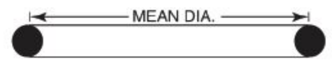
12" x 5/8" Square Tube

21 Round Tube & Pipe



24" Sched. 80 Pipe

22 Round Bar



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conference preview

ONGOING INVOLVEMENT

BY CHRISTIAN CROSBY, PE

Notes on improving fabrication quality through continuous communication by engaging and training shop and field personnel.

Christian Crosby (**ccrosby@cianbro.com**) is operations manager for Cianbro Fabrication and Coating's (an AISC member and certified fabricator) Georgetown, Mass., plant.

A YEAR OR SO AGO, I was attending an NSBA meeting and during a break in the action, I was able to catch up with several colleagues that I hadn't spoken with in a while.

After a quick update of each other's lives, I noticed that our conversation shifted toward telling "fish stories." You know, the type of story where each person describes a "fish" they caught and as the stories go on, the "fish" get bigger—only our stories weren't about fish and, frankly, they weren't stories we were particularly proud of. They were about failures in our quality management systems. After listening to each other's stories for a while, one colleague turned to me and asked, "What can we do to really improve the quality of our fabricated steel?" I thought about it for a minute or two but as I started to respond, our meeting resumed and our discussion was tabled. Unfortunately, time slipped away, and we never finished this discussion.

I've thought about this question over the past several months, acknowledging to myself that fabrication errors have long been a part of steel bridge construction. I have tried many different solutions to this question over the years, but the solution that most resonates with me—the one that I have had the best success with—is one that engages team members, practices continuous process improvement and provides training. Here, we'll explore these three components.

Team Member Engagement

Team member engagement is characterized by the active participation of employees at all levels of the organization in an effort to improve the business. While this sounds both easy and obvious, a recent Gallup poll (2016) indicates this is not the norm and that only 34% of workers feel engaged at their workplace. Here are some simple strategies effective leaders rely on to create and maintain team member engagement:

- Effective and ongoing communication of challenges the company seeks to address
- An honest and sincere commitment to seeking and valuing team member ideas and suggestions
- A workplace that supports innovation
- Well-maintained, clean, safe and well-lit facilities
- Equipment that is maintained and operating properly to meet required tolerances
- Placing team members in appropriate roles and assigning meaningful work
- Providing employees with training, the correct tools and direction to be successful in their roles

Process Improvement

Many of us have read articles on different "flavors of the month" for the latest management techniques to improve our businesses, but what is process improvement without all the trendy phrases? Process improvement is simply this: an intentional set of activities executed with the goal of having a positive outcome on a specific part of the business system. Here are five "how to" steps for process improvement:

1. Understand the process
2. Identify the potential improvements to the process
3. Implement the improvements
4. Monitor or checking on the improvements
5. Act upon the information received from checking on the improvement

Sound familiar? That's because closely follows the Deming Cycle for continuous improvement: plan, do, check and act. As a first step to understand the process, I recommend engaging the team members involved with the process we are analyzing. Who better to break down a process? It is difficult in today's "do more with less" culture in our industry to break away not only ourselves but also our team members from the daily grind to focus in on one specific process, but that is what is need to truly understand the process. One handy tool for understanding any process is called process mapping. This involves watching the process from start to finish without interference, then diagramming the process step by step. I have seen these mapping activities use a dry erase board, Post-It notes or note cards to document each step taken. This technique provides a visual summary of every step in the process. Keeping the team members who work with this process frequently involved with the breakdown is critically valuable. They will bring insight that would likely otherwise be missed.

Armed with a deeper understanding of the process, we must then focus our efforts on identifying the potential improvements to the process. This is accomplished by looking at each step that has been diagramed and then asking questions like:

- What is the purpose of this step?
- Is this step necessary?
- Who should do this step?
- Where should this step be done?
- How should this step be done?
- Can this step be automated?
- Is there wasted time, resources, efforts or money in this step that we can remove?
- What standards shall be held in this step?
- What measurements should be established to track performance of this step?

Once we have discovered where the improvements in the process can be made, we then can empower and assist our engaged team members in implementing the identified improvements.

After the implementation, the next step in the process is to monitor or check on the improved process. How will we know if our improvement has produced the desired results? Simple. We measure it. We want to engage our team members to be the ones to monitor the improvements, and if they have been involved in the entire process, they will then want to monitor their success.

The final step in the "how to" for process improvement is to take action on our measurements. If we set goals and objectives, engage our team members to take the lead on process improvements and measure our outcomes, then the team will have the data needed to make future adjustments to the process. Again, involvement of the team is critical to future success. As with anything in life, energy must be added to this. We all, as engaged team members, will want to invest our time, effort and energy to continually improve our processes to keep moving the company in a positive direction.

Training

I have personally experienced how difficult it is to hire skilled craft team members. I have also heard others in our industry describe their challenges in trying to add skilled craft people to their teams. Fabricators have skilled craft positions to fill, and most of us are currently having a difficult time finding qualified applicants. So we hire "the best of the bunch," maybe give them a quick on-boarding orientation and put them to work. After a while, we notice quality issues arising from which we will dig into root cause only to discover gaps in the new team members' skill sets. Some of us will realize that we as managers failed to properly provide these new team members with adequate training, while others will chalk it up to the new team member not being a "good fit" and then part ways.

It's easy during root cause analysis to stop at the point where we can "blame" someone for the mistake, but if we are diligent in our discovery on why our five M's ([team] member, material, machine, method and management) are not harmonized, we will discover that the true root cause resides with the last M and not the first one. To help drive this point home, one company I worked for had a rule that the summary report from any root cause analysis would start with the phrase "Management failed to…" Operator error was not an acceptable outcome. The manager's responsibility is to manage the business. They must organize the members, materials, machines, methods and themselves (management) to bring work in the door and execute the work to the customers' requirements, and at the same time meet the stakeholders' expectations.

It's easy to overlook the value of training our craft team members. We see it as an added business expense or a loss of valuable time instead of an investment in our team. Managers need to understand that training is not only an investment for new hires but also an investment in existing team members. Training is a means of increasing team member engagement. It gives these team members an opportunity for growth within the company, a path for them to follow and a means for them to grow professionally and personally.

We have already established that skilled craft team members are not walking in the door, yet we will put new hires into production with minimal skills and expect them to perform at a high level. And somehow, we are surprised when quality issues arise. Consider, for a moment, bringing in a new team member, evaluating their current skill set and tailoring an individual, progressive training program to not only fill the gaps in their skill set but also meet their career aspirations. What does this look like? Well, it's different for every person and company. For example:

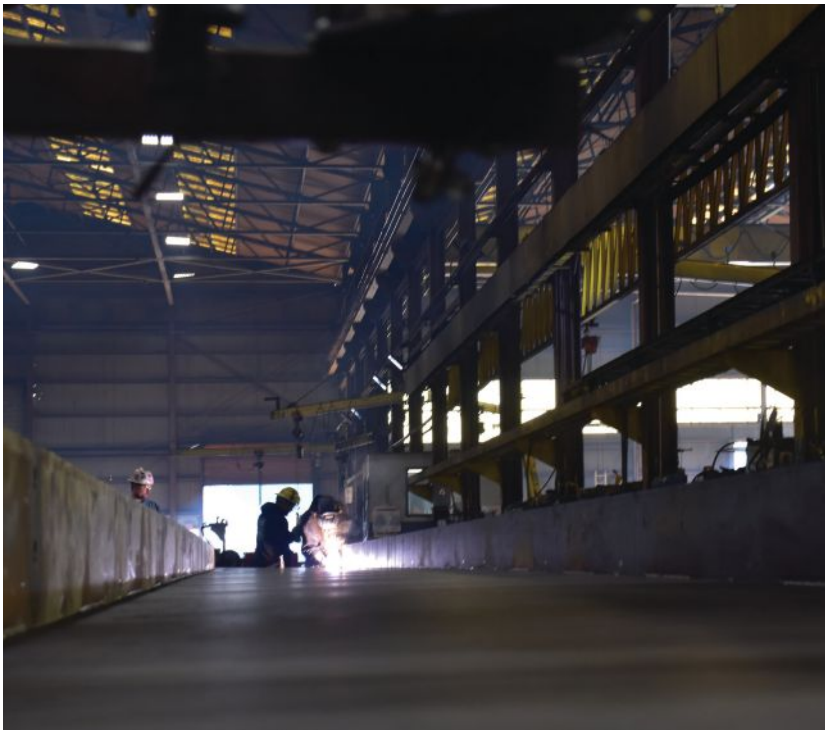
- On-the-job training working with a more experienced team member who has agreed to in advance to mentor new team members. Shadowing, mentoring, whatever you call it must be intentional
- Formal classroom training with a hands-on lab and formal assessment to evaluate the effectiveness of the training
- Formal hands-on lab with assessment (think "welder qualifications" but apply it to other skills)
- Informal but intentional on-the-job instruction by a crew leader with specific intervals and a time line

- Lunch-and-learn for craft skills. Bring in a subject expert and train the team members over soup and a sandwich
- Classroom training from a specific equipment manufacturer on how to operate their equipment
- In-plant training on specific equipment, either from a current operator or equipment manufacturer
- Online training

We know that highly skilled craft applicants are not walking in the door. So in order to resolve or, better yet, prevent quality issues—and to meet the demand for skilled team members—we need to be intentional about training.

Remember: engaged team members, process improvement and training strategies can improve the overall quality of bridge fabrication and, really, any process. ■

This article is a preview of the session "Improving the Quality of Steel Bridge Fabrication through Communication" at the 2019 NASCC: The Steel Conference, taking place April 3-5 in St. Louis. For more information and to register, visit ***www.aisc.org/nascc****.*



conference preview

THE REAL SECRET OF CALIBRATION

Solid advice on calibrating your welding machines.

BY ART BUSTOS AND LARRY MARTOF

THERE HAS BEEN a lot of talk recently about "calibration" of welding machines.

As a matter of fact, the American Welding Society's (AWS) forums are filled with discussions on this topic. The funny thing is that calibration is not an AWS requirement—so why do the AISC Certification programs require welding machines to be calibrated? To answer this, let's first explore quality management.

A quality management system (QMS) is a set of processes designed to provide reliability, consistency and quality to structural steel fabrication and erection. In its essence, it combines quality control (QC) or inspection with quality assurance (QA) or process control. A strong QMS will recognize that both QC and QA are needed in order for a process to function practically and efficiently. The welding process fits very neatly into this structure. From the QC perspective, welds need inspection, since AWS requires that, at a minimum, all welds are visually inspected. Chapter N of the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, **www.aisc.org/specifications**) requires the welding process to be observed (see Chapter N5 4a) to ensure that the welding procedure specification (WPS) is being followed, which is another element of inspection.

As for QA, it is incorporated into every weld from the start. The process of creating the WPS is done to provide a level of "assurance" that the welds created using the WPS parameters will be of sufficient strength to meet the design loads. When a welding operator is qualified for this welding procedure, there is confidence or "assurance" that they can produce an acceptable weld using the procedure. Throughout the qualification of the procedure and the operator, there are inspections performed to confirm acceptability. As long as the qualified operator uses the qualified procedure and we perform the needed inspections, we have "assurance" that the welds produced are meeting their intent.

But there's another important component when it comes to QA for a welding process: the welding machine. Without it, we have no welds. It provides the link between the operator and the weld—much like the welding lead connects the machine to the stinger. The operator relies on the welding machine to provide feedback that the WPS is being followed, which comes in the form of the machine's meters. If the meters are not accurate, then the operator will not know if they have properly set their machine, and they will not have "assurance" that the welds will meet the strength needed. How do we provide the operator with this assurance? We calibrate the meters.

To reiterate, calibrating a welding machine is not an AWS requirement. Rather, it is a QMS requirement with QA at its core. Calibrating the machine's meters provides the operator with an accurate starting point. When this is combined with the monitoring of the welding process to the WPS, we then have the means to provide "assurance" of the entire welding process.

Here's how the calibration process works: The quality control inspector (QCI) calibrates the welding machine using a handheld meter that is calibrated and traceable to a national standard. Then, they monitor the welding by positioning the handheld meter as close to the welding gun as possible to see that the WPS parameters are being met.

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conference preview

When long welding leads are being used, this monitoring could reveal that the welding machine output may need to be increased.

With this comparison being performed against the WPS, the operator can accurately adjust the machine—because they already know the meters are accurate, since they were calibrated. The QCI can then go on to other tasks, because they have assurance that the welding process is meeting all requirements, while the operator can continue to monitor their welding process accurately and produce acceptable welds.

Remember: The welding process is a combination of QA and QC functions. The QA functions of calibration and procedure qualification provide confidence in the welding, and the QC inspections complete the process for meeting the project requirements. ■

*This article is a preview of the session "The Real Secret of Calibration" at the 2019 NASCC: The Steel Conference, taking place April 3-5 in St. Louis. For more information, visit **www.aisc.org/nascc**.*

conference preview

PRE-BID DUE DILIGENCE

BY STEVEN M. HENDERSON, DAVID B. RATTERMAN AND AARON R. KLEIN

Here are some red flags that steel fabricators should look for during the bidding process.

Steven M. Henderson and **David B. Ratterman** are members and **Aaron R. Klein** is an attorney, all with the Construction Services Group at Stites & Harbison, PLLC, in Louisville, Ky.

IN TODAY'S MARKET, steel fabricators confront complex risks on a daily basis, including project uncertainty and increased market volatility.

Now more than ever, it is crucial to devote time and attention to pre-bid due diligence—which, if done properly, will replace increased risk with increased profits.

But effective pre-bid due diligence is tedious and time consuming. At its core, it boils down to an examination of two risks: (1) the quality of project participants and (2) the quality of the contract documents. Here, we'll examine these risks and provide some guidance on how to identify them.

Design-Assist: What, Why—and Watch Out!

Design-assist is an emerging twist on modern project delivery methods, where the owner engages the construction team (prime contractor and key trade subcontractors) during the design phase to collaborate with the architect and engineer during the preparation of construction documents. It is intended to reduce the cost and time of construction, improve constructability and add value through the added expertise and insight of the prime contractor and key trade subcontractors. Under a design-assist contract, a fabricator's scope of work may be limited to design-assist services only, or simply be one additional component to the scope of an otherwise standard steel fabrication contract.

But as beneficial as this methodology is intended to be, it presents significant risk to fabricators. A fabricator's participation in the design process might expose the fabricator to liability for design errors and omissions—or prevent them from later making claims to recover additional costs resulting from design errors. To address this concern, fabricators should evaluate the sophistication and reputation of the other parties participating in the project. Fabricators should also closely examine the proposed contract and ensure that they are not exposed to additional liability for design errors. The design-assist contract must clearly set forth the obligations and liabilities of the construction team with respect to the plans and specifications so that there are no unintended consequences.

A fabricator should also assess the likelihood of scope and/or design changes, as well as schedule changes and delay. Where the design is novel and the initial contract documents are incomplete, special care should be taken. This can be a formula for unexpected changes to the character of the contract work. (For more on design-assist, see Section 9 of the AISC *Code of Standard Practice for Steel Buildings and Bridges*—ANSI/AISC 303, available at **www.aisc.org/specifications**—as well as "Design-Assist and the AISC *Code of Standard Practice*" in the February 2019 issue, available at **www.modernsteel.com**.)

Fast-Track Projects: Know Your Rights

Fast-track projects have become increasingly popular in recent years due to the clogged post-recession project pipeline. Fast-track construction is typically used where a project requires construction to begin before final design documents are issued. This allows owners to push projects to completion and generate revenue from the finished

project as quickly as possible to take advantage of a strong economy. And let's acknowledge that there are many people in the construction world who are of the opinion that every project nowadays is a fast-track project.

But fast-track construction is not all gravy and can present a variety of risks that fabricators must consider, including budgeting, scope, design errors, change orders that alter the scope or character of the work and delays. The good news is that fabricators can translate the increased risk of the fast-track project delivery method into increased profits through due diligence during the bidding and contract negotiation process.

For example, a common issue with fast-track projects is the compressed project schedule. A fabricator should know that they can and should take exception to any schedule issues in the bid if it is not tenable from their perspective. Does the schedule include sufficient detail as to when final design documents will be available to the fabricator? If not, that issue should be addressed in the bid and the fabricator's contract. Fabricators should also ensure that the contract requires fabricator input on all future schedule changes and allows an equitable adjustment to the subcontract price if the cost of performance increases due to an accelerated schedule, delays in the issuance of structural design documents and specifications or delays in the review and approval of final shop drawings. Ultimately, a fabricator should not take the job if the fabricator is not confident in its ability to meet the fast track project schedule steel delivery dates.

Also note that Section 3.6 of the 2016 *Code* offers protection to fabricators if subsequently issued non-structural components of the design documents increase the scope of the fabricator's work. It states: "When the fast-track project delivery system is selected, release of the structural *design documents* and *specifications* shall constitute a *release for construction*, regardless of the status of the architectural, electrical, mechanical, and other interfacing designs and *contract documents*. Subsequent *revisions*, if any, shall be the responsibility of the owner..."

Ironically, fast-track projects are notorious for creating catastrophic delay problems—and these are sometimes blamed on the fabricator regardless of actual fault. Accordingly, it is important for fabricators to be aware of their legal rights. The following examples are legal defenses that may apply:

1. Late steel delivery does not automatically entitle the owner to delay damages; if a steel delay is excusable (weather) or concurrent with an owner/general contractor-caused delay, you are not responsible for the delay
2. If a delay is chargeable to the owner or prime contractor, you may be entitled to compensation (depending on your contract and applicable law.
3. No damage for delay clauses are disfavored and void in many states, regardless be wary of no damage for delay clauses and demand it removed from the contract.

Incomplete Design Documents

Fabricators often find themselves tangled up in disputes caused by incomplete design documents. Effective pre-bid due diligence is vital to effectively identifying and addressing the risks associated with incomplete or ambiguous documents. If faced with this situation, fabricators should provide notice of any design deficiencies discovered during the bidding process and get clarification on those issues prior to submitting a bid. If that does not occur, they should include contingencies in the bid to address any issues with the design documents. For example, a fabricator should clarify the scope of design assist work (if any), payment, use of allowances or unit prices, etc.

It is also important to remember that fabricators are entitled to reasonable and accurate design documents. For example, the AISC *Code* requires complete, released construction drawings before detailing begins—even on fast-track jobs. Further, Section 1.5.1 states that a "fabricator is not responsible for the suitability, adequacy, or building code conformance to the design." Also, Section 3.1 states that "structural design documents shall clearly show work to be performed, including: size and location of members, geometry and work points, and more."

In reality, design errors are often not apparent during the bidding process and must be addressed by change order during the fabrication process. Fabricators should properly document all errors discovered and immediately notify the structural engineer in accordance with the contract documents. Please note that Section 3.3 of the *Code* states: "It is not the *fabricator's* responsibility to discover discrepancies, including those that are associated with the coordination of the various design disciplines." In addition, fabricators should consider mid-project peer review to protect against these types of errors. Mid-project peer review is a process by which a third-party structural engineer or architect conducts a thorough examination at a chosen point during the project. This process provides added insurance against errors and related liabilities.

The Law of Contract Formation

It is vital for fabricators to have a basic understanding of the law of contract formation. It is not only a shield that protects against liability, but also a sword that can be used to create favorable contract terms for fabricators. The four essential elements of contract formation include: offer, acceptance, consideration and mutual intent to be bound.

In a perfect legal world, no fabricator would ever begin work without a fully executed contract. However, common business practices do not always align with an attorney's armchair view of the world. Contrary to popular belief, both parties do not have to sign on the dotted line to form an enforceable contract. A fabricator's offer (including terms favorable to the fabricator), notice to proceed with fabrication and commencement of work (or "beneficial reliance," such as mobilization, scheduling shop time or purchasing materials) can be sufficient to create an enforceable contract under most circumstances.

Fabricators should be aware of caveats and exceptions to protect against forming a contract without intending to do so. One example is that a fabricator can qualify their bid on a private project upon acceptance of favorable terms and conditions. Similarly, on public projects, fabricators can take exception to any conditions added by the prime contractor that are not included in the public bid solicitation—e .g., advanced acceptance of the prime's standard form subcontract.

Fabricators often wonder whether they are required to use the prime's standard form subcontract. The answer is generally no, unless the subcontract has been specifically incorporated into the bid documents and the fabricator has not taken exception to any of the subcontract's terms. It also important to know that prior use of a form subcontract with a prime contractor does not bind you to use it in a subsequent contract with the same prime.

Form contracts issued by owners and prime contractors often contain what we lawyers refer to as "killer clauses." A killer clause is one that is onerously one sided in the favor of the other party and attempts to force a fabricator to take responsible for risks that the fabricator cannot control. These clauses take many forms and commonly include provisions such as pay-if-paid clauses, advanced waiver of mechanic's lien rights, no-damage-for-delay clauses and broad form indemnification clauses that require fabricators to indemnify against damages caused by another party's negligence. A fabricator or their attorney should always be on the lookout for these types of clauses during the bidding process if possible. In some states, they may be illegal and unenforceable, but you should not rely on a judge or arbitrator to declare these types of provisions unenforceable in the future. Instead, you should take exception to these clauses during the bidding process and negotiate for fair contract terms. At a minimum, prime contractors will often agree to slight modifications to their standard contract terms that will reduce your risk exposure. For example, a fabricator could at least modify the contract to preserve their ability

to file a lien or assert a bond claim, regardless of owner non-payment.

As a fabricator, you do not have to know everything about contract law. However, you should consider identifying killer clauses a crucial component of your pre-bid due diligence. If you identify and address legal red flags before an issue arises, you can place yourself in a much better position to mitigate risk and maximize your profits on every project. ■

This article is a preview of the session "Due Diligence: Warning Flags before You Submit Your Bid" at the 2019 NASCC: The Steel Conference, taking place April 3-5 in St. Louis. For more information and to register, visit ***www.aisc.org/nascc****.*

conference preview

TO GRIND OR NOT TO GRIND?

BY TERRI MEYER BOAKE

That is the essential question when dealing with AESS welds. And the answer is often "No!"

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IT HAS BEEN MORE than two years since AISC introduced the revised category approach to designing with architecturally exposed structural steel (AESS).

If you're not familiar with the topic, the objective of the updated AESS section (Section 10) in the 2016 AISC *Code of Standard Practice* (ANSI/AISC 303-16, **www.aisc.org/specifications**) is to improve communication among the team members. The intent is to establish basic best practices that are *always* adhered to within the categories and allow the team to focus the discussion on the important *optional* details.

Although the section may at first appear complex, the core principles are extremely simple and based upon the questions "Can you see it?" and "Can you touch it?" Much time and expense has been wasted through the years on fabricating and detailing for high levels of finish that have not been warranted, either by the project type itself (due to budget, or cultural significance) or by the distance to view. Not all AESS projects require the same level of execution even though all of the new categories set higher expectations than for concealed structural steel. Specifying too high a level of AESS can price these elements right out of the budget with unnecessary fabrication work.

The primary culprit in terms of unnecessary work is weld grinding, which can extend a project's timeline and add cost. In the rare cases where it is warranted, the configuration of the welded connection must allow for the removal of the weld ridge while still ensuring structural integrity.

The creation of a completely remediated welded connection requires additional time and good access to the components to ensure high-quality results.

A visual sample is used to allow the team to decide on the best strategy for the weld treatment of this round HSS-to-plate connection, as a function of the budget and time constraints.

When Is Grinding Warranted?

The good news is that weld grinding is only required under AESS categories 3 and 4, which both designate a viewing distance of closer than 20 ft (categories 1 and 2 are reserved for AESS with a viewing distance of farther than 20 ft)—and even under these higher categories, it isn't always necessary. The only grinding necessary for AESS 1 or 2 is done to remove sharp edges to ensure that coatings adhere to the steel properly and nobody gets injured.

AESS 4, on the other hand, includes the highest level of weld remediation and finish expectations. That said, it was not designed to be the default category for AESS, much in the way that "weld all around" should never be the go-to symbol for welds. Rather, it is reserved for close-to-view AESS that necessitates the highest finish levels. That said, weld grinding isn't required for every AESS 4 project.

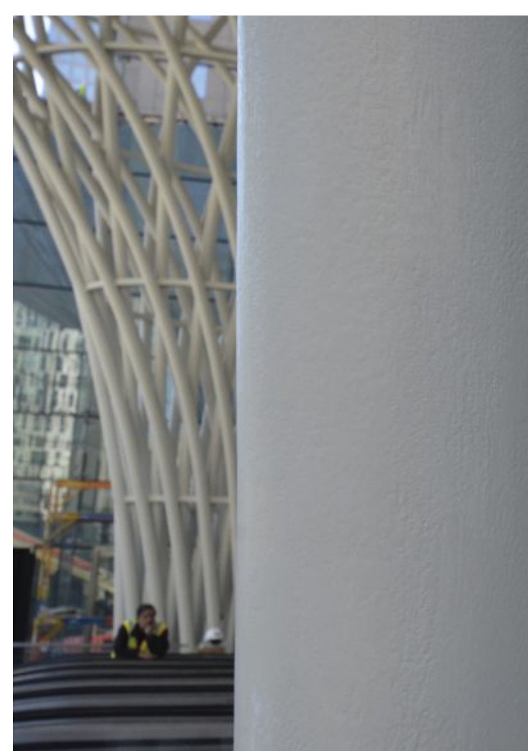
The aesthetic agenda of some projects obviates the need for weld remediation. When using galvanized or weathering steel in an AESS application, the rugged appearance allows for good quality welds to be left "as is." The complexity of the steel pictured here will push it to AESS 3. Connections within the elements have been welded, and splice connections between the elements are using custom discreet bolted connections for faster site assembly.

Determining Factors

So how do you determine whether weld grinding is warranted? Start with a visual mock-up, which is a requirement for AESS 3 and 4. This mock-up should be used to determine the expectations of the welds' appearance and the approach to fabrication, and can help fix the project's cost and eliminate change orders, disputes and delays.

Remember, the word "appearance" is the key factor here. After all, AESS is typically driven by aesthetics. While the designer may want welds to *look* continuous, they don't necessarily have to *be* continuous. As a matter of fact, continuous welds should be

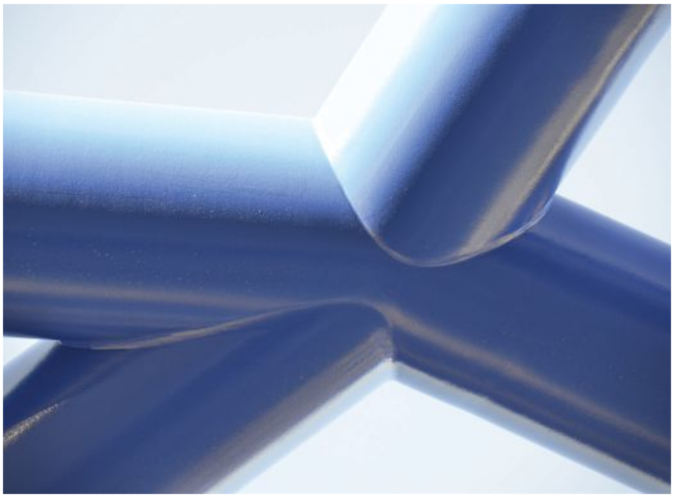
above: Details like as this typical AESS 3 pin connection will always require weld remediation. The parabolic cut in the tube where it is attached to the plate insert will need to be remediated to create a smooth-looking taper.



below: The curved steel HSS diagrid basket columns at Brookfield Place in New York City were carefully fabricated and detailed to AESS 4, as the material is very much within public view. An intumescent coating system was used for fire protection.

specifically ruled out many cases since they can cause deformation of the steel. In addition, it is acceptable to use body filler between stitch welds to provide a continuous appearance. Once the welds are primed and painted, the appearance is the same as ground welds, but the costs are very different.

Hollow structural sections (HSS) present an interesting scenario in that nearly all HSS has a weld seam. For round sections, grinding can be difficult and remediation might also be necessary to fill gouges caused by the grinding wheel. AESS 3 specifies that the weld seam on a HSS be simply oriented away from view—



above, right: In order for the HSS-to-HSS connections on this canopy to achieve a precise final appearance, pre-planned weld remediation was necessary. The steel is situated low enough for visual scrutiny.

Although this project required significant custom plate work to create its curved box elements, fillet welding was used and weld grinding avoided. The simple inset of the plate provided space for the weld and created an attractive shadow line in the detail.

A seamless appearance was essential for the visual success of the connection between these two HSS sections. The result would have been improved had the weld seam on the right-hand section been oriented away from view and towards the window.

no grinding necessary. If the structure is viewable from all angles, then the least viewed angle is chosen. AESS 4 also allows for HSS weld seams to be oriented away from view, though grinding and filling are allowed under this category. Typically, AESS 4 projects make greater use of custom steel and plate material, so HSS is not specified as routinely in this category as it is in AESS 3 projects.

As for grinding welds at member-to-member connections and splices, this is permitted under AESS 3 and 4, but may not actually be required. It depends on the aesthetic expectations and the texture and complexity of the steel components.

In addition, consider that AESS 3 allows for the option of using all welded connections. In many instances, particularly for splices being performed on-site, welded connections are more time-consuming and the use of hidden or discreet bolted connections may be better suited for a particular project's erection process. Such connections can be made to look visually trim and adhere to the desired aesthetic goals but might obviate the need for extended site welding and its associated expenses. (See the March 2016 article "The Splice is Right," available at **www.modernsteel.com**, for more information.)

A final consideration is that AESS 4 requires welded connections to be contoured and blended, which is appropriate for a category that typically involves highly customized components, including large custom castings. Castings in particular often require extensive grinding and surface remediation to soften the rough "orange peel" finish, a natural byproduct of the casting process, in order to better blend the surface characteristics with adjacent hot-rolled steel material.

At the end of the day, grinding for remediation purposes should be reviewed on a case-by-case basis. And in all instances, it should be reserved for AESS 3 and 4 only. The above guidelines can help you determine whether grinding your AESS 3 or 4 elements is necessary, and I'll cover more considerations in my session at NASCC: The Steel Conference. And remember: Any and all AESS advice is much more helpful when you plan ahead! So sit down with the entire team as early in the design stage as possible and decide on the best approach for your AESS project. ■

This article is a preview of the session "Architecturally Exposed Structural Steel (AESS): Communicating for Success" at the 2019 NASCC: The Steel Conference, taking place April 3-5 in St. Louis. For more information and to register, visit ***www.aisc.org/nascc****.*

And for everything you always wanted to know about AESS (*but were afraid to ask), see "Maximum Exposure" in the November 2017 issue, available at* ***www.modernsteel.com****.*

conference preview

DETERMINING DRIFT

A look at residual drift and post-earthquake residual fatigue life of buckling restrained braces.

BY BRANDT W. SAXEY, SE,
CURT HASELTON, PE, PHD,
AND CHIA-MING UANG, PHD

BUCKLING-RESTRAINED BRACED FRAMES (BRBFs) have become a popular seismic force-resisting system since being incorporated into AISC's *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341, **www.aisc.org/specifications**) and ASCE 7 in 2005.

BRBFs designed in accordance with these provisions are expected to provide significant inelastic deformation capacity primarily through the buckling-restrained brace (BRB) element within the frame. Under seismic loading, the steel core of the BRB yields in tension and develops a higher-mode local buckling in compression to also force steel yielding, allowing the BRB to harness the inherent ductility of the steel core.

While BRBs offer a high level of ductility and energy dissipation, there are two key issues that engineers should consider when implementing them:

1. How will the BRB affect the building performance during an earthquake, including the level of residual drifts to be expected after the earthquake (i.e., will the building lean too much)?
2. How can the remaining life of the BRB's steel core be determined such that a decision can be made on whether the BRB must be replaced after such an event?

BRB Impact, During and Following an Earthquake

Addressing the first question, the seismic performance of BRBF buildings can be quantitatively assessed using the new FEMA P-58 risk assessment method. This method quantifies the benefits of the high inelastic deformation capacity of the BRB and the resulting low likelihood that they will need to be replaced after an earthquake. The FEMA P-58 method also accounts for the effects of residual drifts and whether a building will need to be demolished after the earthquake because it is simply leaning over too much. This has been the topic of a one-year analytical study that quantifies the residual drifts of BRBF buildings, with the results indicating that residual drifts can be minimized by keeping the peak drifts low (which naturally occurs with BRB designs), relying on the restoring force of the gravity system (which is always present) and potentially on moment-resisting connections of the beams to columns within the BRBF (if desired to further reduce the residual drifts).

Residual drift reductions beyond what FEMA P-58 would have predicted are shown in Figure 1, which shows that the BRBF residual drifts are typically lower than the FEMA P-58 generic defaults (by as much as a factor of 2). These updated residual drift models are implemented and automated in analysis tools such as the Seismic Performance Prediction Program (SP3) software that enables rapid FEMA P-58 risk analysis by practicing engineers.

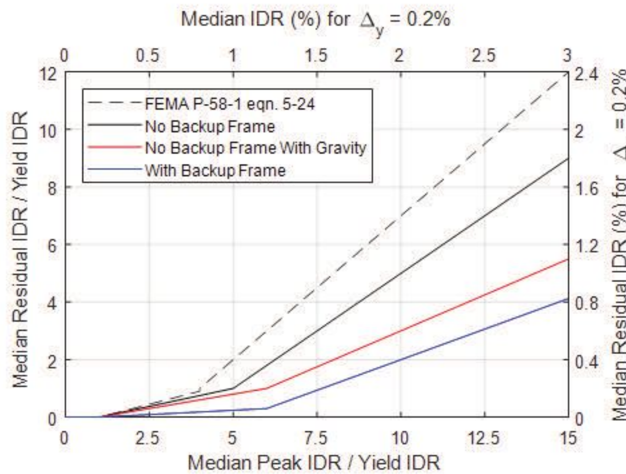


Figure 1. FEMA P-58-based residual drift models for BRB buildings.

Assessing the Aftermath

Addressing the second question involves determining the amount of brace inelastic deformation capacity used up by an earthquake such that a decision can be made as to whether a BRB needs to be replaced. To answer this question, a second study was conducted involving a series of low-cycle fatigue tests of full-scale BRBs to develop a fatigue life assessment model for BRBs. This model aims to quantify the fatigue capacity of the BRBs so that remaining capacity after a seismic event can be determined.

Three sets of four nominally identical BRB specimens were tested at the University of California, San Diego. The three sets had incrementally larger core cross-sectional areas (A_{sc}) with expected yield strengths (P_{ye}) of 250, 500 and 750 kips, respectively. Within each set, three braces were tested to fracture with constant-amplitude cyclic tests of ±0.25%, ±0.75% and ±2.0% core strains (one level for each of the three BRB specimens). Table 1 depicts the test matrix and Figure 2 shows the sample hysteretic responses of one set of specimens.

Table 1. Test matrix.

Test Specimen		BRB Properties				Constant Strain Amplitude (in./in.)	Variable Amplitude Tests
		Core Steel	A_{sc} (in.^{2})	P_{ye} (kips)	L_b (in.)		
A Series	A1	A36	5.66	250	215-5⁄8	0.25%	
	A2					0.75%	
	A3					2.00%	
	A4					–	Modified AISC Protocol
B Series	B1	A36	11.21	500	215	0.25%	
	B2					0.75%	
	B3					2.00%	
	B4					–	Simulated Earthquake
C Series	C1	A36	17.26	750	213-9⁄16	0.25%	
	C2					0.75%	
	C3					2.00%	
	C4					–	Simulated Earthquake

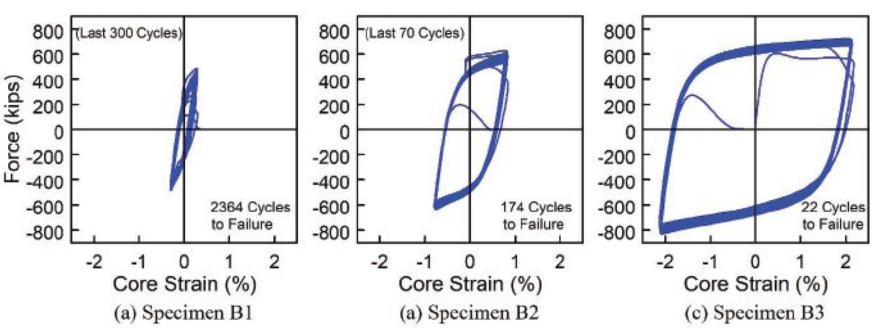


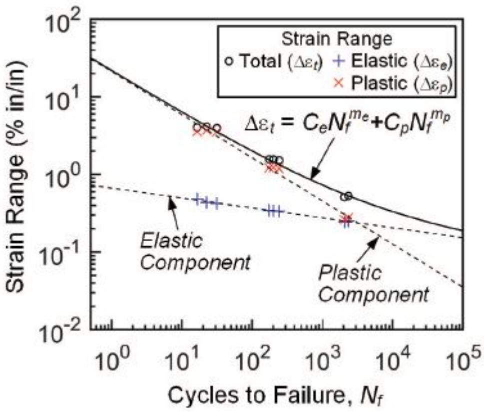
Figure 2. Hysteretic responses of B-series specimens.

The constant-amplitude test results were used to establish a fatigue life assessment model. For each half cycle of the hysteresis loop, the total strain range ($\Delta\varepsilon_t$) was separated into the elastic ($\Delta\varepsilon_e$) and plastic ($\Delta\varepsilon_p$) components. Considering the test results of all nine specimens, Figure 3 (page 60) shows that the relationship between the elastic strain range and the number of cycles to failure (N_f) could be approximated by a linear relationship using a log-log plot. The same linear trend was also observed between the plastic strain range and the number of cycles to failure. Regression analyses were conducted to establish the relationships between both the elastic and plastic strain ranges and the number of cycles to failure—and from this, a fatigue model relating the total strain range to the number of cycles to failure was developed.

The fourth BRB in each set was subjected to a variable strain amplitude test, which was used to verify the effectiveness of the fatigue model that had been created. One specimen was tested with a modified AISC loading protocol repeatedly until fracture. Two other specimens were subjected to simulated earthquake responses, and this process was repeated until fracture. The simulated MCE-level

Brandt Saxey (**brandt.saxey@corebrace.com**) is technical director of CoreBrace, LLC (an AISC member and certified fabricator) in West Jordan, Utah; **Curt B. Haselton** is the John F. O'Connell Endowed Professor at California State University Chico and the CEO of Haselton Baker Risk Group; and **Chia-Ming Uang** is a professor of structural engineering at the University of California, San Diego.

Zac Vidmar, a senior engineer with CoreBrace, **Edward Almeter**, a research engineer at Haselton Baker Risk Group, and **Chao-Hsien Li** and **Matthew Reynolds**, both graduate student researchers at the University of California, San Diego, all contributed to this article.



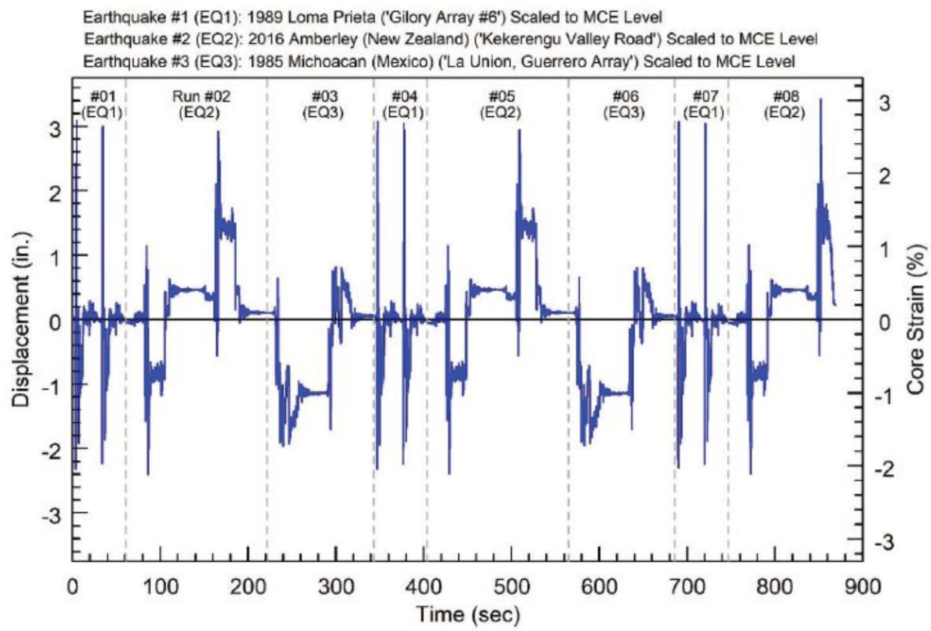


Figure 3, above. Constant-amplitude test results.

Figure 4, right. Sample test results from simulated earthquake responses.

BRB responses were generated from nonlinear response analyses of a four-story BRBF building, and it should be noted that each of the tested BRB specimens survived the simulated response more than 10 times. An example of the simulated earthquake responses of one of the specimens is shown in Figure 4.

The rain-flow counting method was employed for the variable-amplitude tests, and the test results showed that the proposed fatigue model, together with the Miner's damage index (a commonly used cumulative damage model for fatigue failures), could satisfactorily assess the remaining fatigue life of BRBs under earthquake-generated loading. Thus, if the deformation of a BRB subjected to a seismic event is known (through the use of building instrumentation or other means), the methodology can be used by practicing engineers to assess the remaining life of a BRB to a reasonable accuracy.

A Reliable System

Both studies have confirmed that a BRBF is a reliable seismic force-resisting system. The analytical study involving a new FEMA P-58 risk assessment method showed that BRBFs can have much lower residual drifts than the FEMA default values—and also identified methods for reducing residual drifts. And the low-cycle fatigue testing of full-scale BRBs established a procedure that allows engineers to assess the remaining life of BRB. We'll provide a comprehensive review of both studies at our 2019 NASCC: The Steel Conference session. ■

*This article is a preview of the session "Seismic Risk Assessment of Buckling Restrained Braces–Including Evaluation of Brace Residual Capacity and Building Performance" at the 2019 NASCC: The Steel Conference, taking place April 3-5 in St. Louis. For more information and to register, visit **www.aisc.org/nascc**.*

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For more information, visit **www.controlledautomation.com** or call 501.557.5109.

NASCC

2019 NASCC: The Steel Conference Features Daily Keynotes, Women Who Weld Workshops

If you're involved with designing or constructing of steel buildings or bridges, NASCC: The Steel Conference is the premier opportunity to immerse yourself in the latest design concepts, construction techniques and cutting-edge research while engaging with thousands of industry professionals. Taking place April 3-5 in St. Louis, it will offer nearly 150 sessions on topics ranging from properly specifying welds to connection design to tackling the skilled trade shortage.

The conference also features an extraordinary keynote speaker on each day:

On Wednesday, April 3, **Ozan Varol**, from Lewis and Clark Law School will talk about "The Power of Contrarian Thinking." Varol's articles and keynotes on contrarian thinking have been a smash hit with everyone from Silicon Valley entrepreneurs to New York Times best-selling authors. In this talk, Ozan will explain how you can cultivate extraordinary thinking to produce extraordinary results in your life and business.

On Thursday, April 4, **Jon D. Magnusson** of Magnusson Klemencic Associates will speak on "The Joy of Steel...So Many Possibilities." The most important discovery of this personal journey is that while it may appear to be about steel, it is really about people—people working together to create incredible structures.

On Friday, April 5, **Ronald D. Ziemian** from Bucknell University will give the T.R. Higgins Lecture: "Structural Stability – Letting the Fundamentals Guide Your Judgment." The primary objective of this lecture is to show how most stability problems can be understood by focusing on the big picture rather than on the details of the seemingly complex mathematics.

The Steel Conference will also include two "Women Who Weld Workshops." These half-day introductory workshops are for women interested in learning the basics of MIG welding. Women Who Weld is a nonprofit organization that teaches women how to weld and find employment in the welding industry. The first day's workshop will be comprised of female conference attendees and the second one will feature women from the local St. Louis area.

In addition, don't miss out on two exciting networking events being offered at the conference: the welcome reception in the exhibition hall and the conference dinner at the Anheuser-Busch Brewery.

To register for the conference and peruse the Advance Program, visit **www.aisc.org/nascc**.

Ozan Varol

Jon D. Magnusson

Ronald D. Ziemian

People and Companies

- **Magnusson Klemencic Associates (MKA)** has announced three principal promotions for 2019: **Farshad Berahman, CEng, PhD**, leads the firm's High-Rise Structures Technical Specialist Team, improving its capabilities in tall building design with wind and seismic engineering advancements; **Sean Clifton, SE, PE**, is a key member of the company's Residential and Hotel Specialist Group with extensive experience in residential, hospitality and large mixed-use developments; and **Danya Mohr, SE, PE**, is a key member of the Retail/Mixed-Use Specialist Group and draws upon his education as an architectural engineer to bring a synergistic approach to the integration of architecture and structural design.

- **SmithGroup** has promoted **John Kretschman, PE**, **David Vernellis, PE**, and **John Tran, AIA**, to vice president. Kretschman, who joined the firm in 1999, continues in his current role as director of operations for the Madison, Wis., office. Vernellis joined the firm in 2000 and will continue in his role as director of operations for the Phoenix office. Tran, who joined the Phoenix office in 2014, will continue his role as a design principal.

- **Nucor Corporation** (an AISC member producer) has announced plans to build a state-of-the-art plate mill in the Midwest; the exact location is yet to be determined. The new mill is expected to be fully operational in 2022 and will be capable of producing 1.2 million tons of steel plate products for structural use per year. The project is expected to create approximately 400 full-time jobs.

news & events

SSBC

Student Steel Bridge Competition Underway; Seventeen Regional Events Lead to Finals in May

The bridge-building challenge has been thrown down, and hundreds of engineering students across the country have accepted. Regional competitions—17 in all, involving 600–700 students on approximately 200 school bridge teams—will soon be under way for this year's annual Student Steel Bridge Competition (SSBC), sponsored by AISC. Forty teams, comprised of the top few finishers from the regional competitions, will move on to the 2019 National Finals.

The annual competition challenges student teams to design and fabricate a scale-model steel bridge, then assemble it as quickly as possible; the bridges are also load tested and weighed. Each bridge must span approximately 20 ft, carry 2,500 lb and meet all other specifications of the competition rules. Bridges are judged not only on the structural requirements and construction speed, but also on aesthetics and economy.

Regional events will be held through March and April at the following schools:

- South Dakota State University (March 22–23)
- University of Tennessee, Knoxville (March 28–29)
- Louisiana Tech University (March 29)
- George Mason University (March 29–30)
- California Polytechnic State University, San Luis Obispo (April 5–6)
- North Carolina State University (April 5–6)
- University of Colorado at Boulder (April 5–6)
- Saint Martin's University (April 12)
- University of Oklahoma (April 12)
- University of Pittsburgh at Johnstown (April 12)
- University of Maine (April 12–13)
- Valparaiso University (April 12–13)
- The University of Akon (April 13)
- University of Michigan (April 13)
- Rochester Institute of Technology (April 19–20)
- University of Texas at San Antonio (April 26–27)
- New Jersey Institute of Technology (April 27)

Southern Illinois University in Carbondale, Ill., will host the finals for the first time, on May 31 and June 1. Every year, the competition is exciting and inspiring, and we invite you to join us for the 2019 edition! Visit **www.aisc.org/ssbc** for more information on the competition, including details on volunteer opportunities at the regional events.

advertiser index

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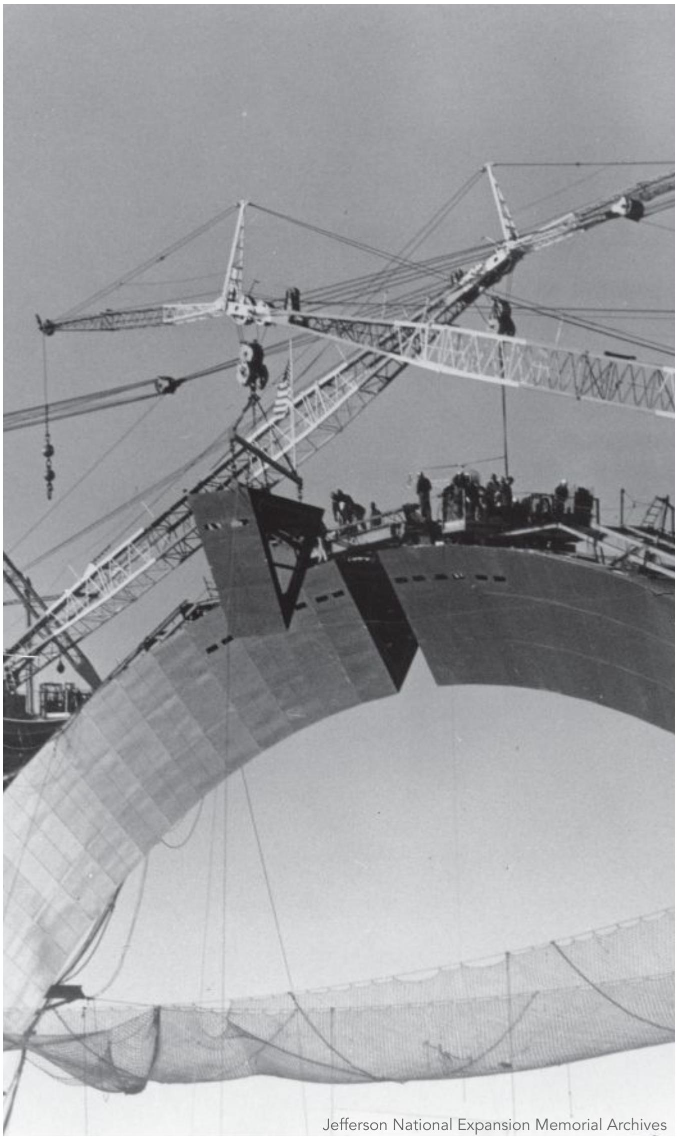

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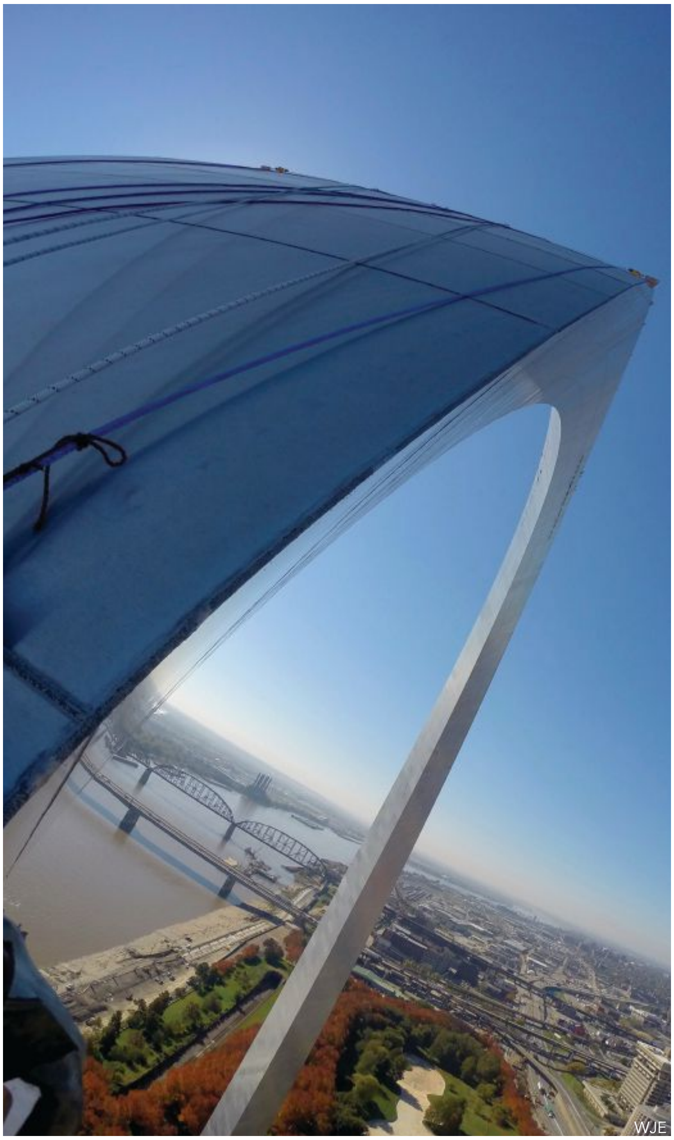

WJE

AN ALL-ACCESS ARCH PASS

ST. LOUIS' GATEWAY ARCH was built to commemorate the westward expansion of the nation. Designed by Eero Saarinen and Associates and Severud-Elstad-Krueger Associates, it is 630 ft high, with the two legs set 630 ft apart. Constructed between 1963 and 1965, the structure was erected using 143 triangular prefabricated double-wall carbon and stainless steel sections or "stations."

Over time, the exterior, stainless steel experienced different types of blemishes and staining, and Wiss, Janney, Elstner Associates, Inc., (WJE)—which specializes in investigating, analyzing, testing and developing repair methods for buildings and structures—was hired to determine the causes of these visual anomalies.

However, the Arch was built without easy access to the exterior skin except at grade and from an access hatch at the observation deck. WJE used aerial lifts to complete an up-close inspection of the stainless steel near the base, and designed a custom industrial rope system to facilitate inspection of the higher portions of the structure. This system allowed personnel to have hands-on access to the stainless steel skin without damaging it.

Want to learn more about this project—and see some amazing photos of the Arch, both recent and historic? Then check out our special NASCC: The Steel Conference issue, which will be available later this month. You can also learn more about it at the session "The Gateway Arch–Unique Perspectives" at the conference, which takes place April 3-5 in St. Louis (as well as pay a visit to the Arch itself). For more information and to register, visit **www.aisc.org/nascc**.

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